Attorney Docket: **5367-694P/CON\409926**

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Dated: July 17, 2017

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Transmitted herewith for filing is the utility patent application of:

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For: Organic-Light-Emitting Diode

Enclosed are:

- Transmittal letter
- Specification, Claims 1 to 18 & Abstract (182 pages)
- Application Data Sheet
- Copy of Executed Declaration and Power of Attorney (40 pp.) from prior application
- Sixty (60) Sheets of drawings (Figs. 1 to 65C)
- Information Disclosure Statement
- PTO Form SB/08A
- Copy of Notice of Recordation of Assignment Document from the Inventors to OSRAM OPTO SEMICONDUCTORS GMBH (the assignment of the parent application, U.S. Application Serial No. 13/139,514 filed on January 3, 2012 was recorded on November 29, 2011 at Reel/Frame 027296/0115, as indicated in the attached copies, and applies to this continuation application):
- Copy of Notice of Recordation of Assignment Document from the OSRAM OPTO SEMICONDUCTORS GMBH to OSRAM OLED GMBH was recorded on January 21, 2016 Reel/Frame 037567/0993, as indicated in the attached copies, and applies to this continuation application

"In the case of a division or continuation application, a prior assignment recorded against the original application is applied to the divisional or continuation application because the assignment recorded against the original application gives the assignee rights to the subject matter common to both applications" (see MPEP §306).

[x] To the extent not paid otherwise, the Commissioner is hereby authorized to charge payment of the following fees associated with this application or credit any overpayment to Deposit Account No. 503111.

[x] Any patent application processing fees under 37 CFR 1.17 for extension of time fees.

[x] Any filing fees under 37 CFR 1.16(h)(i) for presentation of extra claims.

[x] Priority is claimed for this invention from U.S. Application Serial No. 13/139,514 filed January 3, 2012 which claims priority under 35 U.S.C. 371 of International application No. PCT/DE2009/001741 filed on December 9, 2009, and of German application no. 10 2008 061 563.3 filed on December 11, 2008.

Respectfully submitted,
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PTO/SB/14 (08-12)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number 5367-694P/CON\409926
	Application Number
Title of Invention	Organic-Light-Emitting Diode

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

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☐ **An Address is being provided for the correspondence Information of this application.**	
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Application Information:

Title of the Invention	**Organic-Light-Emitting Diode**		
Attorney Docket Number	**5367-694PCON\409926**	**Small Entity Status Claimed** ***No***	
Application Type	***Regular***		
Subject Matter	***Utility***		
Total Number of Drawing Sheets (if any)	**60**	**Suggested Figure for Publication (if any)**	

Publication Information:

☐	Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐	**Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	• Customer Number	US Patent Practitioner	Limited Recognition (37 CFR 11.9)
Customer Number	27799		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

Prior Application Status			
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
This application is a	**Continuation**	13/139,514	2012-01-03
13/139,514	**371 of International**	PCT/DE2009/001741	2009-12-09

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b)

Application Number	Country	Filing Date (YYYY-MM-DD)	Priority Claimed
10 2008 061 563.3	**DE**	**2008-12-11**	[X] YES
			[] YES
			[] YES
			[] YES
			[] YES

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition

[]	This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization to Permit Access:

[] Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.1 4(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 1 19(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.
Applicant 1
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should beidentified in this section.

[x] Assignee	[ ] Legal Representative under 35 U.S.C. 117
[ ] Person to whom the inventor is obligated to assign.	[ ] Person who shows sufficient proprietary interest

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :	

If the Assignee is an Organization check here. [x]

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NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications					
Signature	/Thomas Langer/			Date (YYYY-MM-DD)	2017-07-17
First Name	Thomas	Last Name	Langer	Registration Number	27,264

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

ORGANIC LIGHT-EMITTING DIODE

RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Application Serial No. 13/139,514 filed January 3, 2012 which claims the priority under 35 U.S.C. 371 of International application No. PCT/DE2009/001741 filed on December 9, 2009. Priority is also claimed of German application no. 10 2008 061 563.3 filed on December 11, 2008. The entire contents of all these applications is hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] Organic light-emitting diodes and luminaires are described.

SUMMARY OF THE INVENTION

[0003] One object of the invention is to provide organic light-emitting diodes which can be used particularly diversely.

[0004] This and other objects are attained in accordance with one aspect of the present invention directed to an organic light-emitting diode comprising an organic layer sequence, a radiation exit area and an encapsulation. The organic layer sequence comprises at least one radiation-emitting region which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation. The radiation exit area is structured, so that the electromagnetic radiation has a directional emission profile. The encapsulation forms a seal of the organic layer sequence against environmental influences.

[0005] The organic light-emitting diodes described below can be, for example, organic light-emitting diodes which are transparent, emit on both sides, emit white light, emit colored light, emit infrared radiation, emit light diffusely,

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are rigid, are flexible and/or emit directional radiation. The luminaires can be, for example, luminaires which are used as an alarm clock, which form part of a shower cubicle, which form part of a shower head, which serve as solar protection, which serve as rain protection, which are provided for general lighting, which can be used in mobile fashion and/or which inherently combine a plurality of these functions.

[0006] Embodiments of organic light-emitting diodes described here are presented below. In this case, the embodiments of the organic light-emitting diodes can be combined among one another in any desired manner.

[0007] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a radiation-emitting region in which electromagnetic radiation is generated during the operation of the organic light-emitting diode.

[0008] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation.

[0009] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode emits infrared radiation during the operation of the organic light-emitting diode.

[00010] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode emits colored light during the operation of the organic light-emitting diode.

[00011] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic

light-emitting diode emits white light during the operation of the organic light-emitting diode.

[00012] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises at least one first charge carrier transport layer and at least one second charge carrier transport layer. By way of example, the organic light-emitting diode comprises a hole transport layer and also an electron transport layer as charge carrier transport layers.

[00013] In accordance with at least one embodiment of an organic light-emitting diode described here, a hole transport layer of the organic light-emitting diode comprises a matrix material that is p-doped.

[00014] In accordance with at least one embodiment of an organic light-emitting diode described here, an electron transport layer of the organic light-emitting diode comprises a matrix material that is n-doped.

[00015] In accordance with at least one embodiment of an organic light-emitting diode described here, a hole transport layer of the organic light-emitting diode comprises a matrix material and also a p-type dopant which has Lewis acid character or is a Lewis acid.

[00016] In accordance with at least one embodiment of an organic light-emitting diode described here, the matrix material and the dopant of at least one charge carrier transport layer of the organic light-emitting diode are chosen in such a way that the organic light-emitting diode gives a predetermined color impression in the switched-off operating state. That is to say that, through a suitable choice of matrix material and dopant, the organic light-emitting diode appears for example transparent, bluish, reddish, greenish or in some other color in the switched-off state. Furthermore, it

is possible for the organic light-emitting diode to appear white in the switched-off state. Furthermore, the organic light-emitting diode can appear in different colors when viewed from different sides.

[00017] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode has a hole transport layer comprising a matrix material and a dopant that form a charge transfer complex. In this case, the charge transfer complex has a first absorption spectrum. In this case, the hole transport layer has a predetermined color impression in the switched-off operating state of the organic light-emitting diode.

[00018] In accordance with at least one embodiment of the organic light-emitting diode, the organic light-emitting diode comprises at least one first electrode and at least one second electrode.

[00019] In accordance with at least one embodiment of the organic light-emitting diode, the organic light-emitting diode comprises at least one transparent electrode.

[00020] In accordance with at least one embodiment of an organic light-emitting diode described here, the transparent electrode is formed with a transparent conductive oxide (TCO).

[00021] In accordance with at least one embodiment of an organic light-emitting diode described here, the transparent electrode is formed with a thin, transparent metal layer.

[00022] In accordance with at least one embodiment of an organic light-emitting diode described here, the transparent electrode is formed with a transparent conductive oxide (TCO) and a thin, transparent metal layer.

[00023] In accordance with at least one embodiment of an

organic light-emitting diode described here, the transparent electrode is formed with a thin, transparent metal layer having a thickness of at least 1 nm and at most 50 nm.

[00024] In accordance with at least one embodiment of an organic light-emitting diode described here, at least one electrode of the organic light-emitting diode is configured in reflective fashion.

[00025] In accordance with at least one embodiment of an organic light-emitting diode described here, the reflectivity of at least one electrode of the organic light-emitting diode is at least 80%, particularly preferably at least 90%. The reflectivity has these high values preferably at least for electromagnetic radiation generated in the organic light-emitting diode during operation.

[00026] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode has an electrode comprising an LiF-containing layer on a side facing a radiation-emitting region of the organic light-emitting diode. Preferably, the electrode is then a cathode. By way of example, the electrode is in direct contact with the LiF-containing layer. For example, said LiF-containing layer completely covers the electrode at a main area, is in direct contact with the electrode and consists of LiF.

[00027] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a radiation-emitting region comprising at least one emission layer which contains an organic material. During operation of the organic light-emitting diode, electromagnetic radiation is generated in the at least one emission layer.

[00028] In accordance with at least one embodiment of an

organic light-emitting diode described here, a radiation-emitting region of the organic light-emitting diode comprises at least two emission layers which emit electromagnetic radiation in different or the same wavelength ranges during operation. By way of example, it is possible for one emission layer in the radiation-emitting region to emit colored light during the operation of the organic light-emitting diode. The other emission layer can be designed to emit infrared radiation. Furthermore, it is possible for all the emission layers of the radiation-emitting region to emit colored light. In this case, different emission layers can emit light of different colors, which is mixed for an external observer to form mixed light, for example white mixed light.

[00029] In accordance with at least one embodiment of an organic light-emitting diode described here, the light-emitting diode comprises in a radiation-emitting region at least one emission layer suitable for emitting light from the spectral range for infrared light.

[00030] In accordance with at least one embodiment of an organic light-emitting diode described here, the light-emitting diode comprises in a radiation-emitting region at least one emission layer suitable for emitting light from the spectral range for red light.

[00031] In accordance with at least one embodiment of an organic light-emitting diode described here, the light-emitting diode comprises in a radiation-emitting region at least one emission layer suitable for emitting light from the spectral range for blue light.

[00032] In accordance with at least one embodiment of an organic light-emitting diode described here, the light-emitting diode comprises in a radiation-emitting region at least one emission layer suitable for emitting light from the spectral range for green light.

[00033] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a first emission layer in the radiation-emitting region which emits red light, a second emission layer which emits green light, and also a third emission layer which emits blue light.

[00034] In this case, the emission layers can be arranged to form a layer stack in the radiation-emitting region of the organic light-emitting diode. The emission layer facing the anode contains, for example, a matrix material suitable for transporting holes. The emitter material is then introduced into the matrix material.

[00035] The emission layer facing a cathode of the organic light-emitting diode then preferably contains a matrix material suitable for transporting electrons, the emitter material being introduced into said matrix material.

[00036] The emission layer arranged between the other two emission layers then preferably contains both a material suitable for transporting holes and a further material suitable for transporting electrons. For this purpose, charge transporting layers respectively comprising a first and a second matrix material are preferably arranged between the emission layers. The first matrix material is then a hole transporting matrix material, and the second matrix material is an electron conducting matrix material.

[00037] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a radiation-emitting region having at least three emission layers which emit white mixed light during operation.

[00038] In accordance with at least one embodiment of an

organic light-emitting diode described here, the organic light-emitting diode is a transparent organic light-emitting diode. In this case, all the layers of the organic light-emitting diode are embodied in radiation-transmissive fashion.

[00039] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode is embodied in pellucid fashion. That is to say that electromagnetic radiation that passes through the organic light-emitting diode is hardly scattered or not scattered at all therein. If an organic light-emitting diode embodied in pellucid fashion in this way is placed for example onto a sheet of paper with printed text, then the text can still be read through the organic light-emitting diode. Preferably, at most 50% of the electromagnetic radiation passing through in the wavelength range of visible light is scattered and/or absorbed upon passing through the organic light-emitting diode. Particularly preferably, at most 25% of the electromagnetic radiation passing through in the wavelength range of visible light is scattered and/or absorbed upon passing through the organic light-emitting diode.

[00040] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode is embodied in radiation-transmissive fashion such that at least 50% of the radiation passing through is not absorbed in the organic light-emitting diode. Preferably, at least 75% of the radiation passing through is not absorbed in the organic light-emitting diode.

[00041] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode is an organic light-emitting diode which emits on both sides. That is to say that the organic light-emitting diode emits electromagnetic radiation from two radiation exit areas of the organic light-emitting diode during operation. The radiation exit areas can be arranged

parallel to one another. Preferably, a radiation-emitting region of the organic light-emitting diode is situated between the two radiation exit areas. In this case, the organic light-emitting diode can be embodied as radiation-transmissive or non-radiation-transmissive. The organic light-emitting diode can furthermore be suitable for emitting electromagnetic radiation having mutually different wavelengths from both radiation passage areas. By way of example, visible light can pass through one radiation passage area, whereas infrared radiation passes through the other radiation passage area.

[00042] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises at least one charge transporting layer which comprises a hole transporting matrix material and an electron transporting matrix material. The charge transporting layer is then suitable for transporting both holes and electrons.

[00043] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a radiation-transmissive electrode having a first layer composed of a first TCO material, a second layer, composed of a second TCO material, and also a third layer, which is arranged between first and second layers and is embodied as a transparent metal layer. In this case, the first and second TCO materials preferably differ from one another. The layers can directly adjoin one another. In this case, the thickness of the metal layer is, for example, between at least 1 nm and at most 50 nm, particularly preferably between at least 20 nm and at most 40 nm. The thin metal layer can be made so thin that it is netlike. In this case, it is possible that the first TCO layer and the second TCO layer can be situated in openings of the thin metal layer in direct contact with one another. In this case, the organic light-emitting diode can have, for example, an anode and/or a cathode embodied in each case in the layer

construction described. If both electrodes of the organic light-emitting diode are embodied in the manner described, then the organic light-emitting diode can be a radiation-transmissive, a transparent or a pellucid organic light-emitting diode. Furthermore, the organic light-emitting diode can then be an organic light-emitting diode which emits on both sides and which is not embodied as radiation-transmissive, but rather emits electromagnetic radiation through both electrodes.

[00044] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode has a different color expression in the switched-off operating state than in the switched-on operating state. By way of example, the organic light-emitting diode can appear bluish in the switched-off operating state, whereas it emits white light in the switched-on operating state. Furthermore, it is possible for the organic light-emitting diode to give a different color impression in each case from two main areas, for example from two radiation passage areas, in the switched-off state.

[00045] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode is a transparent organic light-emitting diode which emits on both sides and which appears colored from both emission sides in the switched-off operating state and emits white light in the switched-on state. In this case, the colored impression can be different at the two emission sides of the organic light-emitting diode. By way of example, the organic light-emitting diode can appear red from one side, whereas it appears blue from the other side.

[00046] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode is encapsulated. That is to say that the organic light-emitting diode has at least one encapsulation

which permits a seal of the functional layers of the organic light-emitting diode against environmental influences, such as moisture or atmospheric gases. The functional layers of the organic light-emitting diode are, for example, electrodes, charge carrier barrier layers, charge carrier transport layers and/or radiation-emitting layers such as emission layers.

[00047] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises at least one first carrier. The first carrier can be a rigid carrier. By way of example, the first carrier is then formed from a glass, from a ceramic material or a metal. Furthermore, the first carrier can be a flexible carrier. The first carrier is then formed for example from a film or from a laminate.

[00048] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a second carrier alongside a first carrier. In this case, the second carrier can be formed from the same materials as the first carrier. Furthermore, it is possible for the first and second carriers to be formed from different materials. At least one of the carriers is at least partly transmissive to electromagnetic radiation generated in the radiation-emitting region of the organic light-emitting diode.

[00049] In accordance with at least one embodiment of an organic light-emitting diode described here, the first carrier and the second carrier are formed with a glass. That is to say that the first carrier and the second carrier contain a glass or consist of a glass. By way of example, both carriers then consist of the same glass.

[00050] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises at least one carrier formed

with a borosilicate glass. The organic light-emitting diode can comprise two carriers, for example, which consist of this glass.

[00051] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises at least one carrier formed from a soda-lime glass. By way of example, the organic light-emitting diode then comprises two carriers consisting of this glass.

[00052] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a first carrier, which is embodied as radiation-transmissive, and a second carrier, which is embodied as non-radiation-transmissive. By way of example, the second carrier is embodied as reflective and/or absorbent for electromagnetic radiation generated in the radiation-emitting region of the organic light-emitting diode.

[00053] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a first carrier and also a second carrier. Functional layers of the organic light-emitting diode are arranged between first and second carriers. Furthermore, the first carrier and the second carrier are connected to one another by means of a connecting means, which laterally encloses the functional layers of the organic light-emitting diode and connects the two carriers to one another. In other words, the connecting means and the two carriers form a cavity, in which the functional layers of the organic light-emitting diode are arranged. The connecting means, the first carrier and the second carrier constitute the encapsulation or a part of the encapsulation of the organic light-emitting diode.

[00054] In accordance with at least one embodiment of an

organic light-emitting diode described here, the connecting means comprises a glass solder material. By way of example, the connecting means is formed by a glass solder material. The glass solder material can directly adjoin the first and/or the second carrier at least in places.

[00055] In accordance with at least one embodiment of an organic light-emitting diode described here, the connecting means comprises a glass frit material. By way of example, the connecting means is formed by a glass frit material. The glass frit material can directly adjoin the first and/or the second carrier at least in places.

[00056] In accordance with at least one embodiment of an organic light-emitting diode described here, the connecting means comprises an adhesive. By way of example, the connecting means is formed by an adhesive. The adhesive can directly adjoin the first and/or the second carrier at least in places.
[00057] In accordance with at least one embodiment of an organic light-emitting diode described here, both the first carrier and the second carrier are embodied as radiation-transmissive, transparent or pellucid. Such carriers are particularly well suited to the formation of radiation-transmissive, transparent or pellucid organic light-emitting diodes.

[00058] In accordance with at least one embodiment of an organic light-emitting diode described here, at least one part of the encapsulation for the functional layers of the organic light-emitting diode is formed by an insulation layer, which can contain at least one of the following electrically insulating materials: resist, epoxy resin, silicon oxide, silicon nitride. Alongside its properties for encapsulating the functional layers of an organic light-emitting diode described here, the insulation layer can also serve for electrically insulating the first electrode of the organic light-emitting diode from a second electrode of the organic

light-emitting diode.

[00059] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode has at least one thin-film encapsulation which forms at least one part of the encapsulation of the organic light-emitting diode. The thin-film encapsulation can produce a basic impermeability with respect to environmental influences, such as moisture and atmospheric gases, for the functional layers of the organic light-emitting diode. By way of example, the thin-film encapsulation is produced by applying oxide and/or nitride layers to functional layers of the organic light-emitting diode. The application can be effected by means of a PECVD method, for example.

[00060] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a diffusion barrier for the purpose of encapsulation. The diffusion barrier can be formed for example from an amorphous material, such as amorphous silicon dioxide, for example. The diffusion barrier can be applied by means of atmospheric pressure plasma, for example, to functional layers of the organic light-emitting diode and/or an insulation layer and/or a thin-film encapsulation.

[00061] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode has an encapsulation comprising at least one first layer embodied as thin-film encapsulation, and also a second layer embodied as diffusion barrier. Preferably, these two layers then directly adjoin one another at least in places, wherein, for example, the thin-film encapsulation is applied to functional layers of the organic light-emitting diode and the diffusion barrier is applied to the thin-film encapsulation.

[00062] In accordance with at least one embodiment of an

organic light-emitting diode described here, the organic light-emitting diode comprises a diffusion barrier having a thickness of at least 50 nm and at most 1000 nm, preferably of at least 100 nm and at most 250 nm.

[00063] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a diffusion barrier for the purpose of encapsulation, said diffusion barrier having at least two individual layers, wherein the individual layers are deposited one above the other. Preferably, each of the individual layers has a thickness of at least 50 nm and at most 100 nm. In this case, the diffusion barrier can be constructed from individual layers consisting in each case of silicon dioxide or alternately of silicon dioxide and silicon nitride.

[00064] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode has a resist layer for the purpose of encapsulation. The resist layer can be used for example as an alternative or in addition to a diffusion barrier.

[00065] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode has a layer stack composed of a resist layer and a thin-film encapsulation, which are used for sealing the functional layers of the organic light-emitting diode. By way of example, the resist layer is arranged directly onto the functional layers of the organic light-emitting diode. The thin-film encapsulation is then arranged directly on the resist layer. By way of example, the thin-film encapsulation then encloses the resist layer at all exposed areas of the thin-film encapsulation.

[00066] In accordance with at least one embodiment of an organic light-emitting diode described here, the encapsulation

of the organic light-emitting diode comprises a pre-encapsulation layer, which can serve as a planarization layer for a thin-film encapsulation of the organic light-emitting diode. By way of example, the pre-encapsulation layer is a transparent oxide or a radiation-transmissive adhesive. The pre-encapsulation layer can then cover a thin-film encapsulation in places, for example. Preferably, the pre-encapsulation layer then covers the thin-film encapsulation at all exposed outer areas of the thin-film encapsulation.

[00067] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises as encapsulation at least one first carrier and one second carrier which are connected to one another by means of a connecting means, which laterally encloses the functional layers of the organic light-emitting diode. At the same time, the encapsulation comprises between the two carriers at least one of the following layers or encapsulation possibilities: insulation layer, resist layer, pre-encapsulation layer, thin-film encapsulation layer, and/or diffusion barrier.

[00068] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises at least one encapsulation layer sequence having at least two encapsulation layers for the purpose of encapsulation. By way of example, the encapsulation layer sequence has at least one first encapsulation layer, which can be applied by means of plasma enhanced chemical vapor deposition. In this case, the first encapsulation layer can directly adjoin the functional layers of the organic light-emitting diode at least in places. Alternatively, the first encapsulation layer can be applied for example by means of deposition methods such as physical vapor deposition, sputtering or the like.

[00069] In accordance with at least one embodiment of an

organic light-emitting diode described here, the first encapsulation layer of the encapsulation layer sequence has a thickness of at least 50 nm, preferably at least 100 nm, particularly preferably of at least 1 µm.

[00070] In accordance with at least one embodiment of an organic light-emitting diode described here, the encapsulation layer sequence comprises at least one second encapsulation layer which can be arranged directly on the first encapsulation layer. That is to say that the second encapsulation layer can be in direct contact with the first encapsulation layer. By way of example, the second encapsulation layer covers the entire exposed outer area of the first encapsulation layer.

[00071] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a second encapsulation layer deposited onto a first encapsulation layer by means of atomic layer deposition for the purpose of encapsulation.

[00072] In accordance with at least one embodiment of an organic light-emitting diode described here, the second encapsulation layer has a thickness of at least 1 nm, preferably of at least 10 nm, and at most 30 nm.

[00073] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a first carrier encapsulated at least in places with the encapsulation layer sequence having a first encapsulation layer and a second encapsulation layer. The first carrier can be a flexible carrier, for example, which is formed by a plastic film or a laminate. That is to say that the encapsulation layer sequence can also be used for hermetically sealing carriers for functional layers of the organic light-emitting diode.

[00074] In accordance with at least one embodiment of an organic light-emitting diode described here, the entire organic light-emitting diode is covered with the encapsulation layer sequence all around. In this case, it is possible for the organic light-emitting diode to comprise a first carrier, a second carrier and also a connecting means, which form a first encapsulation for the functional layers of the organic light-emitting diode. The encapsulation layer sequence can then be arranged in places or completely at the exposed outer areas of first carrier, second carrier and/or connecting means. Furthermore, it is also possible for the functional layers additionally or alternatively to be sealed directly with the encapsulation layer sequence. That is to say that the functional layers of the organic light-emitting diode then directly adjoin the encapsulation layer sequence.

[00075] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises the encapsulation layer sequence having a first encapsulation layer and a second encapsulation layer for the purpose of encapsulation, wherein the first encapsulation layer and the second encapsulation layer each comprise an inorganic material, the first encapsulation layer is arranged directly on functional layers of the organic light-emitting diode, and the second encapsulation layer is arranged directly on the first encapsulation layer.

[00076] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises the encapsulation layer sequence having a first encapsulation layer, a second encapsulation layer and a third encapsulation layer for the purpose of encapsulation, wherein the third encapsulation layer is arranged directly on the functional layers of the organic light-emitting diode, the first encapsulation layer is arranged directly on the third encapsulation layer, the second

encapsulation layer is arranged directly on the first encapsulation layer, the first and second encapsulation layers each comprise an inorganic material, and the third encapsulation layer comprises an amorphous inorganic material. In this case, it is possible for the second and third encapsulation layers to be embodied identically.

[00077] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises the encapsulation layer sequence having a first layer and a second layer, wherein the first encapsulation layer and the second encapsulation layer each comprise an inorganic material, the second encapsulation layer is arranged directly on the first encapsulation layer, and the encapsulation layer sequence is hermetically impermeable at a temperature of greater than or equal to 60°C and at a relative air humidity of greater than or equal to 85% for longer than 500 hours.

[00078] In accordance with at least one embodiment of an organic light-emitting diode described here, the first encapsulation layer and the second encapsulation layer of the encapsulation layer sequence for encapsulating the organic light-emitting diode each have a volume structure, wherein the volume structure of the second encapsulation layer is independent of the volume structure of the first encapsulation layer. In this case, the volume structure of the second encapsulation layer preferably has a higher amorphicity than the volume structure of the first encapsulation layer. Particularly preferably, the second encapsulation layer is amorphous.

[00079] In accordance with at least one embodiment of an organic light-emitting diode described here, the second encapsulation layer of the encapsulation layer sequence comprising first encapsulation layer and second encapsulation layer has a thickness having a thickness variation which is

independent of a surface structure and/or a volume structure of the first encapsulation layer sequence. In this case, the thickness variation is preferably less than or equal to 10%.

[00080] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises an encapsulation layer sequence having a plurality of first encapsulation layers and a plurality of second encapsulation layers for the purpose of encapsulation, wherein the first and the second encapsulation layers are applied alternately one directly above another.

[00081] In accordance with at least one embodiment of an organic light-emitting diode described here, the encapsulation layer sequence completely encloses the functional layers of the organic light-emitting diode. In this case, the encapsulation layer sequence can also completely enclose a first and/or a second carrier.

[00082] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode has a first carrier and a second carrier, and also the encapsulation layer sequence arranged between first and second carriers, for the purpose of encapsulation.

[00083] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode has a first carrier and a second carrier and also a connecting means, which connects first and second carriers to one another, for the purpose of encapsulation. Furthermore, the organic light-emitting diode has the encapsulation layer sequence having at least two encapsulation layers, which covers and thus encapsulates an interface between the connecting means and the first carrier and/or the second carrier.

[00084] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic

light-emitting diode has a protective layer arranged between an organic layer sequence of the organic light-emitting diode and an electrode of the organic light-emitting diode. By way of example, said protective layer is a sputtering protective layer that protects the organic layer sequence against damage during the sputtering of electrode material onto the organic layer sequence.

[00085] In accordance with at least one embodiment of an organic light-emitting diode described here, the sputtering protective layer contains or consists of a transition metal oxide. In this case, the sputtering protective layer can be in direct contact with an electrode of the organic light-emitting diode and/or an organic layer of the organic light-emitting diode.

[00086] In accordance with at least one embodiment of an organic light-emitting diode described here, the light emitted through at least one radiation exit area of the organic light-emitting diode does not have a Lambertian emission characteristic. By way of example, this electromagnetic radiation then has a directional emission profile. That is to say that in this case the emission of electromagnetic radiation is not symmetrical, rather an intensified emission in the direction of a main emission direction takes place.

[00087] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode comprises a structured radiation exit area. By way of example, the radiation exit area of the organic light-emitting diode is structured into a multiplicity of prisms arranged parallel to one another. The radiation exit area can then have first areas and second areas, for example, wherein the first areas are inclined by a first angle relative to a plane running for example parallel to a main extension plane of the organic layer sequence of the organic light-emitting diode. The second areas are then inclined by second

angles relative to said plane.

[00088] By way of example, a carrier of the organic light-emitting diode is correspondingly structured in order to form the structured radiation exit area. Furthermore, it is possible for the encapsulation layer sequence, for example the second encapsulation layer to be correspondingly structured. Furthermore, it is also possible for a correspondingly structured layer to be applied for example on a carrier for the organic light-emitting diode or some other encapsulation for the organic light-emitting diode. That is to say that the structured radiation exit area can be formed by the structuring of an element of the encapsulation of the organic light-emitting diode. However, it is also possible for the structured radiation exit area, for example in the form of a further layer, to be applied as an independent element onto the encapsulation of the organic light-emitting diode.

[00089] In accordance with at least one embodiment of an organic light-emitting diode described here, the radiation exit area of the organic light-emitting diode is structured into a multiplicity of prisms arranged parallel to one another. In this case, the prisms preferably have macroscopic orders of magnitude in one direction. In this direction, the length of the prisms can be at least 1 cm, preferably at least 1 decimeter. In a direction perpendicular thereto, the prisms can have an order of magnitude which is in the submillimeters range, such that no diffraction effects can occur at the prisms in this direction. By way of example, the length of the prisms in this direction is 500 µm or less.

[00090] In accordance with at least one embodiment of an organic light-emitting diode described here, an irradiation exit area of the organic light-emitting diode is structured into a multiplicity of first areas and second areas, wherein the first areas are embodied as radiation-transmissive and the second areas are embodied as reflective. In this way,

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electromagnetic radiation can leave the radiation passage area only through the first areas. As a result, a directional emission is effected through the first radiation passage area, in a manner dependent on the first angle by which the first areas are inclined.

[00091] In accordance with at least one embodiment of the organic light-emitting diode, the organic light-emitting diode is an organic light-emitting diode which emits on both sides and which has two radiation passage areas arranged at opposite sides of the organic light-emitting diode. In this embodiment, it is possible for both of the radiation exit areas to be structured in the manner described. That is to say that directional electromagnetic radiation is then emitted by the organic light-emitting diode through both radiation exit areas. Furthermore, it is also possible, however, for only one of the radiation exit areas to be structured in the manner described. Electromagnetic radiation having a Lambertian emission characteristic is then emitted by the organic light-emitting diode from the other radiation exit area, for example.

[00092] In accordance with at least one embodiment of an organic light-emitting diode described here, for the purpose of generating directional electromagnetic radiation, a radiation exit area of the organic light-emitting diode is not structured, rather for example the top side of a carrier of the organic light-emitting diode, to which carrier the functional layers of the organic light-emitting diode are applied, is structured. By way of example, the carrier is then structured into a multiplicity of parallel prisms having first areas and second areas, which are arranged in a manner tilted with respect to one another. The functional layers can then be applied to the first and/or to the second areas at the top side of the carrier. In this case, it is possible that functional layers which are arranged on different areas can be driven separately from one another. It is thus possible to realize for example an organic light-emitting diode which

alternately emits electromagnetic radiation in two different main extension directions. In a simple case, the separate drivability can be achieved by virtue of at least one electrode of the organic light-emitting diode not being arranged continuously over the entire organic layer sequence, but rather being separated into regions corresponding to the individual areas of the structured carrier. By means of the angle that the areas of the structured carrier form with one another and also the basic area of the respective areas it is possible to set a specific desired emission characteristic, that is to say a desired emission direction and emission intensity of the electromagnetic radiation generated by the organic light-emitting diode during operation.

[00093] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode is provided for illuminating an area to be illuminated, on which the organic light-emitting diode is fixed at least indirectly. That is to say that the organic light-emitting diode is arranged at least indirectly on an element to be illuminated having an area to be illuminated. In this case, the organic light-emitting diode can be adhesively bonded onto the element to be illuminated by means of a transparent adhesive, for example. Other fixing methods such as hook and loop fasteners, screw connections, clamping connections, press-fit connections or the like are also possible. The organic light-emitting diode is preferably embodied as transparent or pellucid at least in places, such that, in the switched-off state, the area to be illuminated can be discerned through the organic light-emitting diode. The area to be illuminated can be, for example, the surface of a tile, of a poster, of a slab, of a traffic sign, of an information board, of a sign, of an image, of a mirror, of a glass pane, or of any other element.

[00094] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic

light-emitting diode is designed for illuminating an area to be illuminated, wherein the organic light-emitting diode emits during operation a first component of electromagnetic radiation, which passes toward the outside directly from the radiation-emitting region of the organic light-emitting diode without impinging beforehand on the area to be illuminated. Furthermore, the radiation has a second component, which, before emerging from the organic light-emitting diode, impinges on the area to be illuminated and has been at least partly reflected by the latter.

[00095] In accordance with at least one embodiment of an organic light-emitting diode described here, the relative ratio of the intensities of the two radiation components mentioned, that is to say of the intensities of indirectly emerging electromagnetic radiation and directly emerging electromagnetic radiation, can be set and chosen by means of an optical cavity and/or by means of first electrodes and second electrodes of the organic light-emitting diode that are set with different degrees of transparency.

[00096] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode is a transparent or pellucid organic light-emitting diode arranged on an area to be illuminated of an element to be illuminated, wherein the area to be illuminated is visible through the organic light-emitting diode in the switched-off state of the organic light-emitting diode. In the switched-on state, the intensity of the directly emitted electromagnetic radiation in comparison with the indirectly emitted electromagnetic radiation can then be chosen to be so great that the area to be illuminated is no longer discernible. That is to say that the organic light-emitting diode can be switched from a transparent operating state to a luminous operating state in which an area arranged behind the organic light-emitting diode is no longer discernible. Such an intensity distribution can be achieved by

means of an optical cavity, for example.

[00097] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode is a transparent organic light-emitting diode wherein an electrically switchable optical element is arranged at a radiation exit area. The electrically switchable optical element is, for example, an electrically switchable diffuser or an electrochromic material. Such an arrangement of organic light-emitting diode and electrically switchable element can be used for example in conjunction with an element to be illuminated, wherein the element to be illuminated can be, for example, a mirror or a transparent element such as a glass plate. By means of the electrically switchable optical element, such an arrangement can be switched for example from transparent to opalescent. In this way, a concealing screen that can be switched on and off can be realized, for example, which can also be utilized as a luminaire.

[00098] In accordance with at least one embodiment of an organic light-emitting diode described here, the electrically switchable optical element is embodied in structured fashion. That is to say that the electrically switchable optical element is applied in a specific pattern, for example, to a radiation exit area of the organic light-emitting diode. In this way, by way of example, information or a decoration can be inserted into the beam path of the organic light-emitting diode upon the electrically switchable optical element being switched on and can be masked out again upon the electrically switchable optical element being switched off.

[00099] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode is embodied at least as radiation-transmissive and is arranged with one of its radiation exit areas on a reflective optical element such as a mirror or a retroreflector.

[000100] In accordance with at least one embodiment of an organic light-emitting diode described here, the organic light-emitting diode is embodied in radiation-transmissive fashion and arranged with one of its radiation exit areas on a reflective optical element such as mirror or a retroreflector. Furthermore, a color filter is arranged at the opposite radiation exit area of the organic light-emitting diode. The color filter has, for example, a high transmission for a first spectral subrange of the visible wavelength spectrum and high absorption for a second spectral subrange of the visible wavelength spectrum. An intensity maximum of the electromagnetic radiation generated by the organic light-emitting diode during operation lies within the first spectral subrange transmitted by the color filter. Advantageously, that proportion of the ambient light which is reflected back from the reflective element to the radiation exit area and is coupled out from the organic light-emitting diode in this way produces substantially the same color impression as the light emitted by the organic light-emitting diode.

[000101] In accordance with at least one embodiment, an organic light-emitting diode described here comprises a reflective layer which reflects electromagnetic radiation impinging on the light-emitting diode from outside back in the direction of the radiation exit area of the organic light-emitting diode. The organic light-emitting diode furthermore comprises, at the radiation exit area, a color filter, such that the organic light-emitting diode brings about the same color impression independently of the operating state. That is to say that the organic light-emitting diode has the same color impression in the switched-off operating state as in the switched-on operating state.

[000102] In accordance with at least one embodiment of an organic light-emitting diode described here, a touch sensor is integrated into the organic light-emitting diode. By way of

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example, the touch sensor is a capacitively or resistively operating touch sensor. That is to say that the organic light-emitting diode forms for example a light source and simultaneously an operating element.

[000103] Luminaires are specified below which are provided for example for general lighting or as lights in road traffic. In this case, the luminaires can comprise organic light-emitting diodes described here as light sources. The luminaires can furthermore comprise any combination of organic light-emitting diodes described as light sources. Furthermore, it is also possible to combine the luminaires described here or elements of the luminaires described here to form further luminaires.

[000104] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises at least one organic light-emitting diode in accordance with at least one embodiment described here.

[000105] In accordance with at least one embodiment of a luminaire described here, the luminaire is designed for general lighting and furthermore has a wake-up function. That is to say that the luminaire can be operated in the manner of an alarm clock in one operating state of the luminaire.

[000106] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises a driving device, by means of which an activation time – for example a wake-up time – can be set by the user of the luminaire. At said activation time, the luminaire then starts to emit light.

[000107] In accordance with at least one embodiment of a luminaire described here, the luminaire is designed for general lighting and as an alarm clock, wherein the luminaire comprises at least one transparent, pellucid organic light-emitting diode in accordance with at least one of the previous

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embodiments. The organic light-emitting diode can be arranged, for example, in front of an area to be illuminated, which is visible through the organic light-emitting diode in the switched-off operating state of the luminaire.

[000108] In accordance with at least one embodiment of the luminaire, the luminaire comprises a driving device, which, starting from a specific activation time, increases the light intensity of the light emitted by the luminaire, for example continuously.

[000109] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises a driving device, which is designed to increase, starting from an activation time, the light intensity of the light emitted by the luminaire in steps, wherein for predeterminable times, the luminaire generates light having a constant light intensity, which is increased in predeterminable time intervals.

[000110] In accordance with at least one embodiment of a luminaire described here, the luminaire is designed to generate light having a light intensity of between zero and at least 1000 cd, preferably at least 5000 cd, particularly preferably at least 10 000 cd. By way of example, for this purpose the luminaire comprises at least one organic light-emitting diode having a phosphorescent emitter material in its radiation-generating region. The organic light-emitting diode can also comprise fluorescent emitter materials in its radiation-generating region, in addition to the phosphorescent emitter material.

[000111] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises at least one touch-sensitive operating element which can be operated by the user of the luminaire by means of a touch sensor. The operating element can be arranged for example in a radiation exit area of the luminaire. Particularly preferably, an

organic light-emitting diode in accordance with at least one of the previous embodiments which has an integrated touch sensor is employed for forming the touch-sensitive operating element.

[000112] In accordance with at least one embodiment of the luminaire, the luminaire can be operated by means of a remote control. By way of example, the remote control can exchange information with the luminaire by means of radio or infrared radiation.

[000113] In accordance with at least one embodiment of the luminaire, the luminaire is subdivided into a multiplicity of segments. By way of example, different segments can be suitable for generating electromagnetic radiation having different wavelengths.

[000114] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises a driving device, which is designed to increase the color temperature of the light emitted by the luminaire continuously or in steps.

[000115] In accordance with at least one embodiment of the luminaire, the luminaire is designed to generate light, preferably white light having color temperatures of at least 4000 K to color temperatures of at most 25 000 K.

[000116] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises a driving device, which is designed to increase the light intensity and also the color temperature of the light generated by the luminaire during operation in steps or continuously, wherein the light intensity is increased, for example, as the color temperature is increased.

[000117] In accordance with at least one embodiment of a luminaire described here, the luminaire is designed to

simulate a sunrise in time-lapse fashion. That is to say that, starting from a specific start time, the luminaire generates white light, in the case of which the color temperature is increased continuously or in steps from at least 4000 K to at most 25 000 K, wherein the light intensity is simultaneously increased from 0 cd to a maximum of 10 000 cd. In this case, the rise in the color temperature can take place at the same time or independently of a rise in the light intensity.

[000118] In accordance with at least one embodiment of a luminaire described here, the luminaire serves as a splash guard alongside its use as a light for general lighting. By way of example, the luminaire forms the part of a shower cubicle. Thus, the luminaire can form the part of a wall of a shower cubicle or can be arranged on a wall of the shower cubicle. Furthermore, it is possible for the luminaire to form the wall for the shower cubicle.

[000119] In accordance with at least one embodiment of the luminaire, the luminaire comprises at least two carriers between which at least one organic light-emitting diode or functional layers of an organic light-emitting diode are arranged. In this case, preferably at least one of the carriers is embodied such that it scatters light diffusely, with the result that the luminaire is not pellucid, but rather also serves as a concealing screen.

[000120] In accordance with at least one embodiment of the luminaire, the luminaire comprises at least one organic light-emitting diode having at least one double encapsulation. In this case, double encapsulation means that at least two of the possibilities described here for encapsulating an organic light-emitting diode are used in combination in order, in this way, to obtain a particularly well hermetically sealed organic light-emitting diode.

[000121] In accordance with at least one embodiment of the

luminaire described here, the luminaire is designed to come directly into contact with water.

[000122] In accordance with at least one embodiment of a luminaire described here, the luminaire is designed to be adhesively bonded in the sense of a transfer onto the wall of a shower cubicle.

[000123] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises at least one inorganic light-emitting diode as light source of the luminaire.

[000124] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises at least one organic light-emitting diode as light source and also at least one inorganic light-emitting diode as light source.

[000125] In accordance with at least one embodiment of a luminaire described here, the luminaire has at least one carrier formed with a radiation-transmissive material suitable for guiding light. By way of example, the carrier is a glass plate.

[000126] In accordance with at least one embodiment of a luminaire described here, at least one inorganic light-emitting diode is arranged at the carrier of the luminaire, said carrier being embodied as an optical waveguide, said at least one inorganic light-emitting diode coupling electromagnetic radiation into the optical waveguide. The electromagnetic radiation coupled in can, for example, be distributed in the optical waveguide and be emitted toward the outside by the latter over a large area.

[000127] In accordance with at least one embodiment of a luminaire described here, the luminaire has an operating state in which infrared radiation is generated. By way of example,

the infrared radiation is used for warming a user of the luminaire, for deicing a pane or for heating a moist environment. For example, by means of the infrared radiation, the user of a shower cubicle comprising the luminaire can be warmed and/or the shower cubicle can be dried by means of the infrared radiation after the conclusion of showering. In this case, the infrared radiation can be generated by at least one inorganic or by at least one organic light-emitting diode.

[000128] In accordance with at least one embodiment of the luminaire, the luminaire is suitable for emitting ultraviolet radiation during operation. By way of example, the ultraviolet radiation is generated by at least one inorganic light-emitting diode of the luminaire. In this case, the ultraviolet radiation can be used for tanning a user of the luminaire and/or for disinfecting the environment of the luminaire. By way of example, a luminaire embodied as a splash guard in a shower or integrated in a shower head can be used in this way.

[000129] In accordance with at least one embodiment of the luminaire, the luminaire is integrated in a shower or in a bath tub. By way of example, the luminaire forms a splash guard or is part of a shower head. The luminaire can then serve as an indicating device for the water temperature. By way of example, the luminaire can be suitable for emitting blue light, which indicates cold water. Furthermore, the luminaire can be suitable for emitting red light, which indicates hot water, and mixed colors comprising red and blue components for indicating warm water.

[000130] In accordance with at least one embodiment of a luminaire described here, the color locus, the light intensity and/or the color temperature can be adjustable by means of the mixing faucet of a water supply. For this purpose, the mixing faucet is connected to a driving device for the luminaire.

[000131] In accordance with at least one embodiment of the

luminaire, the luminaire can comprise a touch-sensitive operating element, by means of which, in addition to operating states of the luminaire, it is also possible to set the water temperature and/or the water pressure for example in a shower cubicle or in a bath tub.

[000132] In accordance with at least one embodiment of a luminaire described here, the luminaire serves as a light for general lighting and forms at least the part of a spray or shower head.

[000133] In accordance with at least one embodiment of a luminaire described here, the luminaire is in direct contact with water during operation. That is to say that, for example, water washes around a carrier of the luminaire. In this case, water can wash around the luminaire while the latter is in a switched-on operating state.

[000134] In accordance with at least one embodiment of a luminaire described here, the luminaire is in direct contact with water, wherein the water serves as an optical waveguide for the electromagnetic radiation generated by the luminaire. That is to say that the light generated by the luminaire during operation is at least partly coupled into at least one water jet in which it can propagate like in an optical waveguide. In this way it is possible – for example upon illumination of a multiplicity of water jets with different colors – to give the impression of a rainbow.

[000135] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises at least one organic light-emitting diode having an opening. In this case, the opening preferably extends continuously from one main side of the organic light-emitting diode to the opposite main side of the organic light-emitting diode. The opening can be closed at the edge with a connecting means such as a glass solder material or a glass frit. Furthermore, it is possible to

employ even further measures for sealing the organic light-emitting diode in the region of the opening, such as an encapsulation layer sequence, a thin-film encapsulation, a diffusion barrier or the like. Preferably, water flows through the opening in at least one operating state of the organic light-emitting diode. In this case, it is also possible for the organic light-emitting diode to have a multiplicity of openings through which water can flow during the operation of the organic light-emitting diode.

[000136] In accordance with at least one embodiment of a luminaire described here, the luminaire, alongside a light for general lighting, is a mirror and also a display device for displaying simple graphical elements. In this case, the luminaire can be used for example as a bathroom mirror or wardrobe mirror. The luminaire preferably has at least three operating states: a first operating state, in which the luminaire serves for general lighting and emits light, a second operating state, in which the luminaire actively emits no electromagnetic radiation and serves as a mirror, and also a third operating state, in which the luminaire displays simple graphical elements such as patterns or the like. In the third operating state, the luminaire can additionally serve as a mirror and/or for general lighting, wherein the emitted light intensity is then preferably reduced in comparison with the first operating state.

[000137] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises a structured electrically switchable element. The electrically switchable element is structured in accordance with a predetermined pattern, for example. If the electrically switchable optical element is operated in a switched-on electrical operating state, for example, the pattern to be represented is visible. The electrically switchable optical element is, for example, an electrically switchable diffuser or an electrochromic material. By way of example, the electrically switchable

optical element can be used in a luminaire serving for general lighting and as a mirror.

[000138] In accordance with at least one embodiment of a luminaire described here, the luminaire can be operated by means of gesture control. That is to say that the luminaire comprises an optical sensor, for example a camera, and also an evaluation circuit for evaluating the signals of the optical sensor. A switch-on, switch-off or other changes of operating states can then be effected by means of gesture control.

[000139] In accordance with at least one embodiment of a luminaire described here, the luminaire forms a tile or the part of a tile. Preferably, the luminaire is embodied in non-slip fashion in this case.

[000140] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises two carriers between which spacers are arranged at regular distances. The spacers can be posts or dams, for example, which connect the two carriers to one another. The spacers are, for example, formed with a glass solder or a glass frit material or consist of one of these materials.

[000141] In accordance with at least one embodiment of a luminaire described here, the luminaire serves as wall or floor heating. In this case, the luminaire need not necessarily be suitable for generating visible electromagnetic radiation. It is sufficient, for example, if the luminaire comprises at least one organic light-emitting diode suitable for generating infrared radiation. Furthermore, it is possible for the luminaire to comprise organic light-emitting diodes which emit infrared radiation and also organic light-emitting diodes which emit visible light. Furthermore, it is possible for the luminaire to comprise at least one organic light-emitting diode which comprises, in its radiation-generating region, an emission layer comprising an infrared-emitting

emitter material, and also at least one emission layer comprising an emitter material which emits colored light.

[000142] In accordance with at least one embodiment of the luminaire, the luminaire is embodied in flexible fashion and can be applied to a carrier in the manner of a transfer. By way of example, the carrier is an element to be illuminated. In this case, the luminaire can be embodied such that it is transparent and emits on both sides, such that the element to be illuminated by the luminaire is visible during the operation of the luminaire. By way of example, the luminaire can, in this way, be adhesively bonded onto a tile which is presented in a manner highlighted by means of the luminaire.

[000143] In accordance with at least one embodiment of a luminaire described here, the luminaire can be operated by means of induction or capacitive driving. That is to say that, in this case, the luminaire has no external connection conductors that are connected to a current source. Rather, the luminaire comprises for example an antenna suitable for picking up electromagnetic radiation, with which the luminaire is operated.

[000144] In accordance with at least one embodiment of a luminaire described here, a large-area luminaire having a multiplicity of organic light-emitting diodes is involved. In this case, the organic light-emitting diodes can be arranged for example in a combined series and parallel circuit. The large-area, segmented luminaire can form, for example, a ceiling light or solar protection.

[000145] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises at least two organic light-emitting diodes which are suitable for generating light of mutually different colors.

[000146] In accordance with at least one embodiment of a

luminaire described here, the luminaire comprises at least two organic light-emitting diodes which are mechanically connected to one another by means of connection conductors. Alongside a mechanical stabilization of the luminaire, the connection conductors then also serve for making electrical contact with the organic light-emitting diodes of the luminaire.

[000147] In accordance with at least one embodiment of a luminaire described here, the luminaire is embodied in flexible fashion, such that it is bendable. In this case, it is possible for the luminaire to maintain its form after bending. That is to say that the luminaire can be brought to a desired form by the user of the luminaire by bending, for example.

[000148] In accordance with at least one embodiment of a luminaire described here, the luminaire has a luminous area comprising an area content of at least 0.1 m^2.

[000149] In accordance with at least one embodiment of a luminaire described here, the luminaire has a luminous area having an area content of at least 0.5 m^2.

[000150] In accordance with at least one embodiment of a luminaire described here, the luminaire has a luminous area having an area content of at least 1.0 m^2.

[000151] In accordance with at least one embodiment of a luminaire described here, the luminaire has a luminous area having an area content of at least 2.5 m^2.

[000152] In accordance with at least one embodiment of a luminaire described here, the luminaire has a luminous area having an area content of at least 5.0 m^2.

[000153] In accordance with at least one embodiment of a luminaire described here, the luminaire has a luminous area

having an area content of at least 10.0 m^2.

[000154] In accordance with at least one embodiment of a luminaire described here, the luminaire serves for covering a device used for cooling or heating a room. By way of example, the device is a radiator, an air-conditioning system or a ventilation shaft.

[000155] In accordance with at least one embodiment of a luminaire described here, the luminaire serves as a simple temperature indicator. By way of example, the luminaire in this case comprises a temperature sensor, which detects the ambient temperature or the temperature of an object to which the luminaire is connected. In this case, the luminaire emits light having a color locus and/or a color temperature which is correlated with the measured temperature.

[000156] By way of example, the luminaire is applied as a covering directly on a radiator. In this case, the luminaire, depending on the temperature of the radiator, can emit bluish light – for a cold radiator – or reddish light – for a warm radiator.

[000157] In accordance with at least one embodiment of a luminaire described here, the luminaire has a rear wall comprising at least one cooling device. The cooling device can be, for example, cooling lamellae, cooling channels, or a water cooling system.

[000158] In accordance with at least one embodiment of a luminaire described here, the luminaire can be fixed to a further element by means of a fixing means. By way of example, the fixing means is an adhesive strip, a magnet, screws, clamps or a hook and loop fastener.

[000159] In accordance with at least one embodiment of a luminaire described here, the luminaire has a driving device,

by means of which the luminaire can be operated in a flickering manner. That is to say the luminaire emits light which flickers like a candle. This can be realized, for example, by means of a temporal variation of the current intensity with which the luminaire is operated.

[000160] In accordance with at least one embodiment of a luminaire described here, the luminaire serves as a desk lamp for illuminating a work area.

[000161] In accordance with at least one embodiment of a luminaire described here, the luminaire emits electromagnetic radiation in a directional manner. For this purpose, the luminaire can comprise, for example, an organic light-emitting diode that emits directional light. Furthermore, it is possible for the luminaire to have a structured radiation exit area that leads to a directional emission of light by means of light refraction and/or light reflection.

[000162] In accordance with at least one embodiment of a luminaire described here, the luminaire is used as a light for general lighting and as a room divider. In this case, the luminaire can be embodied as a large-area luminaire, for example, which is embodied not as transparent and not as pellucid, but rather such that it scatters light diffusely. In this way, the luminaire can also serve as a concealing screen.

[000163] In accordance with at least one embodiment of a luminaire described here, the luminaire is a luminaire which emits on both sides and which is embodied such that it scatters light diffusely. That is to say that the luminaire has at least two oppositely arranged radiation exit areas through which, for example, light can leave the luminaire. In this case, the luminaire is embodied as visually impenetrable, such that it serves as a concealing screen.

[000164] In accordance with at least one embodiment of a

luminaire described here, the luminaire is embodied such that it can be rolled up and unrolled. By way of example, for this purpose, the luminaire can be subdivided into individual segments which are each formed by a single organic light-emitting diode or at least two organic light-emitting diodes which, in turn, can be embodied in rigid fashion. Furthermore, it is possible for the luminaire to be embodied as fully flexible and to be able to be unrolled and rolled up in this way. In this case, the luminaire can comprise, for example, a single organic light-emitting diode embodied in flexible fashion.

[000165] In accordance with at least one embodiment of a luminaire described here, the luminaire also serves for sound insulation alongside its property as a light for general lighting. By way of example, in this case, the luminaire comprises an insulating material suitable for acoustic insulation.

[000166] In accordance with at least one embodiment of a luminaire described here, the luminaire is embodied as a louver. The luminaire in this case comprises, for example, a multiplicity of organic light-emitting diodes which are electrically contact-connected and mechanically connected to one another by means of a holding device.

[000167] In accordance with at least one embodiment of a luminaire described here, the luminaire serves for room darkening and/or as a concealing screen. That is to say that the luminaire can have a radiation exit area facing away from a window, for example. That side of the luminaire which faces away from the radiation exit area can comprise a radiation-absorbing or radiation-reflecting area facing the window.

[000168] In accordance with at least one embodiment of a luminaire described here, at least parts of the luminaire form an enclosure having at least one side wall and, if

appropriate, a top. The luminaire or at least parts of the luminaire can then form, for example, a changing cubicle, a passenger shelter, a rain shelter or the like. By way of example, all the walls and top parts of the enclosure are formed by at least one luminaire.

[000169] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises a light barrier, by means of which an operating state of the luminaire can be switched. By way of example, the luminaire can be switched on or off by means of the light barrier.

[000170] In accordance with at least one embodiment of a luminaire described here, the luminaire forms a dividing wall in an open-plan office.

[000171] In accordance with at least one embodiment of a luminaire described here, the luminaire forms solar protection alongside its properties for general lighting. In this case, the luminaire can have, for example, an outer area that faces away from the radiation exit area of the luminaire and is formed in absorbent or reflective fashion.

[000172] In accordance with at least one embodiment of a luminaire described here, the luminaire comprises at least one solar cell suitable for generating electric current upon irradiation with sunlight. By way of example, the at least one solar cell is arranged on a side of the luminaire which lies opposite the radiation exit area of the luminaire. The luminaire can furthermore comprise a rechargeable battery that can be charged with light of the solar cell. In this way, by way of example, a quantity of current generated during the day by means of the solar cell can serve for generating light in conditions of poor visibility.

[000173] In accordance with at least one embodiment of a luminaire described here, the luminaire is emergency lighting.

By way of example, the emergency lighting can be operated by means of solar power generated by the luminaire.

[000174] In accordance with at least one embodiment of a luminaire described here, the luminaire forms at least part of a garment or of a bag. In this case, the luminaire can comprise at least one organic light-emitting diode with a retroreflector, such that the luminaire increases the visibility of the user of the luminaire even in the switched-off operating state.

[000175] In accordance with at least one embodiment of a luminaire described here, the luminaire is an umbrella. The umbrella can comprise an organic light-emitting diode and/or at least one inorganic light-emitting diode as light source. Furthermore, it is possible for the umbrella to comprise both inorganic and organic light-emitting diodes as light sources.

[000176] In accordance with at least one embodiment of a luminaire described here, the luminaire is integrated into the window of a motor vehicle. In this case, it is possible for only parts of the window to comprise an organic light-emitting diode. Furthermore, it is also possible, however, for the entire window of the motor vehicle to be formed by a transparent organic light-emitting diode. By way of example, all the windows of the motor vehicle can then be formed by organic light-emitting diodes.

[000177] In accordance with at least one embodiment of a luminaire described here, the luminaire forms an indicator device or a signal light of a motor vehicle. By way of example, the luminaire is a brake light, an indicator light, a rear light or the like. In this case, the luminaire can form at least part of a window of a motor vehicle.

[000178] In accordance with at least one embodiment of a luminaire described here, the luminaire forms a warning sign

or a traffic sign.

BRIEF DESCRIPTION OF THE DRAWINGS

[000179] The organic light-emitting diodes described here and also the luminaires described here will be explained in greater detail below on the basis of exemplary embodiments in relation to the associated figures.

[000180] Figure 1 shows, on the basis of a schematic band diagram, the construction of an organic light-emitting diode in accordance with one exemplary embodiment.

[000181] Figure 2 shows, on the basis of a schematic sectional illustration, the construction of an organic light-emitting diode in accordance with one exemplary embodiment.

[000182] Figure 3 shows, on the basis of a schematic sectional illustration, the construction of an organic light-emitting diode in accordance with one exemplary embodiment, wherein the organic light-emitting diode 1 emits white light during operation.

[000183] Figure 4 shows a transparent first electrode for one exemplary embodiment of an organic light-emitting diode described here.

[000184] Figure 5 shows a transparent second electrode for one exemplary embodiment of an organic light-emitting diode described here.

[000185] Figures 6A, 6B, 6C and 6D show, on the basis of schematic sectional illustrations, the construction of organic light-emitting diodes in accordance with different exemplary embodiments which give a desired colored impression in the switched-off operating state.

[000186] Figure 7 shows, on the basis of a schematic plan view, one exemplary embodiment of an organic light-emitting diode encapsulated by means of a connecting means.

[000187] Figure 8 shows, on the basis of a schematic sectional illustration, one exemplary embodiment of an organic light-emitting diode encapsulated by means of a connecting means.

[000188] Figure 9 shows, on the basis of a schematic sectional illustration, one exemplary embodiment for the encapsulation of an organic light-emitting diode.

[000189] Figures 10 to 13, 14A and 14B show, on the basis of schematic sectional illustrations, exemplary embodiments of organic light-emitting diodes which are sealed by means of resist layers, insulation layers, diffusion barriers, thin-film encapsulations and/or pre-encapsulation layers.

[000190] Figures 15 to 19 show, on the basis of schematic sectional illustrations, exemplary embodiments of organic light-emitting diodes which are sealed by means of an encapsulation layer sequence.

[000191] Figure 20 shows, on the basis of a schematic sectional illustration, one exemplary embodiment of an organic light-emitting diode with a sputtering protective layer.

[000192] Figures 21 to 25 show, on the basis of schematic illustrations, the construction of organic light-emitting diodes having a directional emission profile in accordance with different exemplary embodiments.

[000193] Figures 26A, 26B and 27 show, on the basis of schematic sectional illustrations, the construction of exemplary embodiments of organic light-emitting diodes which are used for illuminating an element to be illuminated.

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[000194] Figure 28 shows, on the basis of a schematic sectional illustration, the construction of one exemplary embodiment of an organic light-emitting diode 1 with a wavelength conversion substance disposed downstream thereof.

[000195] Figures 29 and 30 show, on the basis of schematic sectional illustrations, exemplary embodiments of organic light-emitting diodes which each have a retroreflector.

[000196] Figures 31A and 31B show, on the basis of schematic sectional illustrations, one exemplary embodiment of an organic light-emitting diode described here wherein the organic light-emitting diode comprises a touch sensor.

[000197] Figures 32A to 32I show, on the basis of schematic illustrations, exemplary embodiments of a luminaire described here which has a wake-up function.

[000198] Figures 33A to 33D show, on the basis of schematic illustrations, exemplary embodiments of a luminaire described here which constitutes a splash guard.

[000199] Figures 34A, 34B, 34C and 35 show, on the basis of schematic illustrations, further exemplary embodiments of a luminaire which constitutes a splash guard.

[000200] Figures 36, 37A, 37B, 38, 39A, 39B, 40A, 40B show, on the basis of schematic illustrations, exemplary embodiments of a luminaire described here with a shower head.

[000201] Figures 41A to 41D and 42A to 42C show, on the basis of schematic illustrations, one exemplary embodiment of a luminaire described here which can be utilized as a mirror.

[000202] Figures 43 and 44A, 44B show, on the basis of schematic illustrations, one exemplary embodiment of a

luminaire described here which can be utilized as a tile.

[000203] Figures 45A to 45C and 46A, 46B show, on the basis of schematic illustrations, one exemplary embodiment of a luminaire described here which forms a large-area ceiling light.

[000204] Figures 47A to 47D, 48 to 49A, 49B show, on the basis of schematic illustrations, one exemplary embodiment of a luminaire described here which serves for covering an object.

[000205] Figures 50A to 50D show, on the basis of schematic illustrations, exemplary embodiments of luminaires 2 described here which can be used as large-area desk lights.

[000206] Figures 51A, 51B, 52A to 52C and 53 show, on the basis of schematic illustrations, exemplary embodiments of luminaires 2 described here which can be used as room dividers.

[000207] Figures 54A to 54C show, on the basis of schematic illustrations, exemplary embodiments of luminaires 2 described here which can be used as louvers.

[000208] Figures 55A to 55D show, on the basis of schematic illustrations, exemplary embodiments of luminaires 2 described here which can be used as changing cubicles.

[000209] Figures 56A to 56C show, on the basis of schematic illustrations, an exemplary embodiment of a luminaire described here which can be used as solar protection.

[000210] Figures 57A and 57B show, on the basis of schematic illustrations, one exemplary embodiment of a luminaire described here which forms a bag.

[000211] Figures 58A and 58B show, on the basis of schematic illustrations one exemplary embodiment of a luminaire described here which serves as an emergency light.

[000212] Figure 59 shows, on the basis of a schematic illustration, one exemplary embodiment of a luminaire described here which can be used as advertising means on vehicles.

[000213] Figures 60A to 60D show, on the basis of schematic illustrations, one exemplary embodiment of a luminaire described here which serves as an umbrella.

[000214] Figures 61A to 61C show, on the basis of schematic illustrations, exemplary embodiments of luminaires which are used as signal lamps in a motor vehicle.

[000215] Figures 62 and 63 show, on the basis of a schematic illustration, exemplary embodiments of a luminaire which is used for illumination in a motor vehicle.

[000216] Figures 64A to 64C show, on the basis of schematic illustrations, exemplary embodiments of a luminaire which is used as a warning sign.

[000217] Figures 65A to 65C show, on the basis of schematic illustrations, exemplary embodiments of a luminaire which forms rain protection.

DETAILED DESCRIPTION OF THE DRAWINGS

[000218] Elements which are identical, of identical type or act identically are provided with the same reference symbols in the figures. The figures and the size relationships of the elements illustrated in the figures among one another should not be regarded as to scale. Rather, individual elements may be illustrated with an exaggerated size in order to enable better illustration and/or in order to afford a better

understanding.

[000219] Figure 1 shows, on the basis of a schematic band diagram, the construction of an organic light-emitting diode 1 in accordance with one exemplary embodiment.

[000220] The organic light-emitting diode 1 comprises a first electrode 101. The first electrode is an anode, for example. Via the first electrode 1, positive charge carriers - so-called holes - are impressed into the organic light-emitting diode.

[000221] The hole transport layer 102 adjoins the first electrode 101. The hole transport layer 102 transports the positive charge carriers toward the radiation-emitting region 104 of the organic light-emitting diode 1.

[000222] The hole transport layer 102 is succeeded by an electron barrier layer 103, which prevents the penetration of electrons from the radiation-emitting region 104 into the hole transport layer 102.

[000223] The electron barrier layer 3 is succeeded by the radiation-emitting region 104. During the operation of the organic light-emitting diode 1, electromagnetic radiation is generated in the radiation-emitting region. Therefore, the emission 108 of electromagnetic radiation occurs in the radiation-emitting region. Preferably, electromagnetic radiation in the spectral range of infrared radiation to UV radiation is generated in this case. The radiation-emitting region is explained in greater detail for example with reference to figures 2 and 3.

[000224] The radiation-emitting region 104 is succeeded by a hole barrier layer 105, which prevents the penetration of positive charge carriers into the adjoining electron transport layer 106.

[000225] The electron transport layer 106 adjoins the hole barrier layer 105 and transports negative charge carriers – electrons – from the second electrode 107, embodied as a cathode, to the radiation-emitting region 104.

[000226] The hole transport layer 102 and the electron transport layer 106 are first and second charge carrier transport layers. The hole transport layer 102 and the electron transport layer 106 comprise, for example, a matrix material that is p- and n-doped, respectively.

[000227] Depending on the embodiment of the charge carrier transport layer as hole transport layer 102 or as electron transport layer 106, the matrix material can be selected from a group comprising phenanthroline derivatives, imidazole derivatives, triazole derivatives, oxadiazole derivatives, phenyl-containing compounds, compounds comprising condensed aromatics, carbazole-containing compounds, fluorene derivatives, spirofluorene derivatives and pyridine-containing compounds and also combinations of at least two or more of the materials mentioned.

[000228] For a charge carrier transport layer embodied as hole transport layer 102, the following matrix materials, in particular, are suitable:

[000229] N,N'-bis(naphthalen-1-yl)-N,N'-bis(phenyl)benzidine (NPB),

[000230] N,N'-bis(naphthalen-2-yl)-N,N'-bis(phenyl)benzidine (β-NPB),

[000231] N,N'-bis(3-methylphenyl)-N,N'-bis(phenyl)benzidine (TPD),

[000232] N,N'-bis(3-methylphenyl)-N,N'-bis(phenyl)-9,9-spirobifluorene (spiro-TPD),

[000233] N,N'-bis(naphthalen-1-yl)-N,N'-bis(phenyl)-9,9-spirobifluorene (spiro-NPB),

[000234] N,N'-bis(3-methylphenyl)-N,N'-bis(phenyl)-9,9-

dimethylfluorene (DMFL-TPD),
[000235] N,N'-bis(naphthalen-1-yl)-N,N'-bis(phenyl)-9,9-dimethylfluorene (DMFL-NPB),
[000236] N,N'-bis(3-methylphenyl)-N,N'-bis(phenyl)-9,9-diphenylfluorene (DPFL-TPD),
[000237] N,N'-bis(naphthalen-1-yl)-N,N'-bis(phenyl)-9,9-diphenylfluorene (DPFL-NPB),
[000238] 2,2',7,7'-tetrakis(N,N-diphenylamino)-9,9'-spirobifluorene (spiro-TAD),
[000239] 9,9-bis[4-(N,N-bisbiphenyl-4-yl-amino)phenyl]-9H-fluorene (BPAPF),
[000240] 9,9-bis[4-(N,N-bisnaphthalen-2-yl-amino)phenyl]-9H-fluorene (NPAPF),
[000241] 9,9-bis[4-(N,N-bisnaphthalen-2-yl-N,N'-bisphenylamino)phenyl]-9H-fluorene (NPBAPF),
[000242] 2,2',7,7'-tetrakis[N-naphthalenyl(phenyl)amino]-9,9-spirobifluorene (spiro-2NPB),
[000243] N,N'-bis(phenanthren-9-yl)-N,N'-bis(phenyl)benzidine (PAPB),
[000244] 2,7-bis[N,N-bis(9,9-spirobifluorene-2-yl)amino]-9,9-spirobifluorene (spiro-S),
[000245] 2,2'-bis[N,N-bis(biphenyl-4-yl)amino]-9,9-spirobifluorene (2,2'-spiro-DBP),
[000246] 2,2'-bis(N,N-diphenylamino)-9,9-spirobifluorene (spiro-BPA).

[000247] The dopant for the hole transport layer 102 is a p-type dopant and can in this case comprise or be a metal oxide, an organometallic compound, an organic material or a mixture thereof. Additionally or alternatively, the dopant can comprise a plurality of different metal oxides and/or a plurality of different organometallic compounds and/or a plurality of different organic compounds. In particular, the dopant can have Lewis acid character or be a Lewis acid. Lewis acids, that is to say electron pair acceptors, can be particularly well suited to forming charge transfer complexes.

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[000248] The dopant can comprise one or a plurality of metal oxides comprising one or a plurality of metals, wherein the metals are selected from tungsten, molybdenum, vanadium and rhenium. Particularly preferably, the dopant can comprise one or a plurality of the metal oxides WO_3, MoO_3, V_2O_5, Re_2O_7 and Re_2O_5. While rhenium pentoxide is suitable for enabling, as dopant, a hole transport layer 102 having a blue color impression, the other metal oxides mentioned are suitable for enabling a yellow to orange-colored color impression. Oxides of rhenium, in particular, are Lewis acids which can readily be evaporated at a temperature of less than 250°C and at a pressure of 10^{-6} mbar and are therefore well suited to a p-type doping. It has been possible to show experimentally that the doping properties with regard to the electronic properties of the hole transport layer 102 of rhenium pentoxide and rhenium heptoxide differ only little, such that metal oxides of this type can be chosen depending on a predetermined color impression. The other metal oxides mentioned exhibit similar processing properties for p-type doping.

[000249] Furthermore, the dopant for the p-type doping of the hole transport layer 102 can also comprise organometallic compounds having Lewis acid character. Particularly in the case of organometallic compounds or complexes having an impeller structure, the Lewis acid character of the axial position is particularly pronounced.

[000250] Furthermore, the organometallic compounds can comprise ruthenium and/or rhodium. By way of example, the dopant can comprise as organometallic compound a trifluoroacetate (TFA), for example dirhodium tetratrifluoroacetate ($Rh_2(TFA)_4$), which with (NPB) can give a bluish color impression or the isoelectronic ruthenium compound $Ru_2(TFA)_2(CO)_2$, which enables an orange-colored color impression.

[000251] Furthermore, the dopant for p-type doping can

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comprise organic materials which comprise aromatic functional groups or are aromatic organic materials. In particular, the dopant can comprise aromatic materials having a pronounced number of fluorine and/or cyanide (CN) substituents.

[000252] For a charge carrier transport layer embodied as electron transport layer 106, the following matrix materials, in particular, are also suitable:
[000253] 8-hydroxyquinolinolato-lithium (Liq),
[000254] 2,2',2''-(1,3,5-benzinetriyl)-tris(1-phenyl-1-H-benzamidazole) (TPBi),
[000255] 2-(4-biphenylyl)-5-(4-tert-butylphenyl)-1,3,4-oxadiazole (PBD),
[000256] 2,9-dimethyl-4,7-diphenyl-1,10-phenanthroline (BCP),
[000257] 4,7-diphenyl-1,10-phenanthroline (BPhen),
[000258] bis(2-methyl-8-quinolinolate)-4-(phenylphenolato)-aluminum (BAlq),
[000259] 1,3-bis[2-(2,2'-bipyridin-6-yl)-1,3,4-oxadiazo-5-yl]benzene (Bpy-OXD),
[000260] 6,6'-bis[5-(biphenyl-4-yl)-1,3,4-oxadiazo-2-yl]-2,2'-bipyridyl (BP-OXD-Bpy),
[000261] 3-(4-biphenylyl)-4-phenyl-5-tert-butylphenyl-1,2,4-triazole (TAZ),
[000262] 4-(naphthalen-1-yl)-3,5-diphenyl-4H-1,2,4-triazole (NTAZ),
[000263] 2,9-bis(naphthalen-2-yl)-4,7-diphenyl-1,10-phenanthroline (NBphen),
[000264] 2,7-bis[2-(2,2'-bipyridin-6-yl)-1,3,4-oxadiazo-5-yl]-9,9-dimethylfluorene (Bby-FOXD),
[000265] 1,3-bis[2-(4-tert-butylphenyl)-1,3,4-oxadiazo-5-yl]-benzene (OXD-7).

[000266] For an electron transport layer 106, the matrix material is n-doped. That can mean that the dopant enables an n-type doping of the matrix material of the first charge carrier transport layer. In particular, the dopant can be embodied as an electron donor having a low ionization

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potential, that is to say a high-level HOMO (Highest Occupied Molecular Orbital).

[000267] In this case, the dopant can comprise or be an alkali metal salt, an alkaline earth metal salt, an organometallic compound or a mixture thereof. Additionally or alternatively, the dopant can comprise a plurality of different alkali metal salts and/or a plurality of different alkaline earth metal salts and/or a plurality of different organometallic compounds. In particular, the dopant can comprise a carbonate. Furthermore, the dopant can particularly preferably comprise cesium. Cs_2CO_3, for example, can give a bluish color impression in BCP or in BPhen as matrix material.

[000268] Furthermore, the dopant for n-type doping can comprise a metallocene, that is to say an organometallic compound comprising a metal M and two cyclopentadienyl radicals (Cp) in the form $M(Cp)_2$. Alternatively or additionally, the dopant can also comprise a metal-hydropyrimidopyrimidine complex. The metal can comprise or be tungsten, molybdenum and/or chromium, for example.

[000269] By way of example, chromocene or decamethylchromocene can enable grey-colored color impressions for an n-doped electron transport layer 106, while organometallic compounds comprising 1,2,4,6,7,8-hexahydro-2H-pyrimido[1,2-a]pyrimidine (hpp) such as, for instance $W_2(hpp)_4$, $Mo_2(hpp)_4$ and $Cr_2(hpp)_4$ enable red to orange-colored color impressions.

[000270] The matrix materials of the charge carrier transport layers 102, 106 mentioned here and the dopants mentioned here for the matrix materials can form charge transfer complexes which absorb part of an electromagnetic radiation incident from outside on the organic light-emitting diode 1 with a first absorption spectrum and, in a switched-off electronic operating state, bring about a predetermined color impression

of the component, which can be perceived by an external observer through the first electrode 101, for example. In this case, the matrix material and the dopant form electron-donor-acceptor complexes, the absorption bands of which preferably lie in the visible wavelength range. In this case, the absorption band of the charge transfer complexes is dependent on the respective energetic position of their HOMOs (Highest Occupied Molecular Orbital) and LUMOs (Lowest Unoccupied Molecular Orbital) relative to one another. Consequently, in addition to the charge carrier conductivity for holes and/or for electrons, the charge transfer complexes can have the first absorption spectrum, which can enable the predetermined color impression.

[000271] Through a suitable choice of the matrix material and of the dopant, at least of the charge carrier transport layer adjoining a radiation-transmissive or transparent electrode, it is possible to ensure electronic properties with regard to the electronic functionality of the organic light-emitting diode, such as, for instance, electrical conductivity and/or the charge carrier injection, and at the same time the predetermined color impression for the desired external appearance, at least in the switched-off electronic operating state (in this respect, also see the exemplary embodiments in figures 6A to 6D).

[000272] The first electrode 101 is a transparent anode, for example. The first electrode 101 is therefore preferably at least partly transmissive to electromagnetic radiation generated in the radiation-emitting region 104. Preferably, the first electrode 101 is transparent to said radiation. In this case, the first electrode can, for example, comprise a transparent conductive oxide or consist of a transparent conductive oxide. Transparent conductive oxides ("TCO" for short) are transparent conductive materials, generally metal oxides, such as, for example, zinc oxide, tin oxide, cadmium oxide, titanium oxide, indium oxide or indium tin oxide (ITO).

Alongside binary metal-oxygen compounds such as, for example ZnO, SnO_2 or In_2O_3, ternary metal-oxygen compounds such as, for example, Zn_2SnO_4, $CdSnO_3$, $ZnSnO_3$, $MgIn_2O_4$, $GaInO_3$, $Zn_2In_2O_5$ or $In_4Sn_3O_{12}$ or mixtures of different transparent conductive oxides also belong to the group of TCOs. Furthermore, the TCOs do not necessarily correspond to a stoichiometric composition and can also be p- or n-doped.

[000273] The second electrode 107 can be embodied as a cathode and therefore serve as electron-injecting material. The second electrode 107 can be a cathode which is configured in reflective fashion and which at least partly reflects electromagnetic radiation generated in the radiation-emitting region 104. Preferably, the reflectivity is then at least 70%, at least 80% or particularly preferably at least 90%.

[000274] Inter alia, in particular aluminum, barium, indium, silver, gold, magnesium, calcium or lithium and also compounds, combinations and alloys thereof can prove to be advantageous as cathode material. In addition, the second electrode 107 can have, on a side facing the radiation-emitting region 104, a layer comprising LiF, which has good electron injection properties. Alternatively or additionally, the second electrode can also comprise one of the abovementioned TCOs or a layer sequence composed of TCO layers and a metal layer. The second electrode 107 can then likewise be transparent.

[000275] Alternatively, the first electrode 101 can also be embodied as a cathode, and the second electrode 107 as an anode.

[000276] The electron barrier layer 103 can contain or consist of, for example, α-NPD (N,N'-di-1-naphthyl-N,N'-diphenyl-4,4'-diaminobiphenyl).

[000277] This material has a HOMO of -5 ± 0.4 eV and a LUMO

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of more than −2.2 eV. The hole mobility is approximately 10^{-4} cm^2/Vs.

[000278] The hole barrier layer 105 can comprise BCP or BPhen as material. What is important here is the electron mobility of more than 10^{-6} cm^2/Vs, preferably more than 10^{-5} cm^2/Vs, given a very low to even no hole mobility.

[000279] Figure 2 shows, on the basis of a schematic sectional illustration, an enlargement of an excerpt from an organic light-emitting diode 1 described here. In this case, figure 2 shows the radiation-emitting region 104 adjoined by the electron barrier layer 103 and the hole barrier layer 105. In the present case, the radiation-emitting region 104 comprises an emission layer. The emission layer 101 comprises at least one organic material which is suitable for generating electromagnetic radiation upon energization.

[000280] By way of example, the material of the emission layer 101 can be suitable for generating infrared radiation. The emission layer 101 then contains, for example, at least one of the following materials: Yb-tris(8-hydroxyquinoline), Er-tris(8-hydroxyquinoline), YbQ3, ErQ3.

[000281] Furthermore, it is possible for the emission layer 101 to comprise emitter materials for generating red, green and/or blue light, which emitter materials can be embedded in matrix materials. By way of example, suitable emitter materials are described in conjunction with figure 3.

[000282] Figure 3 shows, on the basis of a schematic sectional illustration, a further exemplary embodiment of an organic light-emitting diode 1 described here. It is clarified with reference to figure 3 that the radiation-emitting region 104 can have a plurality of emission layers 111, 112, 113.

[000283] The first emission layer 111 is, for example, an

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emission layer suitable for emitting red light. The emission layer 101 then contains, for example, the following phosphorescent emitter material: $Ir(DBQ)_2acac$ (iridium(III)bis(2-methyldibenzo-[f,h]quinoxaline)-(acetylacetonate)). This emitter material has a main emission wavelength of above 600 nm, and in the CIE diagram from 1931 an x value of > 0.6 and a y value of < 0.36.

[000284] The red emission layer 101 can comprise a matrix that transports holes. One suitable matrix material is α-NPD (N,N'-di-1-naphthyl-N,N'-diphenyl-4,4'-diaminobiphenyl). The material has a HOMO of -5.5 ± 0.4 eV and a LUMO of -2.1 ± 0.4 eV. The hole mobility is approximately 10^{-4} cm^2/Vs and the triplet position T1 is above 1.8 eV.

[000285] The second emission layer 112 is, for example, an emission layer which emits green light during the operation of the organic light-emitting diode 1. The emission layer 112 then contains, for example, a green emitter material, which can be embedded in a first and second matrix material. By way of example, Irppy (fac-tris(2-phenylpyridyl)iridium) can be used as green emitter material. The material has a main emission wavelength at 500 to 570 nm, and in the CIE diagram from 1931 an x value of approximately 0.37 and a y value of approximately 0.6.

[000286] A hole transporting first matrix material in the second emission layer 112 can be, for example, TCTA (4,4',4''-tris(carbazol-9-yl)triphenylamine), or it can be CBP (4,4'-bis(carbazol-9-yl)biphenyl).

[000287] These materials have a HOMO of -6.0 to -5.3 eV and a LUMO of -2.3 ± 0.1 eV, a T1 of above 2.5 eV and a hole mobility of approximately 10^{-4} cm^2/Vs.

[000288] An electron conducting second matrix material in the second emission layer 112 is, for example, BCP or BPhen, where

the electron mobility should be greater than 10^{-5} cm^2/Vs, preferably 10^{-4} cm^2/Vs.

[000289] The third emission layer 113 is then, for example, an emission layer which emits blue light during the operation of the organic light-emitting diode 1. The blue, third emission layer 113 can be a fluorescent emission layer, comprising the blue fluorescent emitter material DPVBi (4,4'-bis(2,2-diphenylethen-1-yl)diphenyl).

[000290] This material has a main emission wavelength at 450 to 770 nm, a full width at half maximum at approximately 60 nm, and in the CIE diagram from 1931 x values of 0.14 to 0.22 and y values of 0.11 to 0.20.

[000291] The blue emitter material can be present in an electron conducting matrix, which can comprise TBADN (2-tert-butyl-9,10-di(2-naphthyl)anthracene) as material. This material has a HOMO of -5.8 to -5.3 eV and LUMO of -2.5 to -1.8 eV. The band gap is more than 3 eV and the electron mobility is greater than 10^{-6} cm^2/Vs, preferably greater than 10^{-5} cm^2/Vs.

[000292] Overall, during the operation of the organic light-emitting diode 1, white mixed light is emitted by the three emission layers 111, 112 and 113 in the radiation-emitting region 104.

[000293] The first electrode 101 and the second electrode 107 can be chosen as specified in conjunction with figure 1. Furthermore, the hole transport layer 102, the electron barrier layer 103, the hole barrier layer 105 and the electron transport layer 106 can be chosen as described in conjunction with figure 1.

[000294] In the exemplary embodiment of figure 3, the use of at least one of the following matrix materials is

advantageous, for example, for the hole transport layer 102: 1-TNATA (4,4',4''-tris(N-(naphth-1-yl)-N-phenylamino)triphenylamine), MTDATA (4,4',4''-tris(N-3-methylphenyl-N-phenylamino)triphenylamine), 2-TNATA (4,4',4''-tris(N-naphth-2-yl)-N-phenylamino)triphenylamine), α-NPB (N,N'-bis(naphthalen-1-yl)-N,N'-bis(phenyl)benzidine), β-NPB (N,N'-bis(naphthalen-2-yl)-N,N'-bis(phenyl)benzidine), TPD (N,N'-bis(3-methylphenyl)-N,N'-bis(phenyl)benzidine), spTAD (2,2',7,7'-diphenylaminospiro-9,9'-bifluorene), Cu-PC (phthalocyanine-copper complexes), further phthalocyanine-metal complexes, pentacene and TAPC (1,1-bis[(4-phenyl)-bis(4',4''-methylphenyl)amino]cyclohexane).

[000295] These materials have a HOMO of -5.2 ± 0.4 eV and a LUMO of -2.2 ± 0.4 eV. The hole mobility is approximately 10^{-4} cm^2/Vs and the conductivity of a doped layer given 2 to 10% by volume of the dopant is approximately 10^{-5} S/cm.

[000296] By way of example, F_4-TCNQ (2,3,5,6-tetrafluoro-7,7,8,8-tetracyanoquinodimethane) serves as dopant in the hole transport layer 102. Further dopants are molybdenum oxide and rhenium oxide, for example.

[000297] The electron transport layer 106 can advantageously contain one of the following materials as matrix material or consist of one of the following materials: BPhen, Alq_3, (tris(8-hydroxyquinoline)aluminum), $BAlq_2$ (bis[2-methyl-8-quinolinato]-[4-phenylphenolato]aluminum(III)), BCP, TPBi (1,3,5-tris(1-phenyl-1H-benzimidazol-2-yl)benzene), TAZ (3-(4-biphenyl)-4-phenyl-5-(4-tert-butylphenyl)-1,2,4-triazole), TAZ2 (3,5-diphenyl-4-naphth-1-yl-1,2,4-triazole), t-Bu-PBD (2-(4-biphenylyl)-5-(4-tert-butylphenyl)-1,3,4-oxadiazole), triazine or triazine derivatives. The matrix material has a HOMO of -6.4 to -6.0 eV, a LUMO of -2.3 to -1.8 eV, an electron mobility of more than 10^{-6} cm^2/Vs, preferably more than 10^{-5} cm^2/Vs, and a conductivity in a doped layer (given 6 to 50% by volume of dopant) of 10^{-5} S/cm. By way of example,

lithium, cesium or calcium can be used as dopant.

[000298] For all of the layers, of course, other matrix materials, dopants or emitter materials are possible, as are other compositions of the mixed matrix materials. Further materials for emitter materials, transport materials and dopants are possible and can be exchanged at any time.

[000299] In addition to the exemplary embodiment of an organic light-emitting diode described here, as described in conjunction with figure 1, the radiation-emitting region 104 in the exemplary embodiment in accordance with figure 3 has a first charge transporting layer 114 and a second charge transporting layer 115.

[000300] The first charge transporting layer 114 is arranged between the first, red-emitting emission layer 111 and the second, green-emitting emission layer 112.

[000301] The first charge transporting layer 114 comprises a first and second matrix material, for example.

[000302] The first matrix material of the first charge transporting layer 114 can comprise a hole transporting matrix material, which can be 1-TNATA or α-NPD, for example. These materials have a HOMO of -5.5 ± 0.6 eV and a LUMO of -2.1 ± 0.4 eV. The hole mobility is approximately 10^{-4} cm^2/Vs and the triplet position T1 is > 1.8 eV.

[000303] An electron conducting second matrix material in the first charge transporting layer 114 can be BCP (2,9-dimethyl-4,7-diphenyl-1,10-phenanthroline), for example. A further example is BPhen (4,7-diphenyl-1,10-phenanthroline).

[000304] These materials have the property that the HOMO is -6.4 to -5.7 eV and the LUMO is -2.3 to -1.8 eV, T1 is > 2.5 eV, and the electron mobility is approximately

10^{-6} cm^2/Vs.

[000305] A second charge transporting layer 115 is arranged between the second emission layer 112, which emits green light, and the third emission layer 113, which emits blue light.

[000306] The second charge carrier transporting layer 115 is composed of a first and a second matrix material. The first matrix material can be a hole transporting matrix material, which can be TCTA or CBP. The second electron conducting matrix material can be BCP or BPhen.

[000307] In the exemplary embodiment described in conjunction with figure 3, electromagnetic radiation is emitted through the transparent first electrode 101, which is embodied as an anode. In this case, the first electrode 101 has a thickness of between 80 nm and 140 nm, for example 120 nm.

[000308] The hole transport layer 102 preferably has a thickness of between 10 nm and 400 nm. The electron barrier layer 103 preferably has a thickness of between 5 nm and 10 nm. The first emission layer 111 preferably has a thickness of between 5 nm and 15 nm, and the first charge carrier transporting layer 114 preferably has a thickness of between 5 nm and 10 nm. The second emission layer 112 preferably has a thickness of between 5 nm and 15 nm. The second charge carrier transporting layer 115 preferably has a thickness of between 5 nm and 10 nm. The third emission layer 113 preferably has a thickness of between 5 nm and 10 nm. The hole barrier layer 105 preferably has a thickness of between 5 nm and 10 nm. The electron transport layer 106 preferably has a thickness of between 20 nm and 300 nm. The second electrode 107, embodied as a cathode, preferably has a thickness of between preferably 100 nm and 200 nm.

[000309] Furthermore, it is possible for first electrode 101

and second electrode 107 in each case to be embodied in transparent fashion. The organic light-emitting diode 1 is then a component which can emit electromagnetic radiation in at least two opposite directions. By way of example, a component which emits white light in two opposite directions can then be involved. Furthermore, such an organic light-emitting diode 1 can be a transparent organic light-emitting diode. In this case, transparent means that the organic light-emitting diode 1 is transmissive to electromagnetic radiation preferably in the visible frequency range, such that at least 50% of the radiation passing through can pass through the organic light-emitting diode 1, without being absorbed. In this case, the organic light-emitting diode 1 can also be pellucid. That is to say that the light passing through is not or hardly scattered by the organic light-emitting diode 1.

[000310] The organic light-emitting diode in accordance with figure 3 is therefore a radiation-emitting device in which a charge transporting layer is in each case arranged between two emission layers.

[000311] In this case, the charge transporting layers each comprise a matrix, which comprises a hole conducting and an electron conducting matrix material or is a mixture of a first, hole transporting matrix material and a second, electron transporting matrix material.

[000312] In conjunction with the schematic sectional illustrations in figures 4 and 5, further exemplary embodiments are described in greater detail for the first electrode 101 (figure 4) and the second electrode (figure 5). These electrodes can be used in organic light-emitting diodes described here.

[000313] For this purpose, the first electrode 101 and second electrode 107 preferably both comprise a transparent, electrically conductive oxide (TCO) material.

[000314] In this case, at least one of the first electrode 101 and second electrode 107 can comprise a layer sequence having a first TCO layer 121 comprising a first transparent, electrically conductive oxide (TCO), a second TCO layer 122 comprising a transparent metal and a third metal layer 120 comprising a second TCO. The layer sequence having two layers each comprising a TCO and a layer in between, embodied as a transparent metal layer, can enable an electrode which has a high transverse conductivity owing to the transparent metal layer 120 and a reduced reflectivity owing to the high refractive index layers 121, 122 comprising TCO. For an organic optoelectronic component which is transparent on both sides, that is to say fully transparent, it is also possible for both electrodes 101, 107 each to comprise such a layer sequence. What can thereby be achieved, in particular, is that the two transparent electrodes precisely do not form an optical microresonator or form at least a microresonator having a low quality factor.

[000315] In this case, the first TCO and/or the second TCO can comprise one or more of the abovementioned materials for TCOs. In particular, the first TCO and/or the second TCO can comprise or be composed of ITO, indium zinc oxide, aluminum zinc oxide and/or zinc oxide. Furthermore, the first and/or the second TCO can be doped with aluminum, vanadium and/or gallium or a combination or mixture thereof. A thickness d of a TCO layer 121, 122 comprising a TCO can be, in particular, greater than or equal to 5 nm and less than or equal to 150 nm.

[000316] The transparent metal can comprise aluminum, chromium, molybdenum, nickel, silver, platinum, barium, indium, gold, magnesium, calcium or lithium and also compounds, combinations and alloys thereof or consist of one of the abovementioned materials or combinations or alloys thereof. In this case, a metal layer 120 comprising a

transparent metal can have a thickness d of greater than or equal to 1 nm and less than or equal to 50 nm, in particular greater than or equal to 20 nm and less than or equal to 40 nm.

[000317] In particular, the first electrode 101 and/or the second electrode 107 can be embodied in areal fashion or alternatively in a manner structured into first and/or second electrode partial regions. By way of example, the first electrode 101 can be embodied in the form of first electrode strips arranged parallel alongside one another, and the second electrode 107 can be embodied as second electrode strips arranged parallel alongside one another and running perpendicularly to said first electrode strips. Overlaps of the first and second electrode strips can therefore be embodied as separately drivable luminous regions. Furthermore, it is also possible for only the first 101 or the second electrode 107 to be structured.

[000318] The combination of a transparent metal layer 120 and a transparent TCO layer 121, 122 makes it possible to realize a first 101 and/or a second electrode 107 having both good electrical and good optical properties.

[000319] In this case, "good electrical properties" can mean that the electrode 101, 107 has a low electrical resistance typical of metals and therefore also a good transverse conductivity, that is to say a high electrical conductivity, typical of a metal, along the extension direction of the electrode. In particular, the combination of a transparent metal layer 120 and a transparent TCO layer 121, 122 makes it possible to achieve a lower electrical resistance and hence a higher transverse conductivity than, for example, with a layer composed of a transparent, electrically conductive oxide alone.

[000320] "Good optical properties" can mean, in particular,

that the electrode has a high transparency and furthermore a low reflectivity, in particular a lower reflectivity than a layer comprising a transparent metal alone. That can be achieved by virtue of the fact that the TCO layer 121, 122 can act as an antireflection coating. Materials having a high refractive index such as, for instance, dielectric oxides, for instance silicon oxide or tantalum oxide, and, in particular, transparent, electrically conductive oxides or mixtures thereof can be suitable for this purpose.

[000321] In this case, a high refractive index can be, for example, a refractive index of greater than or equal to 1.9. By way of example, TCOs can have refractive indices in the range of approximately 1.9 to approximately 2.1.

[000322] Alternatively or additionally, the first and/or second electrode can also have one or a plurality of layers suitable for antireflection coating and composed of a further material having a high refractive index, for instance from the region of the tellurides or sulfides, for instance ZnSe having a refractive index of approximately 2.5. Furthermore, the materials mentioned can also be present in combinations or mixtures in the first 101 and/or second electrode 107.

[000323] Figures 6A to 6D show further exemplary embodiments of organic light-emitting diodes 1 described here.

[000324] Figures 6A and 6B show an organic light-emitting diode 1 in a switched-off electronic operating state (figure 6A) and in a switched-on electronic operating state (figure 6B).

[000325] The organic light-emitting diode 1 has a first carrier 130, which is embodied in radiation-transmissive fashion. By way of example, the first carrier 130 consists of a glass. On the first carrier 130 are a transparent first electrode 101 and a second electrode 107 arranged. Between the

transparent first electrode 101 and the second electrode 107 an organic layer sequence 133 is arranged. In the exemplary embodiment shown, the organic light-emitting diode 1 is therefore embodied as a bottom emitter since it can emit through the first carrier 130.

[000326] The organic layer sequence 133 has at least one radiation-emitting region 104 and also a hole transport layer 102. In this case, the hole transport layer 102 is arranged between the first electrode 101 and the radiation-emitting region 104.

[000327] In the exemplary embodiment shown, the transparent first electrode 101 is embodied from indium tin oxide (ITO) and serves as an anode, while the second electrode 107 has a 0.7 nm thick LiF layer and a 200 nm thick aluminum layer.

[000328] The hole transport layer 102 comprises a matrix material and a dopant, which form charge transfer complexes. In this case, the charge transfer complexes have a first absorption spectrum. Electromagnetic radiation having a wavelength in the absorption range can be absorbed by the charge transfer complexes with excitation thereof. That part of an electromagnetic radiation incident on the organic light-emitting diode 1 from outside, here indicated by means of the arrows 190, which corresponds to the absorption spectrum is therefore absorbed, while the non-absorbed part 191 of the electromagnetic radiation 190 can be scattered and reflected by the hole transport layer 102. As a result, the hole transport layer 102 can be perceived by an external observer and, in the switched-off electronic operating state of the organic light-emitting diode 1, brings about a predetermined color impression in the form of the electromagnetic radiation 191.

[000329] In the exemplary embodiment shown, the hole transport layer 102 consists of NPB as matrix material, which

is p-doped with 5% Re_2O_7. In this case, the dopant is distributed homogeneously in the matrix material. This gives rise to a uniform yellowish color impression in the switched-off operating state.

[000330] The radiation-emitting region 104 has, for example, a 40 nm thick layer composed of tris(8-hydroxyquinoline)-aluminum (Alq_3) as fluorescent electroluminescent material, which simultaneously serves as electron transport material. Arranged between the hole transport layer 102 and the active region 30 is a 10 nm thick NPB layer 123, which improves the hole injection from the hole transport layer 102 into the radiation-emitting region 104. As an alternative thereto, the hole transport layer 102 can also comprise the dopant with a thickness gradient in the matrix material, wherein the dopant concentration can decrease toward the radiation-emitting region 104 continuously or discontinuously.

[000331] As is indicated by the arrows 193 in figure 6B, the organic light-emitting diode 1 emits green-colored electromagnetic radiation through the radiation-emitting region 104, the first electrode 101 and the first carrier 1 in the switched-on operating state. In this case, the dashed arrows 190 and 191 indicate that although electromagnetic radiation which is incident on the organic light-emitting diode 1 from outside can still be scattered and reflected, the color impression brought about thereby is outshone by the electromagnetic radiation 193 generated in the radiation-emitting region and is therefore not perceptible.

[000332] In further exemplary embodiments, the hole transport layer 102 is embodied as a 50 nm thick layer comprising NPB as matrix material and comprising Re_2O_5 as dopant having dopant concentrations of 5%, 20% and 50%. In this case, it is found that the perceptible color impression of the light-emitting diodes 1 in the switched-off electronic operating state changes from light blue to deep blue as the concentration of

the dopant increases. In the switched-on electronic operating state, by contrast, green electromagnetic radiation 193 is always emitted.

[000333] In a further exemplary embodiment, the hole transport layer 102 comprises NPB as matrix material and dirhodium tetratrifluoroacetate as dopant in the case of a thickness of 200 nm. While green electromagnetic radiation 193 is emitted in the switched-on electronic operating state, the hole transport layer 102 gives a bluish color impression in the switched-off electronic operating state.

[000334] An organic electronic component as a comparative component having a construction in accordance with figures 6A and 6B, but an undoped hole transport layer 102 composed of NPB, likewise emits green electromagnetic radiation 193, but gives only a pale blue color impression with low color saturation in the switched-off electronic operating state.

[000335] The exemplary embodiments in figures 6A and 6B, shown here purely by way of example, therefore show that a predetermined color impression can be set in the switched-off electronic operating state and can be chosen by means of the choice of matrix material and dopant, while the electromagnetic radiation emitted in the switched-on electronic operating state can always give the same luminous impression.

[000336] Figures 6C and 6D illustrate a further exemplary embodiment for an organic light-emitting diode 1 in a switched-off electronic operating state (figure 6C) and in a switched-on electronic operating state (figure 6D), which embodiment constitutes a modification of the previous exemplary embodiment.

[000337] In contrast to the organic light-emitting diode 1 in figures 6A and 6B, the organic light-emitting diode 1 here

additionally has a transparent second electrode 107 composed of a transparent metal film, and also an electron transport layer 106 between the radiation-emitting region 104 and the second electrode 107. Therefore, in the exemplary embodiment shown, the organic light-emitting diode 1 is embodied as an OLED which emits on both sides. The hole transport layer 107 can be embodied as described in connection with the previous exemplary embodiments and can give a light blue color impression, for example, in the switched-off electronic operating state.

[000338] The electron transport layer 106 comprises a matrix material and a dopant, which form charge transfer complexes which absorb part of the electromagnetic radiation 190 incident on the light-emitting diode 1 from outside with a second absorption spectrum. The non-absorbed electromagnetic radiation, here indicated by the arrows 192, can be perceived by an external observer as a predetermined color impression through the second electrode 102. In this case, the color impression which can be perceived through the electron transport layer 106 through the second electrode 107 in the switched-off electronic operating state can be different than the color impression which can be perceived through the first electrode 101 on account of the hole transport layer 102.

[000339] In the exemplary embodiment shown, the electron transport layer 106 is 150 nm thick and comprises BCP as matrix material and Cs_2CO_3 as dopant having a concentration of 10%. As a result, in the switched-off electronic operating state, the electron transport layer 106 gives a deep blue color impression for an external observer. In the switched-on operating state, as shown in figure 6D, this color impression is outshone by the electromagnetic radiation generated in the radiation-emitting region 104, which radiation gives a green luminous impression as in the previous exemplary embodiments.

[000340] While the organic light-emitting diode, in the

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switched-off electronic operating state, can give a different color impression through the hole transport layer 102 than through the electron transport layer 106, in the switched-on electronic operating state the same luminous impression is given on both sides through the electromagnetic radiation 193 generated in the radiation-emitting region 104.

[000341] In a further exemplary embodiment having a construction in accordance with figures 6C and 6D, the electron transport layer 106, given a thickness of 150 nm, comprises Bpyppy as matrix material and Cs_2CO_3 with a concentration of 10% as dopant. The charge transfer band of the electron transport layer 106 is so intensive that it determines the color impression through the second electrode 107. As a result, the electron transport layer 106 can give a red color impression in the switched-off electronic operating state, while green electromagnetic radiation is once again emitted in the switched-on electronic operating state.

[000342] It is possible to combine the exemplary embodiments in accordance with figures 1 to 6. Such a combination can result, for example, in a transparent organic light-emitting diode which emits on both sides and which appears colored in accordance with a desired color from both sides in the switched-off operating states and emits white light in the switched-on state.

[000343] The encapsulation and hermetic sealing of organic light-emitting diodes 1 described here is explained in greater detail below. The layer construction of the functional layers such as the electrodes 101, 107, and the organic layer sequence 133, can in this case be as described in conjunction with figures 1 to 6. Furthermore, the layer construction can follow any desired combination of the layers and materials described in conjunction with figures 1 to 6.

[000344] A further exemplary embodiment of an organic light-

emitting diode 1 described here is explained in greater detail in conjunction with figure 7, on the basis of a schematic plan view. Figure 8 shows an associated sectional illustration.

[000345] The organic light-emitting diode 1 comprises a first carrier 130 and a second carrier 131. In this case, first carrier 130 and second carrier 131 are preferably embodied in plate-like fashion. That is to say that first carrier 130 and second carrier 131 are substantially planar sheets. The functional layers of the organic light-emitting diode 1 are arranged between first carrier 130 and second carrier 131. In this way, first carrier 130 and second carrier 131 serve for encapsulating the organic layer sequence 133.

[000346] First carrier 130 and second carrier 131 can be formed from the same material or from different materials. At least one of the two carriers is at least partly transmissive to electromagnetic radiation generated in the radiation-emitting region 104 of the organic light-emitting diode 1. Furthermore, it is possible for both carriers to be at least partly transmissive to said electromagnetic radiation.

[000347] By way of example, at least one of the carriers is formed with a glass. That is to say that this carrier contains a glass or preferably consists of a glass. The glass can be, for example, a borosilicate glass. Furthermore, it is possible for the glass to be a soda-lime glass (also: window glass). A soda-lime glass is distinguished by lower production costs by comparison with a borosilicate glass.

[000348] If one of the two carriers is embodied as a non-radiation-transmissive carrier, then said carrier can consist of a metal or contain a metal or consist of a ceramic material or contain a ceramic material.

[000349] Furthermore, it is possible for first carrier 130 and second carrier 131 each to consist of a glass. The two

carriers can then also consist of the same glass.

[000350] The organic layer sequence 133 arranged between first carrier 130 and second carrier 131 can be electrically contact-connectable for example by means of the first electrode 101 and the second electrode 107, wherein first electrode 101 and second electrode 107 can be accessible from outside the organic light-emitting diode 1, as is indicated in figure 8, for example.

[000351] For the purpose of connecting first carrier 130 and second carrier 131, in the exemplary embodiments in figures 7 and 8, a connecting means 140 is situated between first carrier 130 and second carrier 131. The connecting means encloses the organic layer sequence 133 in a frame-like manner. In this case, the expression "in a frame-like manner" does not relate to the geometrical form of the course of the connecting means 140. All that is important is that the connecting means 140 laterally completely encloses the organic layer sequence 133. The connecting means 140 is therefore led as a track around the organic layer sequence 133, wherein the connecting means 140 can be in direct contact with first carrier 130 and second carrier 131.

[000352] The connecting means 140 can be, for example, a glass solder material, a glass frit material or an adhesive. Furthermore, it is possible for the organic light-emitting diode 1 to have, alongside the connecting means 140, a further connecting means, which is likewise arranged around the organic layer sequence 133 in a frame-like manner. The materials of the two connecting means can then differ from one another. By way of example, one connecting means can be formed with an adhesive, and the other connecting means can then be formed with a glass solder or a glass frit material.

[000353] An explanation is given, on the basis of the schematic sectional illustration in figure 9, of the fact that

the connecting means 140 can be hardened or softened by means of a source 145 of electromagnetic radiation 146.

[000354] If the connecting means 140 is, for example, an adhesive such as Nagase or ThreeBond, then it is possible to use the source 145 for locally curing the adhesive. In this case, the source 145 is arranged in such a way that hardly any or no electromagnetic radiation 146 at all impinges on the organic layer sequence 133. That is to say that the organic layer sequence 133 cannot be damaged by the electromagnetic radiation 146 of the source 145.

[000355] If the connecting means 140 is a glass solder or a glass frit material, then the glass solder or the glass frit material 140 can be softened by means of the electromagnetic radiation 146. The softened glass solder or glass frit material then wets at least one of the carriers, thereby giving rise to a hermetically impermeable seal of the organic light-emitting diode 1. In particular, in this case, the source 145 can be a laser which emits infrared radiation 146, for example, which penetrates through the second carrier 131 and is only absorbed in the connecting means 140.

[000356] Figure 10 shows, on the basis of a schematic sectional illustration, a further exemplary embodiment of an organic light-emitting diode 1 described here. The organic light-emitting diode 1 comprises a first carrier 130, which can consist of a glass, for example. The glass is preferably at least partly transmissive to electromagnetic radiation generated in the radiation-emitting region 104 of the organic light-emitting diode 1.

[000357] The first carrier 130 is succeeded by a connection line 155. The connection line 155 is a radiation-transmissive, electrically conductive layer. The connection layer 155 can be formed, for example, by one of the transparent electrode materials presented above. The first electrode 101 is arranged

on the connection line 155, said first electrode likewise being embodied in transparent fashion.

[000358] Busbars 157 can be arranged in or at the first electrode 101. The busbars can be formed by thin metal strips, for example. By way of example, a layer sequence having layers composed of chromium and aluminum is suitable for forming the busbars. Furthermore, the busbars can consist of aluminum, chromium, silver or mixtures of these materials. The busbars improve the transverse conductivity of the first electrode 101. They can be insulated from the overlying organic layer sequence 133 by an insulation layer, for example, such that current is not directly impressed from the busbars 157 into the organic layer sequence 133. The busbars 157 then serve only for the better distribution of electric current within the first, transparent electrode 101.

[000359] The organic layer sequence 133 is succeeded by the second electrode 107. The second electrode 107 is embodied in reflective fashion, for example, as described above.

[000360] The first electrode 101 can be electrically contact-connected from outside the organic light-emitting diode 1 by means of the connection location 152, which can be formed with a TCO material or a metal. The connection location 152 is electrically insulated from the second electrode 107 by means of an insulation layer 151 containing an electrically conductive material such as a resist, an epoxy resin or a silicon oxide.

[000361] During the operation of the organic light-emitting diode 1, an emission 108 of electromagnetic radiation generated in the organic layer sequence 133, in particular in the radiation-emitting region 104, is effected through the first carrier 130 toward the outside.

[000362] The organic light-emitting diode 1 furthermore has a

thin-film encapsulation 154 serving for encapsulating the organic layer sequence 133. The thin-film encapsulation 154 produces a basic impermeability to environmental influences, such as moisture and atmospheric gases, for the organic layer sequence 133. The thin-film encapsulation 154 can be applied by means of a PECVD method (plasma enhanced chemical vapor deposition), for example. The thin-film encapsulation 154 can, for example, consist of oxide and/or nitride layers, such as SiO or SiN, or contain said materials. In this case, it is also possible for the thin encapsulation 154 to comprise a layer sequence which alternately has nitride and oxide layers.

[000363] In this case, the thin-film encapsulation 154 can have lattice defects 163 (in this respect, also see figure 19). Said lattice defects 163 can result, for example, in so-called pinholes or other imperfections which lead to a permeability of the thin-film encapsulation 154 to atmospheric gases or moisture.

[000364] In the exemplary embodiment in figure 10, a diffusion barrier 153 is arranged on the thin-film encapsulation 154. The diffusion barrier 153 is formed from amorphous SiO_2, for example. In this case, the diffusion barrier 153 is deposited by means of atmospheric pressure plasma, for example. The diffusion barrier 153 can, in particular, also be deposited onto the side areas of the organic light-emitting diode 1. Thus, the diffusion barrier 153 can also cover the insulation layer 151 and the connection locations 152 at least in places. The organic light-emitting diode 1 is therefore encapsulated with the diffusion barrier 153 and protected from environmental protection influences both from its outer area facing away from the first carrier 130 and at its side areas.

[000365] The diffusion barrier 153 can also be applied by means of atmospheric pressure plasma in a plurality of individual layers. Consequently, the different partial regions

of the diffusion barrier 153 can also have different thicknesses. In this way, a diffusion barrier 153 of increased thickness can be applied where the risk of formation of lattice defects 163 is highest – for example at edges of layers.

[000366] An atmospheric pressure plasma (also called AP plasma or normal pressure plasma) is understood in this case to mean the special case of a plasma in which the pressure approximately corresponds to that of the surrounding atmosphere. The use of an atmospheric pressure plasma has some advantages over the use of a low-pressure plasma encapsulation technique. The apparatus outlay for coating with an atmospheric pressure plasma is significantly less than in the case of the low-pressure plasma. In the case of the low-pressure plasma it is necessary, for example, for the component that is to be coated to be introduced into a chamber and for the pressure then to be reduced therein. After the deposition process, the pressure has to be adapted to normal pressure again and the component has to be removed from the chamber again. In the case where an atmospheric pressure plasma is used, by contrast, it is not necessary to introduce the component – here the organic light-emitting diode 1 – into a closed chamber. The coating with the diffusion barrier 153 is therefore also possible on an assembly line, for example, using an atmospheric pressure plasma.

[000367] The diffusion barrier can have a thickness d of 50 nm to 1000 nm. Preferably, the diffusion barrier 153 has a thickness d of at least 100 nm and at most 250 nm. At the edges of the organic light-emitting diode 1, the thickness of the diffusion barrier 153 can also be chosen to be larger.

[000368] The diffusion barrier 153 can also be produced from individual layers. In this case, two or more individual layers can be deposited one above another. Each of the individual layers can have a thickness of, for example, at least 50 nm

and at most 100 nm. The impermeability of the overall layer can be increased by applying individual layers.

[000369] The diffusion barrier 153 can comprise silicon dioxide or consist thereof. In this case, the silicon dioxide can only be formed in the gas phase. In order to form the silicon dioxide, it is possible to use a silane and a further compound serving as oxygen source. By way of example, SiH_4 can be used as silane and N_2O as oxygen source.

[000370] Figure 11 shows, on the basis of a schematic sectional illustration, a further exemplary embodiment of an organic light-emitting diode described here. In contrast to the exemplary embodiment in figure 10, in this exemplary embodiment the diffusion barrier 153 is only arranged at the side areas of the organic light-emitting diode 1. Instead of a diffusion barrier 153, a resist layer 150 is applied to that outer area of the organic light-emitting diode which faces away from the first carrier 130. That is to say that, in this exemplary embodiment, the outer area facing away from the first carrier 130 is encapsulated by a combination of a thin-film encapsulation 154 with a resist layer 150.

[000371] A further exemplary embodiment of an organic light-emitting diode 1 described here is explained in greater detail in conjunction with figure 12. In contrast to the exemplary embodiment in figure 11, in this exemplary embodiment a diffusion barrier 153 produced by means of an atmospheric pressure plasma is arranged between the thin-film encapsulation 154 and the resist layer 150. The resist layer covers the diffusion barrier 153 at least in places.

[000372] A further exemplary embodiment of an organic light-emitting diode 1 described here is explained in greater detail in conjunction with figure 13. In contrast to the exemplary embodiment in figure 11, in this exemplary embodiment a diffusion barrier 153 produced by means of an atmospheric

pressure plasma is additionally applied to the resist layer 150. The diffusion barrier 153 covers the resist layer 150 at all exposed surfaces. A particularly impermeable encapsulation of the organic layer sequence 133 against external environmental influences is realized as a result.

[000373] A further exemplary embodiment of an organic light-emitting diode described here is explained in greater detail in conjunction with figure 14A. In this exemplary embodiment, the insulation layer 151, the connection location 152 and also the thin-film encapsulation 154 are covered at least in places by a pre-encapsulation layer 156, which serves for encapsulating the organic layer sequence 133 and as a planarization layer for the thin-film encapsulation 153 at the side areas of the organic light-emitting diode 1. The pre-encapsulation layer 156 can comprise, for example, a transparent epoxide or a radiation-transmissive adhesive. A second carrier 131 is applied to the pre-encapsulation layer 156, onto the outer area thereof which faces away from the first carrier 130. The second carrier 131 can be a glass plate, for example. It is then possible for an emission 108 to be effected both through the first carrier 130 and through the second carrier 131. The organic light-emitting diode 1 can then be an organic light-emitting diode 1 which emits on both sides. In this case, the diffusion barrier 153 produced by means of atmospheric pressure plasma serves substantially for laterally sealing the organic light-emitting diode 1.

[000374] In this case, it is furthermore possible that first carrier 130 and second carrier 131 can be formed by mutually different materials. By way of example, one of the two carriers can be formed by a non-radiation-transmissive material, such as a metal plate, for example.

[000375] Furthermore, it is possible for first carrier 130 and second carrier 131, as described in conjunction with figures 7 and 8, for example, to be connected to one another

by means of a connecting means 140. The connecting means can then be a glass solder or a glass frit material or an adhesive. The connecting means 140 is additionally sealed by the diffusion barrier 153 at the side areas of the organic light-emitting diode 1. Such a organic light-emitting diode 1 is elucidated in greater detail in figure 14B on the basis of a schematic sectional illustration.

[000376] In conjunction with figures 15, 16, 17, 18 and 19, exemplary embodiments of organic light-emitting diodes 1 described here are explained in greater detail wherein at least parts of the organic light-emitting diode 1 are encapsulated by at least two encapsulation layers 161, 162 forming an encapsulation layer sequence 160. That is to say that the encapsulation layer sequence 160 has at least one first encapsulation layer 161 and a second encapsulation layer 162, as a result of which an efficacious and effective encapsulation is made possible. In this case, the effective encapsulation can be brought about precisely by the combination of the two encapsulation layers 161, 162.

[000377] The first encapsulation layer 161 and the second encapsulation layer 162 can each comprise materials suitable for protecting the organic light-emitting diode 1 against harmful influences of the surroundings, such as atmospheric gases and moisture, through the combination of the first encapsulation layer 161 and the second encapsulation layer 162. In this case, the first encapsulation layer 161 and the second encapsulation layer 162 can each comprise an inorganic material or consist of an inorganic material.

[000378] The first encapsulation layer 161 can comprise or consist of an oxide, a nitride or an oxynitride. By way of example, the oxide, nitride or oxynitride can comprise aluminum, silicon, tin, zinc, titanium, zirconium, tantalum, niobium or hafnium. Particularly preferably, the first layer can comprise silicon nitride, such as, for instance, Si_2N_3,

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silicon oxide (SiO_x), such as, for instance, silicon dioxide, aluminum oxide, such as, for instance, Al_2O_3, and/or titanium oxide, such as TiO_2. Furthermore, the first encapsulation layer 161 can also consist of a TCO material or contain such a TCO material. Furthermore, it is possible for the first encapsulation layer 161 to comprise or consist of a metal or a metal alloy. In this case, the first encapsulation layer 161 can comprise aluminum and/or aluminum alloys, for example.

[000379] The abovementioned materials can be applied by means of plasma enhanced chemical vapor deposition (PECVD), for example, in order to produce the first encapsulation layer 161. In this case, a plasma can be generated in a volume above and/or around the radiation-emitting layer sequence 133 and the electrodes 101, 107, wherein at least two gaseous starting compounds are fed to the volume, which starting compounds can be ionized in the plasma and excited to react with one another. The generation of the plasma can make it possible that the temperature to which the at least one surface of the component has to be heated in order to make it possible to produce the first encapsulation layer 161 can be lowered in comparison with a plasmaless CVD method.

[000380] As an alternative thereof, the first encapsulation layer 161 can be applied by means of physical vapor deposition, such as sputtering, for instance.

[000381] Furthermore, the first encapsulation layer 161 can also comprise a glass or consist of a glass. In this case, the glass can, for example, comprise one or a plurality of the abovementioned oxides and be able to be applied by means of plasma spraying.

[000382] In the case of plasma spraying, an arc can be generated in a so-called plasma torch between at least one anode and at least one cathode by means of high voltage, through which arc a gas or gas mixture can be conducted and

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thereby ionized. The gas or gas mixture can comprise argon, nitrogen, hydrogen and/or helium, for example. By way of example, pulverulent material for the first encapsulation layer 161 can be sprayed into the plasma flow generated by the arc and the gas or gas mixture flow. The pulverulent material can be melted by the temperature of the plasma and applied to the top side 107a of the second electrode 107, for example, by means of the plasma flow. The pulverulent material can be provided, for example, with an average grain size of less than or equal to a few hundred micrometers, preferably less than or equal to 100 µm, and furthermore greater than or equal to 100 nm, preferably greater than or equal to 1 µm. The more finely the material is provided, that is to say the smaller the average grain size, the more uniformly the first encapsulation layer 161 can be applied. The more coarsely the material is provided, that is to say the larger the average grain size, the more rapidly the first encapsulation layer 161 can be applied. Furthermore, the structure and also the quality of the first encapsulation layer can depend on the speed, the temperature and/or the composition of the plasma gas.

[000383] As an alternative to plasma spraying, a first encapsulation layer 161 comprising glass can also be applied by means of flame spraying or by means of a thermal evaporation method.

[000384] The abovementioned methods for applying the first encapsulation layer 161 enable the latter to be applied cost-effectively with a high growth rate. In particular, after application, the first encapsulation layer 161 can have a thickness d of greater than or equal to 50 nm, and particularly preferably a thickness d of greater than or equal to 100 nm. Furthermore, the first encapsulation layer 161 can have a thickness d of less than or equal to 1 µm. By means of such a thick first encapsulation layer, the encapsulation arrangement, alongside the encapsulation, can also enable a

mechanical protection of the organic light-emitting diode 1 against damaging external influences.

[000385] The abovementioned methods, in particular at temperatures of the component of less than 120°C, and particularly preferably of less than 80°C, enable the first encapsulation layer 161 to be able to be applied directly on the component, without the component or parts thereof being damaged.

[000386] The volume structure of the first encapsulation layer 161 can be present, for example, in crystalline and/or polycrystalline form. In this case, it can be possible for the volume structure of the first encapsulation layer to have, for example, structural and/or lattice defects 163 such as, for example, dislocations, grain boundaries and/or stacking faults.

[000387] Furthermore, the first encapsulation layer 161 can have, on the side which faces away from the organic layer sequence 133 and on which the second encapsulation layer 162 is arranged, a surface structure in the form of macroscopic topographical structures such as, for instance, slopes, elevations, angles, edges, corners, depressions, trenches, grooves, microlenses and/or prisms and/or in the form of microscopic topographical structures such as, for instance, a surface roughness and/or pores (in this respect, see figure 19, in particular). In this case, structures of the surface structure which are resolvable by means of visible light are ascribed to the macroscopic structures, while microscopic structures are precisely no longer resolvable by means of visible light. That can mean that here structures designated as macroscopic have dimensions of greater than or equal to approximately 400 nm, while microscopic structures have dimensions which are less than approximately 400 nm.

[000388] The surface structure can be governed by the

abovementioned application methods themselves or else be producible, in particular in the case of macroscopic structures, by suitable further method steps such as, for instance, the deposition through a mask and/or subsequent processing by means of mechanical and/or chemical removing methods. Macroscopic structures can be suitable for light refraction and/or scattering, for example, in the case of a transparent encapsulation layer sequence 160.

[000389] In particular both the abovementioned structural and lattice defects of the volume structure of the first encapsulation layer 161 and pores in the surface structure of the first encapsulation layer 161 can form undesirable permeation paths for moisture and/or oxygen, which can enable or at least facilitate diffusion through the first encapsulation layer.

[000390] The second encapsulation layer 162 can be suitable for enabling, in combination with the first encapsulation layer 161, the hermetically impermeable encapsulation of the organic light-emitting diode 1. For this purpose, the second encapsulation layer 162 can be suitable, in particular, for sealing the abovementioned permeation paths that can occur in the first encapsulation layer.

[000391] For this purpose, the second encapsulation layer 162 can be arranged directly on the first encapsulation layer 161 and in direct contact with the first encapsulation layer 161. That can mean that the second encapsulation layer 162 has a common interface with the first encapsulation layer 161, and furthermore an upper surface facing away from the common interface. The common interface is arranged, for example, at the top side 161a of the first encapsulation layer 161.

[000392] The second encapsulation layer 162 can be embodied in such a way that it can at least partly or approximately follow the surface structure of the first encapsulation layer

161, which can mean that, in particular, the top side of the second encapsulation layer 162 also at least partly or approximately follows the topographical structure of the interface.

[000393] The fact that the upper surface of the second encapsulation layer 162 at least partly follows the interface between the first 161 and second encapsulation layer 162 and hence the surface structure of the first encapsulation layer 161 can mean here and hereinafter that the upper surface of the second encapsulation layer 162 likewise has a topographical surface structure. In this case, the topographical surface structure at the top side 162a of the second encapsulation layer 162 can preferably be embodied identically or similarly to the topographical surface structure at the top side 161a of the first encapsulation layer 161. "Identically" or "similarly" can mean in connection with two or more topographical surface structures, in particular, that the two or more topographical surface structures have identical or similar height profiles with mutually corresponding structures, such as elevations and depressions, for instance. By way of example, the two or more topographical surface structures in this sense can each have elevations and depressions arranged laterally alongside one another in a specific characteristic sequence which, for example, apart from relative height differences between the elevations and depressions, are identical for the two or more topographical surface structures.

[000394] In other words, one surface which at least partly follows the topographical surface structure of another area can have an elevation, arranged above an elevation of the topographical surface structure of the other area, or a depression, arranged above a depression of the topographical surface structure of the other area. In this case, the relative height difference between adjacent elevations and depressions of said one surface can also be different than the

relative height difference between the corresponding elevations and depressions of the topographical surface structure of the other area.

[000395] In other words, that can mean that the upper surface of the second encapsulation layer and the interface between the first and second encapsulation layers run parallel or at least approximately parallel. Thus, the second encapsulation layer can have a thickness which is independent or approximately independent of the surface structure of that surface of the first encapsulation layer which faces away from the component. "Approximately parallel", "approximately independent" and "approximately constant" can mean, with regard to the thickness of the second encapsulation layer, that the latter has a thickness variation of less than or equal to 10%, and particularly preferably of less than or equal to 5%, measured in relation to the total thickness of the second encapsulation layer. Such an embodiment of the second encapsulation layer with such a small thickness variation can also be designated as so-called "conformal coating".

[000396] Furthermore, the second encapsulation layer 162 can have a thickness d which is smaller than the dimensions of at least some structures and, in particular, the abovementioned macroscopic structures of the surface structure of the first encapsulation layer. In particular, the second encapsulation layer can also follow those microscopic structures of the surface structure of the first encapsulation layer whose dimensions are larger than the thickness of the second encapsulation layer.

[000397] The thickness of the second encapsulation layer 162 can furthermore be independent of a volume structure of the first encapsulation layer. That can mean that the first encapsulation layer has no thickness variation of greater than 10% and particularly preferably no thickness variation of

greater than 5% even over the partial regions of the first encapsulation layer in which abovementioned lattice and/or structural defects 163 of the volume structure of the first encapsulation layer 161 are situated and which extend, in particular, as far as the common interface 161a with the second encapsulation layer 162.

[000398] Furthermore, the thickness d of the second encapsulation layer 162 can, in particular, also be independent of openings, elevations, depressions and pores in that surface of the first encapsulation layer which faces the second encapsulation layer. In the case where such surface structures are greater than the thickness d of the second encapsulation layer 162 with regard to their dimensions, they can be covered by the second encapsulation layer with uniform and, in the sense above, at least virtually identical thickness by virtue of the second encapsulation layer 162 following the surface structure. In the case where the surface structures are less than or equal to the thickness of the second encapsulation layer 162 with regard to their dimensions, the second encapsulation layer 162 can cover the structure structures without following the latter, and in this case, however, likewise have an, in the above sense, at least virtually constant thickness.

[000399] In particular, the second encapsulation layer 162 can seal openings and/or pores in the first encapsulation layer which have a depth-to-diameter ratio of greater than or equal to 10, and particularly preferably of greater than or equal to 30. The encapsulation layer sequence 160 can have the at least approximately identical thickness d of the second encapsulation layer 162, as described here, in particular also when the first encapsulation layer 161 has a surface structure having overhanging structures, in particular overhanging macroscopic structures, having negative angles.

[000400] Furthermore, the second encapsulation layer 162 can

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have a volume structure which is independent of the surface structure of the top side 161a of the first encapsulation layer 161 facing the second encapsulation layer 162. In addition, the second encapsulation layer 162 can have a volume structure which is independent of the volume structure of the first encapsulation layer 161. That can mean that surface- and/or volume-specific properties and features of the first encapsulation layer 161 such as, for instance, the abovementioned surface structures and/or lattice and/or structural defects in the volume structure of the first encapsulation layer 161 have no influence on the volume structure of the second encapsulation layer.

[000401] The second encapsulation layer 162 can comprise an oxide, a nitride and/or an oxynitride as described in connection with the first encapsulation layer. Particularly preferably, the second encapsulation layer can comprise aluminum oxide, for instance Al_2O_3, and/or tantalum oxide, for instance Ta_2O_5.

[000402] In particular, the second encapsulation layer 162 can have a volume structure having a higher amorphicity, that is to say irregularity in the sense of short-range and/or long-range order of the materials contained, than the first encapsulation layer. That can mean, in particular, that the second encapsulation layer has such a high amorphicity that no crystallinity or crystal structure can be ascertained. In this case, the second encapsulation layer 162 can be completely amorphous, such that the materials forming the second encapsulation layer 162 have no measurable short-range and/or long-range order, but rather have a purely statistical, irregular distribution.

[000403] As a reference for ascertaining the amorphicity of the second encapsulation layer 162 and also of the first encapsulation layer 161, in this case a shallow angle measurement in an X-ray diffractometer can be used, for

example, in which no crystallinity in the form of a crystalline, partly crystalline and/or polycrystalline structure can be ascertained for the amorphous second encapsulation layer 162.

[000404] Although encapsulation layers having a crystalline, that is to say non-amorphous, volume structure often have a higher density than encapsulation layers having an amorphous volume structure, it was surprisingly ascertained in conjunction with the device comprising the encapsulation layer sequence 160, as described here, that the second encapsulation layer 162, if it has a high amorphicity, nevertheless enables, in combination with the first encapsulation layer 161, a hermetically impermeable encapsulation layer sequence 160. In particular, it can be advantageous in this case that the amorphous second encapsulation layer 162 does not continue structural and/or lattice defects 163 of the first encapsulation layer 161, such that, as a result, no continuous permeation paths for moisture and/or oxygen through the encapsulation arrangement can form either. Precisely through the combination of the first encapsulation layer 161 with the amorphous second encapsulation layer 162 it is possible to achieve an encapsulation layer sequence 160 which has a hermetic impermeability with respect to moisture and/or oxygen and at the same time a sufficiently large total thickness also to ensure a mechanical protection of the component.

[000405] The second encapsulation layer 162 can be producible on the first encapsulation layer 161 by a method in which the surface structure and/or the volume structure of the first encapsulation layer 161 have no influence on the volume structure of the second encapsulation layer 162 to be applied. The second encapsulation layer 162 can be producible, in particular, by means of a method such that the material or materials to be applied for the second encapsulation layer 162 can be applied without long-range order, that is to say with an irregular distribution for producing an amorphous volume

structure. In this case, the second encapsulation layer 162 can be applied, for example, in the form of individual layers of the material or materials to be applied, so-called monolayers, wherein each of the monolayers follows the surface structure of the area to be coated. In this case, the constituents and materials of a monolayer can be distributed and applied in a statistically and distributed manner and independently of one another on the entire area to be coated, wherein, particularly preferably, the entire area is covered continuously with the monolayer. In this case, the area to be coated can be that surface of the first encapsulation layer 161 which faces away from the organic layer sequence 133 or a monolayer already applied on the first encapsulation layer 161.

[000406] A method which enables such individual layers to be applied can be designated as a variant of atomic layer deposition. Atomic layer deposition (ALD) can designate a method in which, in comparison with an above-described CVD method for producing an encapsulation layer 162 on a surface, firstly a first of at least two gaseous starting compounds is fed to a volume, in which the component is provided. The first starting compound can adsorb on the surface. For the encapsulation layer sequence 160 described here it can be advantageous if the first starting compound adsorbs irregularly and without a long-range order on the surface. After preferably complete or virtually complete covering of the surface with the first starting compound, a second of the at least two starting compounds can be fed in. The second starting compound can react with the first starting compound adsorbed at the surface as irregularly as possible but preferably with complete area coverage, as a result of which a monolayer of the second encapsulation layer 162 can be formed. As in the case of a CVD method, it can be advantageous if the at least one surface is heated to a temperature above room temperature. As a result, the reaction for forming a monolayer can be thermally initiated. In this case, the surface

temperature, which, for example, can also be the component temperature, that is to say the temperature of the component, can depend on the starting materials, that is to say the first and second starting compounds. By repeating these method steps, a plurality of monolayers can successively be applied one on top of another. In this case, for the production of the encapsulation layer sequence 160 described here it is advantageous if the arrangements of the materials or starting compounds of the individual monolayers are independent of one another from monolayer to monolayer, such that an amorphous volume structure can form not only laterally along the extension plane of the surface to be coated, but also into the height.

[000407] The first and second starting compounds can be, for example, in connection with the materials mentioned further above for the second encapsulation layer, organometallic compounds such as, for instance, trimethyl metal compounds and also oxygen-containing compounds. In order to produce a second encapsulation layer comprising Al_2O_3, it is possible to provide, for example, trimethylaluminum and also water or N_2O as starting compounds.

[000408] A plasmaless variant of atomic layer deposition ("plasmaless atomic layer deposition", PLALD) can in this case designate an ALD method for which no plasma is generated, as described below, but rather in which, in order to form the monolayers, the reaction of the abovementioned starting compounds is initiated only by means of the temperature of the surface to be coated.

[000409] The temperature of the at least one surface and/or of the component can be, for example, greater than or equal to 60°C and less than or equal to 120°C in the case of a PLALD method.

[000410] A plasma enhanced variant of atomic layer deposition

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("plasma enhanced atomic layer deposition", PEALD) can designate an ALD method in which the second starting compound is fed in with simultaneous generation of a plasma, as a result of which, as in the case of PECVD methods, it can be possible for the second starting compound to be excited. As a result, in comparison with a plasmaless ALD method, the temperature to which the at least one surface is heated can be reduced and the reaction between starting compounds can nevertheless be initiated by the generation of plasma. In this case, the monolayers can be applied, for example, at a temperature of less than 120°C and preferably less than or equal to 80°C. In order to produce further monolayers, the steps of feeding in the first starting compound and then feeding in the second starting compound can be repeated.

[000411] The degree of amorphicity of the second encapsulation layer 162 can be implemented by the choice of suitable starting compounds, temperatures, plasma conditions and/or gas pressures.

[000412] After application, the second encapsulation layer 162 can be applied in a thickness d of greater than or equal to 1 nm, particularly preferably of greater than or equal to 10 nm, and less than or equal to 30 nm. That can mean that the second encapsulation layer 162 has greater than or equal to 1 monolayer, particularly preferably greater than or equal to 10 monolayers, and less than or equal to 50 monolayers of the materials of the second encapsulation layer. By virtue of the high density and quality of the second encapsulation layer 162, such a thickness can be sufficient to ensure an effective protection against moisture and/or oxygen for the underlying component in combination with the first encapsulation layer 161. On account of the small thickness d of the second encapsulation layer 162, a short process time and hence a high economic viability of the encapsulation arrangement described here can be ensured. The encapsulation layer sequence 160 can, in particular, be arranged directly and immediately on an

electrode 107, 101. That can mean that the first encapsulation layer 161 of the encapsulation layer sequence 160 is arranged directly and immediately for example on the second electrode 107.

[000413] Furthermore, the encapsulation layer sequence 160 can have a third encapsulation layer, which is arranged between the first encapsulation layer 161 and the organic layer sequence 133. In this case, the third encapsulation layer can comprise, in particular, an inorganic material as described in connection with the second encapsulation layer 162. Furthermore, the third encapsulation layer can be amorphous. Furthermore, the third encapsulation layer can have one or a plurality of further features as described in connection with the second encapsulation layer 162. Furthermore, the second and third encapsulation layers can be embodied identically.

[000414] The first encapsulation layer 161 can be arranged directly and immediately on the third encapsulation layer. Furthermore, the third encapsulation layer can be arranged directly on the component. In this case, the third encapsulation layer can enable, for the first encapsulation layer, a homogeneous application surface independently of the surface of the component.

[000415] Furthermore, the encapsulation layer sequence 160 can have a plurality of first 161 and a plurality of second encapsulation layers 162 which are arranged alternately one above another, wherein the encapsulation layer arranged the closest to the organic layer sequence 133 is a first encapsulation layer 161. The first 161 and second encapsulation layers 162 of the plurality of the first 161 and second encapsulation layers 162, respectively, can each be embodied identically or differently. In this case, here and hereinafter, a "plurality" can mean at least a number of two.

[000416] By means of such repetition of the encapsulation layer construction comprising the first and second encapsulation layers, the encapsulation of the organic light-emitting diode 1 can be improved. Furthermore, the mechanical robustness of the encapsulation layer sequence 160 can be increased. The optical properties of the encapsulation arrangement can be adapted through a suitable choice of the materials of the respective first and second encapsulation layers.

[000417] The following can also be explained in concrete terms with respect to the individual figures 15 to 19:

[000418] A further exemplary embodiment of an organic light-emitting diode 1 described here is explained in greater detail in conjunction with figure 15, on the basis of a schematic sectional illustration. The organic light-emitting diode 1 comprises a first carrier 130. The first carrier can be formed from a radiation-transmissive material, such as a glass, for example, or a non-radiation-transmissive material, such as a metal or a ceramic material, for example. The functional layers 180, that is to say the first electrode 101, the organic layer sequence 133 and also the second electrode 107, are arranged on the first carrier 130. A first encapsulation layer 161, as has just been explained in greater detail, is applied to the side areas and also at the top side 107a of the second electrode 107. The exposed outer area of the first encapsulation layer 161 is completely covered by the second encapsulation layer 162, which is likewise constructed in the manner just explained. The first encapsulation layer 161 and the second encapsulation layer 162 form the encapsulation layer sequence 160.

[000419] A further exemplary embodiment of an organic light-emitting diode 1 described here is explained in greater detail in conjunction with figure 16, on the basis of a schematic sectional illustration. In contrast to the exemplary

embodiment described in conjunction with figure 15, the first carrier 130 in this exemplary embodiment is embodied as a flexible carrier. In this case, the flexible carrier is hermetically sealed all around by an encapsulation layer sequence 60 described above. As an alternative to the first carrier 130 being encapsulated all around, it is also possible for only the top side of the flexible carrier facing the organic layer sequence 133 to be provided with the encapsulation layer sequence 160. At all events, a carrier which is flexible and at the same time sealed hermetically impermeably against external influences such as moisture and atmospheric gases is realized in this way. The first carrier 130 can, in this way, be formed for example by an inherently gas- and/or moisture-permeable plastic film which can hermetically terminate the organic light-emitting diode 1 on account of the encapsulation with the encapsulation layer sequence 160.

[000420] A further exemplary embodiment of an organic light-emitting diode 1 described here is explained in greater detail in conjunction with figure 17, on the basis of a schematic sectional illustration. In this exemplary embodiment, the first carrier 130 and the functional layers 180 arranged on the first carrier 130 are enclosed jointly, all around by the encapsulation layer sequence 160. Such an embodiment is particularly well suited to the formation of a flexible organic light-emitting diode 1. In this case, the first carrier 130 can be configured in flexible fashion, for example as a film. The functional layers 180 are encapsulated jointly with the first carrier 130, thus resulting in a certain flexibility for the entire organic light-emitting diode. That is to say that the organic light-emitting diode is pliable and suitable for withstanding a multiplicity of bending cycles without being damaged.

[000421] A further exemplary embodiment of an organic light-emitting diode described here is explained in greater detail

in conjunction with figure 18. In this exemplary embodiment, the organic light-emitting diode comprises two carriers 130, 131. Both carriers 130, 131 can be embodied as rigid carriers. By way of example, the carriers 130, 131 are each formed with a glass or consist of a glass. The carriers 130, 131 are connected to one another by a connecting means 140 such as is described further above with figures 7 or 8, for example. The connecting means 140 is, for example, a glass solder or a glass frit material. The connecting means 140 adjoins the second carrier 131 and the first carrier 130 at least in places at its top side 140a and its underside 140b, respectively. The side areas 140c of the connecting means 140 are sealed with the encapsulation layer sequence 160. In this case, the encapsulation layer sequence 160 can also extend over the side areas of first carrier 130 and second carrier 131 (not illustrated).

[000422] Figure 18 represents a general example of the fact that the sealing and encapsulation techniques described here can be combined with one another. Thus, the encapsulation layer sequence 160 described in conjunction with figures 15 to 19 can also be combined in combination with the connecting means 140 described here, the diffusion barrier 153, the thin-film encapsulation 154, the pre-encapsulation layer 156 and/or the resist layer 150. Depending on the requirements made of the organic light-emitting diode 1, therefore, it is possible to choose an encapsulation which enables a longest possible lifetime of the organic light-emitting diode 1 in the respective environment in which the organic light-emitting diode 1 is intended to be used.

[000423] In conjunction with figure 19, the encapsulation layer sequence 160 having the first encapsulation layer 161 and the second encapsulation layer 162 is illustrated in an enlarged fashion. As can be seen from figure 19, the top side 161a of the first encapsulation layer, on which the second encapsulation layer 162 is applied, has a surface structure in

the form of a roughness brought about, for example, by the application method by which the first encapsulation layer 161 is produced. Furthermore, the volume structure of the first encapsulation layer 161 has structural or lattice defects 163, such as pores or dislocations, for instance, which are indicated merely schematically and purely by way of example. In this case, the structural and lattice defects 163 can extend – as shown – as far as the top side 161a of the first encapsulation layer 161, that is to say as far as the interface between the first 161 and the second encapsulation layer 162. The second encapsulation layer 162 is embodied in such a way that structural and lattice defects 163 of this type have no influence on the volume structure of the second encapsulation layer 162. The second encapsulation layer 162 is therefore embodied with a uniformly amorphous volume structure and covers the first encapsulation layer 161 over the whole area, as a result of which possible permeation paths for moisture and/or atmospheric gases which are formed by lattice and structural defects 163 of the volume structure of the first encapsulation layer 161 are also sealed. As a result, a hermetic encapsulation of the organic light-emitting diode 1, in particular against moisture and/or oxygen, can be made possible by means of the encapsulation layer sequence 160 and, in particular, by means of the combination of the first 161 and the second encapsulation layer 162.

[000424] In particular the encapsulation techniques described in conjunction with figures 10 to 19 and combinations of these encapsulation techniques are particularly well suited to the formation of a flexible organic light-emitting diode. A flexible organic light-emitting diode 1 is distinguished, inter alia, by the fact that it is pliable to a certain degree, without being damaged in the process. Preferably, the organic light-emitting diode 1 embodied in a flexible fashion is repeatedly pliable without being damaged in the process. The organic light-emitting diode 1 is then suitable, therefore, for withstanding a plurality of bending cycles

without being damaged. Particularly preferably, the organic light-emitting diode 1 can be embodied, for example, flexibly such that it can be wound up onto a roll and can be unwound from the roll, without being damaged in the process.

[000425] In particular the encapsulation layer sequence 160 described here enables such a flexible organic light-emitting diode 1. In order to form a flexible organic light-emitting diode 1, the encapsulation of the organic light-emitting diode is also embodied in a flexible fashion. In this case, flexible means, inter alia, that the encapsulation is pliable to a certain degree, without the encapsulation being damaged in the course of bending.

[000426] Furthermore, in the case of a flexible organic light-emitting diode 1, the first 130 and the second carrier 131 are also embodied in a flexible fashion. By way of example, the carriers 130, 131 are a thin glass layer, a laminate or a film. By way of example, the flexible carrier 130, 131 can be a plastic-glass-plastic laminate or a plastic-metal-plastic laminate.

[000427] A further exemplary embodiment of an organic light-emitting diode 1 described here is explained in greater detail in conjunction with figure 20. In this case, the organic light-emitting diode comprises at least a first electrode 101, an organic encapsulation layer sequence 133 and a second electrode 107. A sputtering protective layer 170 is applied between the organic layer sequence 133 and the second electrode 107. The sputtering protective layer 170 is an electrically conductive, inorganic protective layer.

[000428] The organic layer sequence 133 is protected against impairment and/or damage, in particular during the production of the organic light-emitting diode 1, by means of the electrically conductive, inorganic sputtering protective layer 170. Such impairment or damage can occur, for instance, during

the production of the organic light-emitting diode 1. Such impairment or damage of the organic layer sequence 133 can then result in a shorter lifetime of the organic light-emitting diode 1 or in a lower luminance of the electromagnetic radiation generated by the organic light-emitting diode 1.

[000429] By way of example, the second electrode 107 is deposited onto the organic layer sequence 133 by means of a high-energy process, such as sputtering. Such a high-energy process can lead, in the absence of the sputtering protective layer 170, to damage to the organic layer sequence 133 as a result of the bombardment of the organic layer sequence 133 with gas ions and/or the material to be applied by sputtering. By means of the high-energy process, by way of example, a second electrode 107 consisting of a TCO material or a metal can be applied to the organic layer sequence 133.

[000430] The sputtering protective layer 170 can comprise for example a transition metal oxide, which can comprise for example tungsten oxide, vanadium oxide, molybdenum oxide, rhenium oxide, nickel oxide or combinations or mixtures thereof or consists of these materials. Furthermore, the sputtering protective layer 170 can also comprise metals, such as magnesium or silver, for instance.

[000431] In the exemplary embodiment in accordance with figure 20, the sputtering protective layer 170 contains or consists of a transition metal oxide, such as WO_3, V_2O_5, MoO_3, Re_2O_7 or NiO. The second electrode 107 is applied above the sputtering protective layer 170. The second electrode 107 is applied directly to the sputtering protective layer 170 for example by means of a high-energy deposition process, such as sputtering.

[000432] The possibilities for encapsulation, sealing and for protection of the organic layer sequence 133 against damage

and external influences, as described in conjunction with figures 7 to 20, can be used for all of the organic light-emitting diodes and luminaires described here. In particular, any combination of the organic light-emitting diodes 1 described in conjunction with figures 1 to 6 can be combined by means of one or a combination of the organic light-emitting diodes 1 described in conjunction with figures 7 to 20. In this way, it is possible to produce, for example, organic light-emitting diodes 1 which emit white light, are transparent, emit on both sides and are protected against external influences particularly well by means of diffusion barriers, thin-film encapsulations, encapsulation layer sequences, and/or connecting means. Combinations of the protection methods for organic light-emitting diodes 1, as described in conjunction with figures 7 to 20, can result for example in a organic light-emitting diode 1 which has an organic layer sequence 133 hermetically sealed by means of an encapsulation layer sequence 160, wherein the organic layer sequence 133 encapsulated in this way is arranged between a first carrier 130 and a second carrier 131. In this case, first carrier 130 and second carrier 131 can be connected to one another by means of a connecting means 140, such as a glass solder, for example. The organic light-emitting diode 1 is then distinguished by a particularly good encapsulation which allows the organic light-emitting diode to be used, for example, in particularly moist rooms, such as a bathroom. Such an organic light-emitting diode 1 can then even be used in the vicinity of or in sanitary installations such as a bath tub or a shower.

[000433] In the case of the exemplary embodiments described in conjunction with figures 1 to 20, the radiation exit areas of the organic light-emitting diode 1 are in each case embodied in flat fashion. Such organic light-emitting diodes 1 generally have a Lambertian emission characteristic. In conjunction with figures 21 to 25, exemplary embodiments of organic light-emitting diodes 1 described here will now be

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described in greater detail, wherein the organic light-emitting diode 1 has a directional emission profile.

[000434] In conjunction with figure 21, a first exemplary embodiment of an organic light-emitting diode 1 having a directional emission profile as described here is explained in greater detail on the basis of a schematic perspective illustration. The organic light-emitting diode 1 comprises functional layers 180 having, for example, a first electrode 101, a second electrode 107 and an organic layer sequence 133 arranged between first electrode 101 and second electrode 107.

[000435] The organic light-emitting diode 1 furthermore has a second carrier 131. The second carrier 131 comprises a structured radiation exit area 175. The structured radiation exit area 175 has a multiplicity of first areas 175a and second areas 175b. The first areas 175a are inclined by an angle α relative to a plane running, for example, parallel to the main extension plane (xy plane) of the organic layer sequence 133. The second areas 175b are inclined by an angle β relative to said plane.

[000436] The emission of electromagnetic radiation generated in the organic layer sequence 133 is effected through the second carrier 131 and the radiation passage area 175. In this case, the structured radiation exit area 175 can be applied in the form of a separate layer onto the top side of the second carrier 131 facing away from the organic layer sequence 133. Furthermore, it is possible for the structured radiation exit area 175 to be formed by a structuring of the second carrier 131. Furthermore, it is possible that, instead of the second carrier 131, for example, an encapsulation layer sequence 160 such as is described in greater detail in conjunction with figures 15 to 19 is arranged on the second electrode 107. In this case, for example, the second encapsulation layer 162 can be embodied as a structured radiation exit area. In this case, the second encapsulation layer can be arranged directly on the

first encapsulation layer 161. This is indicated by the dashed line in figure 21.

[000437] In the exemplary embodiment in figure 21, the structured radiation exit area 175 is structured into a multiplicity of prisms arranged parallel to one another, wherein the first areas 175a and the second areas 175b form the top area of the organic light-emitting diode 1 facing away from the organic layer sequence 133. For reasons of clarity, in each case only two of the multiplicity of first areas 175a and second areas 175b are illustrated in figure 21.

[000438] Neither the first areas 175a nor the second areas 175b are arranged parallel to the organic layer sequence 133. Consequently, these areas are also not arranged parallel to the plane (xy plane) in which the organic light-emitting diode 1 – that is to say for example the organic layer sequence – is embodied in planar fashion.

[000439] In this case, the extent of the prisms in the y direction is preferably of macroscopic orders of magnitude, that is to say for example in the range of millimeters to decimeters. For example, the extent of the prisms in the y direction can extend over the entire length of the organic light-emitting diode 1. The width of the prisms in the x direction is preferably greater than the wavelength of the light generated by the organic light-emitting diode 1, such that diffraction effects at the prisms hardly or do not take place. The width of the prisms is preferably of microscopic orders of magnitude, for example in the submillimeters range, such that a structuring in the x direction of the radiation exit area 175 is not visible to the human observer. The width b of a prism can be 500 µm or less, preferably 250 µm or less. The length l of a prism can be 1 cm or more, preferably 5 cm or more.

[000440] The first areas 175a of the structured radiation

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exit area 175 are embodied as transparent or at least radiation-transmissive, whereas the second areas 176 are reflective to the electromagnetic radiation generated in the organic light-emitting diode. The second areas 175b can be made reflective at a shallow angle of incidence for example by vapor deposition with metal particles.

[000441] In this way, in the exemplary embodiment of figure 21, only the first areas 175a constitute radiation exit areas of the organic light-emitting diode 1. That is to say that electromagnetic radiation can leave the organic light-emitting diode 1 only through the first areas 175a. In this way, the organic light-emitting diode 1 has an emission profile which has a main emission direction inclined relative to the z axis in the direction of the x axis. In this case, the inclination angle of the main emission direction of the organic light-emitting diode 1 is substantially determined by the angle α.

[000442] Electromagnetic radiation which is generated by the organic layer sequence 133 and which is reflected at the second areas 175b can likewise emerge from the light-emitting device through the radiation-transmissive first areas 175a after one or more internal reflections. Alternatively, it is possible for the organic light-emitting diode 1 to be an organic light-emitting diode 1 which emits on both sides and in which the organic layer sequence 133 and also the electrodes 101, 107 are embodied in radiation-transmissive fashion. In this way, reflected radiation can emerge from the organic light-emitting diode 1 for example on the opposite side of the radiation exit area 175 illustrated. In this case, the opposite radiation exit area can also be structured in the manner described, thus resulting in an organic light-emitting diode 1 which emits electromagnetic radiation directionally on both sides.

[000443] The angles α and β at which the first 175a and second areas 175b are arranged influence the angular

distribution of the emitted electromagnetic radiation and the frequency of the internal reflections.

[000444] The structured radiation exit area 175 can be, for example, a separate, correspondingly structured film applied to the second carrier 131. Furthermore, it is possible – as already discussed above – for the structured radiation exit area 175 to be structured directly into the second carrier 131 or to be formed by part of an encapsulation layer sequence 160.

[000445] Different emission profiles (angle-dependent distribution of the emitted intensity) of organic light-emitting diodes 1 having a structured radiation exit area 175 are illustrated in conjunction with figure 22. Firstly, the underlying coordinate system is illustrated in figure 22a. The organic light-emitting diode 1 forms, with its lateral organic layer sequence 133 embodied in planar fashion, the xy plane of the coordinate system. In the case of a non-structured radiation exit area 175, a Lambertian emission profile in the direction of the z axis generally arises for the organic light-emitting diode 1. Directional emission profiles can then be achieved by means of the structuring of the radiation exit area 175.

[000446] By way of example, in conjunction with figures 22b and 22c, a type A-1 and type A-2 emission profile, respectively, is shown, which is distinguished by a symmetrical, cardioid radiation direction distribution having two maxima both in the x direction and in the y direction (type A-1) or in one of the two directions (type A-2). Such emission patterns are particularly well suited for example to general lighting in rooms.

[000447] The emission profile shown in figure 22d, called type B, is greatly asymmetrical in at least one of the directions x and y and is particularly well suited for example

to directional lighting. By way of example, such an emission profile can be used for desk lighting in which a work area is illuminated in a directional fashion without dazzling the user. Such an emission profile can be achieved with the exemplary embodiment of an organic light-emitting diode 1 described here as described in conjunction with figure 21.

[000448] In conjunction with figure 23, a further exemplary embodiment of an organic light-emitting diode 1 described here is explained in greater detail on the basis of a perspective schematic illustration.

[000449] In this exemplary embodiment, the top side of the first carrier 130 facing the functional layers 180 is structured into parallel prisms having first areas 175a and second areas 175b. The lateral, planar extent of the organic light-emitting diode 1 and thus of the first carrier 130 lies in the xy plane. Relative to this xy plane, the first areas 175a are inclined by the angle α and the second areas 175b by the angle β. The functional layers 180 are applied to the first areas 175a. The second areas 175b are free of functional layers. In this case, the first carrier 130 can be formed for example with a metal, with a glass, with a ceramic material or with a plastic material. In this case, the first carrier can, in particular, also be embodied in flexible fashion and is formed by a film or a laminate.

[000450] An encapsulation and hermetic sealing of the organic light-emitting diode 1 described in conjunction with figure 23 can be effected for example by means of an encapsulation layer sequence 160 or by other encapsulation methods described in conjunction with figures 7 to 19.

[000451] Advantageously and in contrast to the exemplary embodiment illustrated in conjunction with figure 21, the functional layers 180 in the exemplary embodiment in figure 23 can be separately drivable. In this way, the brightness of the

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light generated by the organic light-emitting diode 1 can be regulated particularly well by more or fewer of the functional layers 180 being energized – depending on the desired brightness. Furthermore, it is possible for the functional layers 180 to differ particularly with regard to the construction of the organic layer sequence 133, such that different functional layers can emit electromagnetic radiation having different wavelengths.

[000452] In conjunction with figure 24, a further exemplary embodiment of an organic light-emitting diode 1 described here is explained in greater detail on the basis of a schematic perspective illustration. In this exemplary embodiment, the first carrier 130 is structured into a multiplicity of parallel prisms. In contrast to the exemplary embodiment in figure 23, not only the first areas 175a are covered with functional layers 180, but also the second areas 175b are covered with functional layers 180.

[000453] In the case of the exemplary embodiment in figure 24, the structured radiation exit area 175 is structured in the form of prisms having the cross section of an isosceles triangle. The arrangement shown results in a symmetrical emission characteristic of the type A-2, with two main radiation directions which are inclined from the z axis by the angle $\alpha = \beta$ in positive and negative x directions. In the y direction, to a first approximation a Lambertian emission profile arises given a sufficient extent of the organic light-emitting diode 1. If the angles a and β are chosen not to be identical, the two main radiation directions are inclined from the z axis by different angles. At the same time, the intensity with which emission is effected in the main emission direction differs on account of the resultant areas of the functional layers 180 having different magnitudes.

[000454] Further possibilities for the structuring of the first carrier 130 or generally for the structuring of the

radiation exit area 175 are described in conjunction with figures 25a, b, c on the basis of schematic sectional illustrations. In the exemplary embodiment described in conjunction with figure 25a, the angles a and β are chosen to have different magnitudes. This results in a distribution of the type A-2 with different intensities in both main emission directions. For an organic light-emitting diode 1 which emits on both sides, for example, the underside of the first carrier 130 can also be correspondingly structured, as is indicated by the dashed line in figure 25a.

[000455] With reference to figures 25b and 25c it is clarified that the structuring of the radiation exit area 175 need not necessarily be effected by the formation of plane areas 175a, 175b arranged at specific angles with respect to one another, rather that a structuring can be effected in any desired way, for example in the manner of cylinder sections and the like.

[000456] Overall, with reference to figures 21 to 25 it is clarified that an organic light-emitting diode 1 having a directional emission characteristic can be specified by means of the structuring of carriers, encapsulation layers and/or functional layers. In this case, the beam directing can be effected for example by reflection, refraction and/or corresponding orientation of the functional layers 180.

[000457] Corresponding structurings can be used for all of the encapsulation and sealing techniques described in conjunction with figures 7 to 20. Furthermore, it is possible to use all of the radiation-emitting layer sequences described in conjunction with figures 1 to 6 for organic light-emitting diodes 1 having a directional emission characteristic. Any desired combinations of the organic light-emitting diodes 1 described in conjunction with figures 1 to 25 are also possible.

[000458] A further exemplary embodiment of an organic light-emitting diode 1 described here is explained in greater detail in conjunction with the schematic sectional illustrations in figures 26A and 26B. The organic light-emitting diode 1 described in conjunction with figures 26A and 26B is particularly well suited to the illumination of an area 185a to be illuminated of an element 185 to be illuminated.

[000459] The area 185a to be illuminated of the element 185 is, for example, part of an outer area of the element 185 to be illuminated.

[000460] By way of example, the element 185 to be illuminated can be a tile, a poster, a slab, a traffic sign, an information board, a sign, an image or any other element. The element 185 to be illuminated can also be a mirror, for example, which has a reflective mirror area as area 185a to be illuminated.

[000461] The organic light-emitting diode 1 is applied at least indirectly to the element 185 to be illuminated. The organic light-emitting diode 1 can be fixed for example directly on the element 185 to be illuminated. By way of example, the organic light-emitting diode 1 can be adhesively bonded by means of a transparent adhesive onto the element 185 to be illuminated. Other fixing methods such as hook and loop fasteners, screw connections, clamping connections, press-fit connections or the like are also possible.

[000462] The organic light-emitting diode 1 is a radiation-transmissive, preferably a transparent organic light-emitting diode 1 such as is described here.

[000463] In the exemplary embodiment in figures 26A and 26B, the organic light-emitting diode 1 comprises a first carrier 130 and a second carrier 131. The functional layers 180, that is to say for example the first electrode 101, the second

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electrode 107 and also the organical layer sequence 133, are arranged between first carrier 130 and second carrier 131. In this case, the organic light-emitting diode 1 can be encapsulated as described here. That is to say that the organic light-emitting diode 1 need not have two carriers 130, 131, rather it can, for example, also be encapsulated by means of a diffusion barrier 153, a thin-film encapsulation 154, a pre-encapsulation layer 156 and/or an encapsulation layer sequence 160. In this case, it is also possible, in particular, for the organic light-emitting diode 1 with the encapsulation layer sequence 160 to be applied, for example adhesively bonded, onto the area 185a to be illuminated of the element 185 to be illuminated. Furthermore, it may be advantageous if the organic light-emitting diode 1 is embodied in flexible fashion. It can then be adapted particularly well to the course of the area 185a to be illuminated.

[000464] Figure 26a shows the organic light-emitting diode 1 in a switched-off operating state. That is to say that no electromagnetic radiation is generated in the radiation-emitting region 104 of the organic light-emitting diode 1. Electromagnetic radiation 190 impinging from outside on the area 185a to be illuminated can penetrate through the transparent organic light-emitting diode 1 and is reflected from the area 185a to be illuminated. In this way, an observer sees only the area 185a to be illuminated, for example an image, a traffic sign, an information board, a mirror or the like.

[000465] Figure 26b illustrates the organic light-emitting diode 1 schematically in a switched-on operating state. In this switched-on operating state, the radiation-emitting region 104 of the organic light-emitting diode 1 emits electromagnetic radiation 191, which impinges on the area 185a to be illuminated and is at least partly reflected there. Furthermore, electromagnetic radiation 193 can also emerge directly from the organic light-emitting diode 1, without

impinging beforehand on the area 185a to be illuminated. The relative ratio of the intensities of indirectly emerging electromagnetic radiation 192 and directly emerging electromagnetic radiation 193 can be adjustable and selectable for example by means of an optical cavity or else by means of first electrodes 101 and second electrodes 107 having different degrees of transparency.

[000466] In this case, an "optical cavity" can mean, here and hereinafter, in particular, that the organic light-emitting diode 1 forms an optical resonator in which electromagnetic radiation having one or more specific wavelengths and/or one or more specific emission directions can preferably be generated, which can also be designated as resonances or modes. For this purpose, by way of example, the first electrode 101, the organic layer sequence 133 and the second electrode 107 can be embodied as an optical cavity. That can mean that the at least partly transparent first electrode 101 and the at least partly transparent second electrode 107 additionally also have a reflectivity for the electromagnetic radiation generated in the radiation-emitting region 104. Alternatively or additionally, the first electrode 101, the organic layer sequence 133 and the second electrode 107 can be arranged between partly reflective layers, which additionally are also partly transparent. The following description of the optical cavity is explained purely by way of example for partly reflective electrodes 101, 107.

[000467] The first electrode 101 and/or the second electrode 107 can have a reflectance R and/or R', respectively, and the organical layer sequence 133 can have a refractive index n for the electromagnetic radiation generated in the radiation-emitting region 104. Since the first 101 and second electrode 107 are partly transparent, $R<1$ and $R'<1$ hold true in this case. The refractive index n can be constant over the organic layer sequence 133 or can be constant at least in partial regions, for example in different organic layers. Furthermore,

the refractive index n can also vary over the organic layer sequence 133. The radiation-emitting region 104 of the organic layer sequence can have a thickness d and can be arranged in a manner spaced apart with an average distance L from the first electrode 101 and with an average distance L' from the second electrode 107. In this case, the average distance L and the average distance L' designate the distances from the first electrode 101 and from the second electrode 107, respectively, which are averaged over the thickness d of the radiation-emitting region 104. In this case, the parameters R, R', n, d, L and L' can be chosen in such a way that the organic layer sequence has a specific emission characteristic.

[000468] By way of example, the reflectances R and R' of the first and second electrodes and the refractive index n of the organic layer sequence 133 can be predetermined on account of the respective choice of material, such that the desired emission characteristic can be made possible by the choice of the average distances L and L' and the thickness d of the radiation-emitting region 104. As an alternative thereto, the dimensions of the organic layer sequence 133 and of the radiation-emitting region 104, that is to say the average distances L and L' and the thickness d can be predetermined, for example by the construction or the method for production of the organic light-emitting diode 1. In this case, the desired emission characteristic can be made possible by the choice of the material for the first 101 and second electrode 107 by way of the reflectance R and R' thereof.

[000469] By way of example, the average distances L and L' can be of the order of magnitude of the wavelength of the electromagnetic radiation generated in the radiation-emitting region 104, or smaller. If the electromagnetic radiation has a spectral distribution of a plurality of wavelengths and/or wavelength ranges, the electromagnetic radiation can in this case also be characterized by an average wavelength and the dimensions of the organic layer sequence 133, here and

hereinafter, can be related to the average wavelength of the electromagnetic radiation.

[000470] Furthermore, the average distances L, L' can also be less than or equal to half the wavelength of the electromagnetic radiation, or less than or equal to a quarter of the wavelength of the electromagnetic radiation, or even less than or equal to an eighth of the wavelength of the electromagnetic radiation. Furthermore or additionally, the average distances L and L' can be greater than or equal to 1/20 of the wavelength of the electromagnetic radiation or else greater than or equal to 1/10.

[000471] Such average distances L and L' can bring about, in conjunction with the partly reflective first 101 and second electrode 107, the formation of an at least semilaterally reflective cavity in the radiation-emitting layer sequence. In this case, a photon or wave packet emitted by an excited state (exciton) in the radiation-emitting region 104 can be reflected at the first electrode 101 and at the second electrode 107. By virtue of the fact that the average distances L and L' can be of the order of magnitude of the wavelength of the electromagnetic radiation or smaller, when expressed in a simplified way, a feedback of the emitted wave packet with the excited state can still be possible during the emission of the wave packet, such that the excited state, during the emission of the wave packet, can be influenced by the electromagnetic field of its "own" reflected wave packet. Depending on the phase angle of the reflected wave packet, an amplification or attenuation of the emission of the excited state can thus be made possible. In this case, the phase angle can be dependent on the refractive index n of the organic layer sequence 133, the reflectivities R, R' of the first 101 and second electrode 107 in conjunction with the penetration depth of the electromagnetic radiation into the first 101 and second electrode 107, and also on the distances between the excited state and the first 101 and second electrode 107 in

conjunction with the emission direction of the wave packet. As a result, a mode structure which can foster and/or bring about an emission of the electromagnetic radiation in specific directions can be formed in the organic layer sequence. Furthermore, the thickness d of the radiation-emitting region 104 can also influence the formation of emission modes.

[000472] The organic light-emitting diode 1 can have an emission characteristic of the electromagnetic radiation generated in the radiation-emitting region 104, such that the electromagnetic radiation is emitted with a first intensity in the direction of the element 185 to be illuminated and is emitted with a second intensity in the direction of the radiation exit area 174. In this case, the first intensity and the second intensity can be defined at outer areas of the organic light-emitting diode 1, that is to say, for example, at surfaces of the first 101 or second electrode 107, of a carrier 130, 133, or of an encapsulation layer sequence 160, which face away from the organic layer sequence 133. "Intensity in the direction" of the element 185 to be illuminated and of the radiation exit area 174 can respectively denote, for the first and second intensities, the respective total intensity into the half-spaces on that side of the organic light-emitting diode 1 which faces and respectively faces away from the element 185 to be illuminated.

[000473] In this case, the electromagnetic radiation having the first intensity, which is emitted from the organic light-emitting diode 1 in the direction of the element 185 to be illuminated, can illuminate the at least partly non-transparent area 185a to be illuminated. By virtue of the fact that the area 185a to be illuminated is at least partly non-transparent, at least part of the electromagnetic radiation having the first intensity can be reflected in the direction of the radiation exit area 174 and be perceptible by an external observer through the radiation exit area 174. In

other words, that can mean that, for an external observer, the area 185a to be illuminated of the carrier element can be illuminated and thus perceptible in a switched-on operating state of the organic light-emitting diode 1. This can be the case, in particular, if the first intensity is greater than the second intensity.

[000474] In this case, such an emission characteristic can be made possible, for example, by the optical cavity as described above.

[000475] Alternatively or additionally, the first 101 and second electrode 107 can have mutually different transmissivities. If, for instance, the first electrode 101 is arranged on that side of the organic layer sequence 133 which faces the element 185 to be illuminated, and has a greater transmissivity than the second electrode 107, it can be possible that the electromagnetic radiation generated in the radiation-emitting region 104 is emitted with a first intensity in the direction of the element 185 to be illuminated, said first intensity being greater than the second intensity.

[000476] As an alternative thereto, the second intensity can be greater than the first intensity. Such an emission characteristic can be made possible, in turn, by means of an optical cavity, for example. Alternatively or additionally, by way of example, the second electrode 107 can be arranged on that side of the organic layer sequence 133 which faces away from the element 185 to be illuminated, and can have a greater transmissivity than the first electrode 101. In this case, it can be possible that the area 185a to be illuminated is perceptible less clearly in comparison with the switched-off operating state of the organic light-emitting diode 1 since an external observer can perceive the reflected electromagnetic radiation having the first intensity and the electromagnetic radiation having the second intensity that is emitted directly

via the radiation exit area of the radiation-emitting arrangement, as a superimposition. Furthermore, in the switched-on operating state, the area 185a to be illuminated can be no longer perceptible at all if the electromagnetic radiation having the first intensity that is reflected at the at least partly non-transparent main surface is outshone in the above sense by the electromagnetic radiation having the second intensity.

[000477] Thus, the organic light-emitting diode 1 and the radiation exit area 174 can appear transparent in the switched-off operating state and can appear non-transparent or likewise at least transparent in the switched-on operating state, depending on the ratio of the first intensity to the second intensity.

[000478] The organic light-emitting diode 1 can be embodied such that it is structured for example in such a way that, in the switched-on operating state, the area 185a to be illuminated is perceptible through first regions of the radiation exit area 174 and not through second regions. In this case, the organic light-emitting diode 1 can, for example, emit electromagnetic radiation only in partial regions or else emit electromagnetic radiation over a large area. As a result of such segmented illumination and/or segmented emission of the electromagnetic radiation in the direction of an external observer, it can be possible that, for example, different illumination patterns can be generated or indications or information can be inserted temporarily. In the switched-off operating state, these patterns, indications and/or information are not visible and do not impair the appearance and the perceptibility of the area to be illuminated.

[000479] On account of the adjustable intensity ratio it is possible, therefore, that an observer perceives directly emitted light 193, for example only from the organic light-

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emitting diode 1. Furthermore, it is possible that the observer perceives principally the area 185a to be illuminated of the element 185 to be illuminated. This is possible when the electromagnetic radiation 193 emitted directly toward the outside has a lower intensity than the electromagnetic radiation 191 directed onto the area 185a to be illuminated.

[000480] Furthermore, the impression of the area 185a to be illuminated which is perceived by the observer can also be achieved by an alteration of the wavelength of the light generated by the organic light-emitting diode 1 during operation. For a particularly realistic rendering of the area 185a to be illuminated, however, it may be desirable for the organic light-emitting diode 1 to be a organic light-emitting diode 1 which emits white light and which is transparent. One of the organic light-emitting diodes 1 described here can be used for this purpose.

[000481] In conjunction with figure 27, a further exemplary embodiment of an organic light-emitting diode 1 described here is explained in greater detail on the basis of a schematic sectional illustration. In this exemplary embodiment, in contrast to the exemplary embodiment in figures 26a and 26b, the first carrier 130 is replaced by an encapsulation layer sequence 160 such as is described here. The organic light-emitting diode 1 is once again a transparent organic light-emitting diode 1, which preferably emits white light. An electrically switchable optical element 186 is arranged between the organic light-emitting diode 1 and the element 185 to be illuminated. By way of example, said electrically switchable optical element can be an electrically switchable diffuser. Said diffuser can have two functional states: firstly it can be switched to be diffusely scattering, that is to say opaque; secondly the diffuser can be switched to be transparent.

[000482] By way of example, the diffuser can be formed by an

electrode pair having planar, transparent electrode layers, between which a liquid crystal layer is arranged. By applying an external voltage, it is possible to influence the transmission of electromagnetic radiation through the diffuser in a targeted manner.

[000483] If the electrically switchable optical element 186 is switched to be diffuse, as is illustrated in figure 27, electromagnetic radiation 192 generated by the organic light-emitting diode 1 is diffusely scattered in the electrically switchable optical element 186. To the observer, therefore, the area to be illuminated can be perceived only in a blurred fashion or is no longer perceptible at all. In this way, it is possible for the arrangement of organic light-emitting diode 1, electrically switchable optical element 186 and element 185 to be illuminated to be used in the sense of a luminaire for general lighting.

[000484] When the electrically switchable optical element 186 is switched to be transparent, the area 185a to be illuminated is visible.

[000485] In the exemplary embodiment in figure 27, it can be expedient when the area 185a to be illuminated and the element 185 to be illuminated are themselves transparent. In this way, the arrangement constitutes a transparent luminaire which can be switched to be diffuse as necessary. Such luminaires can be used, for example, as changing cubicles, room dividers or similar elements. Even in the state switched to be diffuse, electromagnetic radiation can still pass through the switchable optical element 186 and thus through the element 185. In this way, the organic light-emitting diode 1 with the switchable optical element 186 and the element 185 to be illuminated serves as a luminaire which emits on both sides and which is visually impenetrable.

[000486] Furthermore, it is possible for the electrically

switchable optical element 186 to be an electrochromic element which can change its color when an external voltage is applied. In this way, by way of example, the light reflected back from the area 185a to be illuminated can be dimmed - depending on the magnitude of the applied voltage.

[000487] Overall, in the case of the exemplary embodiment in figure 27, it is also possible for the area 185a to be illuminated to be a mirror. In this case, by means of the electrically switchable optical element 186, the mirror can be switched from a reflective operating state to a diffusely scattering and hence illuminating operating state.

[000488] In the case of the exemplary embodiment in figure 27, it is furthermore also possible for the electrically switchable optical element 186 to be structured in such a way that there are regions in which no electrically switchable optical element 186 is arranged between the organic light-emitting diode 1 and the area 185a to be illuminated. In this way, by way of example, patterns or spatially delimited color shadings can be produced by means of the electrically switchable optical element 186.

[000489] A further exemplary embodiment of an organic light-emitting diode 1 is explained in greater detail in conjunction with figure 28. In this exemplary embodiment, a wavelength conversion substance 187 is disposed downstream of the organic layer sequence 133 at least in an emission direction. In this case, it is possible - as illustrated in figure 28 - for the organic light-emitting diode 1 to be a organic light-emitting diode 1 which emits on both sides, wherein a wavelength conversion substance 187 is disposed downstream of the organic light-emitting diode 1 in both main emission directions. For different main emission directions it is possible to use different wavelength conversion substances 187.

[000490] By way of example, blue light is emitted in the

radiation-emitting region 104 of the organic light-emitting diode 1. The organic light-emitting diode 1 which emits on both sides can then emit white light in one direction and colored light, for example, in the other direction. In this case, the desired color impression can respectively be set by the choice of a suitable wavelength conversion substance 187. By way of example, the following wavelength conversion substances 187 are appropriate for this purpose: garnets of rare earths and of the alkaline earth metals, for example YAG:Ce^{3+}, furthermore also nitrides, nitridosilicates, sions, sialons, aluminates, oxides, halophosphates, orthosilicates, sulfides, vanadates, perylenes, cumarin and chlorosilicates, or mixtures of these substances.

[000491] In the exemplary embodiment in figure 28, the wavelength conversion substance 187 is introduced into the first carrier 130 and also the second carrier 131. However, the wavelength conversion substance 187 can also be applied into a matrix material as a layer onto an outer area of the first carrier 130 and/or of the second carrier 131. Furthermore, it is possible for the organic light-emitting diode 1 to have no or only one carrier and to be encapsulated differently. On the basis of the exemplary embodiment in figure 28, all that is elucidated in more specific detail is that the electromagnetic radiation emitted by the organic light-emitting diode 1 during operation can also be determined or concomitantly determined by the use of wavelength conversion substances with regard to its color impression.

[000492] Figures 29 and 30 show, on the basis of schematic sectional illustrations, exemplary embodiments of organic light-emitting diodes which in each case have a retroreflector 183.

[000493] A retroreflector is a reflective optical element which, for a large range of angles of incidence, reflects incident ambient light back substantially in the same

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direction from which it comes. To put it another way, a part of a light beam that is incident on the retroreflector 183 and a part of said light beam that is reflected by the retroreflector run substantially parallel. In this case, the angle of incidence is the angle between the incident part of the light beam and the normal to the surface of a main extension plane of the retroreflector 183.

[000494] In particular, the incident and reflected parts form an angle of less than or equal to 15°, preferably of less than or equal to 10°, particularly preferably of less than or equal to 5°. An upper limit for the angle of incidence is, for example, greater than or equal to 45°, preferably greater than or equal to 60°, particularly preferably greater than or equal to 75°.

[000495] In this case, the retroreflector 183 preferably exhibits slight scattering. To put it another way, the incident part of the light beam is reflected back into a narrow, divergent beam cone. The beam cone has a central axis that runs substantially parallel to the incident part of the light beam, that is to say forms therewith for example an angle of less than or equal to 15°, preferably of less than or equal to 10°, and particularly preferably of less than or equal to 5°. The beam cone can have an aperture angle of 5° or less.

[000496] The retroreflection by the retroreflector 183 into a narrow, divergent beam cone is advantageous if the light beam incident from an external light source – such as a headlight of a vehicle – is not intended to be reflected back directly into the external light source, but rather is intended to be perceived for example by an observer in the vicinity of the external light source – for instance by the vehicle driver.

[000497] In the exemplary embodiment in accordance with figure 29, the electrodes 101, 107 and also the organic layer

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sequence 133 are embodied as at least radiation-transmissive, preferably transparent. In this case, the functional layers 180 are applied to a first carrier 130, which can be formed for example by a transparent film or with a glass. At all events, the first carrier 130 is preferably embodied in transparent fashion. Purely by way of example, the organic light-emitting diode 1 in the exemplary embodiment in figure 29 is encapsulated with an encapsulation layer sequence 160 composed of first encapsulation layer 161 and second encapsulation layer 162, as described here. Alternatively, all other encapsulation methods and combinations of these encapsulation methods as described here are also possible for forming the organic light-emitting diode 1.

[000498] The organic light-emitting diode 1 can be, in particular, a organic light-emitting diode 1 that is transparent, emits white light and is embodied in flexible fashion. The organic light-emitting diode 1 is applied to the retroreflector 183 at its outer area facing away from the organic layer sequence 133, that is to say with the first carrier 130.

[000499] In the present case, the retroreflector 183 is formed from a reflective plate 182, into which radiation shaping elements 182 are introduced. By way of example, the radiation shaping elements 182 are pyramidal depressions. In this case, the radiation shaping elements 182 can constitute so-called triple mirrors. To put it another way, each radiation shaping element 182 preferably has exactly three side areas. In this case, the side areas can each form an angle of approximately 90°, for example an angle of between 85° and 95°, with one another, inclusive of the limits.

[000500] The radiation shaping elements 182 can be impressed into the reflective plate 181. Preferably, the reflective plate 181 consists of a reflective metal for this purpose.

[000501] In contrast to the exemplary embodiment in figure 29, in the exemplary embodiment in figure 30 the retroreflector is formed by a part of the first carrier 130. By way of example, the first carrier 130 is embodied as a transparent plastic film or as a glass substrate. The radiation shaping elements 182 are situated as depressions on that side of the first carrier 130 which faces away from the organic layer sequence 133. The radiation shaping elements are coated from said side preferably with a reflective layer, for example a metal layer applied by vapor deposition.

[000502] Furthermore, a color filter 184 is disposed downstream of the organic layer sequence 133, which color filter can be formed for example by color filter particles introduced into the first encapsulation layer 161. Furthermore, it is possible for a color filter 184 as a separate component to be disposed downstream of the organic layer sequence 133 or to be applied as a separate layer onto the encapsulation layer sequence 160.

[000503] The color filter 184 has a high transmission for a first spectral subrange of the visible wavelength spectrum and high absorption for a second spectral subrange of the visible wavelength spectrum. An intensity maximum of the electromagnetic radiation generated by the radiation-emitting region 104 during operation lies within the first spectral subrange transmitted by the color filter 184. As an alternative to a color filter, it is also possible for the retroreflector 183 itself to contain a wavelength-selective mirror layer for reflecting the ambient light, which layer reflects the first subrange and absorbs and/or transmits the second subrange.

[000504] Advantageously, that portion of the ambient light which is reflected back by the retroreflector 183 to the radiation exit area 174 and is coupled out from the organic light-emitting diode 1 produces in this way substantially the

same color impression as the light emitted by the organic light-emitting diode 1. Advantageously, therefore, the organic light-emitting diode 1 brings about the same color impression independently of the operating state.

[000505] For embodiments in which only the color impression is of importance, the retroreflector 183 can in this case also be replaced by any other layer embodied in reflective fashion, or some other element embodied in reflective fashion, which need not have retroreflective properties.

[000506] In conjunction with figures 31A and 31B, an exemplary embodiment of an organic light-emitting diode 1 described here is explained in greater detail on the basis of schematic sectional illustrations, the organic light-emitting diode comprising a touch sensor in this exemplary embodiment. By way of example, functions of the organic light-emitting diode 1 or of other devices can be controlled by means of the touch sensor.

[000507] In the exemplary embodiment in figures 31A and 31B, the organic light-emitting diode comprises a first carrier 130, a functional layer sequence 180 arranged onto the first carrier, and also a second carrier 131. In this case, the encapsulation of the organic light-emitting diode can be effected as described here. With that side of the first carrier 130 which faces away from the functional layers 180, the organic light-emitting diode 1 is applied to an element 185 to be illuminated, said element comprising an area 185a to be illuminated.

[000508] Figure 31B illustrates the fact that pictorial representations of operating elements 197a, 197b, 197c are applied to the area 185a to be illuminated. During the operation of the organic light-emitting diode, said operating elements can be illuminated by electromagnetic radiation generated in the radiation-emitting region 104.

[000509] A third electrode 195 is arranged at that side of the second carrier 131 which faces away from the functional layers 180. The third electrode 195 is succeeded by a covering plate 196. The covering plate can be, for example, a transparent film, sheet or layer. The covering plate 196 can serve as anti-scratch protection. Furthermore, it is possible for the covering plate 196 to increase the light coupling-out of electromagnetic radiation generated in the organic light-emitting diode 1.

[000510] The third electrode 195 is electrically conductively connected to a current source 198, which can be operated with DC current or in a pulsed manner. Field lines 198a are thereby generated by the organic light-emitting diode 1. By way of example, a finger or a pen that touches the covering plate 196 alters the profile of the electric field lines 198a. With the aid of an evaluation circuit 199, it is possible to determine the position of the finger, for example, and in this way to effect the assignment to the operation of one of the operating elements 197a, 197b, 197c.

[000511] In this case, it is also possible for some other touch sensor to be used instead of the above-described capacitively operating touch sensor integrated into an organic light-emitting diode described here.

[000512] Such touch sensors are for example also described in the documents DE 10332956 A1 and DE 10308514 A2, the disclosure content of which is hereby incorporated by reference.

[000513] Furthermore, it is also possible for the operating elements 197a, 197b, 197c not to be represented by images on an area 185a to be illuminated, but rather for the organic light-emitting diode 1 to be constructed at least in places in the manner of a simple organic display suitable for

representing simple images or pictograms.

[000514] Luminaires 2 are explained in greater detail below. The luminaires 2 can be luminaires 2 for general lighting such as lamps or lights which have further functions - besides their use for general lighting. Thus, the luminaires 2 can form a concealing screen, noise protection, protection against rain or a splash guard, solar protection or the like. In the luminaires 2 described below, in each case at least one organic light-emitting diode 1 as described in conjunction with figures 1 to 31 can be used as light source. Furthermore, combinations of the organic light-emitting diodes 1 described in conjunction with figures 1 to 31 can also be used as light source.

[000515] The luminaire 2 described in conjunction with figures 32A to 32G has a wake-up function besides its function for general lighting. That is to say that the luminaire 2 forms a light - for example for room lighting, and an alarm clock. By means of the wake-up function, a user of the luminaire 2 can be woken up at a time of day that can be set, by means of the brightness of the luminaire being increased.

[000516] Figure 32A shows an exemplary embodiment of such a luminaire 2 on the basis of a schematic perspective illustration. In this case, the luminaire 2 is fixed in the manner of a picture on a wall 204. In this case, figure 32A shows the luminaire 2 in a switched-off operating state.

[000517] The luminaire 2 comprises, for example, an organic light-emitting diode 1 as explained in greater detail in conjunction with figures 26 and 27. That is to say that the organic light-emitting diode 1 of the luminaire 2 can be transparent and disposed downstream in an area 185a to be illuminated. The area 185a to be illuminated of the organic light-emitting diode 1 is, for example, a picture, a poster, wallpaper, tiles or the like. Furthermore, the area 185a to be

illuminated can be the reflective surface of a mirror.

[000518] As can be seen from figure 32A, in the switched-off state of the luminaire 2, the area 185a to be illuminated is visible through the transparent layers of the organic light-emitting diode 1.

[000519] Figure 32B shows the luminaire 2 in a switched-on operating state. In this operating state, the area 185a to be illuminated is no longer discernible. This can be achieved, for example, by utilizing an optical cavity, as described in conjunction with figures 26A and 26B. Furthermore, this can be achieved by means of an electrically switchable optical element 186, as described for example in conjunction with figure 27. The luminaire 2 therefore has at least two operating states: in a first operating state, the area 185a to be illuminated is discernible; in a second operating state, the luminaire 2 serves only for general lighting.

[000520] An exemplary embodiment of the luminaire 2 is explained in greater detail with reference to the basic schematic diagram in figure 32C. In this case, the luminaire 2 comprises the organic light-emitting diode 1 and also a driving device 201. An activation time for the luminaire 2 can be set by means of the driving device 201. Said activation time can be a desired wake-up time t1, for example.

[000521] It is possible in this case for the driving device 201 to regulate only two operating states of the organic light-emitting diode 1. Thus, by means of the driving device 201, the organic light-emitting diode 1 can be switched from the switched-off operating state into the switched-on operating state with maximum light intensity Imax at the desired wake-up time t1.

[000522] In another embodiment of the luminaire 2, as explained with reference to the graphical plot in figure 32D,

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however, a slow, continuous increase in the light intensity I up to the maximum light intensity Imax takes place at the wake-up time t1.

[000523] In this case, it can be seen from the graphical plot in figure 32D that the light intensity generated by the organic light-emitting diode 1 assumes a finite value as a result of the organic light-emitting diode 1 being switched on at the wake-up time t1 and rises slowly from there. Such a rise can take place, for example, by means of a correspondingly slow increase in the current intensity with which the organic light-emitting diode 1 is operated. Furthermore, it is possible for the light intensity I to be increased by means of pulse width modulation. A combination of these two possibilities can also prove to be advantageous.

[000524] An alternative possibility for slowly increasing the light intensity I is described in greater detail with reference to the graphical illustration in figure 32E. Here, starting from the wake-up time t1, the light intensity I is increased in steps, the light intensity in each case being kept constant for certain time intervals t2.

[000525] Overall, the temporal profiles of the light intensity as described in conjunction with figures 32D and 32E enable the user of the luminaire to be woken up particularly gently. The light intensity increases from a light intensity I=0 up to a light intensity Imax over a time period of 5 minutes, for example.

[000526] In this case, the light intensity Imax is preferably at least 1000 cd, particularly preferably at least 5000 cd. In the extreme case it is possible for the light intensity Imax to be 10 000 cd.

[000527] Such high light intensities are possible in particular with the phosphorescent emitter materials described

in conjunction with figures 1 to 6. On account of their high efficiency, these materials allow particularly bright light to be generated. A possible temporal delay of the radiation emission by said phosphorescent emitter materials is not of importance in the case of the luminaire 2 in accordance with the exemplary embodiments in figures 32D and 32E, since the light intensity I is intended to be increased relatively slowly.

[000528] By way of example, the luminaire 2 can comprise an organic light-emitting diode 1 as described in conjunction with figure 3. The organic light-emitting diode 1 then preferably emits white light.

[000529] An exemplary embodiment of a luminaire which can be controlled and/or regulated in different ways by the user is described in conjunction with figure 32F. Firstly, the luminaire 2 can comprise operating elements 197 for example in the region of a corner of the luminaire. The operating elements 197 can be operated by the user by means of a touch sensor, for example, as described in conjunction with figures 31A and 31B. That is to say that the luminaire 2 comprises, for example, an organic light-emitting diode 1 with a capacitively operating touch sensor.

[000530] Alternatively or additionally, it is possible for the luminaire 2 to be operated by means of a remote control 202.

[000531] By means of the operating elements 197, the operating state of the luminaire can be set, for example. Thus, the desired wake-up time can be predetermined by means of the operating elements 197 and/or the remote control 202. Furthermore, the operating state of the luminaire can be selected by means of the operating elements 197 and/or the remote control 202. By way of example, the luminaire 2 can thereby be switched from the switched-off operating state, in

which the area 185a to be illuminated is visible, to a luminous operating state, in which the luminaire 2 serves for room lighting.

[000532] A further exemplary embodiment of a luminaire described here is explained in greater detail in conjunction with the schematic illustration in figure 32G. In this exemplary embodiment, the organic light-emitting diode 1 of the luminaire 2 is subdivided into a multiplicity of segments 203. The segments 203 are individually drivable functional layers 180, which can differ from one another, for example by virtue of different emitter materials. Furthermore, the segments can be individual organic light-emitting diodes 1. Such a luminaire 2 makes it possible to realize, alongside or as an alternative to a temporal profile of the light intensity I, also a temporal profile of the color locus and/or of the color temperature T.

[000533] By way of example, firstly warm-white, reddish light having a color temperature T of approximately 4000 K can be generated at the wake-up time t1, wherein, for example, segments 203 that generate a reddish white light are principally operated.

[000534] In the temporal profile, it is then possible for the color temperature to rise up to a maximum color temperature Tmax of approximately 25 000 K. At this color temperature, cold, bluish, white light is generated by the organic light-emitting diode 1 of the luminaire 2.

[000535] In this way, therefore, the luminaire 2 is designed to generate white light having color temperatures T of at least 4000 K to at most 25 000 K, wherein the light intensity I can simultaneously rise from 0 cd to 10 000 cd. In the temporal profile, therefore, a sunrise in time lapse is simulated by the luminaire 2. In this way, the luminaire 2 enables the user of the luminaire to be woken up particularly

naturally and gently.

[000536] In figures 32H and 32I, two possibilities for temporally varying the color temperature T are illustrated graphically on the basis of graphical plots. In this case, the color temperature T can be increased from T0 approximately 4000 K to Tmax approximately 25 000 K continuously (see figure 32H) or in steps (see figure 32I). The increase in the light intensity I as described in conjunction with figures 32D and 32E can simultaneously be effected.

[000537] Overall, exemplary embodiments of a luminaire which also comprises a wake-up function besides its function for general lighting are described in conjunction with figures 32A to 32E. The organic light-emitting diode 1 of the luminaire 2 can be embodied in transparent and flexible fashion. The luminaire can be suitable for generating white light having different color temperatures and can be provided for generating light having different color temperatures and light intensities. Behind the organic light-emitting diode 1 of the luminaire 2, an area 185a to be illuminated can be arranged, which can be exchanged by the user. In this way, the luminaire 2 can be combined with any desired posters, wall tiles, pictures, mirrors or the like, which allows particularly diverse use of the luminaire. In this case, the luminaire 2 contains at least one organic light-emitting diode 1 as described in greater detail in conjunction with figures 1 to 31, or an organic light-emitting diode 1 that constitutes a combination of the organic light-emitting diodes 1 described in conjunction with figures 1 to 31.

[000538] A further exemplary embodiment of a luminaire 2 described here is explained in greater detail in conjunction with the schematic illustrations in figures 33A to 33D.

[000539] Figure 33A shows, on the basis of a schematic perspective illustration, a further exemplary embodiment of a

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luminaire 2 described here. In this case, the luminaire 2 forms large-area room lighting that can be utilized as part of a shower cubicle 215. That is to say that the luminaire 2 performs a double function: firstly it serves as a light for general lighting, and secondly it constitutes a splash guard.

[000540] In this case, the luminaire 2 is emissive on both sides, such that electromagnetic radiation 190 from the luminaire 2 can be directed into the interior of the shower cubicle 215. Furthermore, electromagnetic radiation 191 is emitted in opposite directions from the shower cubicle into the room to be illuminated.

[000541] An exemplary embodiment of a luminaire 2 which can be utilized as part – for example as a boundary wall – of a shower cubicle 215 is explained in greater detail in conjunction with the schematic sectional illustration in figure 33B. The luminaire 2 comprises at least one organic light-emitting diode 1 as explained in greater detail in conjunction with or in the combination of figures 1 to 32.

[000542] In this case, the organic light-emitting diode 1 comprises a first carrier 130 and also a second carrier 131, which are arranged parallel or substantially parallel to one another. First carrier 130 and second carrier 131 are preferably each formed from a radiation-transmissive material. In this case, first carrier 130 and second carrier 131 are not necessarily transparent; it is sufficient if one of the carriers, or both carriers, is or are embodied as diffusely radiation-transmissive, for example. In this case, the functional layers 180 of the organic light-emitting diode need not necessarily be embodied in transparent fashion; it is sufficient if the functional layers 180 are emissive on both sides.

[000543] A first and/or second carrier 130, 131 embodied in diffuse fashion has the advantage in this case that the

luminaire 2 also functions as a concealing screen of the shower cubicle besides its properties for lighting and for a splash guard. First carrier 130 and second carrier 131 can, for example, be formed with an opalescent glass or consist of an opalescent glass. Furthermore, it is possible for at least one of the two carriers to have a surface structuring or a patterning which – in addition to light scattering – can also serve for the artistic decoration of the outer area of the luminaire 2 and/or for beam directing of the electromagnetic radiation 190, 191.

[000544] First carrier 130 and second carrier 131 can be embodied as planar plates. Furthermore, it is possible for the carriers – as illustrated in figures 33A and 33B – to be bent in the manner of a cylinder lateral surface segment and for the luminaire 2 thus to have curved radiation exit areas 174.

[000545] The functional layers 180 of the organic light-emitting diode 1 can be encapsulated, in the cavity formed by the first carrier 130 and the second carrier 131, by means of the carriers 130, 131 and a connecting means 140 arranged marginally. Furthermore, other techniques for encapsulating and sealing the functional layers 180, as described for example in conjunction with figures 7 to 20, are also possible. Furthermore, combinations of said sealing and encapsulation techniques are also possible.

[000546] In this case, the use of an organic light-emitting diode in a bathroom makes stringent requirements of the hermetic sealing of the organic light-emitting diode 1. The organic light-emitting diode 1 has to withstand a room climate having high air humidity and relatively high temperatures for long times.

[000547] Figure 33C, for example, shows a schematic sectional illustration of an exemplary embodiment of the luminaire 2 in which such a good hermetic sealing can be achieved

particularly efficiently. In this case, the sealing by means of the first carrier 130 and the second carrier 131 and also the connecting means 140 is combined with an encapsulation of the functional layers 180 by an encapsulation layer sequence 160. That is to say that the organic light-emitting diode 1 has a double encapsulation in this case: first, it is protected by the carriers 130, 131 and the connecting means 140, and secondly by the particularly impermeable encapsulation layer sequence 160. This enables particularly efficient encapsulation of the luminaire and therefore use in a bathroom in conjunction with long lifetimes of the luminaire 2.

[000548] The connecting means 140 can be, for example, a glass solder or a glass frit material, which is led in a frame-like manner around the functional layers 180 and also the encapsulation layer sequence 160.

[000549] Furthermore, one of the further encapsulation techniques described in conjunction with figures 7 to 20, such as, for example, a diffusion barrier or a thin-film encapsulation, can be used for encapsulation purposes.

[000550] In conjunction with figure 33D, a further exemplary embodiment of the luminaire 2, in which the organic light-emitting diode 1 is well protected at least against splash water from the shower, is explained on the basis of a schematic sectional illustration. In this exemplary embodiment, the organic light-emitting diode 1 is applied to the outer area of a radiation-transmissive plate 205 that faces away from the shower.

[000551] The organic light-emitting diode 1 can then be, for example, a flexibly embodied organic light-emitting diode 1 which emits on both sides. Such a organic light-emitting diode 1 can have a flexible film as carrier. Furthermore, it is possible for the organic light-emitting diode 1 to be applied

to the outer area of the radiation-transmissive plate 205 in the sense of a transfer.

[000552] Overall, applying the organic light-emitting diode 1 to an outer area of the radiation-transmissive plate 205 enables the organic light-emitting diode 1 to be rapidly removed and thus rapidly exchanged. Therefore, the demands with regard to encapsulation that have to be placed on such a light-emitting diode 1 are not as stringent as in the case of luminaires in accordance with figures 33B and 33C, for example. That is to say that in the exemplary embodiment in figure 33D, the lifetime of the organic light-emitting diode 1 does not limit the lifetime of the shower cubicle, rather the organic light-emitting diode 1 can be replaced by a new organic light-emitting diode 1 after it has been damaged.

[000553] In the exemplary embodiments in figures 33B to 33D, the organic light-emitting diode 1 of the luminaire 2 is illustrated as a large-area organic light-emitting diode 1. However, the organic light-emitting diode 1 can also be divided into a multiplicity of segments 203, which can be suitable, for example, for generating electromagnetic radiation having differing wavelengths. Furthermore, it is possible for the luminaire 2 to comprise a multiplicity of organic light-emitting diodes 1 which, for example, can each have a common first carrier 130. In order to form the organic layer sequence 133 and also the electrodes 101 and 107 of the organic light-emitting diode 1, it is possible to use, for example, the materials described in conjunction with figures 1 to 6 and the layer constructions described in conjunction with said figures. Overall, therefore, the organic light-emitting diode 1 can be - depending on the embodiment - a organic light-emitting diode 1 that is transparent, emits on both sides, emits white light, and/or is flexible.

[000554] A further exemplary embodiment of a luminaire 2 described here is explained in greater detail in conjunction

with the schematic illustrations in figures 34A to 34C. In this exemplary embodiment, too, the luminaire 2 constitutes large-area room lighting and also part, for example the wall, of a shower cubicle 215.

[000555] To supplement, for example, the exemplary embodiment described in conjunction with figure 33C, the luminaire 2 has, in addition to the at least one organic light-emitting diode 1, at least one second light source, which is embodied as a light-emitting diode 210 in the present case (in this respect, cf. figure 34B, for example). The light-emitting diodes 210 are arranged for example at the top area and/or the bottom area of the second carrier 131. However, they can also be applied on the top and/or bottom area of a radiation-transmissive plate 205, as described in conjunction with figure 33D. Generally, at least one inorganic light-emitting diode 210 can be arranged at a side area of a radiation-transmissive carrier or a radiation-transmissive plate, wherein the carrier or the plate can serve as a large-area optical waveguide for electromagnetic radiation generated by the light-emitting diode.

[000556] As explained in conjunction with the schematic sectional illustration in figure 34C, the second carrier 131 forms for example an optical waveguide for electromagnetic radiation 192 generated by the light-emitting diodes 210. In this case, a reflective layer or coating 211, which is transmissive to electromagnetic radiation 190 generated in the organic layer sequence 133, is preferably applied to the inner side of the second carrier 131 facing the organic layer sequence 133. By contrast, the reflective layer 211 is embodied such that it is reflective for electromagnetic radiation 192 generated by the light-emitting diodes 210. In this case, the reflective layer 211 and/or the second carrier 131 can have structurings that allow the electromagnetic radiation 192 to be distributed as uniformly as possible over the entire area of the second carrier 131. The second carrier

131 therefore serves as a planar optical waveguide that permits the electromagnetic radiation generated by the inorganic light-emitting diodes 210 to be emitted homogeneously into the interior of the shower.

[000557] The light-emitting diodes 210 are preferably inorganic light-emitting diodes suitable for generating UV radiation, infrared radiation and/or visible light. In this case, it is possible for the luminaire to comprise light-emitting diodes 210 for generating infrared radiation and also UV radiation and/or visible light.

[000558] The luminaire 2 can comprise, for example, an operating mode in which infrared radiation 192 is generated by the light-emitting diodes 210. Said infrared radiation is conducted by the second carrier 131 and the reflective layer 211 into the interior of the shower cubicle, where it is used firstly for warming a user; secondly, the radiation can be used for faster drying of the shower cubicle after the shower cubicle has been used.

[000559] In a further operating state, only the light-emitting diodes 210 of the luminaire 2 which emit UV light are activated. In this operating state, the emitted radiation 192 is used for tanning a user and/or for disinfecting the shower after the end of the use thereof.

[000560] In a third operating state, light-emitting diodes 210 that emit infrared light and UV light can be operated simultaneously, as a result of which combinations of the functions mentioned are possible. Furthermore, it is also possible for the luminaire 2 to comprise organic light-emitting diodes 1 that are suitable for generating infrared radiation. Suitable emitter materials are described for example in conjunction with figures 1 to 6.

[000561] Furthermore, it is possible for the luminaire to

generate, at least during the operation of the shower, white light with which, depending on the water temperature, red light components (for hot water) or blue light components (for cold water) are admixed for example by means of corresponding inorganic light-emitting diodes 210 or organic light-emitting diodes 1.

[000562] Finally, exemplary embodiments are possible in which, during the operation of the luminaire 2, color profiles of the emitted light are generated or a desired color temperature can be set. This can be realized for example by means of corresponding organic light-emitting diodes 1 and/or inorganic light-emitting diodes 210.

[000563] Overall, the luminaire 2 described in conjunction with figures 33 and 34 realizes particularly variable, large-area room lighting that simultaneously serves as a splash guard in a shower. In this case, the light color, the light temperature and also the light intensity can be adjustable according to the user's wishes. Furthermore, the luminaire 2 can serve as an indicator device for the water temperature, as a result of which, by way of example, it is possible to prevent use of the shower at excessively cold or excessively hot water temperatures.

[000564] Furthermore, it is possible for the light functions such as color, color temperature and/or color intensity to be changed temporally, as explained in greater detail for example in conjunction with the luminaire in accordance with figures 32A to 32I.

[000565] In conjunction with figure 35 an explanation is given, with reference to a basic schematic diagram, of the fact that the luminaire 2 can be operated by means of operating elements 197 that are addressed by means of a touch sensor. For this purpose, it is possible to use a touch sensor as explained in greater detail for example in conjunction with

figures 31A and 31B. In this case, the operating element can be accessible both from the inner side of the shower and from the outer side of the shower.

[000566] Furthermore, it is possible for not only the light function of the luminaire 2 but, for example, also the mixing faucet of the shower and hence the water temperature and the water strength to be regulated by means of the operating element 197.

[000567] On the other hand, it is also possible, however, for, for example, the color of the emitted light of the luminaire 2 to be regulated by means of the mixing faucet during the operation of the shower. That is to say that, by way of example, the color of the light emitted by the luminaire 2 can be adapted by means of the setting of the water temperature.

[000568] A further exemplary embodiment of a luminaire 2 described here is explained here in greater detail in conjunction with the perspectively schematic illustration in figure 36. In this exemplary embodiment, the luminaire 2 is accorded a double function:

[000569] Firstly, the luminaire 2 serves for general lighting. By way of example, it can constitute the main light in a bathroom.

[000570] Secondly, the luminaire 2 comprises a shower head for a shower.

[000571] That is to say that firstly the luminaire 2 emits electromagnetic radiation 190, 191, and secondly the luminaire 2 distributes water via the shower head 220. In this case, the luminaire 2 can be suitable for emitting electromagnetic radiation 190, 191 having different electromagnetic wavelengths simultaneously or successively. For this purpose,

the luminaire 2 can comprise, for example, a plurality of organic light-emitting diodes 1 suitable for generating electromagnetic radiation having mutually different wavelengths. The luminaire 2 can then emit light of different colors for example simultaneously or sequentially. Furthermore, the luminaire can be suitable for emitting white light. For this purpose, the luminaire can comprise one or a plurality of organic light-emitting diodes 1 which each emit white light during operation. Furthermore, it is possible for the luminaire 2 only to emit light of a single color. For this purpose, the luminaire can comprise one or a plurality of organic light-emitting diodes 1 which each emit colored light, for example green or red light, during operation.

[000572] An exemplary embodiment of a luminaire 2 comprising a shower head 220 is described in greater detail in conjunction with the schematic plan view in figure 37A and also the schematic sectional illustration in figure 37B.

[000573] The luminaire 2 comprises the shower head 220. The shower head 220 can be embodied for example as circular, square or in some other shape in the plan view. The shower head 220 can be, on the one hand, the shower head of a handheld shower unit, said shower head having a diameter D of at least 5 cm and at most 20 cm. Furthermore, it is possible for the shower head 220 to be a large-area shower head having, for example, a diameter D of at least 50 cm, preferably at least 80 cm, particularly preferably at least 100 cm. Such a shower head 220 is then preferably fitted directly to the ceiling of a bathroom, for example. Water 222 from such a shower head 220 falls like rain from a relatively large height and in a manner distributed over a relatively large area onto the user of the luminaire 2.

[000574] In this exemplary embodiment, the shower head 220 comprises at least one organic light-emitting diode 1 suitable, for example, for emitting white light 190. For this

purpose, the organic light-emitting diode 1 can have a layer construction as described in greater detail in conjunction with figures 1 to 6. Furthermore, the organic light-emitting diode has an encapsulation as explained in greater detail in conjunction with figures 7 to 20. Combinations of the layer sequences described in the figures and of the encapsulations described in the figures are also possible.

[000575] By way of example, the organic light-emitting diode 1 has a double or triple seal. Thus, the organic light-emitting diode 1 can be sealed by means of a first carrier 130, a second carrier 131 and also a connecting means 140. Furthermore, the organic light-emitting diode 1 can comprise an encapsulation layer sequence 160. Overall, a particularly good encapsulation is preferably chosen for the organic light-emitting diode 1 since the organic light-emitting diode 1 is in direct contact with water 222 at least in places. That is to say that, for example, at least one of the carriers 130, 131 is wetted with water 222 during the operation of the shower head 220 of the luminaire 2.

[000576] The luminaire 2 comprises the shower head 220, which has a passage opening 224, by which said shower head is connected to the water supply. Water 222 passes into the shower head 220 via the passage opening 224. The water 222 flows around the organic light-emitting diode 1 at the outer areas thereof and in this way passes to the cover plate 223 of the shower head. The cover plate 223 has openings 221 through which the water 220 can pass from the shower head.

[000577] In this exemplary embodiment, the cover plate 223 is in this case embodied as radiation-transmissive, for example transparent. Electromagnetic radiation 190 from the organic light-emitting diode 1 can leave the cover plate both through the openings 221 and through the other, non-water-pervious regions of the cover plate 223.

[000578] Overall, the organic light-emitting diode 1 is integrated into the shower head 220 in the exemplary embodiment in figures 37A and 37B.

[000579] In conjunction with figure 38, a further exemplary embodiment of a luminaire 2 with shower head 220 as described here is explained in greater detail with reference to a schematic sectional illustration. In this exemplary embodiment, in contrast to the exemplary embodiment in figures 37A and 37B, the organic light-emitting diode 1 is divided into segments 203. In this case, light having mutually different colors is emitted in the segments 203 during the operation of the organic light-emitting diode 1.

[000580] The segments 203 are jointly encapsulated for example by a common carrier pair 130, 131 and a connecting means 140 arranged marginally and in frame-like fashion. The segments 203 can furthermore be sealed jointly, or each segment can be sealed by itself, by means of an encapsulation layer sequence 160. The segments 203 can be individually drivable, such that light of different colors can be generated simultaneously or sequentially. Alongside the described segmentation of the organic light-emitting diode 1, however, it is also possible for the luminaire 2 to comprise a plurality of organic light-emitting diodes 1 suitable for generating light of mutually different colors.

[000581] As a further, optional difference with respect to the exemplary embodiment explained in greater detail in conjunction with figures 37A and 37B, the cover plate 223 of the shower head 220 can in this case be embodied as non-radiation-transmissive. That is to say that electromagnetic radiation 190, 191 can then leave the shower head 220 only together with the water 222 through the openings 221. In this case, the water jets 222 that leave the shower head 220 can serve as a kind of optical waveguide for the electromagnetic radiation 190, 191 generated in the segments 203 of the

organic light-emitting diode 1.

[000582] That is to say that, during operation, the shower head 220 can emit differently colored water jets 220 at different locations. The non-radiation-transmissive embodiment of the cover plate 223 can result in a particularly good separation of the different light colors. By way of example, with the shower head 220 it is possible in this way to produce a shower of water which is similar in appearance to a rainbow when viewed from a distance.

[000583] In conjunction with figure 39A, a further exemplary embodiment of a luminaire 2 described here is explained in greater detail with reference to a schematic sectional illustration. Figure 39B shows a schematic plan view of the luminaire 2 from that side of the shower head 220 which faces away from the openings 221.

[000584] In this exemplary embodiment, the organic light-emitting diode 1 is provided with the passage opening 224, which is arranged for example at a central location through the organic light-emitting diode 1. That is to say that the organic light-emitting diode has a hole through which water is flushed during the operation of the shower head 220 of the luminaire 2.

[000585] At the edges 224a of the passage opening 224, the organic light-emitting diode 1 can be sealed for example by means of a glass solder or a glass frit as connecting means 140. Furthermore, the connecting means 140 can be provided with an encapsulation layer sequence 160, which additionally seals the connecting means. Such a construction is explained in greater detail by way of example in conjunction with figures 14B and 18.

[000586] The functional layers 180 of the organic light-emitting diode 1 can additionally once again be sealed by an

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encapsulation layer sequence 160, a diffusion barrier 153, a thin-film encapsulation 154, a resist layer 150 or further measures.

[000587] Water 222 passes through the passage opening 224 into a gap arranged between the cover plate 223 of the shower head 220 and the organic light-emitting diode 1. The cover plate 223 once again comprises openings 221 through which the water 220 can pass. In this case, the cover plate 223 can be embodied as radiation-transmissive, then transparent for example, or non-radiation-transmissive. The organic light-emitting diode 1 can emit white light, colored light or light of different colors - as explained for example in conjunction with figure 38.

[000588] In comparison with the exemplary embodiment in figures 37 and 38, in the exemplary embodiment of figure 39, only the underside - facing the cover plate 223 - of the organic light-emitting diode 1 and also the side areas of the organic light-emitting diode 1 in the region of the edge 224 of the passage opening are directly exposed to the water 222. On the other hand, in order to encapsulate the organic light-emitting diode 1, special carriers 130, 131 having a passage opening 224 have to be provided. This can make it more expensive to produce the luminaire 2 as explained in conjunction with figures 39A and 39B.

[000589] In conjunction with figures 40A and 40B, the driving of the luminaire 2 is explained in greater detail with reference to schematic illustrations.

[000590] Figure 40A schematically shows a mixing faucet which can be used to set the water temperature TW by means of a rotary movement of the faucet 22a. In this case, it is possible for the color, that is to say the color locus O and/or the color temperature T, of the light emitted by the organic light-emitting diode 1 simultaneously to be set by way

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of the water temperature TW. Furthermore, it is possible for the setting of the color locus O and/or of the color temperature T to be effected by means of a translational movement of the mixing faucet. Overall, the mixing faucet 225 described in conjunction with figure 40A is therefore used in exemplary embodiments of the luminaire 2 in which the color locus and the color temperature of the light generated by the organic light-emitting diode 1 can also be set by means of the mixing faucet of the shower.

[000591] Furthermore, it is also possible for the shower head 1 to be driven by means of touch-sensitive operating elements 197 as explained in greater detail for example in conjunction with figure 35. Said operating elements can be integrated as touch-sensitive organic light-emitting diodes, for example, into a wall tile, a tile or into a shower cubicle. In particular, the luminaire 2 with shower head 220 can also be combined with the luminaire 2 embodied as part of a shower cubicle 215. That is to say that the exemplary embodiments described in conjunction with figures 33 to 35 can be combined with a luminaire 2 in accordance with the exemplary embodiments in figures 36 to 40 in one and the same shower.

[000592] Figure 40B shows, on the basis of a schematic illustration, a further possibility for driving the luminaire 2 as explained in greater detail in conjunction with figures 36 to 39. By way of example in a manner supplementing a mixing faucet 225, for driving purposes it is possible to use the regulating device 226, by means of which a specific shower program can be preset. By way of example, a temporal profile of the water temperature and also of the light emitted by the luminaire 2 can be preset by means of the shower program.

[000593] In this case, a luminaire 2 with shower head 220 and at the same time a luminaire 2 with a shower cubicle 215 can be driven. In this case, water temperature, pressure of the water jet, color temperature and/or color locus can be changed

in a manner coordinated with one another by the regulating device 226 in temporal succession. By way of example, in this case a simulated sunrise as described in conjunction with figures 32H and 32I, can be simulated by the luminaire 2, wherein at the same time for example the water temperature is increased or decreased continuously or in steps.

[000594] A further exemplary embodiment of a luminaire 2 described here is explained in greater detail in conjunction with the schematic illustrations in figures 41A to 41D. In this exemplary embodiment, the luminaire 2 comprises the functions of a mirror, a light for general lighting and also a display device for simple graphical elements.

[000595] In this case, figure 41A shows a first operating state of the luminaire 2. In this operating state, the luminaire 2 is not actively radiation-generating. The luminaire 2 appears like a normal mirror that reflects back electromagnetic radiation 191 impinging on it. Such a luminaire 2 can be used for example as a bathroom mirror or wardrobe mirror.

[000596] A second operating state of the luminaire 2 is illustrated graphically in conjunction with figure 41B. In this operating state, the luminaire 2 serves as a light for general lighting. In this operating state, the luminaire 2 principally emits electromagnetic radiation 190 that is generated for example by an organic light-emitting diode 1 of the luminaire 2 during the operation of the luminaire. The luminaire 2 does not serve as a mirror in this operating state. That is to say that electromagnetic radiation 191 impinging on the luminaire 2 externally is in this case outshone by the generated electromagnetic radiation 190.

[000597] A third operating state of the luminaire 2 is illustrated schematically in conjunction with figure 41C. In this operating state, patterns 230 are represented by the

luminaire 2. Furthermore, the luminaire 2 can reflect impinging electromagnetic radiation 191 and/or actively emit electromagnetic radiation 190. The fact of whether the luminaire 2 has recognizable reflective properties, that is to say whether electromagnetic radiation 191 that impinges on the luminaire 2 is reflected by the latter in a manner perceptible to the user, is dependent on the light intensity with which electromagnetic radiation 190 is actively generated by the luminaire 2. The light intensity of the electromagnetic radiation 190 that is actively generated by the luminaire 2 can be set for example by means of the current intensity with which the luminaire 2 is energized.

[000598] In conjunction with figure 41D, an exemplary embodiment of a luminaire 2 which has the operating states described in conjunction with figures 41A to 41C is explained in greater detail with reference to a schematic sectional illustration. In this case, the construction of the luminaire 2 is similar to the construction of the organic light-emitting diode 1 explained in greater detail in conjunction with figure 27.

[000599] In this case, the luminaire 2 comprises a transparent organic light-emitting diode 1. The transparent organic light-emitting diode 1 can comprise functional layers 180 arranged between a first carrier 130 and a second carrier 131. Preferably, the organic light-emitting diode 1 comprises a radiation-emitting region 104 suitable for generating white light. The organic light-emitting diode 1 emits electromagnetic radiation 190 from its two main areas.

[000600] Any exemplary embodiment and also any combination of exemplary embodiments described in conjunction with figures 1 to 6 can be used for forming the organic layer sequence 133. Preferably, embodiments as described in conjunction with figures 7 to 20 or combinations of said embodiments are used for encapsulating and hermetically sealing the organic light-

emitting diode 1. All that is important in the exemplary embodiment of the luminaire 2 in figure 41D is that the organic light-emitting diode 1 is embodied in transparent fashion.

[000601] The luminaire 2 furthermore comprises an area 185a to be illuminated of an element 185 to be illuminated. The element 185 to be illuminated is a mirror, and the area 185a to be illuminated constitutes the reflective surface of the mirror.

[000602] An electrically switchable optical element 186 is arranged in a structured manner between the organic light-emitting diode 1, that is to say between the first carrier 130 and the illuminating surface 185a. In the present case, the electrically switchable optical element 186 forms the pattern 230 to be represented. However, it is also possible for the electrically switchable optical element 186 to be a negative image of the pattern 230 to be represented. A transparent material 188 formed from a transparent plastic or glass, for example, is arranged at locations where no electrically switchable optical element 186 is situated between element 185 to be illuminated and first carrier 130. That is to say that the space between the organic light-emitting diode 1 and the area 185a to be illuminated is filled with the transparent material 188 and the electrically switchable optical element 186.

[000603] The electrically switchable optical element 186, then, has two operating states, for example: in a first operating state, the electrically switchable optical element 186 is transparent. In this operating state, the luminaire 2 can, as shown in figure 41A, be operated as a mirror or, as illustrated in figure 41B, be operated as a light, no pattern 230 being discernible.

[000604] On the other hand, the electrically switchable

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optical element 186 has at least one second operating state in which, for electromagnetic radiation 190 generated by the luminaire, said electrically switchable optical element is either absorbent, attenuating or acts as a color filter. In this way, in this operating state, a pattern 230 can be generated by illumination of the structured, electrically switchable optical element 186.

[000605] Depending on the embodiment of the electrically switchable optical element 186, the pattern can appear dark – for example black – or colored. The electrically switchable optical element 186 is an electrochromic element, for example, such as is also used in electrically tintable glass panes.

[000606] As already described in conjunction with figures 26 and 27, the proportion of the electromagnetic radiation 190 which passes directly from the luminaire toward the outside without in the process previously reaching the area 185a to be illuminated can be set by means of an optical cavity. In this way, the manufacturer of the luminaire 2 can preset the contrast with which the pattern 230 is intended to appear in the third operating state.

[000607] In conjunction with figures 42A to 42C, an explanation is given, on the basis of schematic illustrations, of the fact that the luminaire 2 can be operated with a touch-sensitive operating element 197. By way of example, by means of translational movements of the hand on a region of the second carrier 131 of the organic light-emitting diode 1, it is possible to change the operating state or to increase or decrease the brightness of the emitted light (see figures 42A and 42C).

[000608] By means of tapping, as illustrated schematically in figure 42B, on the operating element 197, it is possible, for example, for the luminous function to be switched off and on, that is to say for switching between the first and second

operating states to be effected. Overall, a touch-sensitive organic light-emitting diode 1 as explained in greater detail in conjunction with figure 31 can again be used for forming the operating element 197.

[000609] As an alternative to a touch-sensitive control of the luminaire 2, however, it is also possible for gesture control of the luminaire 2 to be effected. In this case, the user of the luminaire 2 does not have to touch the radiation exit area 174 of the luminaire. Rather, a camera is fixed to or in the vicinity of the luminaire 2. By means of an evaluation circuit, a specific command – for example a change of operating state – can be calculated from images recorded by the camera. This construction – which is more complicated in comparison with touch control – affords the advantage that the radiation exit area 174 is not smeared, for example by fingerprints of the user.

[000610] A further exemplary embodiment of a luminaire described here is explained in greater detail in conjunction with the schematic illustrations in figures 43 and 44. In this exemplary embodiment, the luminaire 2 is part of a tile 235.

[000611] As illustrated schematically in conjunction with figure 43, the luminaire 2 can be used both as a wall tile and as a floor tile.

[000612] An exemplary embodiment of such a luminaire is schematically explained in greater detail in conjunction with figures 44A and 44B. The luminaire comprises an organic light-emitting diode 1, which is preferably embodied in non-slip fashion. For this purpose, the first carrier 130 and the second carrier 131 of the organic light-emitting diode 1 can be formed from a shatter-resistant glass. Spacers 238 are arranged at regular distance between the carriers 130, 131, which spacers can, for example, likewise be formed from a glass material. Thus, the spacers 238 can be, for example,

posts or dams which are formed with a glass solder or a glass frit material. In this case, the spacers 238 prevent the second carrier 131 from being pressed onto the functional layers 180 of the organic light-emitting diode 1.

[000613] The organic light-emitting diode 1 is preferably embodied as a transparent organic light-emitting diode. The organic light-emitting diode can be provided, for example, as described in conjunction with figures 26 and 27, for illuminating the tile 235. In this case, the connection conductors 236 for making electrical contact with the organic light-emitting diode 1 are arranged at the edge side of the organic light-emitting diode 1, where joints of the tiles 235 extend. In this way, the connection conductors 236 do not disturb the visual impression of the tiles.

[000614] As is illustrated schematically in figures 44A and 44B, adjacent luminaires 2 can be electrically connected to one another via electrical connectors 237 and in this way be connected in series or in parallel with one another, for example. However, it is also possible for each of the luminaires 2 to be individually drivable. Electrical connecting conductors for driving the luminaires 2 extend below the tiles 235, for example.

[000615] Besides or in addition to the generation of white light or colored light, the organic light-emitting diode 1 of the luminaire 2 can also be designed for generating infrared radiation. By way of example, an organic light-emitting diode 1 as explained in greater detail in conjunction with figures 1 to 6 can be used for this purpose. A luminaire 2 comprising such an organic light-emitting diode 1 generates heat during the operation of the organic light-emitting diode 1, and can thus be used as an alternative to a wall or floor heating system.

[000616] In a simple embodiment of the luminaire 2 described

in conjunction with figures 43 and 44, the organic light-emitting diode 1 can be a transparent organic light-emitting diode 1 that is adhesively bonded in a simple manner onto a wall, ceiling or floor tile that has already been laid. Such an organic light-emitting diode 1 can be embodied in flexible fashion, for example, and can be fixable on a tile 235 in the manner of a transfer. By way of example, the functional layers are sealed with an encapsulation layer sequence 160 as described further above. The organic light-emitting diode 1 can then be adhesively bonded onto the tile 235 in particular at the outer area of the encapsulation layer sequence 160. In this way, the luminaire can be used in a simple and cost-effective manner for tiles that have already been laid.

[000617] Besides energization of the luminaire 2 via connection conductors 236, inductive or capacitive driving of the luminaire 2 is also conceivable, for example. In this case, the connection conductors 236 can be dispensed with; the energization can be effected by means of a transmitter of electromagnetic radiation, for example. What can disadvantageously arise in this case is that the luminous intensity of the luminaire 2 is reduced by comparison with a luminaire 2 energized by means of electrical connection conductors 236.

[000618] Figure 45A shows an exemplary embodiment of a luminaire 2 described here on the basis of a schematic perspective illustration. The luminaire 2 is a large-area, segmented luminaire 2.

[000619] The luminaire 2 is fixed to the ceiling of a room in the manner of a ceiling light by means of holding devices 239. The holding devices 239 are, for example, power cables, metal wires or rods containing an electrically conductive material. The holding devices 239 are used to effect – besides mechanical fixing of the luminaire 2 – also electrical contact-connection and thus energization of the luminaire 2.

[000620] As is evident in particular from the schematic illustration in figure 45B, the luminaire 2 comprises a multiplicity of organic light-emitting diodes 1. That is to say that the luminaire 2 is segmented into a multiplicity of organic light-emitting diodes 1. The organic light-emitting diodes 1 can be embodied in flexible or rigid fashion, for example.

[000621] Different organic light-emitting diodes 1 of the luminaire 2 can be provided for generating light of different colors. In this way, the luminaire 2 is suitable for emitting light of different colors and/or different color temperatures during operation. The light emitted by the luminaire 2 can thus be flexibly adapted to the requirements of its use. By way of example, the luminaire 2 can generate light similar to daylight, which is particularly well suited to work. Furthermore, it is possible for reddish light to be generated by means of the same luminaire 2 at another time, said reddish light being particularly well suited as evening lighting, for example.

[000622] The organic light-emitting diodes 1 are preferably embodied as described in conjunction with figures 1 to 31, or constitute combinations of the organic light-emitting diodes 1 described there.

[000623] Besides the organic light-emitting diodes 1, the luminaire 2 comprises connection conductors 236. The connection conductors 236 extend, for example, in the manner of a wire-netting fence, such that they delimit - for example rectangular- sections, in each of which an organic light-emitting diode 1 can be arranged. The connection conductors 236 serve for making electrical contact with the organic light-emitting diodes 1 and also for mechanically connecting the individual organic light-emitting diodes 1. In this way, the organic light-emitting diodes 1 can be arranged in a

combined series and parallel circuit.

[000624] Furthermore, it is possible for each of the organic light-emitting diodes 1, or groups of the organic light-emitting diodes 1 which are provided for generating the same light color, to be drivable separately by means of the connection conductors 236. In this case, the connection conductors 236 are embodied for example as cable assemblies having a multiplicity of individual power lines.

[000625] Besides their property for energizing the organic light-emitting diodes 1, the connection conductors 236 form a framework or a matrix for mechanically fixing the organic light-emitting diodes 1. For this purpose, the connection conductors 236 preferably have a certain rigidity corresponding, for example, to the rigidity of a copper wire. The organic light-emitting diodes 1 themselves can be embodied in flexible fashion, and do not have to serve for mechanically stabilizing the luminaire 2. If the connection conductors 236 are embodied as metal wires, then it is furthermore possible that a desired form of the luminaire 2, for example the wavy form illustrated in figure 45A, can be set in a simple manner by the user or by the manufacturer of the luminaire 2 by means of flexure of the connection conductors 236.

[000626] The luminaire 2 described in conjunction with figures 45 and 46 is preferably a relatively large-area luminaire. That is to say that the luminaire 2 can have sizes in the range of a plurality of square meters. By way of example the luminaire 2 has a luminous area of at least 0.5 m^2, preferably at least 1 m^2. The luminous area is in this case formed by the sum of the radiation exit areas 174 of the individual organic light-emitting diodes 1. In this case, each individual organic light-emitting diode 1 preferably has an area content of its radiation exit area 174 of at least 0.5 dm^2.

[000627] In conjunction with the schematic illustration in figure 45C it is shown that an insulator 240 is arranged at crossover points of the connection conductors 236, said insulator electrically insulating the connection conductors 236 from one another. By way of example, the connection conductors 236 extending from left to right in figure 45B are at negative electrical potential. The connection conductors 236 extending from the bottom to the top in figure 45B are then at positive potential. An insulator 240 at least in the region of the crossover points of the connection conductors 236 prevents the connection conductors 236 from being short-circuited.

[000628] Two alternative possibilities for driving the luminaire 2 are briefly explained in conjunction with the schematic illustrations in figures 46A and 46B. Thus, the luminaire 2 can be driven for example by means of an operating element 197 arranged at a wall (cf. figure 46A). Alternatively or additionally, it is possible for the luminaire 2 to be operated by means of a remote control 202 (cf. figure 46B). Furthermore, it is possible for the luminaire 2 to be drivable by means of a touch sensor or gesture control.

[000629] An exemplary embodiment of a luminaire 2 described here which serves for covering an object is explained in greater detail in conjunction with the schematic illustrations in figures 47 to 49. By way of example, the luminaire 2 serves for covering the radiator 245.

[000630] A radiator 245 generally has a non-smooth surface, for example a surface having heating lamellae, in which dust can settle particularly easily. The dust-sensitive regions of the radiator 245 can be clad with the luminaire 2 that can be used for covering the radiator. Furthermore, the luminaire 2 enhances the visual impression of the radiator 245. The visible exterior area of the radiator 245 is replaced by the luminaire 2, which can serve as a light for the general

lighting of the room in which the radiator is arranged.

[000631] The mounting of the luminaire 2 on the radiator 245 in accordance with an exemplary embodiment of the luminaire 2 that can serve for covering is explained in further detail in conjunction with figures 47A and 47B. Figure 47C shows, on the basis of a schematic view, a rear wall 246 of the luminaire 2, said rear wall facing the radiator 245 when the luminaire 2 is in the mounted state. The rear wall 246 is pervaded by a plurality of cooling channels 247, for example, which can extend along the entire width of the rear wall 246.

[000632] As is evident from the schematic plan view of the top side of the radiator 245 with luminaire 2 in figure 47D, the cooling channels 247 are embodied as indentations in the rear wall 246 of the luminaire 2. That is to say the thickness of the rear wall 246 is reduced in the region of the cooling channels 247.

[000633] If the radiator 245 is operated, then, along the cooling channels 247 convection of air takes place, which upon flowing through the cooling channels 247 cools the rear wall 246 of the luminaire 1. In this way, the organic light-emitting diode 1 is also cooled during operation, such that no permissible heating of the organic light-emitting diode 1 can arise. In addition, the rear wall 246 and the organic light-emitting diode 1 of the luminaire 2 can be thermally insulated from one another by a thermal insulation layer (not illustrated). The thermal insulation layer can be formed for example with a material having poor thermal conductivity, such as styropor.

[000634] Alongside the cooling channels 247, fixing means 248 are provided at the rear wall 246. The fixing means 248 are, in a simple exemplary embodiment, adhesive strips by means of which the luminaire 2 can be fixed to the radiator 245.

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[000635] However, it is also possible for the fixing means 248 to be magnets, such that the luminaire 2 adheres to the radiator 245 by means of magnetic forces. Other types of fixtures such as screwing or clamping, for example, are also possible.

[000636] Furthermore, a temperature sensor 249 is arranged at the rear wall 246 of the luminaire 2. The temperature of the radiator 245 is measured by means of the temperature sensor 249. Depending on the measured temperature, it is possible to set, for example, the light intensity and/or the light locus and/or the light temperature of the light emitted by the luminaire 2, that is to say by the organic light-emitting diode 1. That means that there is a correlation between the temperature of the radiator 245 and the electromagnetic radiation 190 emitted by the luminaire 2 through the radiation exit area 174 of the organic light-emitting diode 1. In this way, therefore, the luminaire 2 also serves as a temperature indicator for the heat generated by the radiator 245 during operation.

[000637] Further exemplary embodiments of the luminaire 2 that serves for cladding a heating system are explained in greater detail in conjunction with the schematic perspective illustration in figure 48. In these cases, the luminaire 2 is arranged in front of a radiator 245 for example by means of a stand 251 or a screw connection 252, such that said radiator is covered by the respective luminaire 2. In these cases, there is not necessarily a connection composed of condensed matter between the radiator and the luminaire 2. Therefore, the luminaire 2 can be arranged at a distance from the radiator 245, wherein the gap between radiator 245 and luminaire 2 is filled with air. In such a case, by way of example, the cooling channels 249 described in conjunction with figures 47A to 47D can be dispensed with since sufficient cooling by means of convection takes place via the gap.

[000638] In conjunction with figures 49A and 49B, a further exemplary embodiment of a luminaire 2 which is used for covering a radiator 245 is described in greater detail with reference to schematic sectional illustrations. In this exemplary embodiment, by way of example, a temperature sensor 249 can be dispensed with. Instead, a regulation of the heat 250 emitted by the radiator 245 is effected simultaneously with a regulation of the electromagnetic radiation 190 emitted by the luminaire 2. That is to say that, with an increase in the temperature generated by the radiator 245, for example the color temperature T of the light 190 emitted by the luminaire 2 is decreased or increased. Such a regulation can be effected by means of a remote control 202, by means of touch-sensitive operating elements 197 and/or by means of the valve control of the radiator 245.

[000639] Overall, any combination of the organic light-emitting diodes 1 described here can be used for the luminaire described in conjunction with figures 47 to 49. In this case, it is also possible, for example, for the rear wall 245 to have an area 185a to be illuminated which is illuminated by the organic light-emitting diode 1 of the luminaire, as described in greater detail for example in conjunction with figures 26 and 27. By way of example, the area 185a to be illuminated is the pictorial reproduction of an open fire. By means of the organic light-emitting diode 1 of the luminaire 2, the area 185a to be illuminated can then be illuminated in flickering fashion in the manner of a candle. In this way, the impression of a blazing fire arises in the region of the radiator 245. Such flickering can be effected, for example, by operation of the organic light-emitting diode 1 of the luminaire 2 with temporally varying current intensities. This can be achieved in a simple manner by means of a pulse width modulation circuit.

[000640] It is also possible for the luminaire 2 to comprise segmented organic light-emitting diodes 1 or a multiplicity of

organic light-emitting diodes 1 which can be suitable for generating light of mutually different colors.

[000641] Besides a covering for a radiator 245, the luminaire 2 can, for example, also be used for covering an air-conditioning system or a ventilation shaft in a low-energy house. In this case, particularly if a temperature sensor 249 is present, the luminaire 2 is particularly well suited to covering and cladding elements which are intended to be used for cooling and/or for heating a room. In this case, the luminaire 2 serves as an esthetically appealing temperature indicator which brightens the room.

[000642] A further exemplary embodiment of a luminaire 2 described here is explained in greater detail in conjunction with figures 50A to 50D.

[000643] Figure 50A shows the luminaire 2 in a schematic perspective illustration. The luminaire 2 is a light having a large-area radiation exit area 174, which can be used for example as a desk lamp for illuminating a work area.

[000644] The luminaire 2 comprises as light source preferably at least one organic light-emitting diode 1 as described in greater detail in conjunction with figures 1 to 31.

[000645] The luminaire 2 has a radiation exit area 174, which can comprise an area of 0.1 m^2 or more. By way of example, the radiation exit area 174 has a rectangular basic shape having a length l of at least 50 cm and a height h of at least 20 cm.

[000646] In this case, the luminaire 2 can be embodied such that it emits on both sides, and so, during operation, it can illuminate, for example, two workstations arranged opposite each other. In this case, the luminaire 2 can also comprise a transparent organic light-emitting diode 1 and, in this way, itself be embodied in transparent fashion.

[000647] Furthermore, it is possible for the luminaire 2 to have an area 185a to be illuminated which is arranged on the opposite side of the luminaire 2 to the radiation passage area 174. In this way, in the switched-off state, the luminaire 2 can represent for example an image, a calendar or a company logo.

[000648] In conjunction with figure 50B it is schematically illustrated that the luminaire 2 can emit electromagnetic radiation 190 in a directional manner. For this purpose, the luminaire 2 comprises for example at least one organic light-emitting diode 1 embodied for example as described in conjunction with figures 21 to 25. That is to say that the organic light-emitting diode 1 comprises a structured radiation exit area 175, which is structured into areas 175a and 175b, in such a way that electromagnetic radiation 190 is emitted downward, for example toward a desk surface. Advantageously, therefore, no electromagnetic radiation 190 is emitted upward, for example away from a desk surface, into the face of the user of the luminaire 2. The luminaire 2 is therefore a dazzle-free luminaire which can be used particularly well for desk work.

[000649] Furthermore, it proves to be advantageous that the luminaire 2 is embodied with a particularly large area. In this way, a relatively low luminance at the radiation exit area 174 is sufficient for sufficient illumination of the work area. That is to say that, in the luminaire 2, a high luminance does not have to be concentrated on a relatively small radiation exit area, as is the case, for example, in a conventional desk lamp with an incandescent bulb or halogen lamp. Rather, the emitted light can be distributed over a large area and the luminance can therefore be reduced. This results in a luminaire 2 which is particularly dazzle-free and yields light similar to daylight - at least in the region of the work area.

[000650] An example for the operation of the luminaire 2 is explained in greater detail in conjunction with figure 50C. By way of example, in this case it is possible to integrate a touch-sensitive organic light-emitting diode 1 with a touch-sensitive operating element 197 in the luminaire. By moving over part of the radiation exit area 174 of the luminaire 2, it is then possible for the luminaire 2 to be switched on or dimmed.

[000651] In conjunction with figure 50D it is shown that the luminaire 2, on account of its relatively large length l of at least 50 cm, for example, can also serve for guiding electrical cables. In this case, a cable shaft 255 is integrated into the luminaire 2, which cable shaft can be embodied integrally for example with a stand 251 of the luminaire 2.

[000652] In this case, besides its properties for general lighting, the luminaire 2 also serves as an ordering system.

[000653] Further exemplary embodiments of a luminaire 2 described here are explained in greater detail in conjunction with figures 51 to 53. In this case, the luminaire 2 serves for general lighting and as a room divider.

[000654] The luminaire 2 as shown in conjunction with the schematic illustrations in figures 51A and 51B is a large-area light. The luminaire has a radiation exit area 174 of preferably at least 0.5 m^2, particularly preferably of at least 1 m^2. The radiation exit area 174 of the luminaire is arranged between two stands 251, which can also serve for making electrical contact with the luminaire 2.

[000655] The luminaire 2 comprises at least one organic light-emitting diode 1; preferably, the luminaire 2 comprises a multiplicity of organic light-emitting diodes 1 which are

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connected in parallel and/or in series with one another, for example. The at least one organic light-emitting diode can then be embodied as described in conjunction with figures 1 to 31.

[000656] The luminaire 2 can comprise a touch-sensitive organic light-emitting diode 1 with an operating element 197. By means of the operating element 197, the luminaire 2 can be switched on or off and/or dimmed, for example. Furthermore, it is possible that the selection of a color temperature T or of a color locus O for the electromagnetic radiation emitted by the luminaire 2 can be effected by means of the operating element 197.

[000657] The luminaire 2 can be a luminaire which emits on both sides and which is embodied such that it scatters light diffusely. That is to say that, in this case, the luminaire 2 is not embodied in transparent fashion, but rather merely in radiation-transmissive fashion in the manner of an opalescent glass pane, for example. In this way, besides its properties for general lighting, the luminaire 2 also serves as a room divider affording a concealing screen. Furthermore, it is possible for the luminaire 2 to emit electromagnetic radiation 190 only from one side and to appear like a customary room divider from the other side.

[000658] By means of the luminaire 2 it is possible, on account of the large radiation exit area 174, to generate dazzle-free light since relatively low luminances are necessary in order to illuminate a room by means of the luminaire 2.

[000659] In conjunction with figures 52A to 52C it is illustrated that the luminaire 2, embodied as a room divider, can have a radiation exit area 174 of variable size. This can be achieved, for example, by virtue of the fact that the luminaire 2 has a radiation passage area 174 that can be

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rolled up and unrolled.

[000660] For this purpose, by way of example, as illustrated in conjunction with figure 52B, the luminaire 2 is subdivided into individual lamellae, which can each be formed by rigid organic light-emitting diodes 1. The lamellae, that is to say the individual organic light-emitting diodes 1, are mechanically and electrically connected to one another by connection conductors 236. The connection conductors 236 themselves are embodied in flexible fashion, for example in the sense of a power cable that can be unrolled and rolled up. In this case, the luminaire 2 comprises a multiplicity of organic light-emitting diodes 1 arranged in a series one after another.

[000661] Furthermore, it is possible for the luminaire 2, as illustrated in conjunction with figure 52C, to have a radiation exit area 174 that is not subdivided into individual lamellae. By way of example, the luminaire 2 comprises for this purpose exactly one, large-area organic light-emitting diode 1. Furthermore, it is possible for the luminaire 2 to comprise a multiplicity of organic light-emitting diodes 1 arranged in the manner of a matrix. The organic light-emitting diodes 1 can be flexible organic light-emitting diodes that are introduced between two films. In this way, a large-area luminaire 2 that can be rolled up and unrolled can be constructed from a multiplicity of smaller, flexible organic light-emitting diodes 1.

[000662] In conjunction with figure 53 it is illustrated that the luminaire 2, which forms a room divider, can also involve sound protection. In this case, the luminaire 2 has a rear wall 246 formed with at least one insulating material 256 suitable for acoustic insulation. In a simple case, the rear wall 246 can be a styropor panel. As light source of the luminaire 2, at least one organic light-emitting diode 1 is then connected to the insulating material 256 forming the rear

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wall 246.

[000663] An exemplary embodiment of a luminaire described here in which the luminaire is embodied as a louver is explained in greater detail in conjunction with figures 54A to 54C. In this case, the luminaire 2 comprises a multiplicity of organic light-emitting diodes 1 which are electrically contact-connected and mechanically held by means of a holding device 239. At one end face, the organic light-emitting diodes 1 comprise a connection plug 257, which engages into the holding device 239. The luminaire 2 can be electrically connected by means of connection conductors 236, for example. The holding device 239 is a rail, for example, in which the individual organic light-emitting diodes 1 are fixed by means of the connection plug. The organic light-emitting diodes 1 can be displaced in the rail.

[000664] In this case, the organic light-emitting diodes 1 can be embodied in flexible or rigid fashion. By way of example, the organic light-emitting diodes 1 have, as first carrier 130, a metal sheet having reflective properties. In this way, that side of each organic light-emitting diode 1 which faces away from the radiation exit area 174 is embodied in reflective fashion. In this case, besides its properties for room lighting, the luminaire 2 also serves for room darkening and/or as a concealing screen.

[000665] The luminaire 2 can comprise different organic light-emitting diodes 1, such that light of different colors or having different color effects can be generated by means of the luminaire 2. The luminaire 2 is arranged in front of a window for example in the sense of a curtain or louver, and in this way generates, even under poor outside light conditions, daylight-like illumination of the room in which the luminaire 2 is arranged. That is to say that the main light of the room is situated for example in the region of the window in which the luminaire 2 is arranged. In this way, when the luminaire 2

is switched on, illumination of the room similar to that through the window takes place. In this case, the luminaire 2 can form the main light source of a room, such that it is possible to dispense with further light sources in the room.

[000666] In this case, the organic light-emitting diodes 1 used as light sources of the luminaire 2 are preferably embodied as described in one of figures 1 to 31 or as a combination of the organic light-emitting diodes 1 described there.

[000667] A further exemplary embodiment of a luminaire 2 described here is explained in greater detail in conjunction with figures 55A to 55D. In this exemplary embodiment, the luminaire, besides its function for general lighting, also serves as a concealing screen. The luminaire 2 has, for example, at least three radiation exit areas 174 embodied as walls.

[000668] The schematic perspective illustration in figure 55A shows the luminaire 2 in a switched-off operating state. In this switched-off operating state, the luminaire 2 is transparent. For this purpose, the luminaire 2 comprises, for example, at least one organic light-emitting diode 1 as light source which is embodied in transparent fashion.

[000669] In conjunction with the basic perspective schematic diagram in figure 55B, the luminaire 2 is shown in a switched-on operating state. In this switched-on operating state, the luminaire 2 emits electromagnetic radiation 190. In this case, it is possible for the electromagnetic radiation to be emitted both outward, into the room, and inward, into the cubicle enclosed by the walls of the luminaire 2. In this case, the luminaire 2 serves both for lighting the interior of the cubicle and as an indicator device for indicating that the cubicle is occupied by a user.

[000670] Furthermore, in the switched-on operating state, the luminaire 2 no longer appears transparent, but rather is visually impenetrable. This is achieved, for example, by virtue of the fact that the luminaire 2 comprises an electrically switchable optical element 186 as described in greater detail in conjunction with figure 27. The electrically switchable optical element 186 is then an electrically switchable diffuser or an electrochromic material. The switching of the luminaire 2 into the switched-on, luminous and visually impenetrable operating state, as illustrated in greater detail in figure 55B, can in this case be effected for example by the cubicle being entered.

[000671] By way of example, a switch can be actuated by means of the actuation of doors at the luminaire 2. Furthermore, it is possible for the luminaire 2 to comprise a light barrier 260, as is explained in greater detail for example in conjunction with figures 55C and 55D. In the event of said light barrier being crossed, said light barrier comprising a plurality of light-emitting diodes 210, laser diodes and/or optical sensors, for example, the luminaire 2 is switched on.

[000672] In this case, the luminaire described can be used for example as a changing cubicle. In this case, it is also possible that the color temperature T and/or color locus O of the light generated by the luminaire 2 can be set by the user of the luminaire 2. In this way, the clothing being tried on by the user can be checked by the user under different lighting conditions. The user can thereby check for example the effect of the clothing in daylight, office lighting, twilight and the like.

[000673] Furthermore, the luminaire described can be used as a separating wall in an open-plan office. The light emitted by the luminaire then serves as an office light and signals that the workstation at which the luminaire 2 is situated is occupied. Switching between transparent and diffuse can also

be effected independently of the light emission by the luminaire, such that the user of the luminaire can switch the latter to be non-radiation-transmissive, in diffusely scattering fashion, as necessary, in order to create a more private working atmosphere.

[000674] Figures 56A to 56C show, on the basis of schematic illustrations, a further exemplary embodiment of a luminaire 2 described here. In this exemplary embodiment, the luminaire 2 forms solar protection - besides its properties for general lighting.

[000675] Figure 56A shows the luminaire 2 on the basis of a schematic sectional illustration in a switched-off operating state. The luminaire 2 is in this switched-off operating state for example during the day, upon insolation. In this operating state, the luminaire 2 serves for light protection and casts a shadow 265. For this purpose, the luminaire 2 has a, for example, reflective surface at its top side facing away from the radiation exit area 174, said reflective surface reflecting the impinging radiation 191. Furthermore, it is possible for the luminaire 2 to be embodied, at its top side facing away from the radiation exit area 174, as a solar cell which, for example upon insolation, generates current by means of which the luminaire 2 can be operated later, for example at night. By way of example, the document US 7,317,210 discloses a combination of organic light-emitting diode and solar cell which can be used in this case.

[000676] In conjunction with the schematic illustration in figure 56B, the luminaire 2 is shown in a switched-on operating state. In the switched-on operating state, the luminaire 2 emits electromagnetic radiation 190 from its radiation exit area 174. In this case, the luminaire 2 preferably comprises a multiplicity of organic light-emitting diodes 1 or at least one organic light-emitting diode 1 subdivided into a multiplicity of segments 203. Each of the

segments, or each organic light-emitting diode 1, can be suitable for generating light of a different color or having a different color temperature than other segments 203, or light-emitting diodes 1, of the luminaire 2. Depending on the operation of the organic light-emitting diodes 1 or of the segments 203, it is thus possible to generate different light moods by means of different color loci and/or color temperatures of the emitted light. In this case, the different color loci and/or color temperatures can also be generated in different regions of the luminaire 2. That is to say that, for example, regions of the radiation exit area 174 can, for example, rather emit reddish light, whereas other regions of the radiation exit area 174 rather emit bluish light, for example. In this case, the regions of the radiation exit area 174 preferably each comprise a multiplicity of organic light-emitting diodes 1 or segments 203.

[000677] The construction of the luminaire and also the contact-connection of the individual organic light-emitting diodes 1, or of the segments 203, can be as described in conjunction with figure 45.

[000678] Organic light-emitting diodes 1 as described in conjunction with figures 1 to 31 are preferably used as organic light-emitting diodes 1.

[000679] The luminaire 2 is a large-area luminaire preferably having an area content of a radiation exit area 174 of at least 5 m^2, particularly preferably of at least 10 m^2. In this case, the radiation exit area 174 of the luminaire 2 is composed of the radiation exit areas of the organic light-emitting diodes 1 or of the segments 203.

[000680] In conjunction with figure 56C it is schematically illustrated that power can be supplied to the luminaire 2 via a stand 251, in which connection conductors 236 are laid.

[000681] Further exemplary embodiments of luminaires described here are shown in conjunction with figures 57A and 57B. In these exemplary embodiments, the luminaire 2 is embodied as a bag 266. The luminaire 2 can be used for example as a rucksack or as a school satchel.

[000682] For this purpose, organic light-emitting diodes 1 are applied or integrated at least on places of the bag 266. The organic light-emitting diodes 1 are preferably embodied in flexible fashion, such that they can adapt to the contours of the bag 266. That is to say that the bag 266 has at least one radiation entrance area 174, through which electromagnetic radiation 190, preferably light, leaves the luminaire.

[000683] In this case, the luminaire 2 comprises at least one organic light-emitting diode 1 which - as described by way of example in conjunction with figures 29 and 30 - comprises a retroreflector. In this way, even when the organic light-emitting diode 1 is not switched on, the luminaire 2 reflects impinging electromagnetic radiation and therefore serves, in this case, too, for better visibility of the user of the luminaire 2.

[000684] In conjunction with the schematic illustration in figure 57A it is furthermore explained that the bag 266 can have a slot 286, for example, in which is arranged a rechargeable battery 267 by means of which the organic light-emitting diode 1 of the luminaire 2 is supplied with electric current.

[000685] As an alternative or in addition to the embodiment of the luminaire 2 as a bag, it is furthermore conceivable for the luminaire 2 to be embodied as protective clothing, work clothing, headband, head covering or the like. At all events the luminaire 2 comprises at least one organic light-emitting diode 1 having a retroreflector. The luminaire 2 thus serves for improved visibility of its user both in the switched-on

and in the switched-off operating state.

[000686] Further exemplary embodiments of a luminaire 2 described here are explained in greater detail in conjunction with the schematic illustrations in figures 58A and 58B. In these exemplary embodiments, the luminaire 2 serves as emergency lighting, for example as a camping light.

[000687] The luminaire 2 has a radiation exit area 174. Furthermore, the luminaire 2 has a solar cell 269 at the side lying opposite the radiation exit area 174. The solar cell 269 can be a flexible inorganic or organic solar cell embodied in film-like fashion. At least one organic light-emitting diode 1 that is flexible and preferably emits white light serves as light source of the luminaire 2.

[000688] The luminaire 2 can be operated in two different operating states. Firstly, the luminaire 2 can be rolled to form a cylinder, which is closed by a connector 237. Connection locations for making contact with the luminaire 2 via connection conductors 236 can be situated at the connector 237.

[000689] In another operating state, the luminaire 2 can be rolled out. In this case, the luminaire 2 can be operated in suspended fashion, for example, by means of the connection conductors 236 and, if appropriate, a holding device 239, which can likewise be embodied in the manner of a wire or cable. In conjunction with figure 58A it is illustrated, for example, that the luminaire 2 is suspended from the branches of a tree. In this case, the radiation exit area 174 faces the ground, and the solar cell 269 is directed away from the ground.

[000690] Such a luminaire 2 can be charged by insolation, during the day, for example in the suspended state. At night, the luminaire 2 then continuously emits electromagnetic

radiation 190 through the radiation exit area 174. In this case, the luminaire 2 is preferably operated as emergency or camping lighting, such that relatively low luminances are sufficient.

[000691] As an alternative to solar operation, which can be realized for example by means of a rechargeable battery integrated into the luminaire 2, the luminaire 2 can also be connected to an external power source, such as an automobile battery, for example, via the connection conductors 236.

[000692] In conjunction with figure 59, a further exemplary embodiment of a luminaire 2 described here is explained in greater detail with reference to a schematic perspective illustration. The luminaire 2 is a large-area luminaire which can be operated for example by means of a rechargeable battery 267 – in the present case an automobile battery. The luminaire has a radiation exit area 174. The luminaire is fixed to a motor vehicle such as an automobile or a bus by means of the fixing means 248, for example. The fixing means 248 can be a magnet or an adhesive connection.

[000693] The luminaire 2 preferably comprises at least one organic light-emitting diode 1 as described here. The organic light-emitting diode 1 can be a flexible organic light-emitting diode 1 that illuminates an area 185a to be illuminated. The area 185a to be illuminated is, for example, a billboard or a company logo. The luminaire 2 can thus be used for advertising purposes on motor vehicles.

[000694] A further exemplary embodiment of a luminaire described here is explained in greater detail in conjunction with figures 60A to 60D. In this case, the luminaire 2 forms an umbrella 270. The umbrella 270 emits electromagnetic radiation 190 from its inner area.

[000695] This can be realized, firstly, by virtue of the

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luminaire 2 comprising at least one organic light-emitting diode 1 embodied in flexible fashion. The organic light-emitting diode 1 can then be situated on the inner side of the crown of the umbrella 270 or form the crown of the umbrella 270.

[000696] By way of example, electrical contact is made with the at least one organic light-emitting diode 1 by means of the struts or paragon rods 270a of the umbrella 270. The organic light-emitting diode 1 of the umbrella 270 can then be energized by means of at least one rechargeable battery 267, which can be arranged in the grip or handle 270d of the umbrella 270 (cf. figure 60D, for example).

[000697] As an alternative or in addition to at least one organic light-emitting diode 1, it is possible for the umbrella 270 to comprise at least one inorganic light-emitting diode 210 as light source. The at least one inorganic light-emitting diode 210 is fixed for example to or in the tube 270a of the umbrella 270. By way of example, the inorganic light-emitting diodes 210 are fixed to the slide 270b or below the slide 270b of the umbrella 270. The inorganic light-emitting diodes 210 emit onto the inner side of the crown 270e of the umbrella 270, which is embodied as a reflector 271 or organic light-emitting diode 1 having a reflective layer.

[000698] In this case, the reflector 271 can be embodied in such a way that it emits electromagnetic radiation 190 in a directional fashion. It is thereby possible for the umbrella to emit radiation when being held vertically in the direction of movement of the user and, in this way, to illuminate the path ahead of the user.

[000699] Preferably, the inorganic light-emitting diodes 210 are fixedly connected to the slide 270b of the umbrella 270, such that, in the event of the umbrella 270 being open, they are conveyed into a position lying closely below the crown

270e of the umbrella 270. The lighting by the inorganic light-emitting diodes 210 can then be switched on at the same time as the slide 270b is slid up. However, it is also possible that the lighting can be switched on separately, such that it is activated for example only under poor visibility conditions.

[000700] In conjunction with figure 60D it is schematically illustrated that at least one rechargeable battery 267 as power supply for the light sources of the luminaire 2 forming an umbrella 270 can be arranged in the handle 207d of the umbrella. This can be charged, for example, by connection to an electrical power supply. Overall, the luminaire 2 in the exemplary embodiment in figures 60A to 60D constitutes a mobile light which enables improved visibility and an improved view for the user under poor visibility conditions including in road traffic.

[000701] Figures 61A to 61C show a further exemplary embodiment of a luminaire 2 described here in schematic illustrations.

[000702] The luminaire 2 in the present case is a vehicle light such as, for example, a brake light, an indicator light 280 and/or a rear light 281. What is common to the vehicle lights mentioned in this case is that they are integrated in a vehicle window 275. The luminaires 2 comprise, for example, a transparent organic light-emitting diode, the first carrier 130 and second carrier 131 of which are in each case formed with a glass. The organic light-emitting diodes 1 are therefore integrated as transparent organic light-emitting diodes into parts of the vehicle windows 275. In this way it is possible to form an indicator light 280, for example, which can extend over the entire length of the vehicle. This increases the noticeability of the vehicle in road traffic.

[000703] By way of example, the organic light-emitting diodes

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1 described in conjunction with figures 1 to 31 are used as organic light-emitting diode 1 for the luminaire 2 embodied as a vehicle light.

[000704] If the luminaire 2 is a rear light 281 or a brake light, then the luminaire can comprise an organic light-emitting diode 1 having a retroreflector, as explained in greater detail for example in conjunction with figures 29 and 30. In this case, even in the switched-off operating state, the luminaire 2 can reflect back red light, for example when irradiated by an automobile headlight.

[000705] As explained in conjunction with the schematic illustration in figure 61C, the luminaire 2 can be connected to the automobile battery of the motor vehicle for power supply via connection conductors 236.

[000706] In conjunction with figure 62, a further exemplary embodiment of a luminaire described here is explained in greater detail with reference to a schematic perspective illustration. In this exemplary embodiment, for the purpose of forming the luminaire 2, a transparent organic light-emitting diode is integrated over the whole area into a vehicle window 275 – here into the rear window. That is to say that the rear window 275 is formed by a transparent organic light-emitting diode 1. Such a luminaire 2 can serve for example for illuminating the interior of a trunk when the vehicle is not being driven.

[000707] Furthermore, it is possible for the organic light-emitting diode 1 to contain an emitter material suitable for generating infrared electromagnetic radiation. In this case, the organic light-emitting diode 1 can also be used for deicing a vehicle window 275. The organic light-emitting diode 1 then need not necessarily also be suitable for generating visible light. In particular, it is possible in this case for all the vehicle windows 275 of the motor vehicle to be formed

by transparent organic light-emitting diodes which are suitable for generating infrared electromagnetic radiation during operation. In this way, it is also possible, for example, to heat a front window of the motor vehicle, without heating wires threading through the window or without having to arrange in the vehicle a fan that blows hot air onto the vehicle window 275. In this way, it is also possible to prevent the vehicle windows 275 from steaming up.

[000708] By means of an optical cavity as explained in greater detail in conjunction with figures 26 and 27, it is possible for the entire or at least a majority of the infrared radiation generated to be directed toward the outside, out of the vehicle. In this case, by way of example, snow lying on the vehicle windows 275 can be melted away particularly efficiently.

[000709] In conjunction with figure 63, a further exemplary embodiment of a luminaire 2 described here is explained in greater detail with reference to a schematic perspective illustration. In this case, in order to form the luminaire 2, an organic light-emitting diode 1 is integrated in side areas of a trunk. The organic light-emitting diode 1 is integrated into the side areas of a trunk purely by way of example. In principle, it is possible for an organic light-emitting diode 1 to be fitted at any location in the interior of the motor vehicle. In particular, an organic light-emitting diode 1 can also be integrated onto the inner side of the vehicle roof or into the base of the trunk. The organic light-emitting diode 1 allows large-area illumination of the interior of the motor vehicle, without high luminances having to be used for this purpose - on account of the relatively large area of the light exit area 175 of the organic light-emitting diode 1. That means that the organic light-emitting diode 1 allows illumination of the interior of the motor vehicle with relatively low luminances, thus resulting in dazzle-free lighting.

[000710] In conjunction with figures 64A to 64C, a further exemplary embodiment of a luminaire described here is explained in greater detail with reference to schematic illustrations. In this exemplary embodiment, the luminaire 2 forms a warning sign 285 such as can be used in road traffic, for example. In this case, as shown in figures 64B and 64C, the warning sign 285 is embodied in flexible fashion, such that it can be rolled up and unrolled. In figure 64B it is explained that the warning sign 285 can, for this purpose, be divided into individual organic light-emitting diodes 1 that are connected to one another by means of flexible connection conductors 236 that can be rolled up and unrolled.

[000711] In conjunction with figure 64C it is shown that the warning sign 285 can also be formed by one fully flexible organic light-emitting diode 1.

[000712] In both embodiments of the warning sign 285 it can be expedient for the warning sign 285 to emit electromagnetic radiation from two main areas. That is to say that the warning sign 285 is actively luminous from two sides, for example. By way of example, at least one organic light-emitting diode 1 with retroreflector as explained in greater detail in figures 29 and 30 is employed for forming the warning sign 285. In particular, it is possible for the warning sign 285 to have such organic light-emitting diodes 1 at both sides, such that it actively emits and reflects electromagnetic radiation 190 from both sides.

[000713] Further exemplary embodiments of a luminaire 2 described here are explained in greater detail in conjunction with figures 65A to 65C. In this exemplary embodiment, the luminaire 2 forms rain protection, for example a bus shelter. In this case, the luminaire 2 can comprise a plurality of organic light-emitting diodes 1 embodied in transparent fashion. By way of example, the carriers 130, 131 of the

luminaire 2 form the basic body of the bus shelter and thus the rain protection. An encapsulation can then be embodied as in conjunction with the luminaire 2 embodied as a shower cubicle (cf. figures 33 to 35).

[000714] Furthermore, it is also possible, as indicated in figure 65B, for at least one of the organic light-emitting diodes 1 to be embodied as a large-area display device which, by way of example, can display the next transport links, the time of day, the outside temperature or further simple information.

[000715] Finally, it is also possible, as described in greater detail in conjunction with figure 65C, for one of the luminaires 2 to serve for illuminating an area 185a to be illuminated. The area 185a to be illuminated is, for example, an advertisement such as a poster or the like. In this case, the element 185 to be illuminated is exchangeable, such that the area 185a to be illuminated can be changed from time to time.

[000716] The invention is not restricted to the exemplary embodiments by the description on the basis of said exemplary embodiments. Rather, the invention encompasses any novel feature and also any combination of features, which in particular includes any combination of features in the patent claims, even if this feature or this combination itself is not explicitly specified in the patent claims or exemplary embodiments.

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Patent claims

1. An organic light-emitting diode comprising an organic layer sequence, a radiation exit area and an encapsulation,

wherein the organic layer sequence comprises at least one radiation-emitting region which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation,

wherein the radiation exit area is structured, so that the electromagnetic radiation has a directional emission profile, and

wherein the encapsulation forms a seal of the organic layer sequence against environmental influences.

2. The organic light-emitting diode according to claim 1, wherein the structured radiation exit area comprises a multiplicity of prisms which are arranged parallel to one another.

3. The organic light-emitting diode according to claim 2,

wherein the prisms comprises a length and width which are arranged parallel to the main plane of the organic layer sequence,

wherein the length is at least 1 cm, and

wherein the width is bigger than the wavelength of the electromagnetic radiation which is induced by the organic light-emitting diode.

4. The organic light-emitting diode according to claim 1, wherein the emission profile is a symmetrical cardioid in one direction or asymmetrical in at least one of the directions.

5. The organic light-emitting diode according to claim 1,

wherein the structured radiation exit area comprises a multiplicity of first areas and second areas, wherein the first areas are tilted at an angle α to a plane which is arranged parallel to the main plane of the organic layer sequence,

wherein the second areas are tilted at an angle β to said plane, and

wherein the first areas are transparent and the second areas are reflective, so that the directional emission profile has a tilt angle which depends on the angle α.

6. The organic light-emitting diode according to claim 1,

wherein the structured radiation exit area comprises a multiplicity of first areas and second areas, wherein the first areas are tilted at an angle α to a plane which is arranged parallel to the main plane of the organic layer sequence, and

wherein the second areas are tilted at an angle β to said plane, wherein the angles α and β are different from each other.

7. The organic light-emitting diode according to claim 1,

wherein the prisms forms in side view an isosceles triangle,

wherein the directional emission profile is symmetrical and has two main radiation directions, wherein the two main radiation directions are inclined from the z-axis by the angle $\alpha = \beta$ in positive and negative x-directions, and

wherein the main plane forms an x-y-plane.

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8. The organic light-emitting diode according to claim 1, wherein the first areas and/or the second areas are nonplanar.

9. The organic light-emitting diode according to claim 1, wherein the first areas and/or the second areas are formed in the manner of cylinder sections.

10. The organic light-emitting diode according to claim 1, wherein the directional emission profile has a maximum in the direction perpendicular to the first areas.

11. The organic light-emitting diode according to claim 6, wherein the second areas are reflective, which is induced by metallization with metal particles.

12. The organic light-emitting diode according to claim 1, wherein the structured radiation exit area is embodied as a separate structured foil, which is arranged on a carrier.

13. The organic light-emitting diode according to claim 1,

wherein the organic light-emitting diode comprises a carrier which is structured,

wherein the radiation exit area is arranged on the carrier, and

wherein the structuring of the radiation exit area is induced by the structuring of the carrier.

14. The organic light-emitting diode according to claim 1,

wherein the carrier comprises a multiplicity of parallel prisms having first areas and second areas which

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are arranged in a tilted manner with respect to one another,

wherein functional layers of the organic layer sequence are applied to the first and/or the second areas at the top side of the carrier, and

wherein the functional layers, which are arranged on different areas, are driven separately from one another.

15. The organic light-emitting diode according to claim 1,

wherein the carrier comprises a multiplicity of parallel prisms having first areas and second areas,

wherein the areas are arranged in a tilted manner with respect to one another, and

wherein functional layers of the organic layer sequence are applied to the first and/or the second areas at the top side of the carrier, and the respective other areas are free of the functional layers.

16. The organic light-emitting diode according to claim 1, wherein the structuring of the radiation exit area is produced by the structuring of the encapsulation.

17. The organic light-emitting diode according to claim 1,

wherein the organic light-emitting diode is an organic light-emitting diode emitting on both sides, which comprises two radiation exit areas,

wherein the two radiation exit areas are arranged on opposite sides of the organic light-emitting diode, and

wherein the radiation exit areas are structured.

18. A luminaire having at least one light-emitting diode according to claim 1 as a light source,

wherein the luminaire is one of the following devices or is at least part of one of the following devices: alarm

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clock, shower cubicle, shower head, solar protection, rain protection, lamp, bag, signaling light, changing cubicle, vision protection, housing, emergency lighting, mirror, tile, ceiling light, radiator cladding, louver, noise protection, umbrella, warning light.

ABSTRACT OF THE DISCLOSURE

An organic light-emitting diode comprising an organic layer sequence, a radiation exit area and an encapsulation. The organic layer sequence comprises at least one radiation-emitting region which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation. The radiation exit area is structured, so that the electromagnetic radiation has a directional emission profile. The encapsulation forms a seal of the organic layer sequence against environmental influences.

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FIG 1

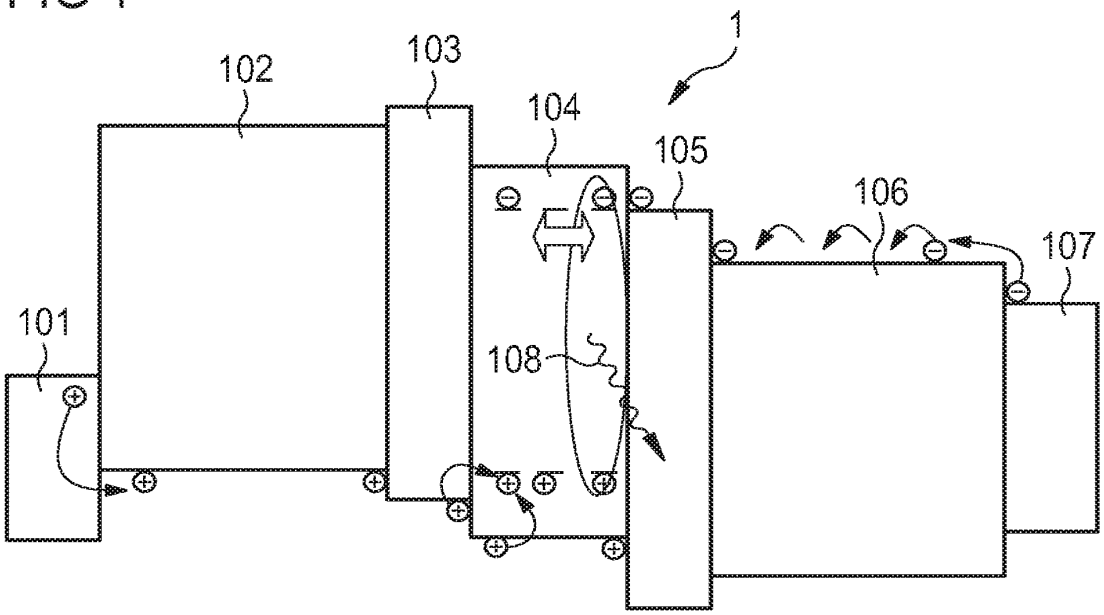


FIG 2

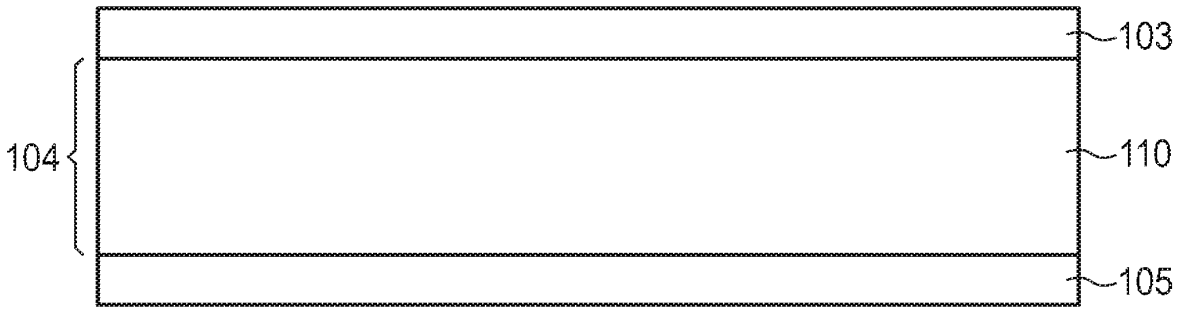


FIG 3

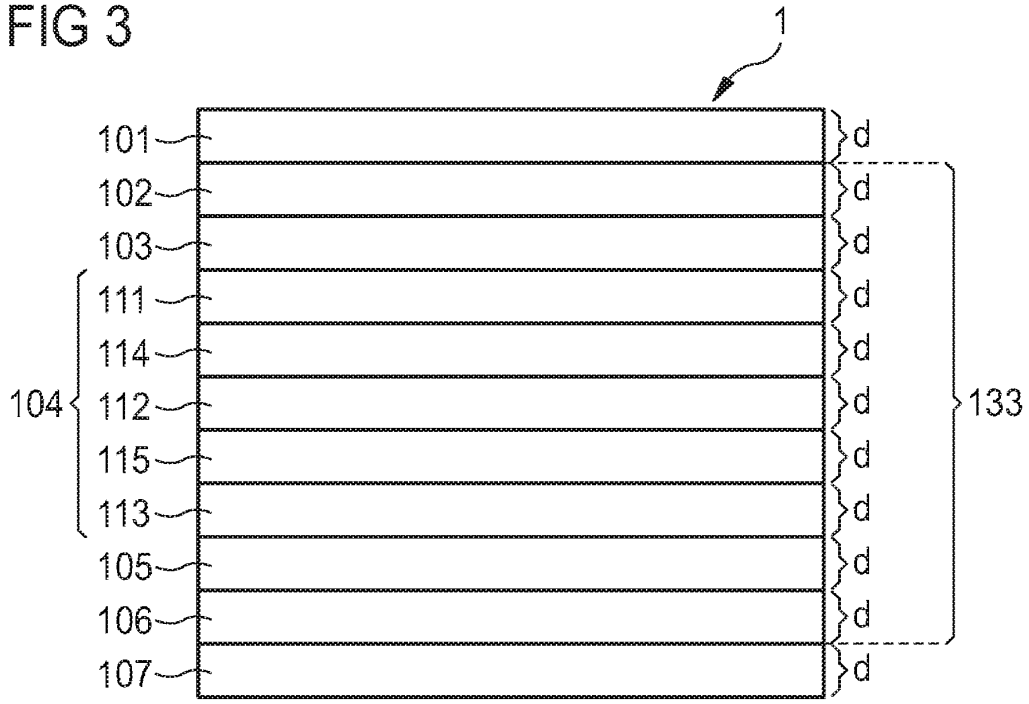


FIG 4

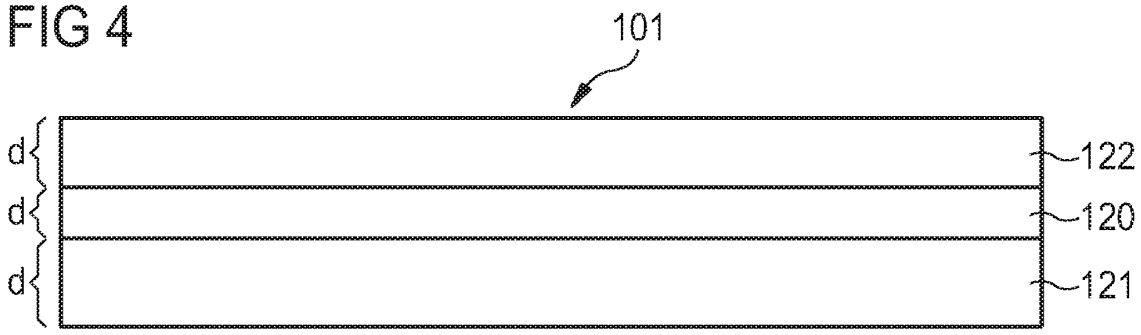


FIG 5

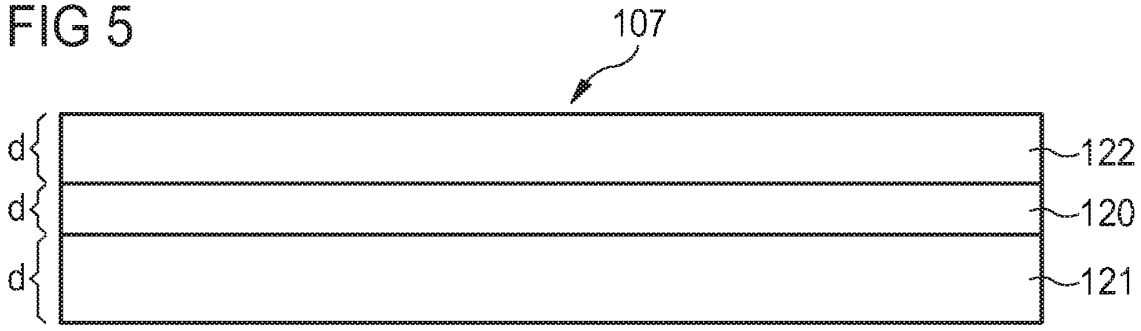


FIG 6A

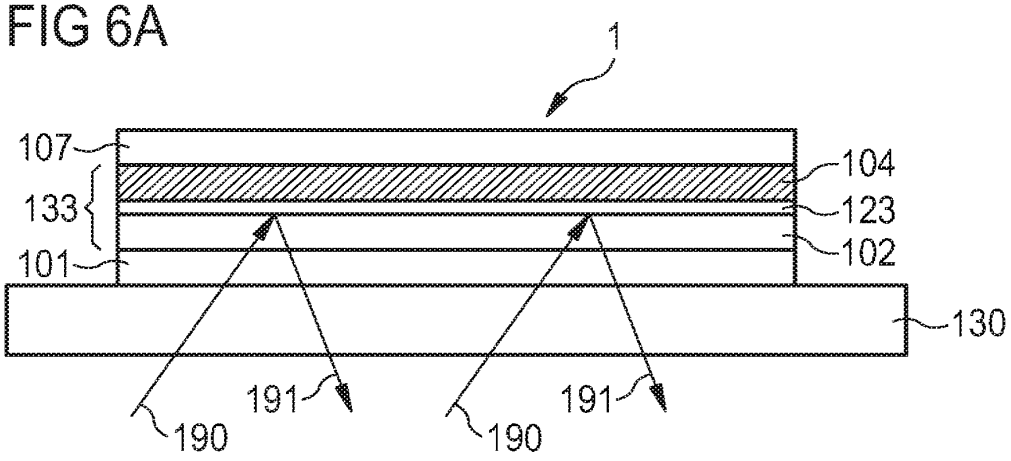

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FIG 6B

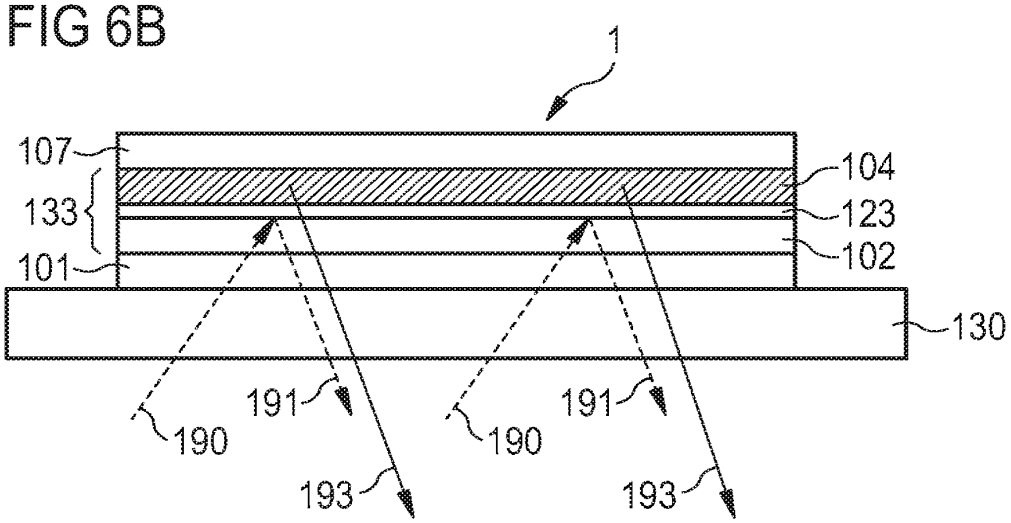

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FIG 6C

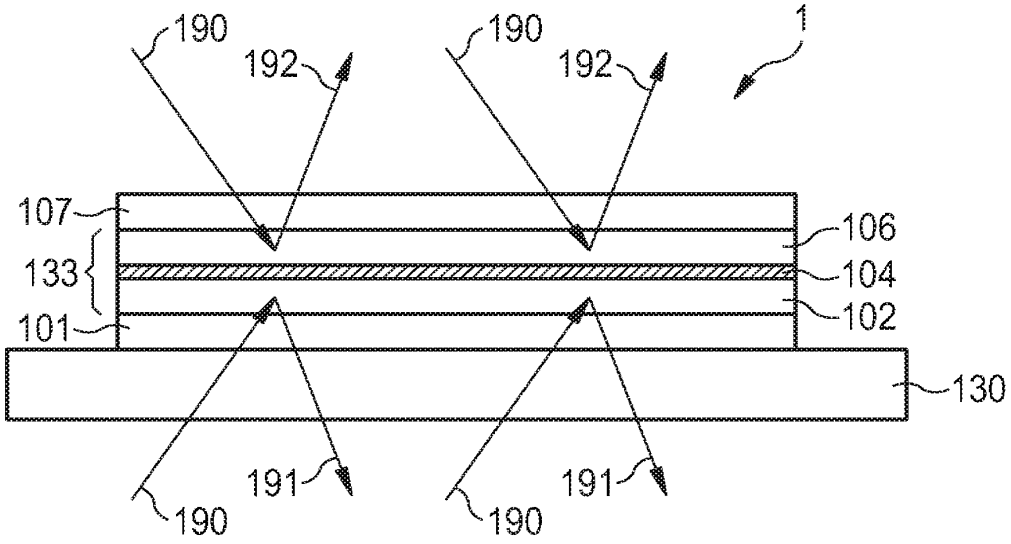

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FIG 6D

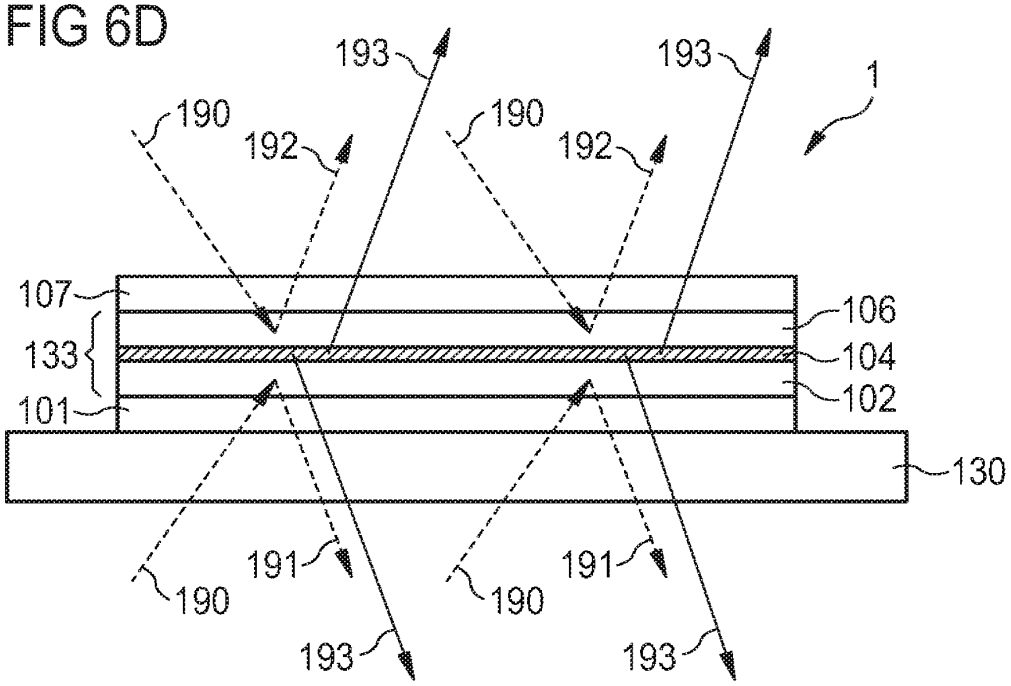

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FIG 7

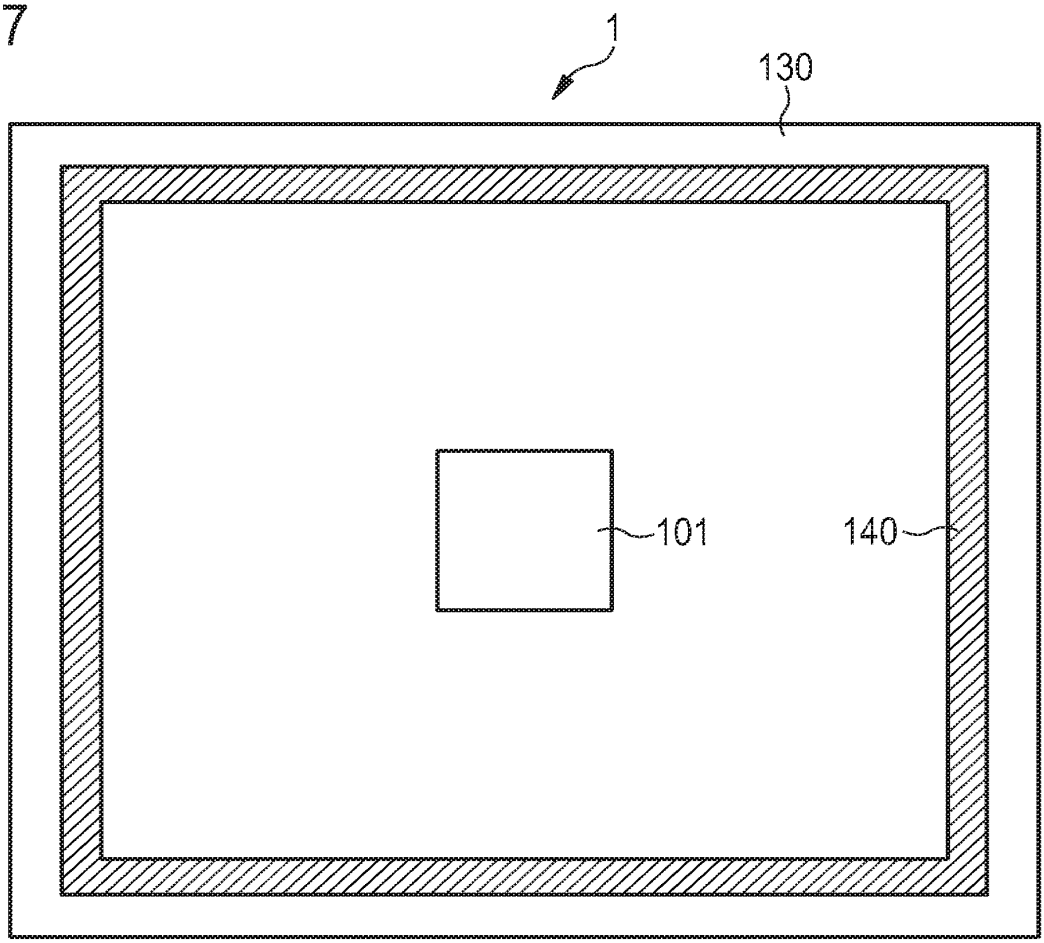


FIG 8

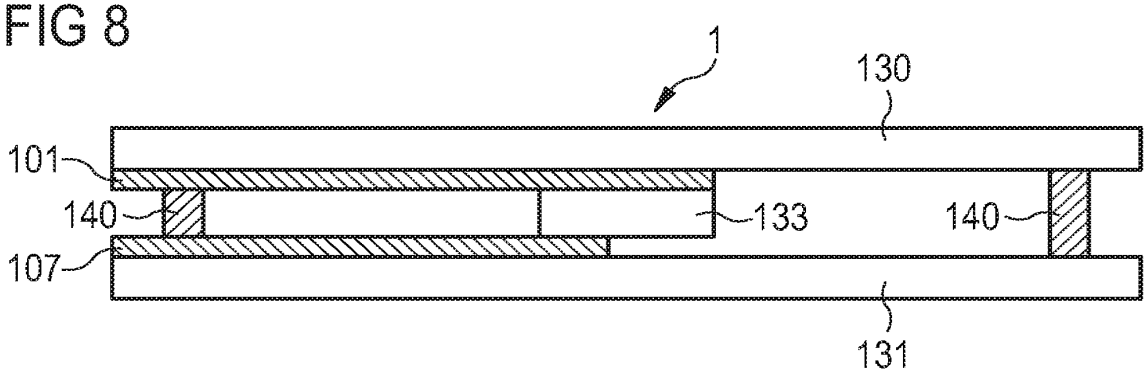


FIG 9

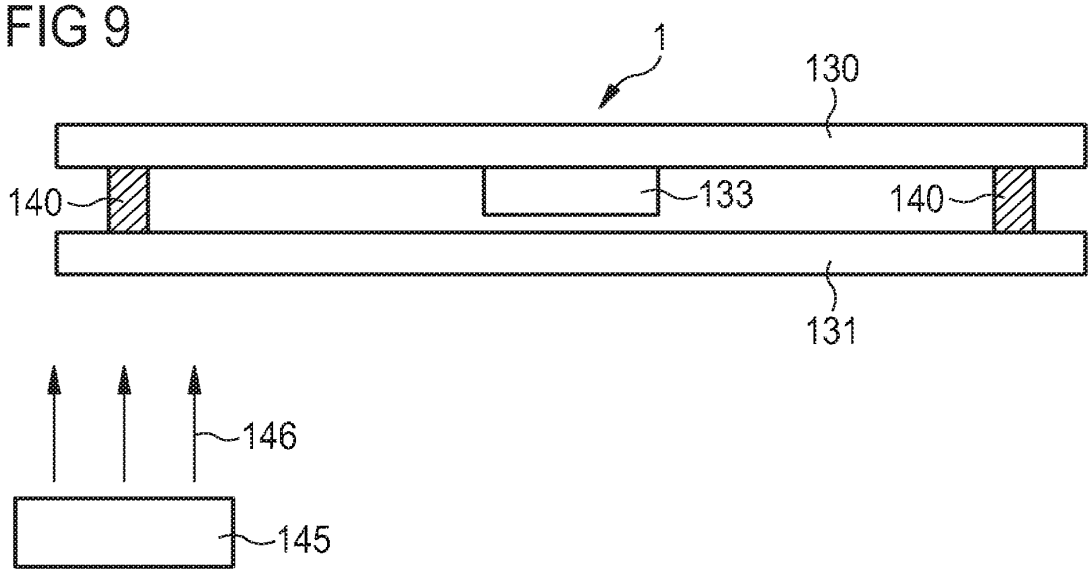

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FIG 10

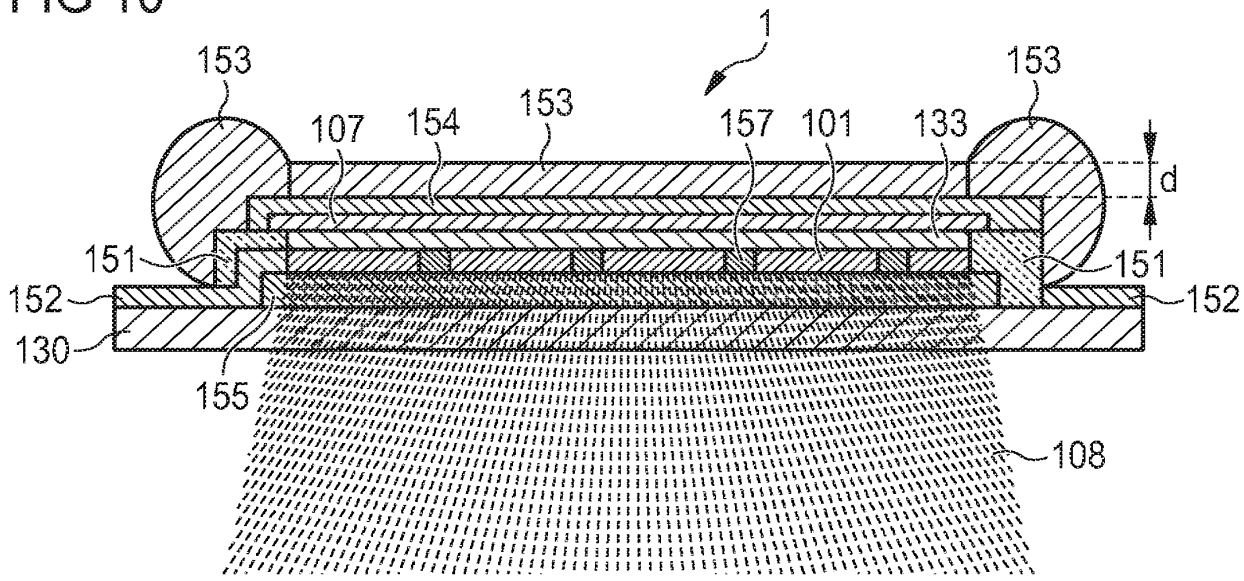

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FIG 11

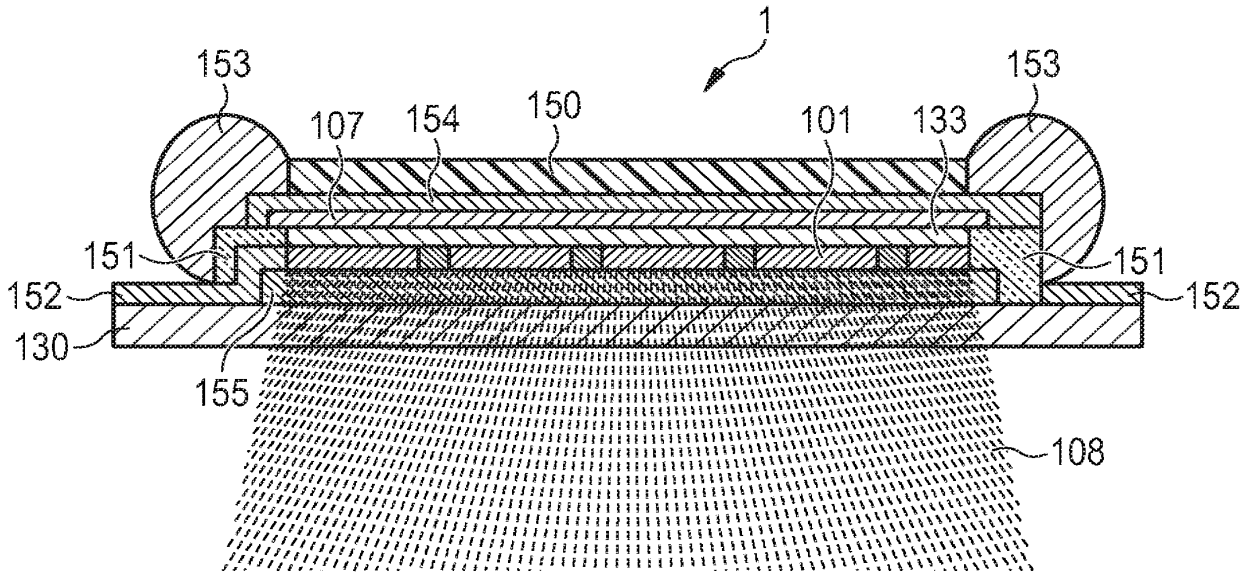

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FIG 12

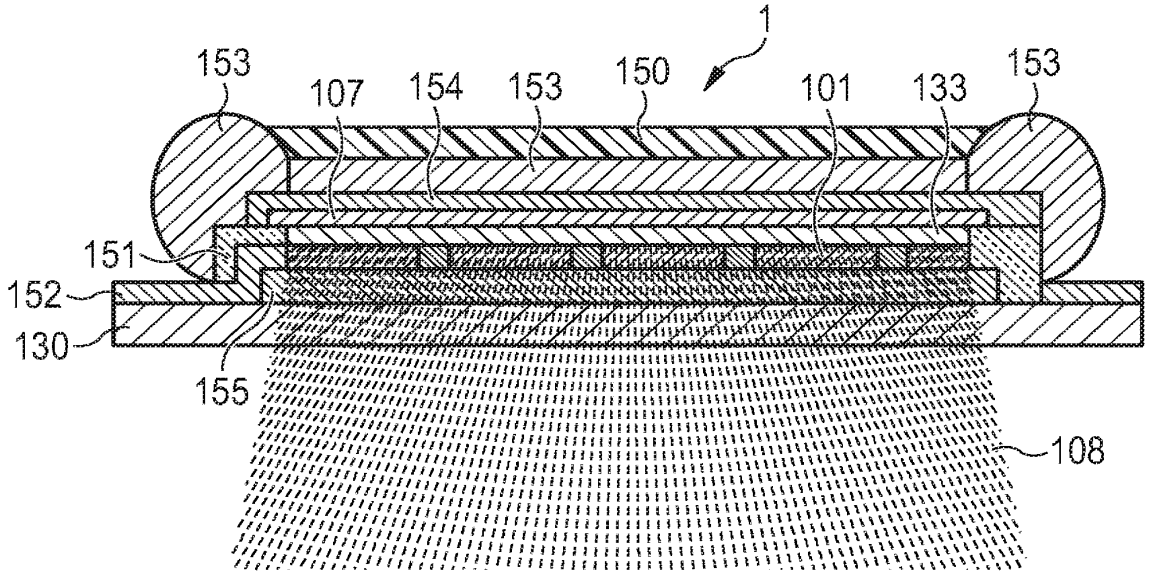

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FIG 13

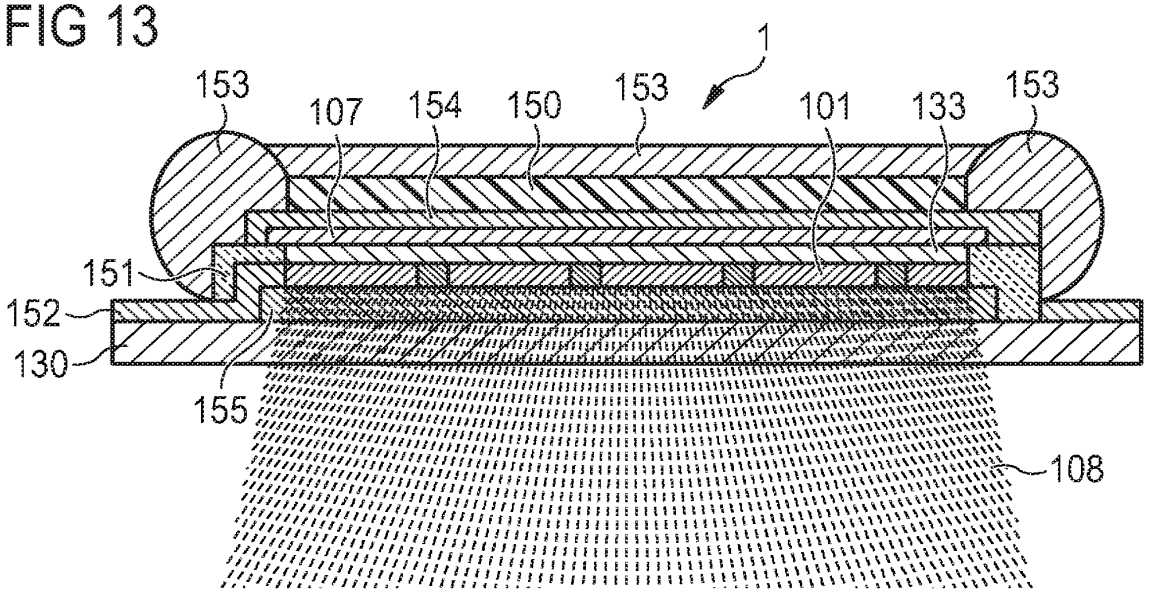


FIG 14A

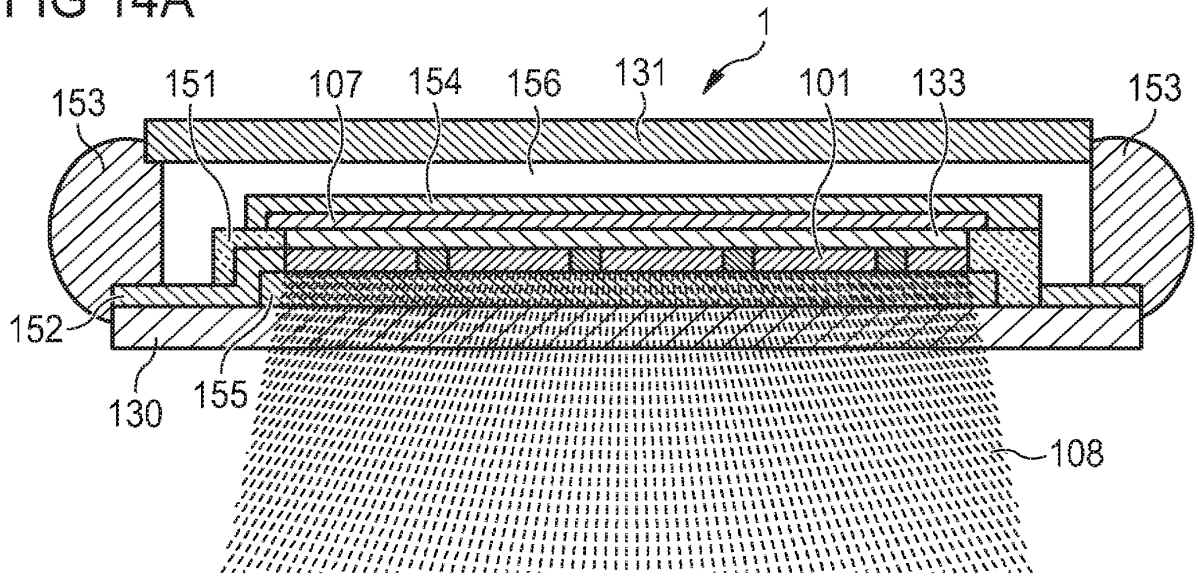


FIG 14B

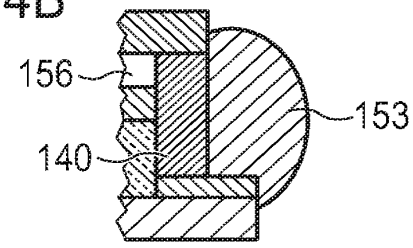


FIG 15

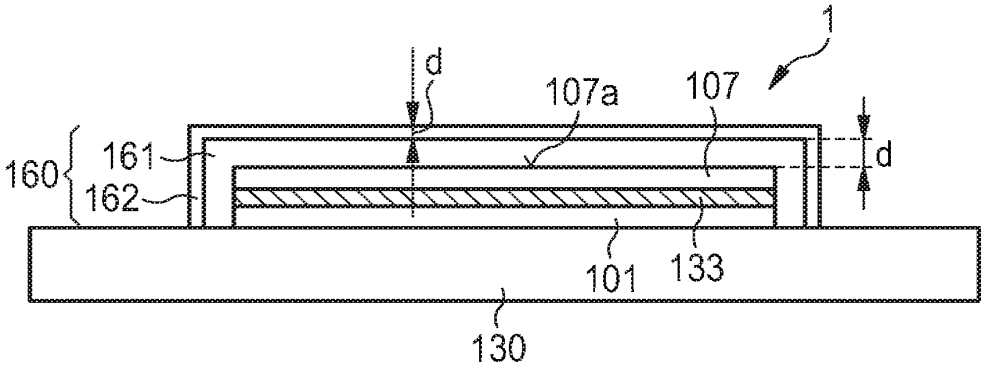


FIG 16

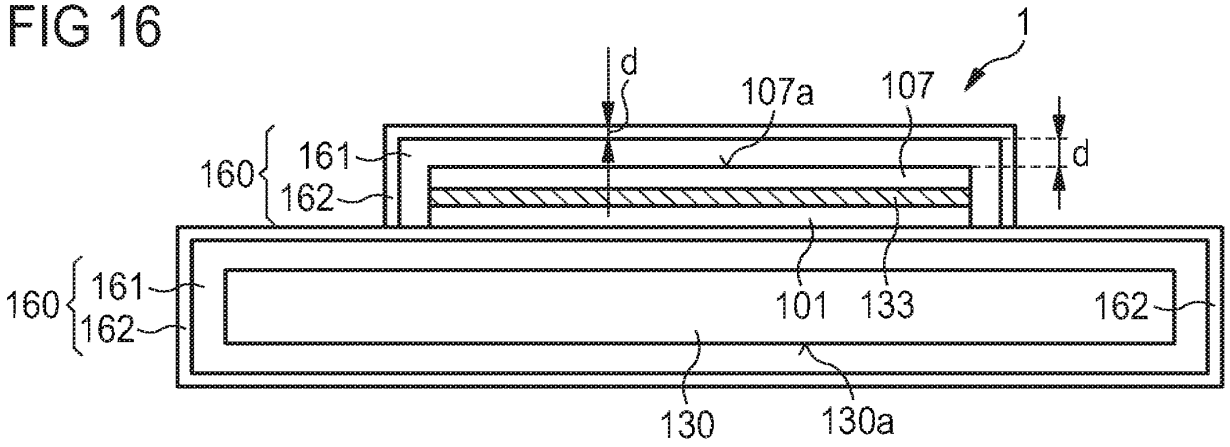


FIG 17

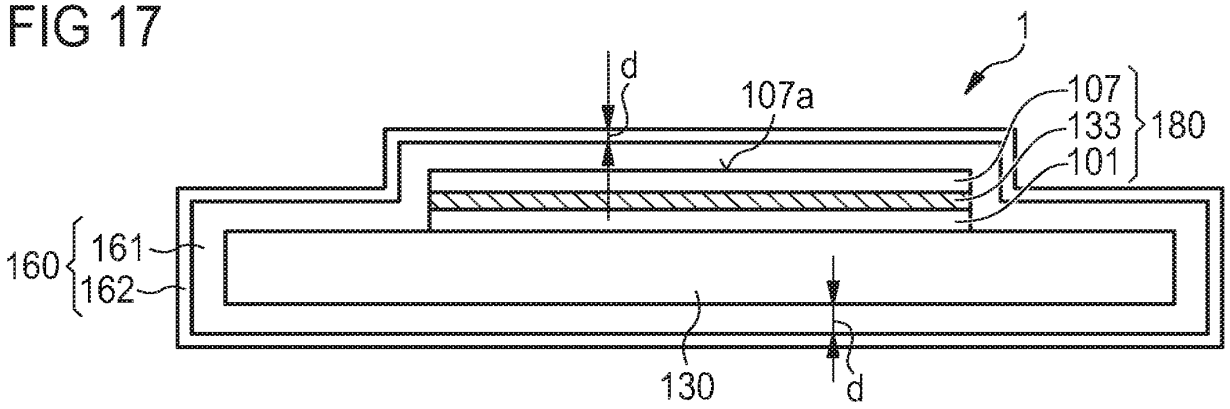


FIG 18

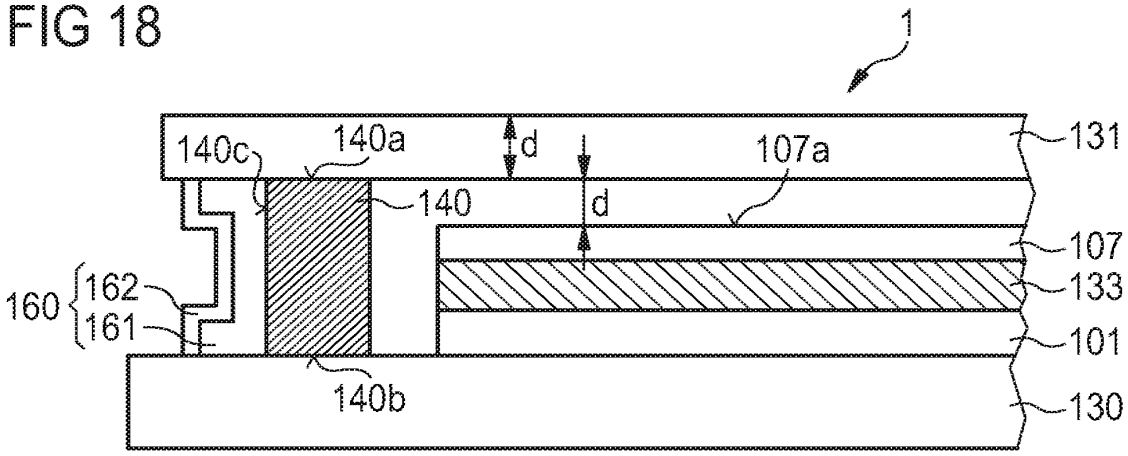


FIG 19

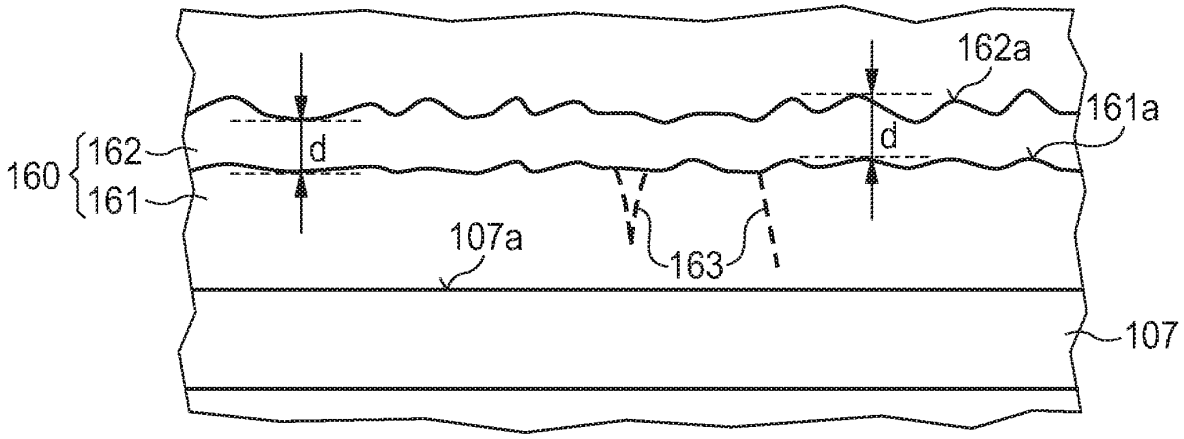


FIG 20

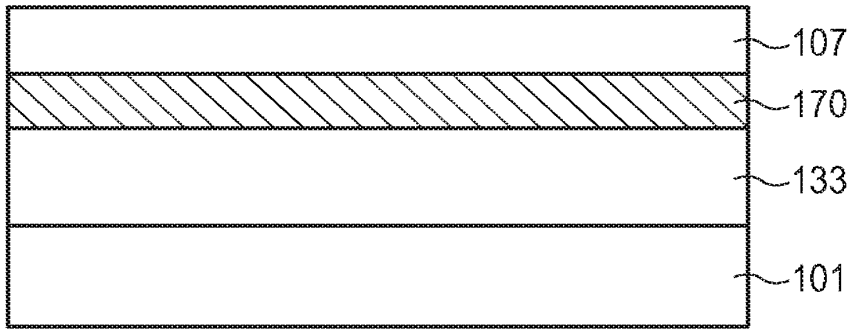


FIG 21

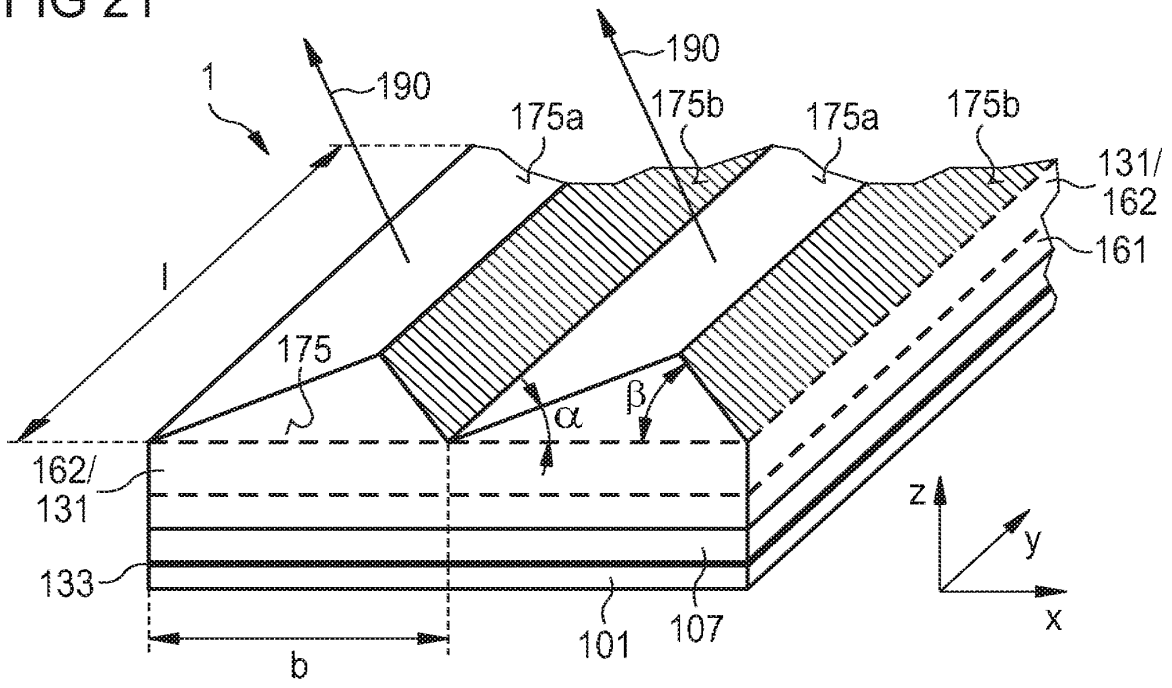

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190
175a
175b
175a
175b
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161
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162/
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x

FIG 22

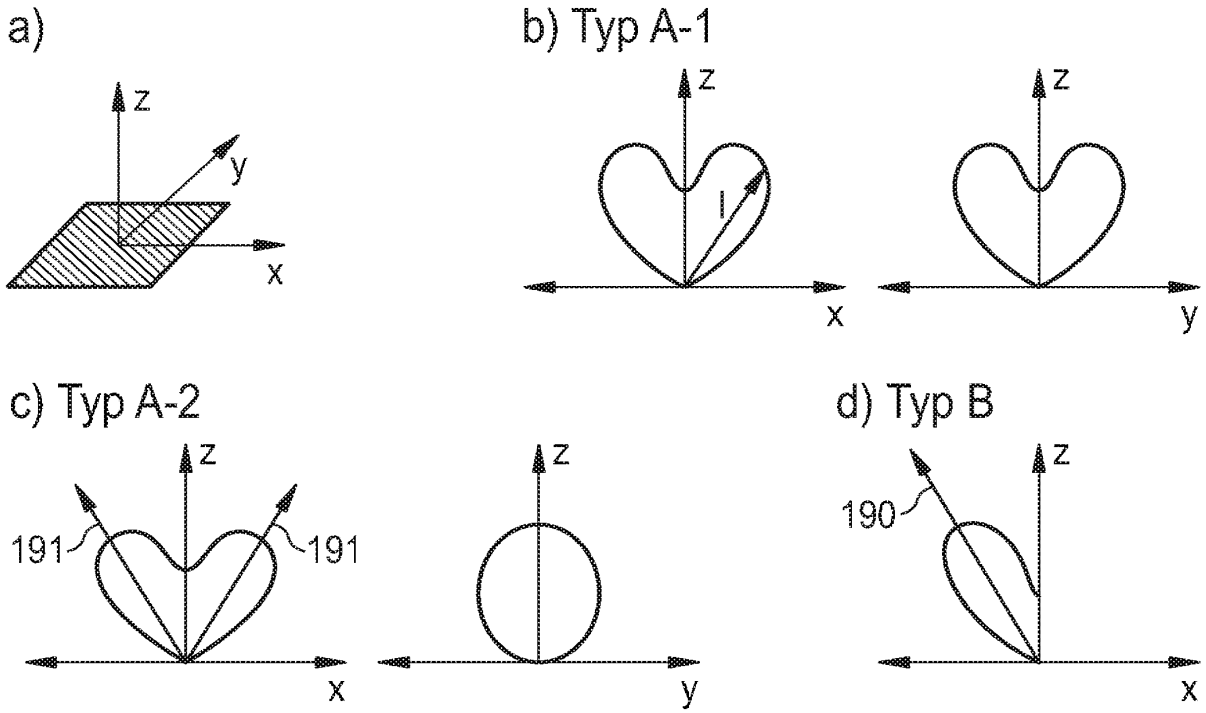

a)
z
y
x
b) Typ A-1
z
l
x
z
y
c) Typ A-2
z
191
191
x
z
y
d) Typ B
z
190
x

FIG 23

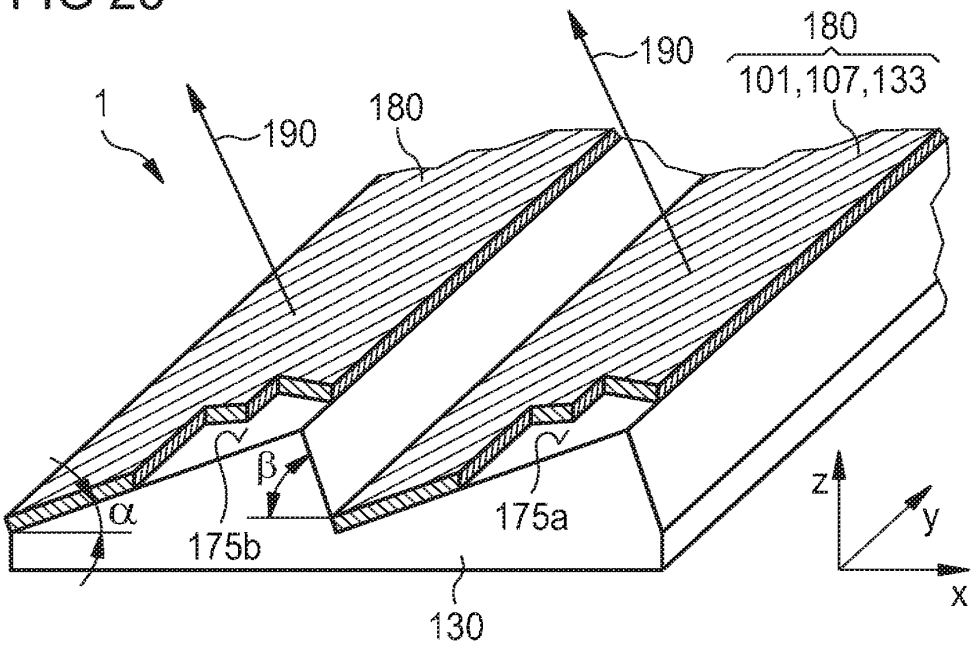

1
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190
180
101,107,133
α
β
175b
175a
130
z
y
x

FIG 24

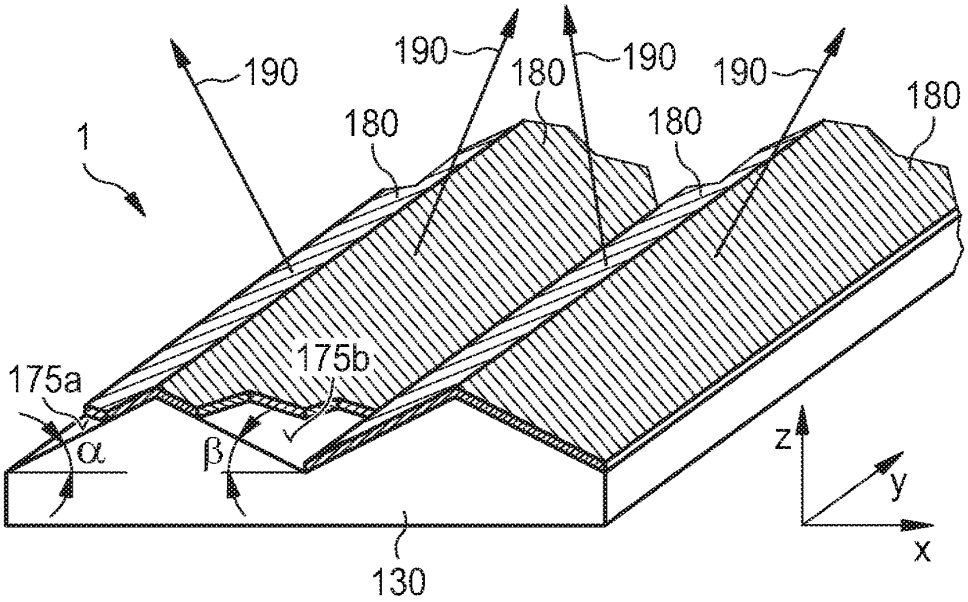

190
190
180
190
190
180
180
180
1
175a
175b
α
β
130
z
y
x

FIG 25

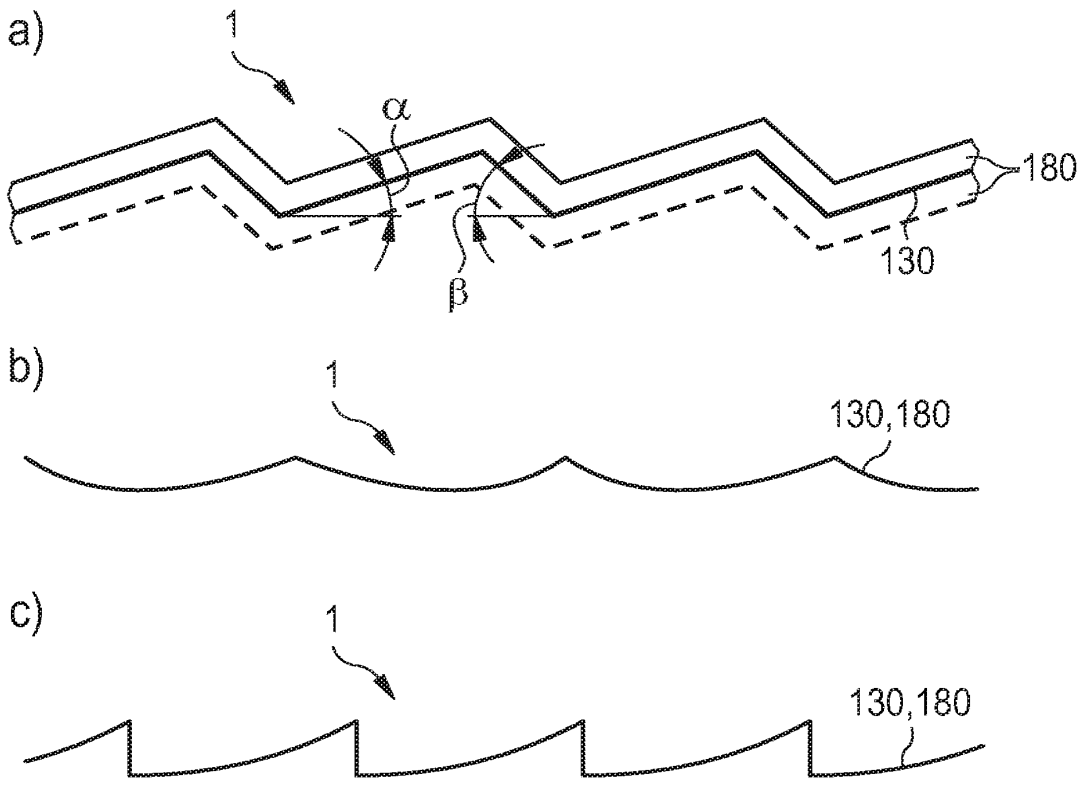


FIG 26A

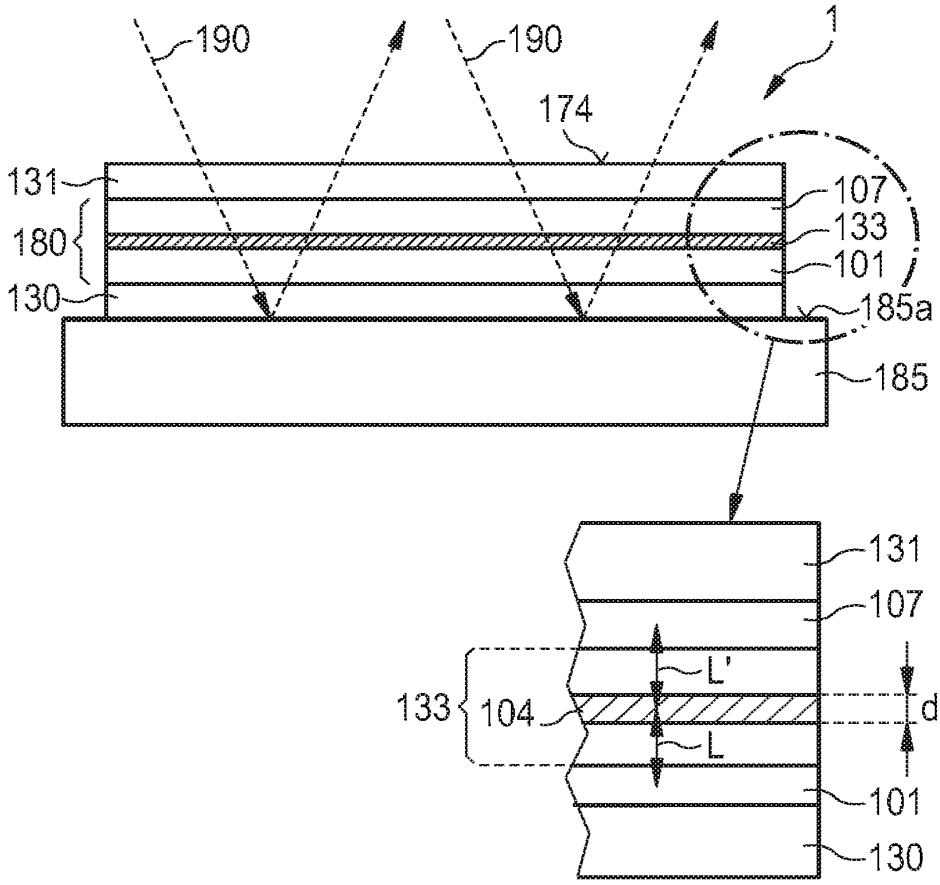


FIG 26B

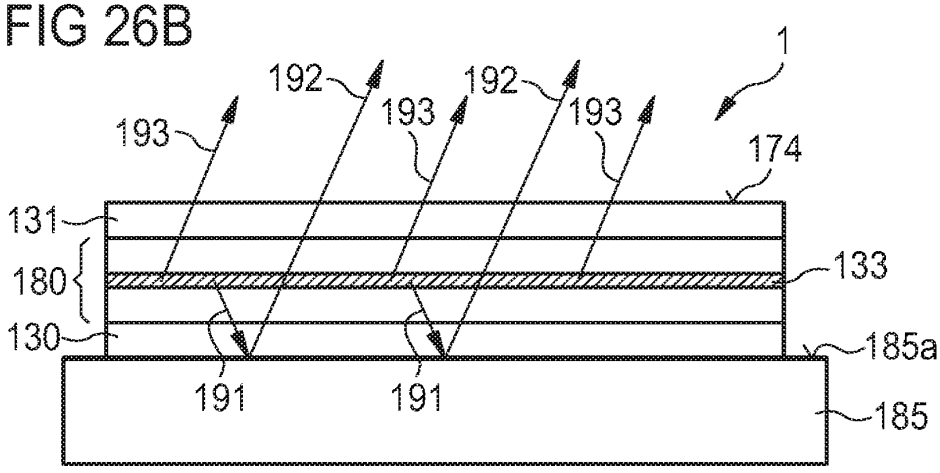


FIG 27

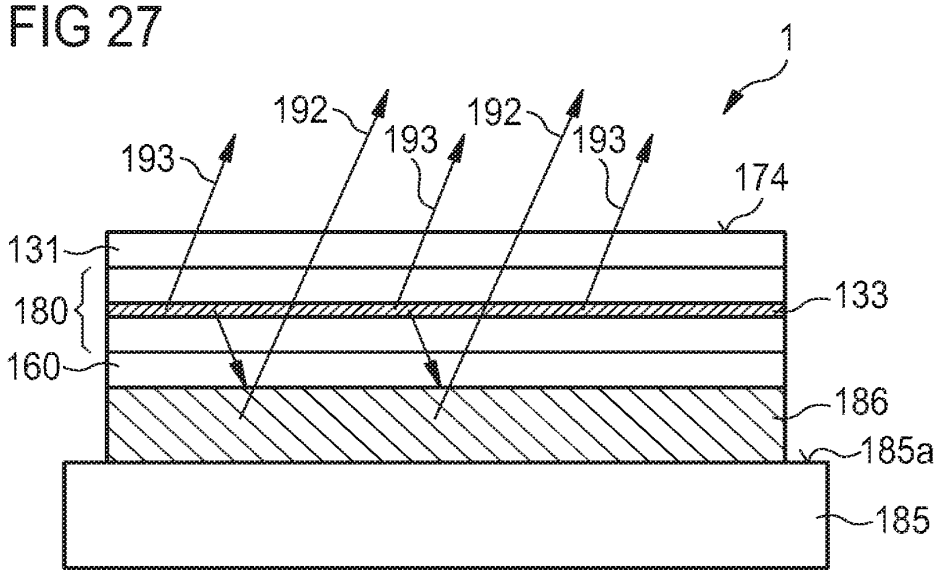

1
192
193
192
193
193
174
131
180
133
160
186
185a
185

FIG 28

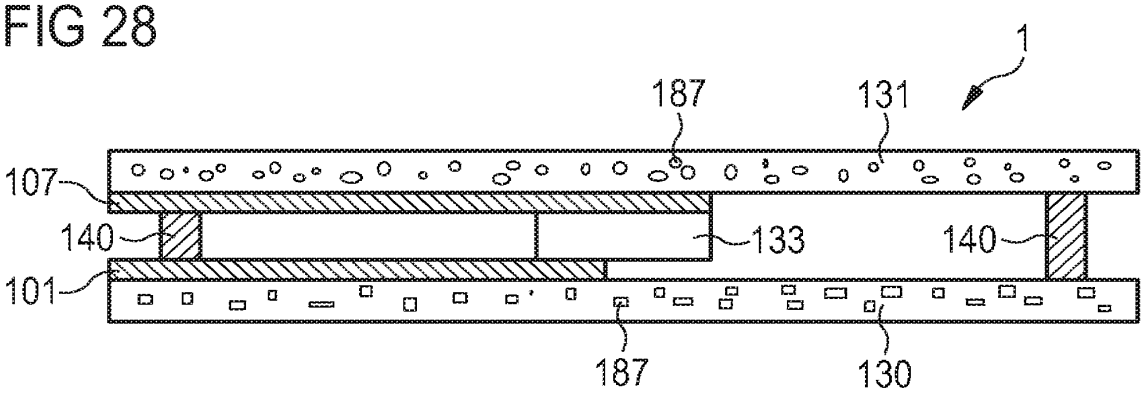

1
187
131
107
140
133
140
101
187
130

FIG 29

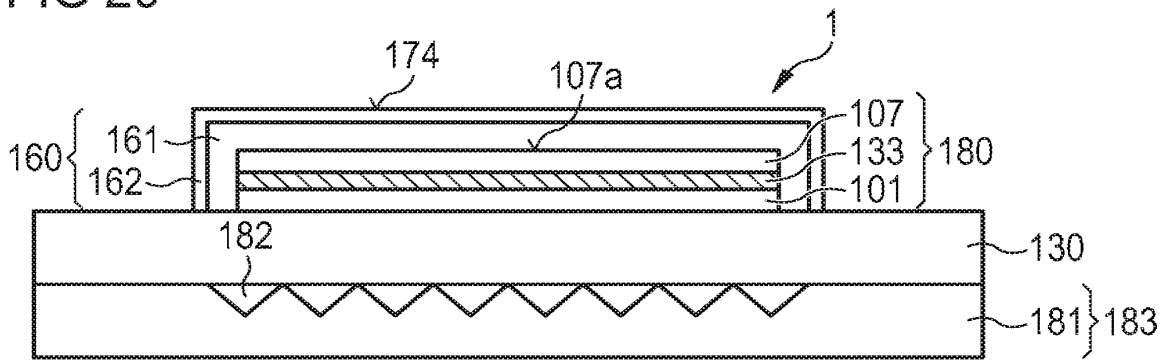

1
174
107a
160
161
162
107
133
101
180
182
130
181
183

FIG 30

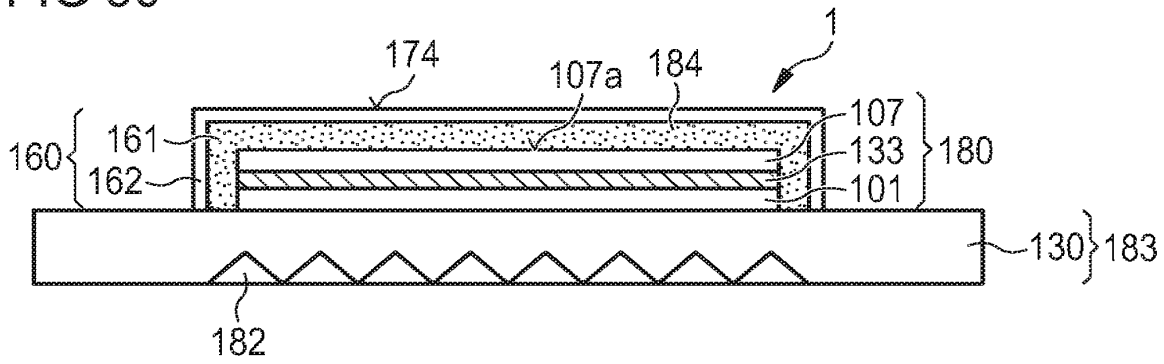

1
174
107a
184
160
161
162
107
133
101
180
130
183
182

FIG 31A

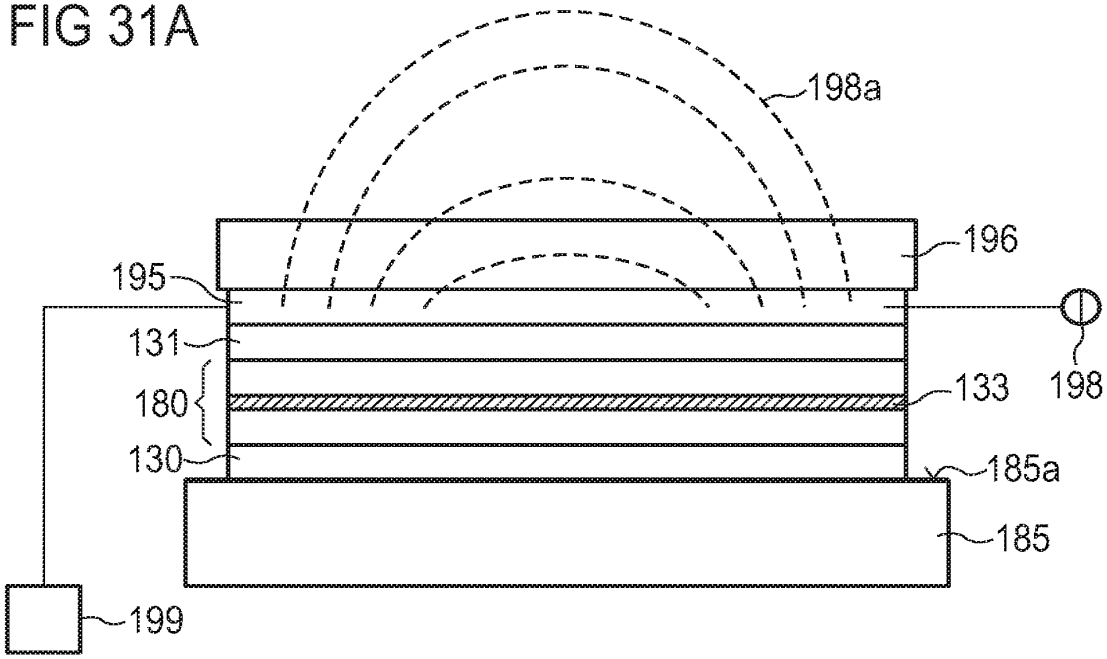


FIG 31B

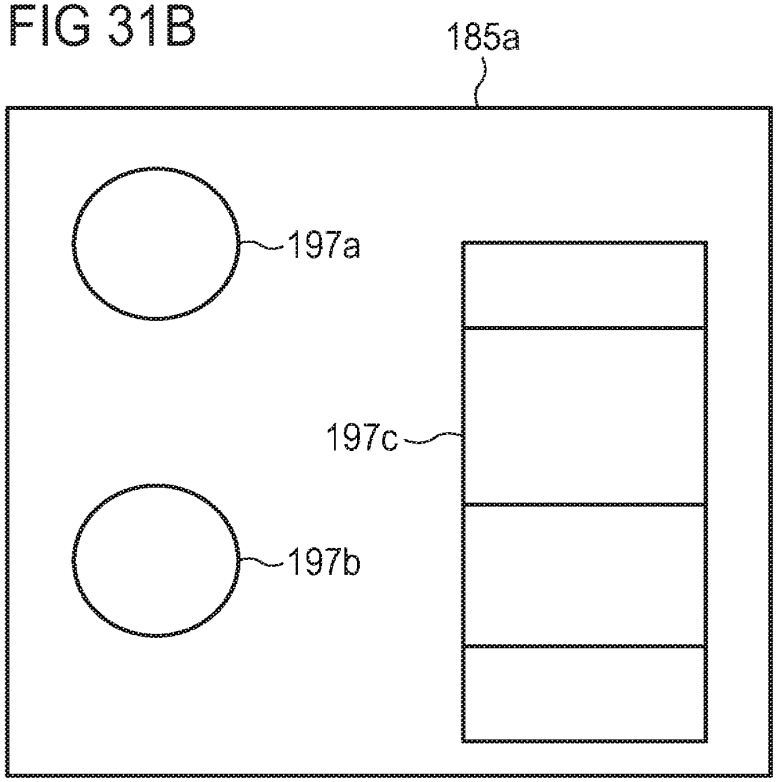


FIG 32A

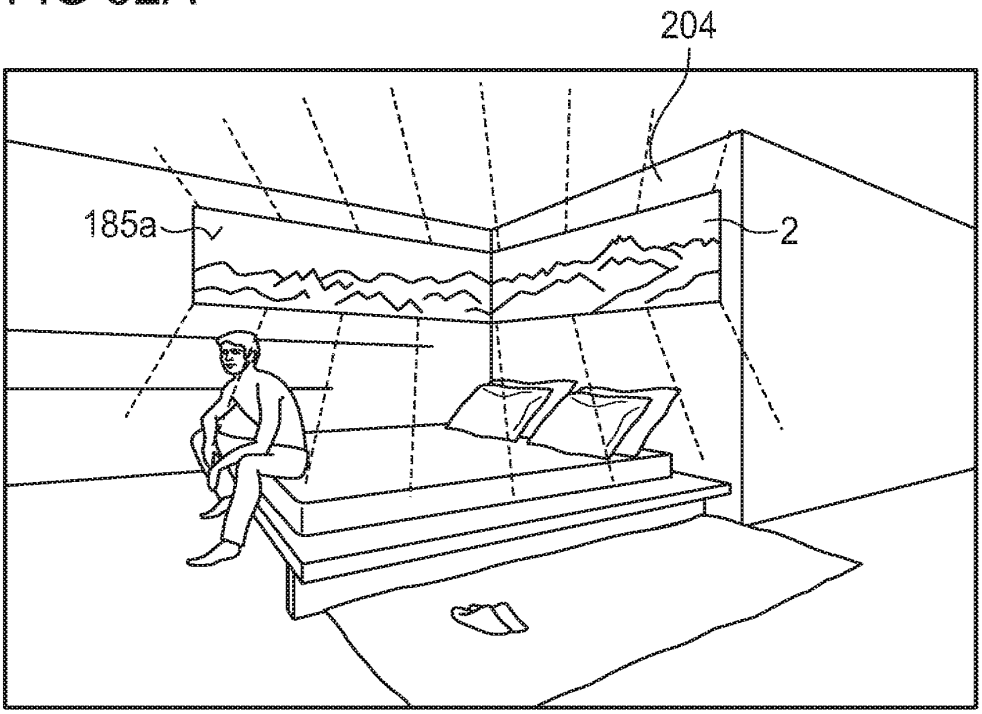


FIG 32B

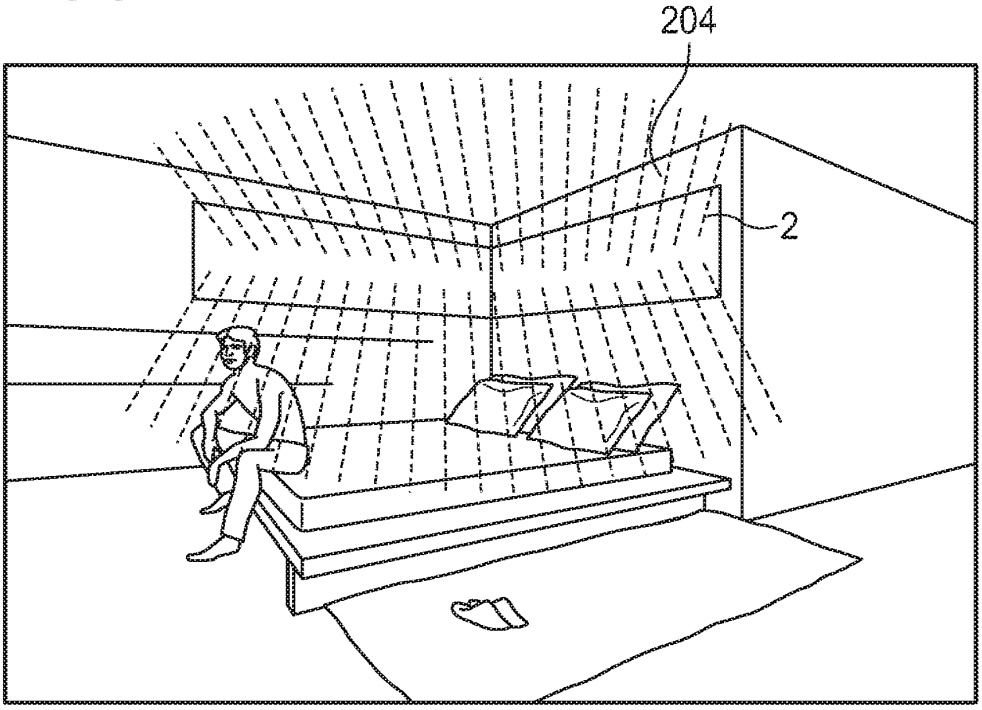


FIG 32C

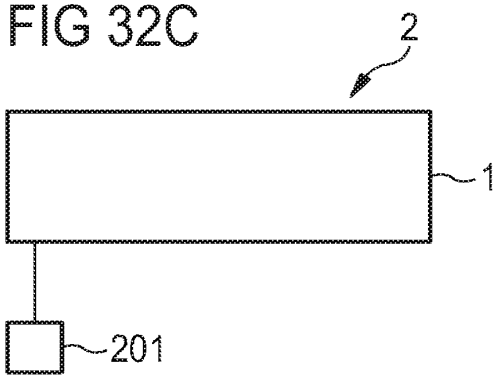


FIG 32D

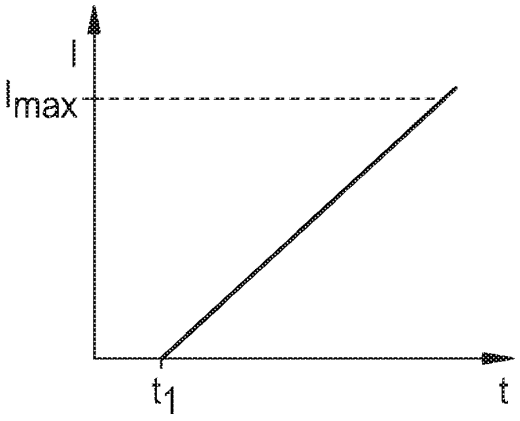


FIG 32E

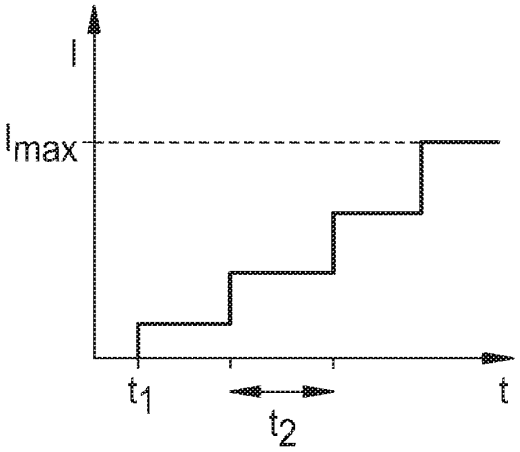


FIG 32F

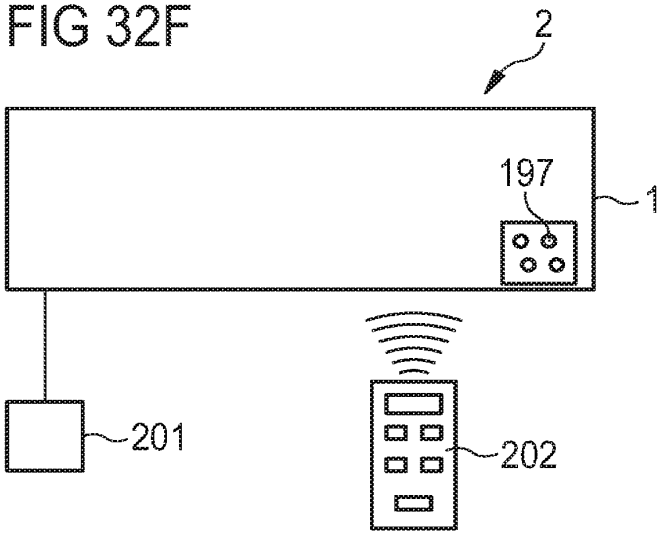


FIG 32G

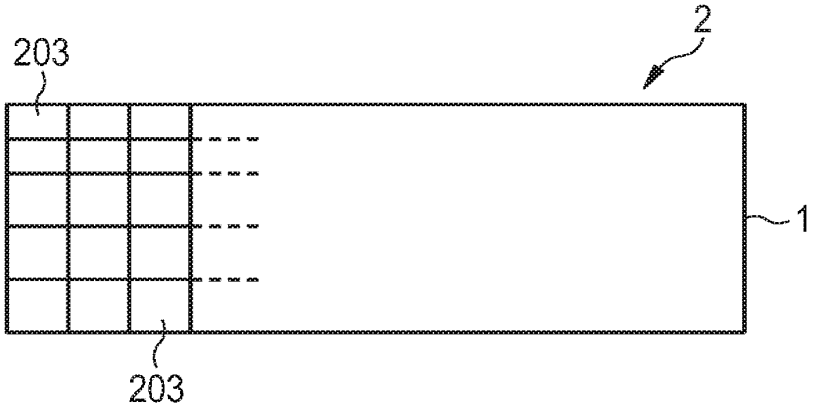


FIG 32H

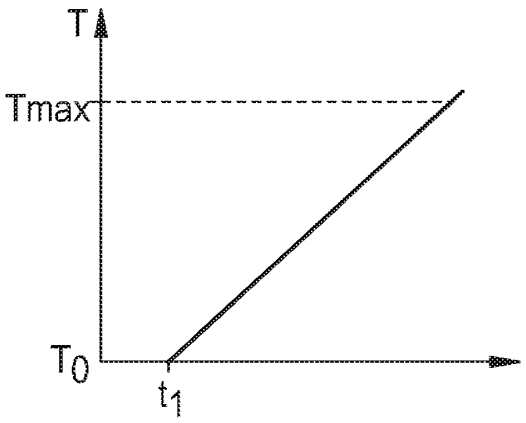


FIG 32I

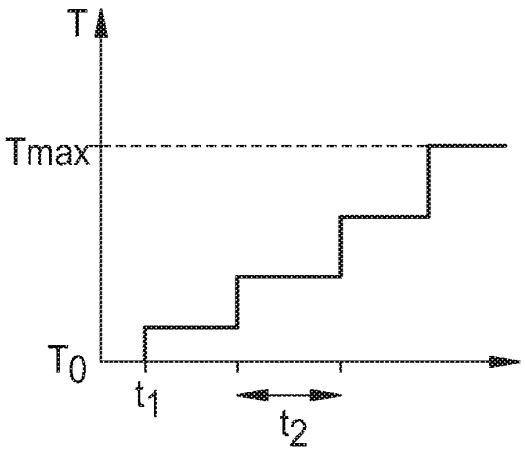


FIG 33A

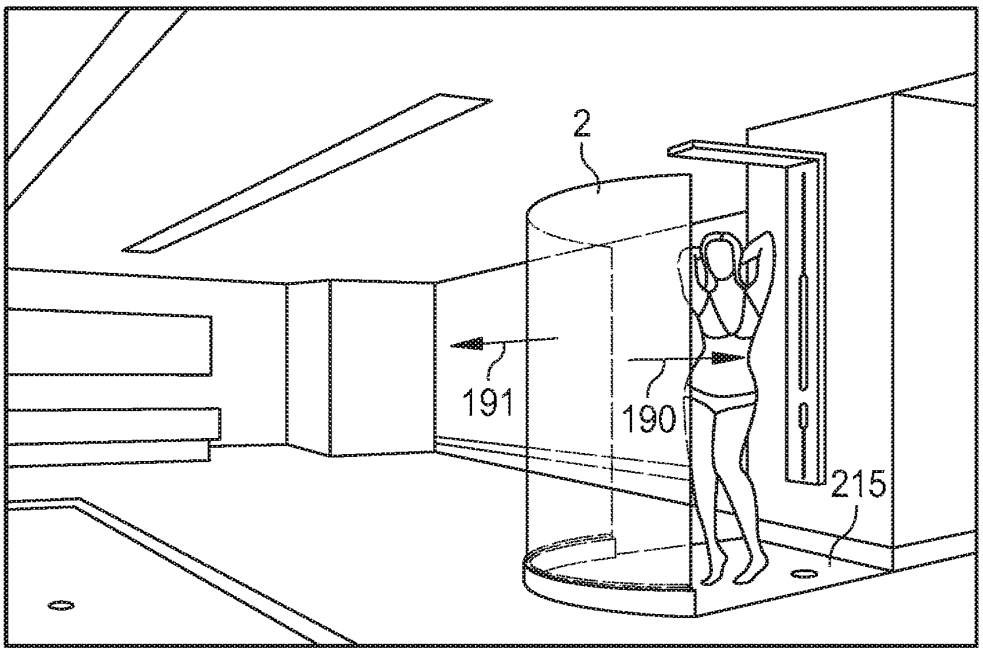


FIG 33B

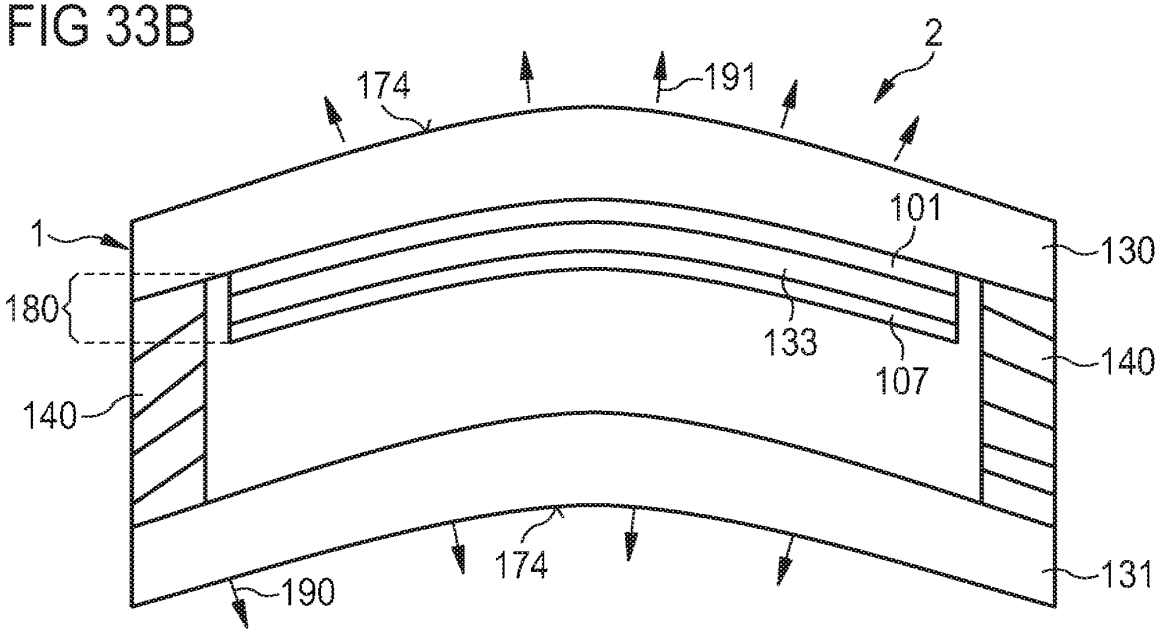


FIG 33C

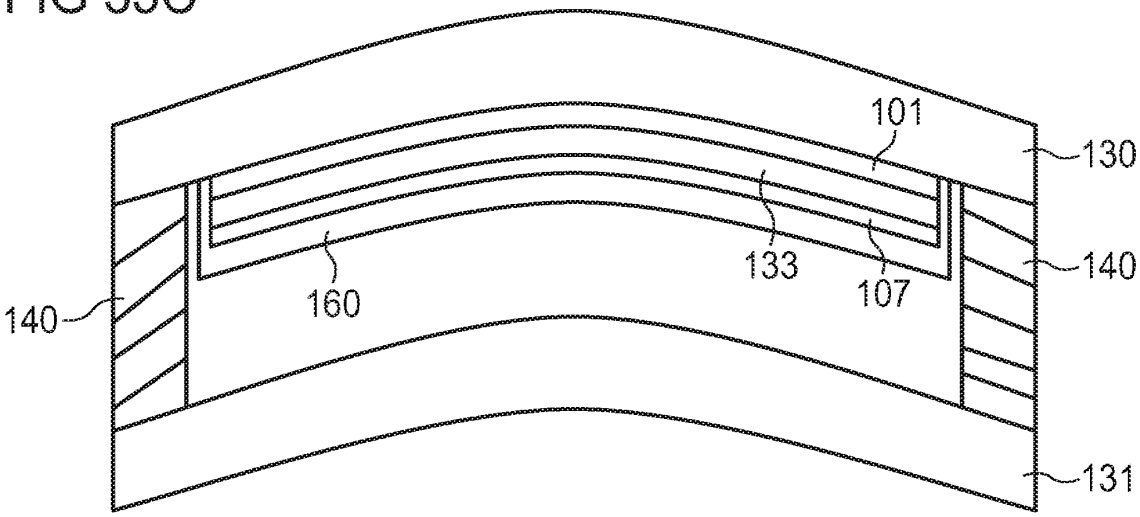


FIG 33D

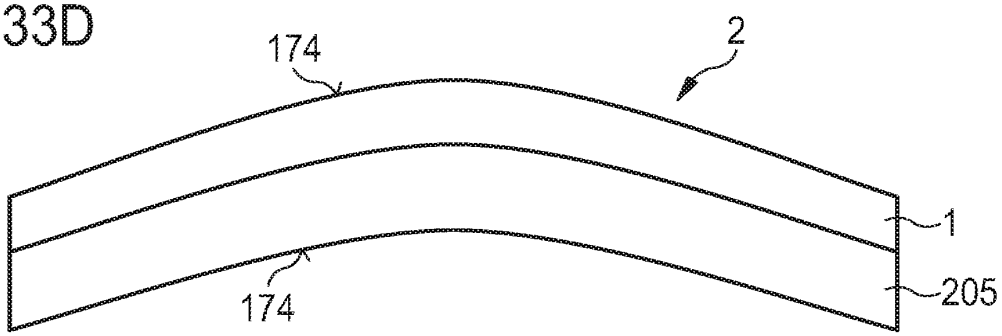


FIG 34A

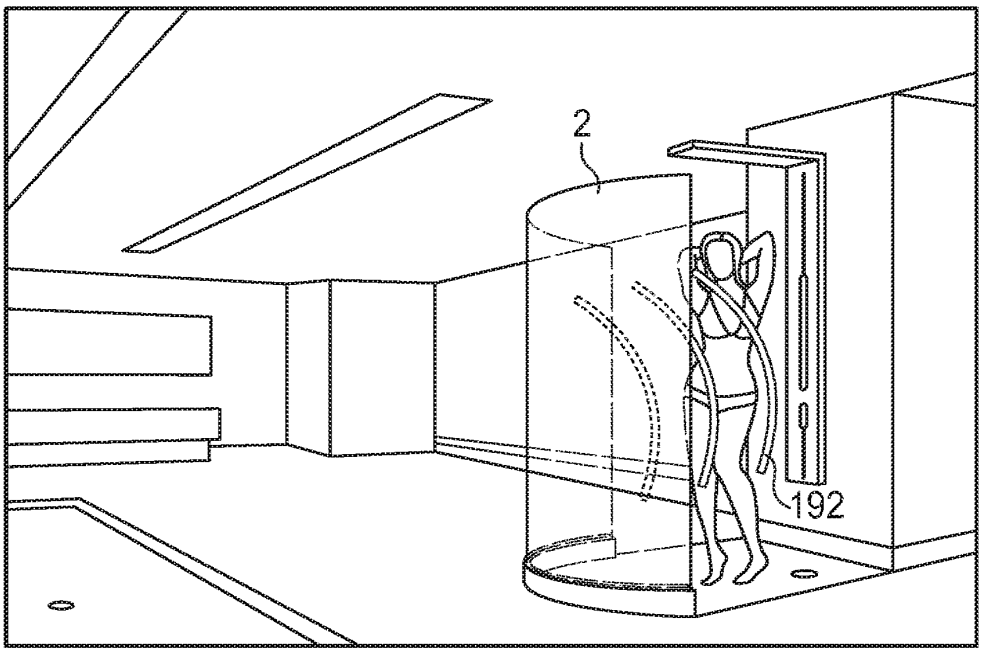


FIG 34B

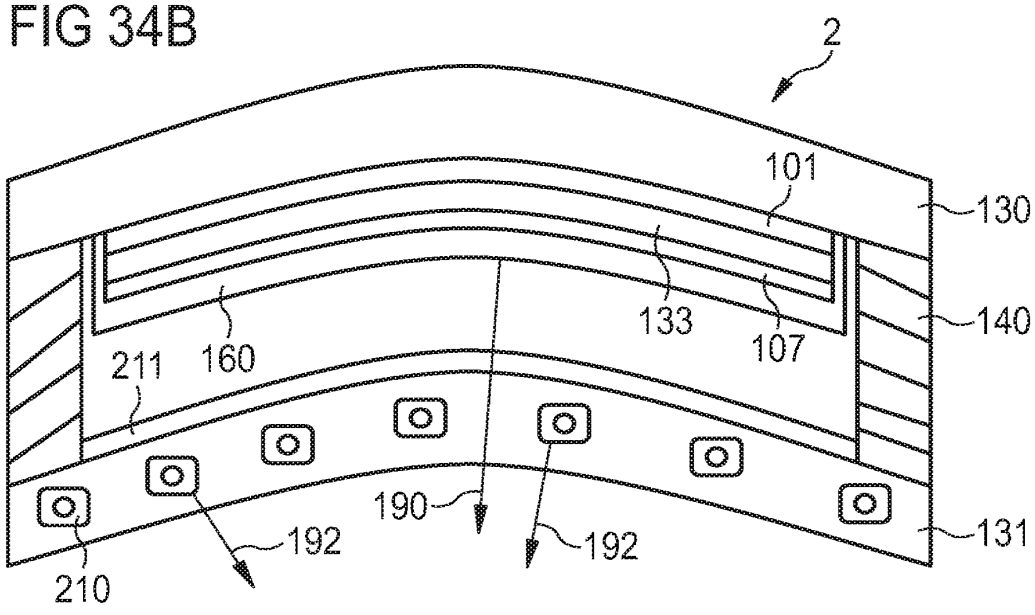


FIG 34C

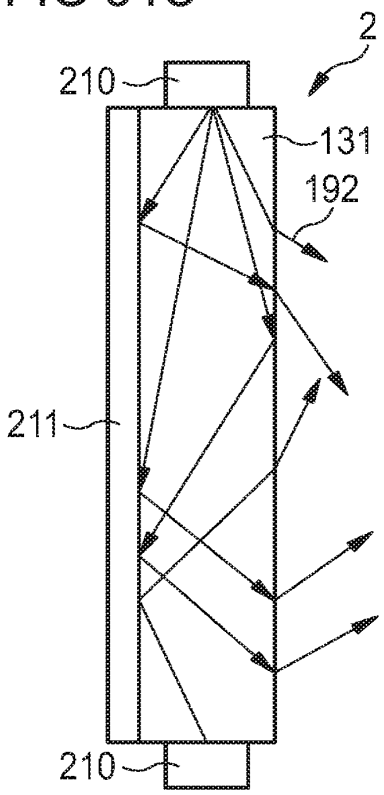


FIG 35

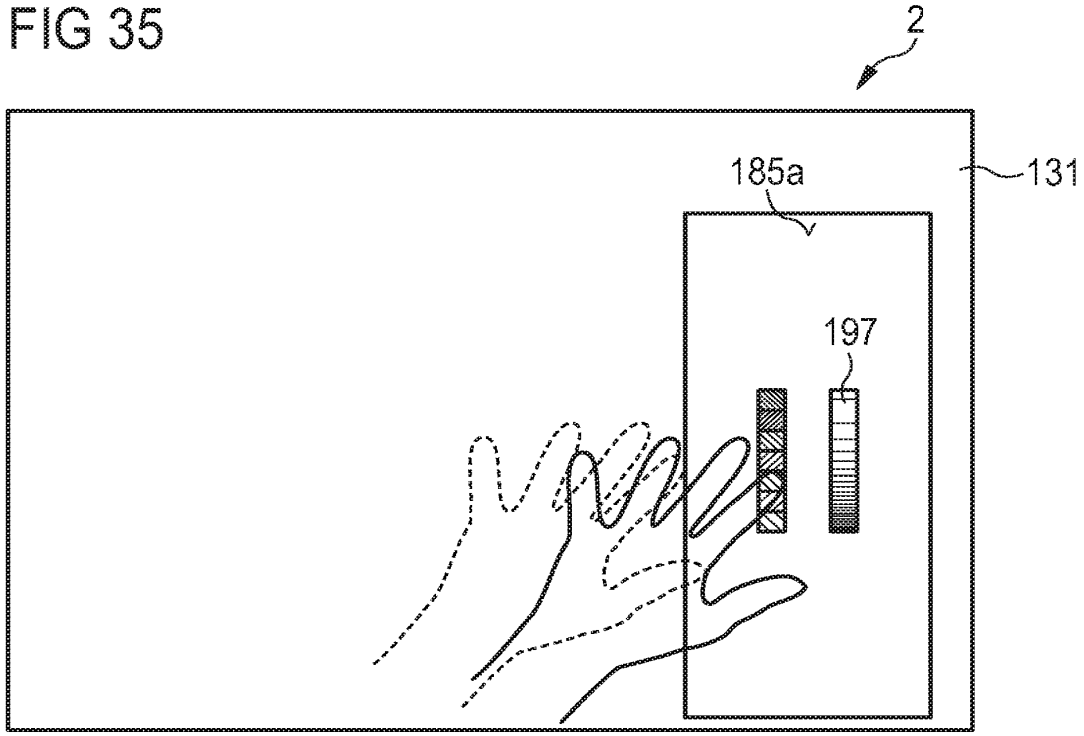


FIG 36

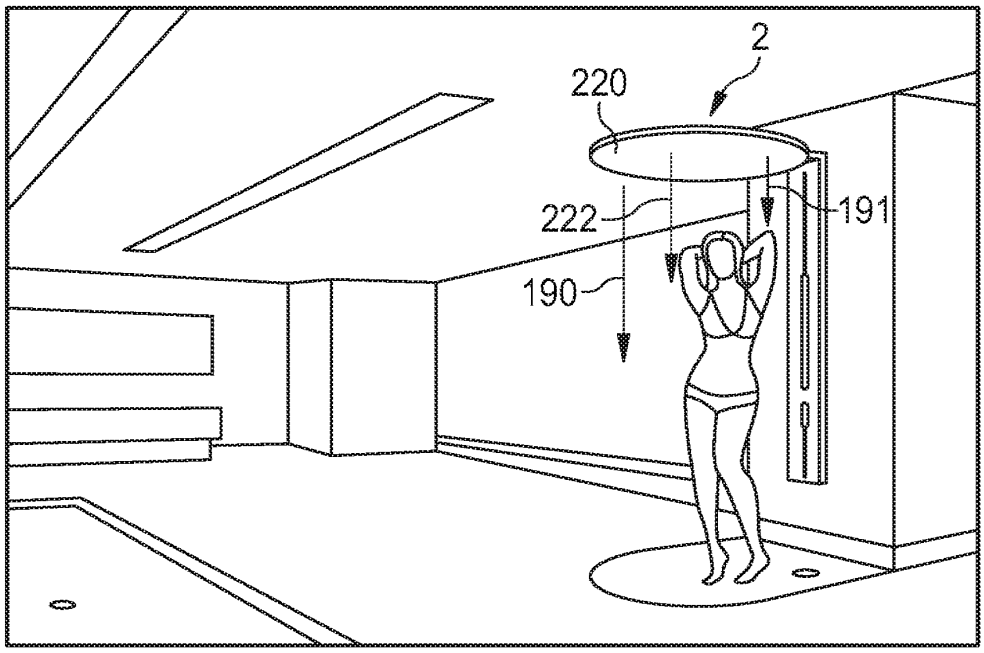


FIG 37A

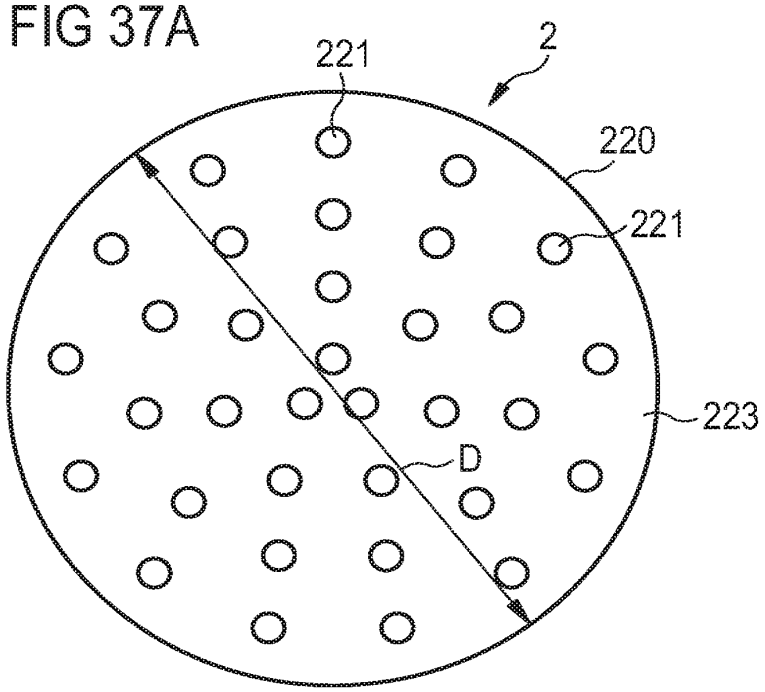


FIG 37B

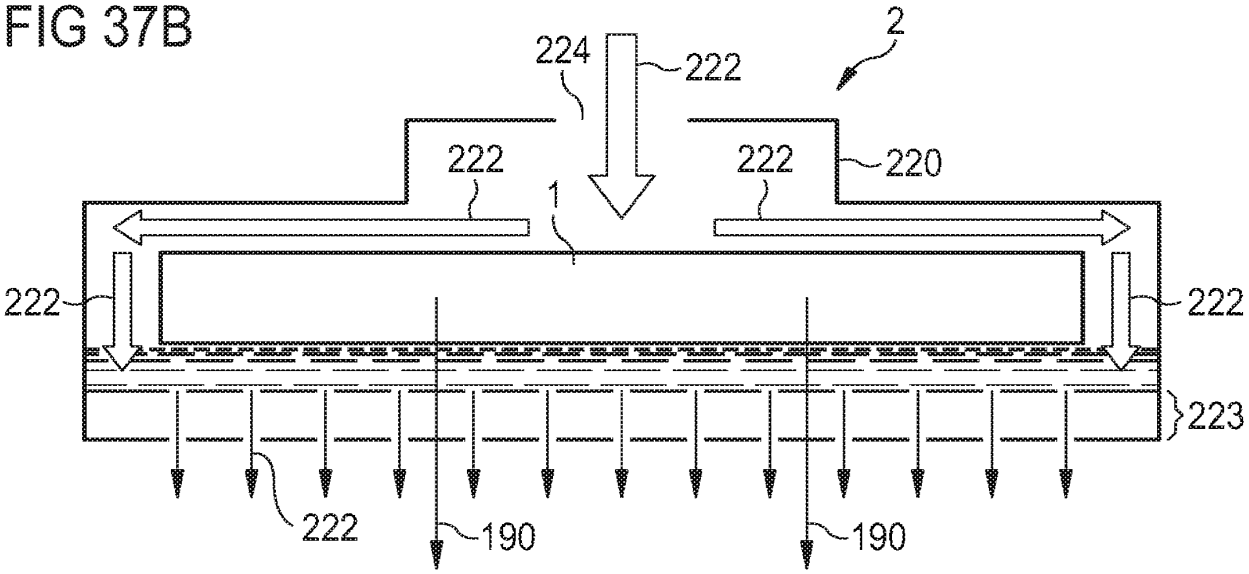


FIG 38

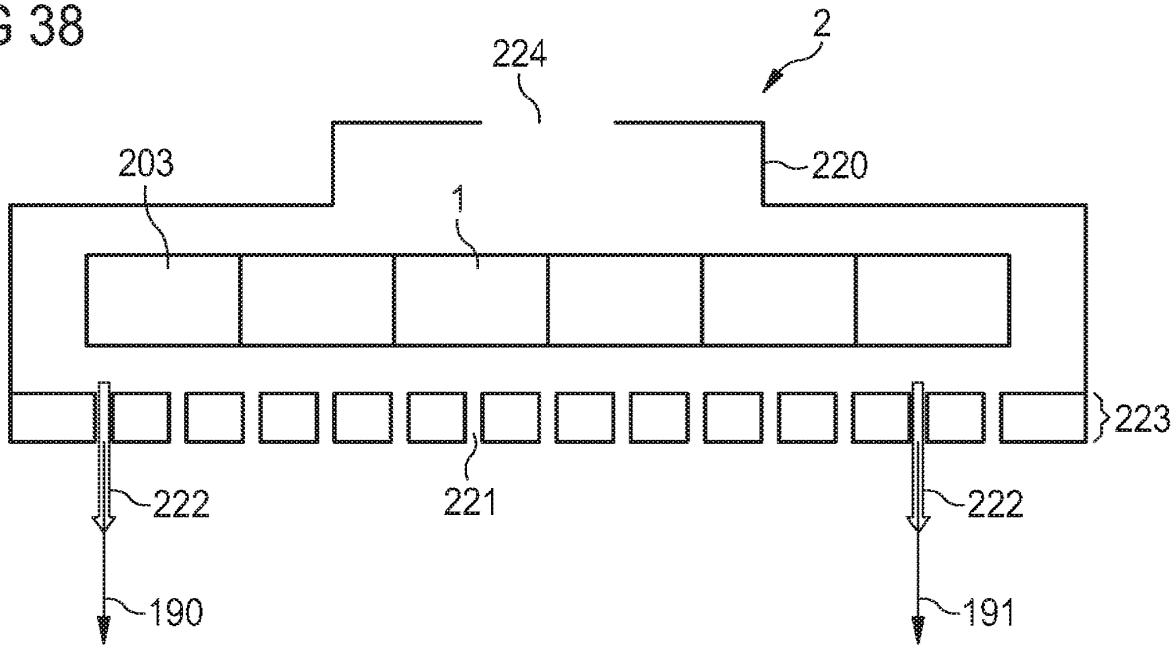


FIG 39A

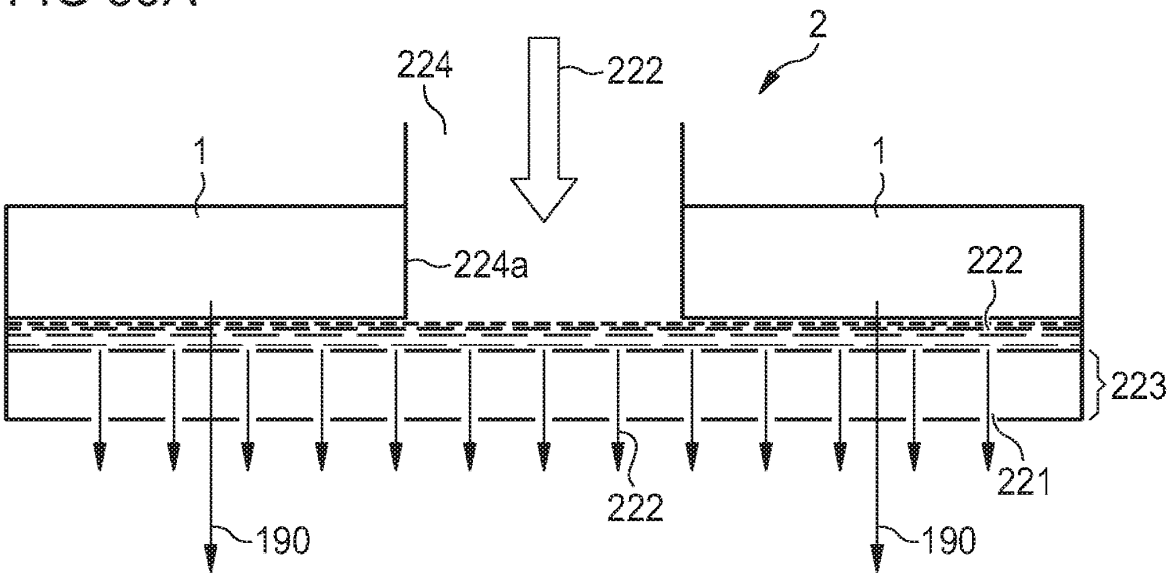


FIG 39B

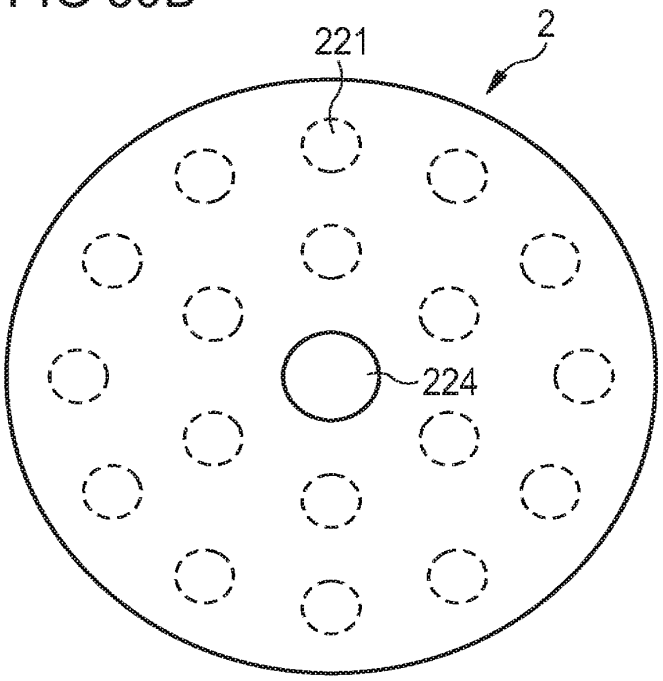


FIG 40A

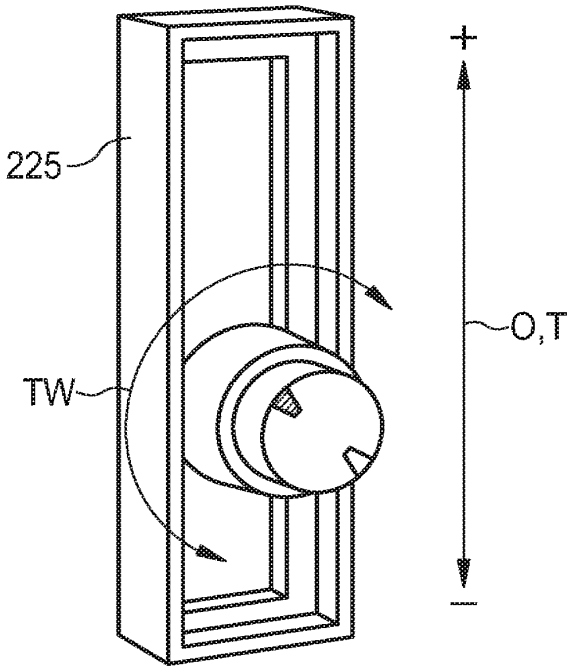


FIG 40B

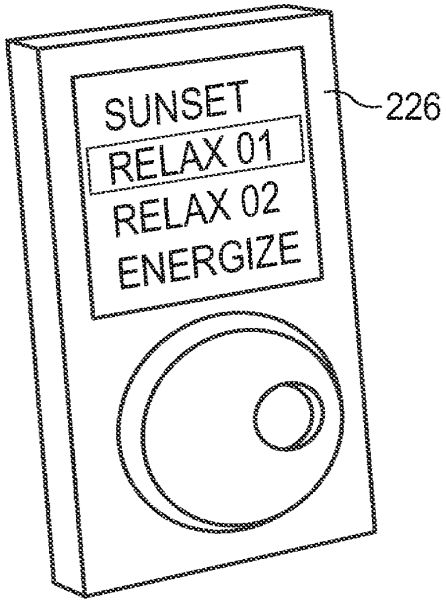


FIG 41A

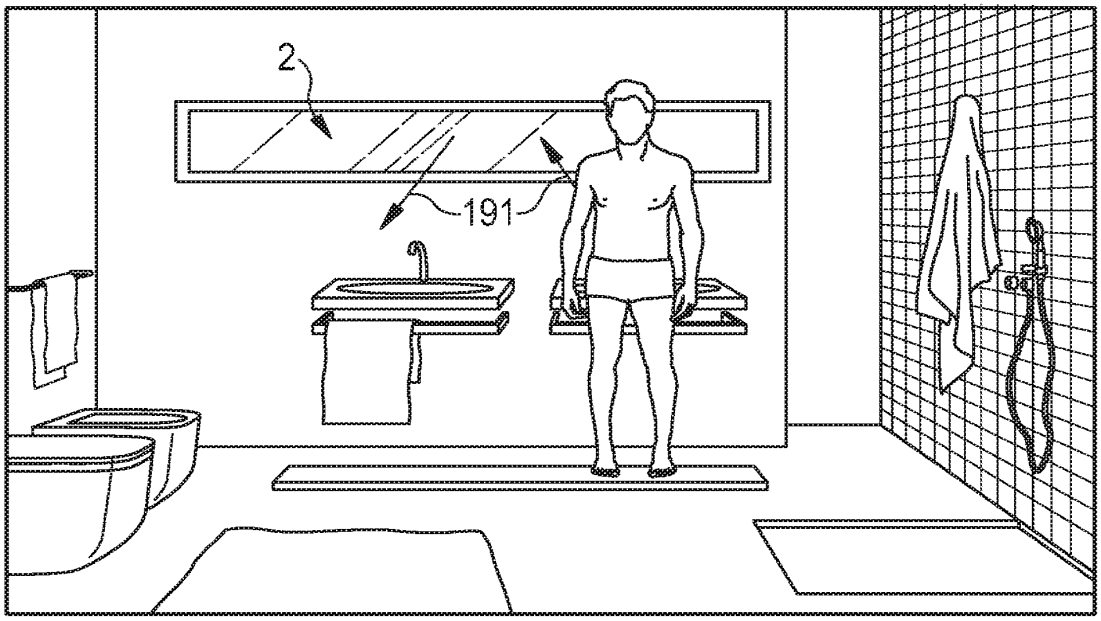


FIG 41B

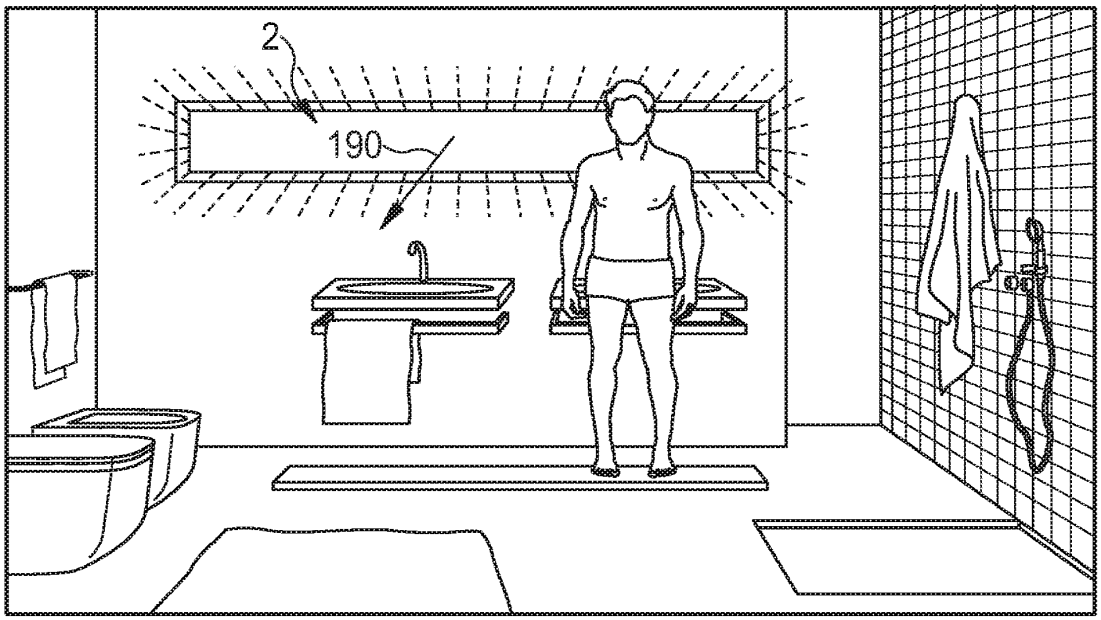


FIG 41C

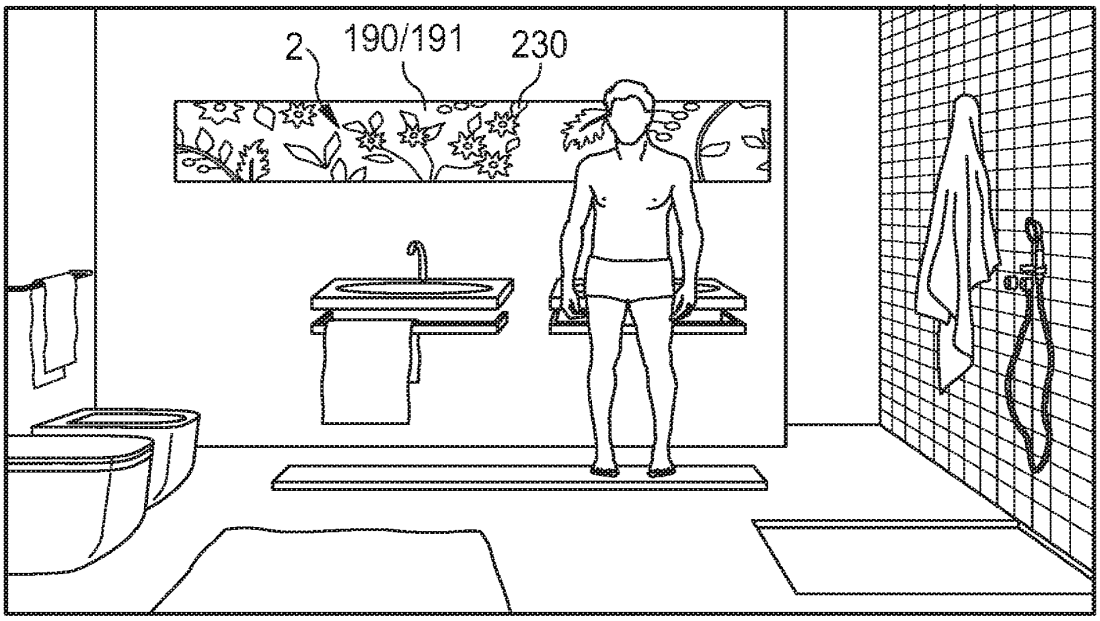


FIG 41D

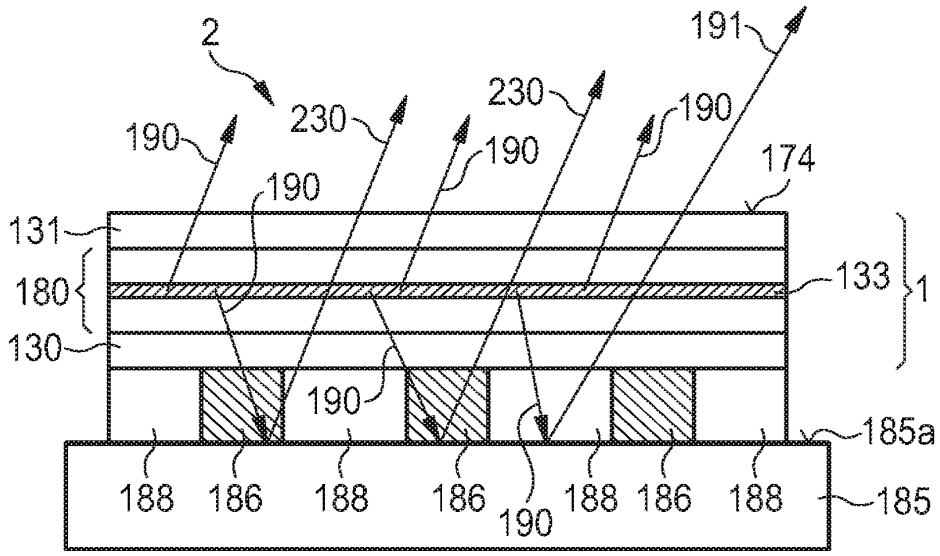


FIG 42A

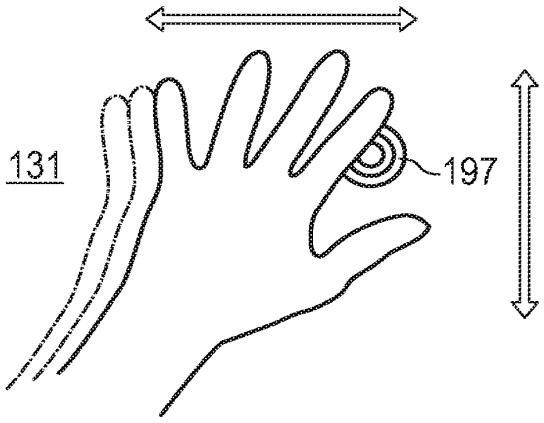


FIG 42B

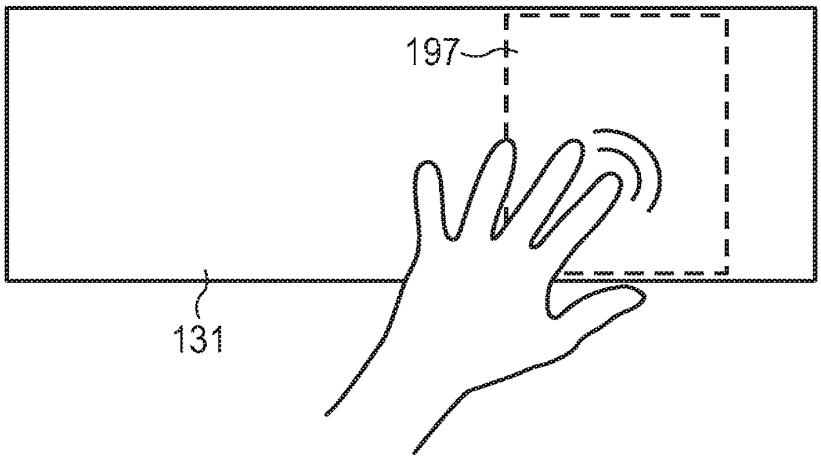


FIG 42C

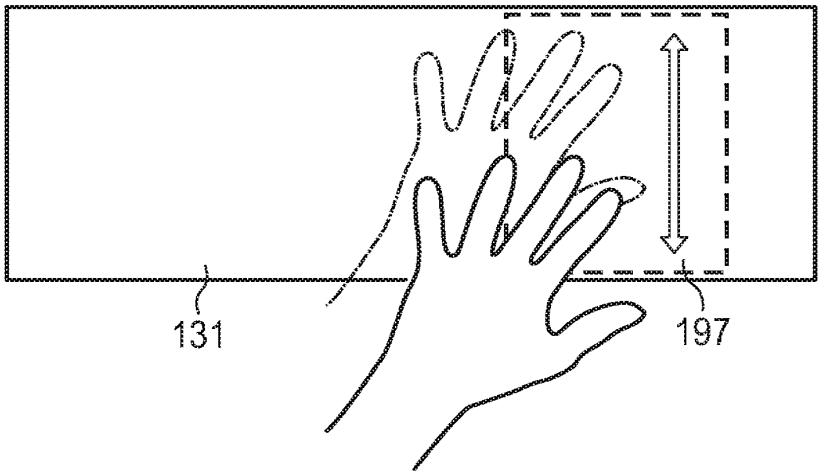


FIG 43



FIG 44A

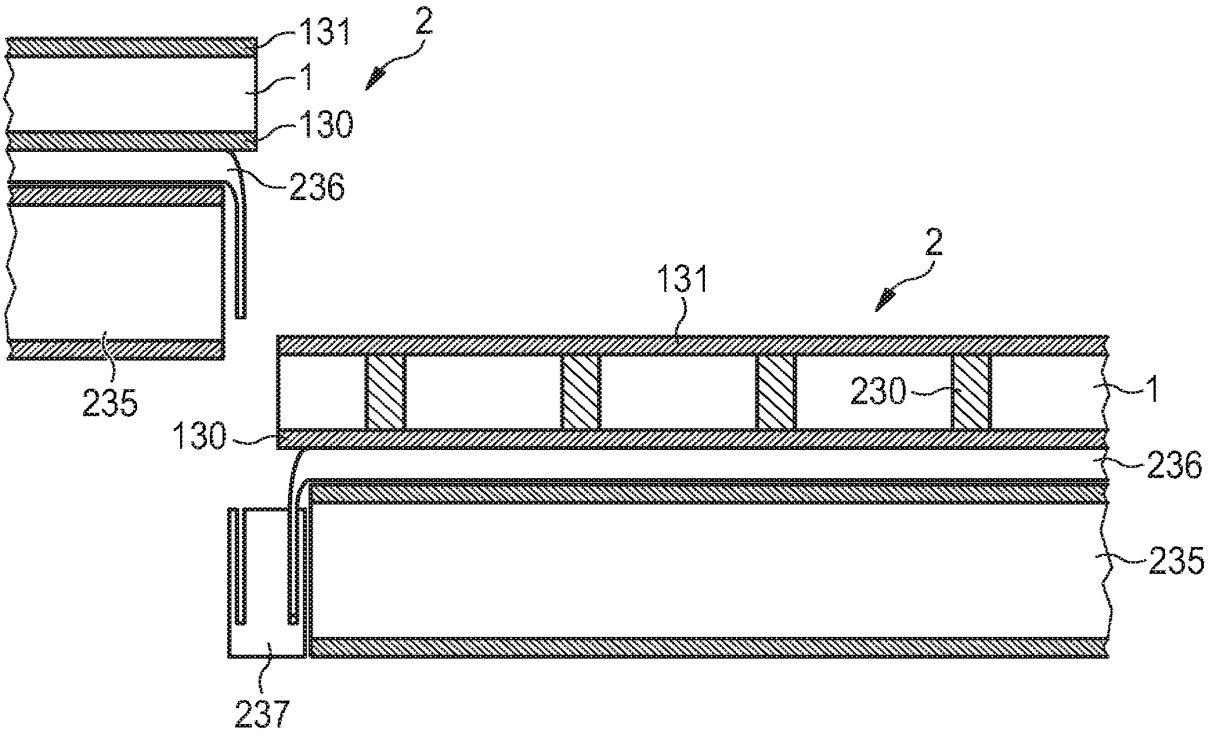


FIG 44B

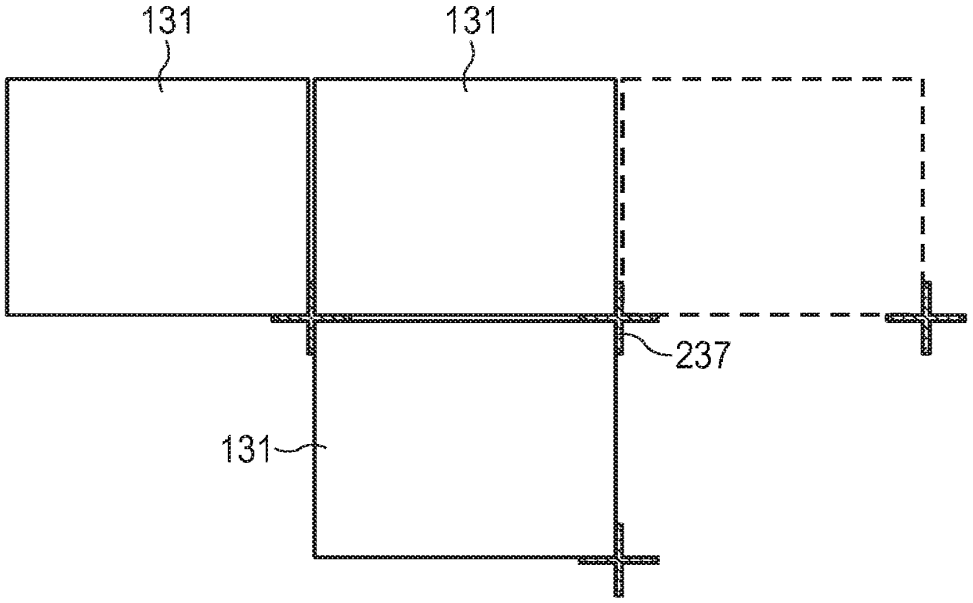


FIG 45A

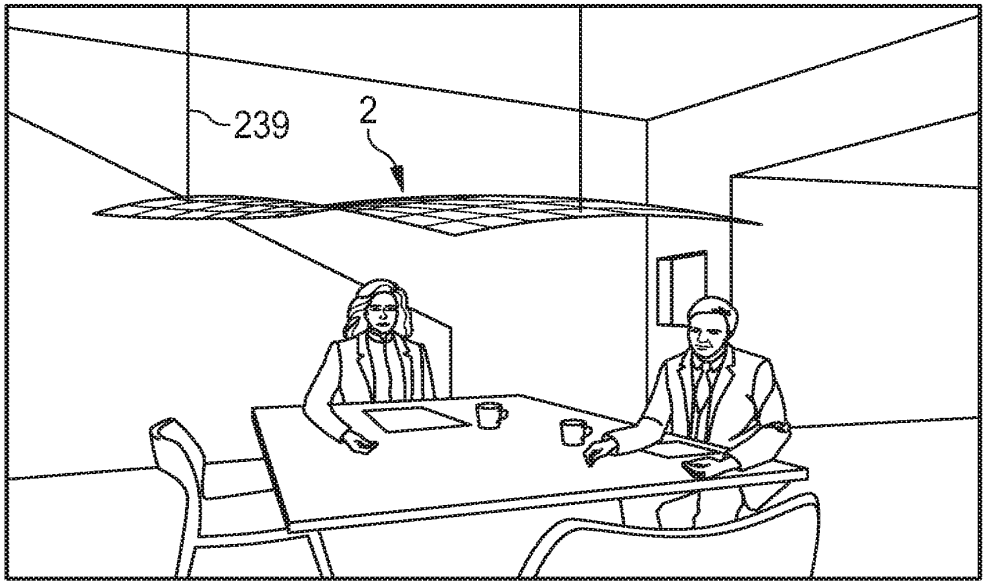


FIG 45B

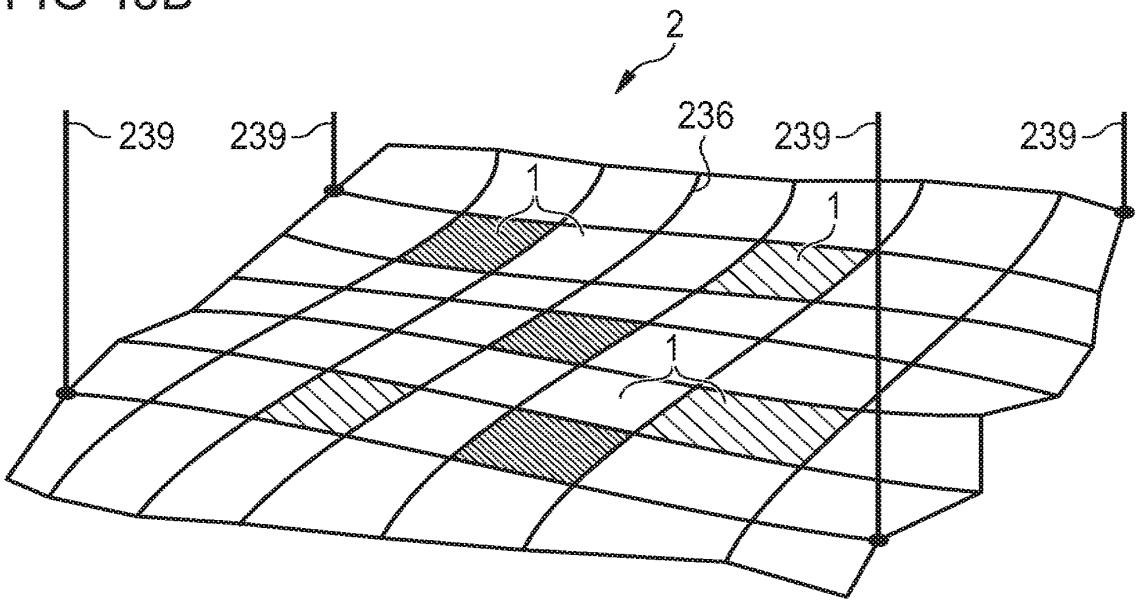


FIG 45C

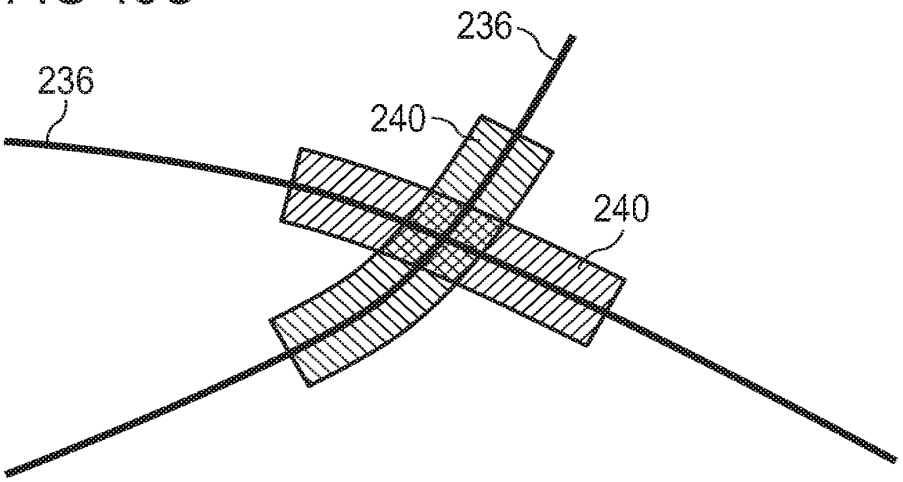


FIG 46A

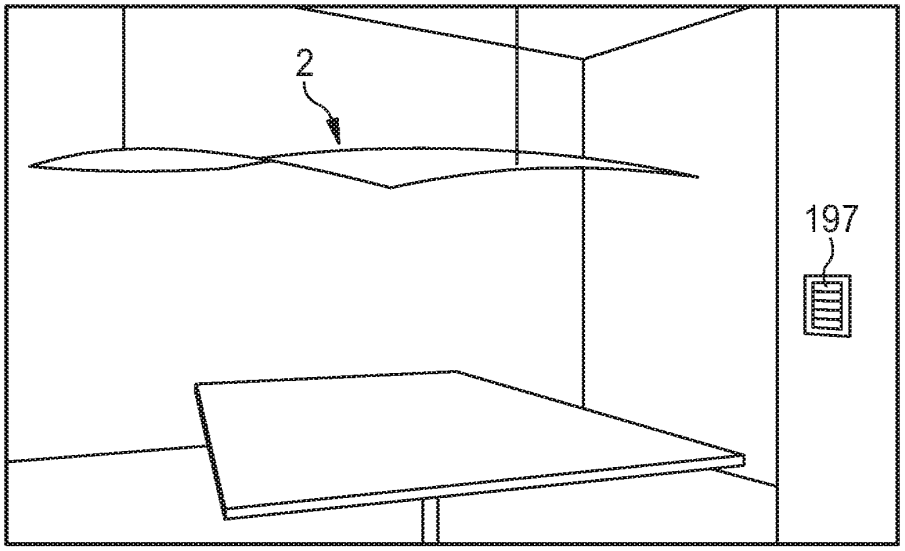


FIG 46B

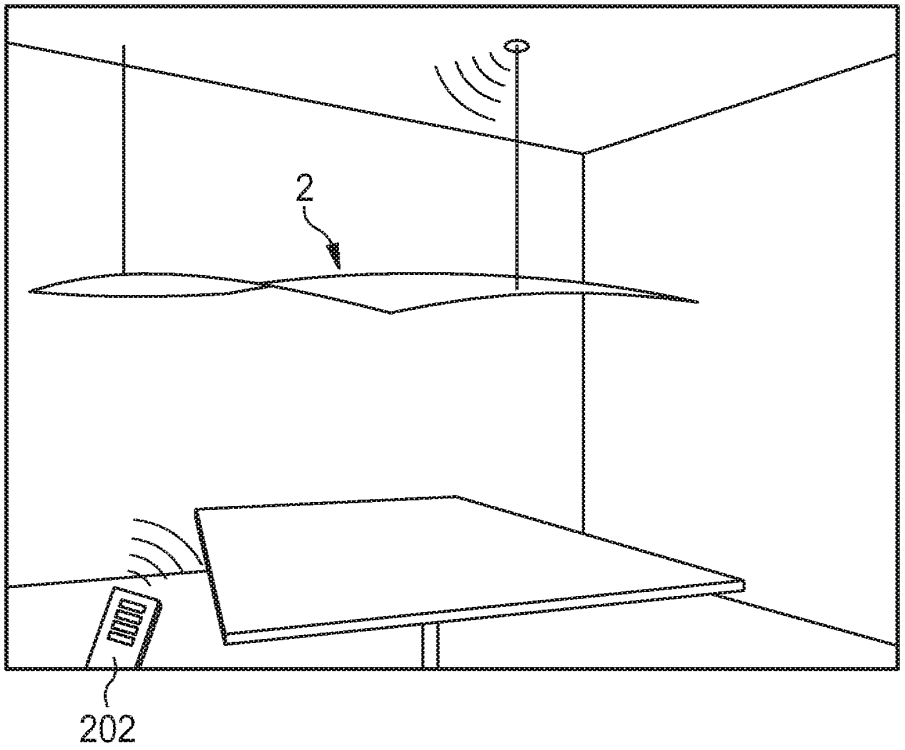


FIG 47A

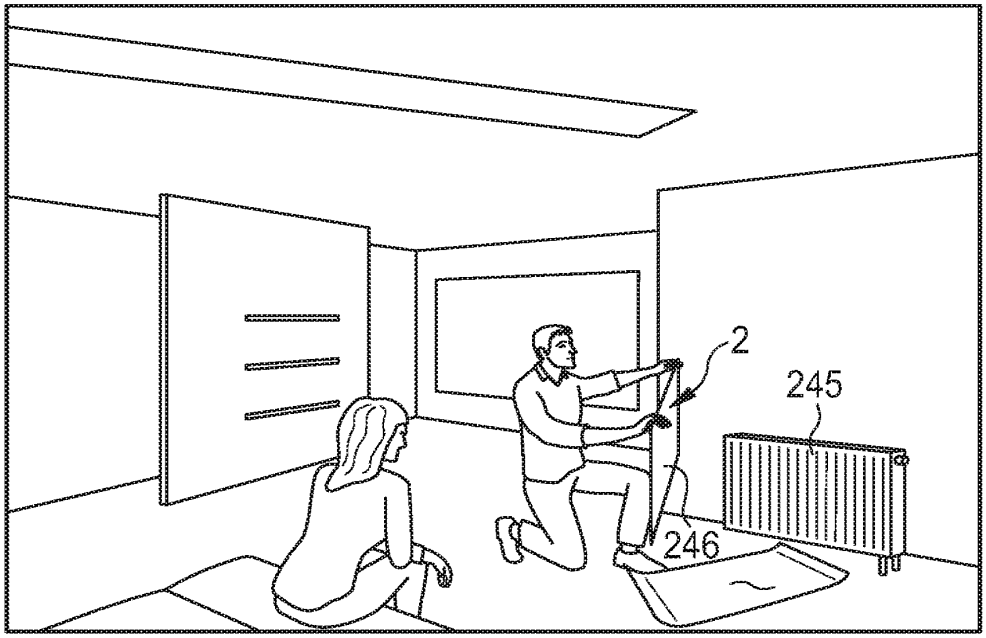


FIG 47B

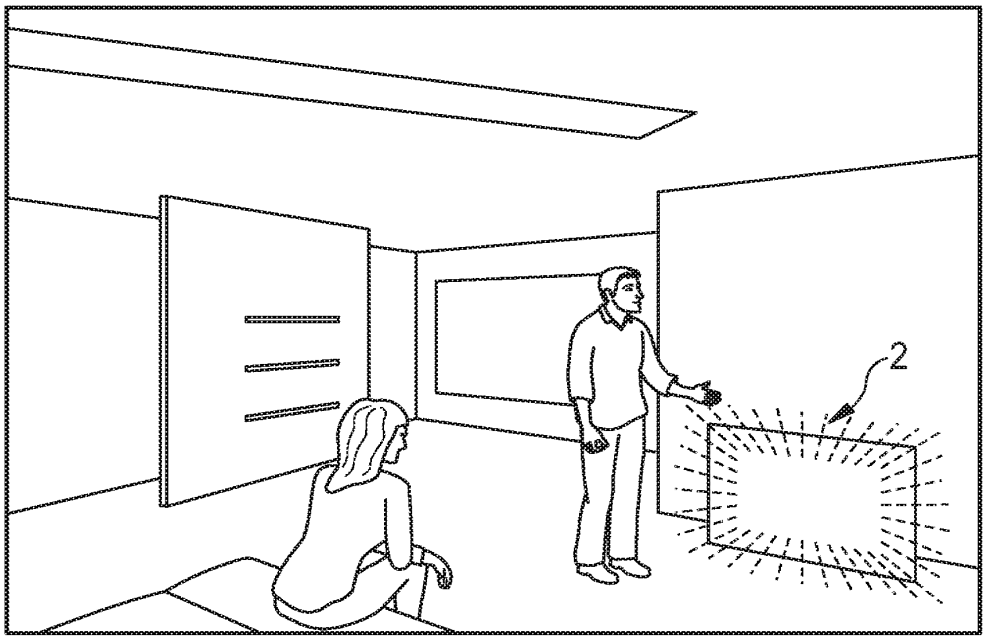


FIG 47C

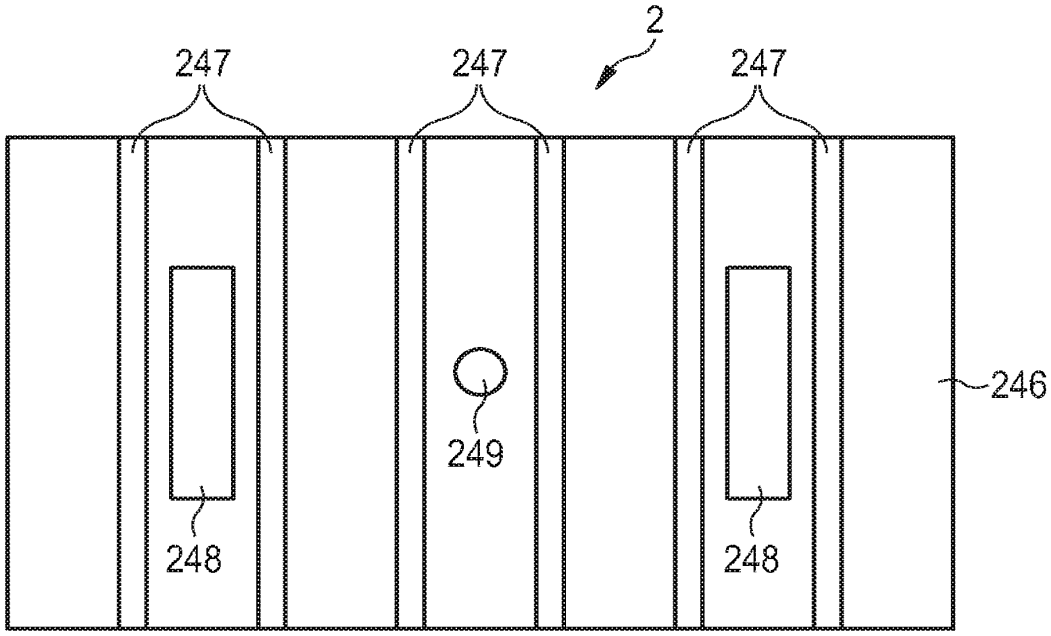


FIG 47D

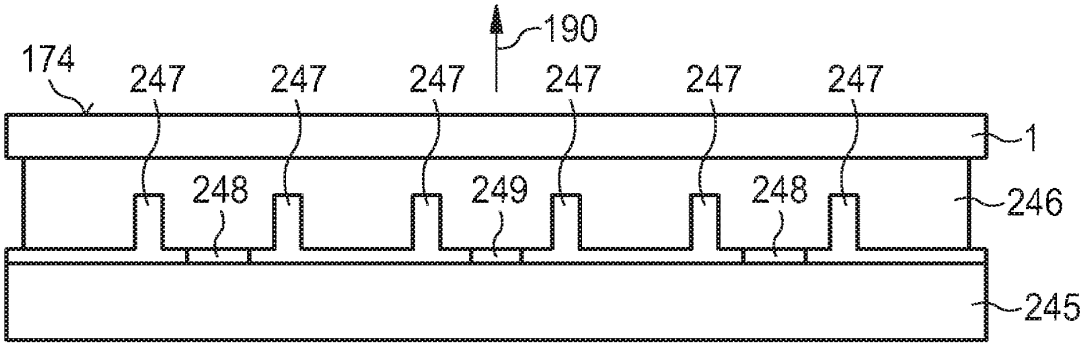


FIG 48

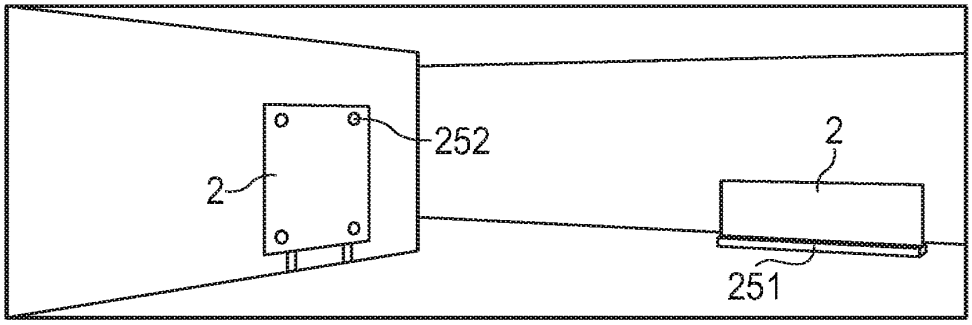


FIG 49A

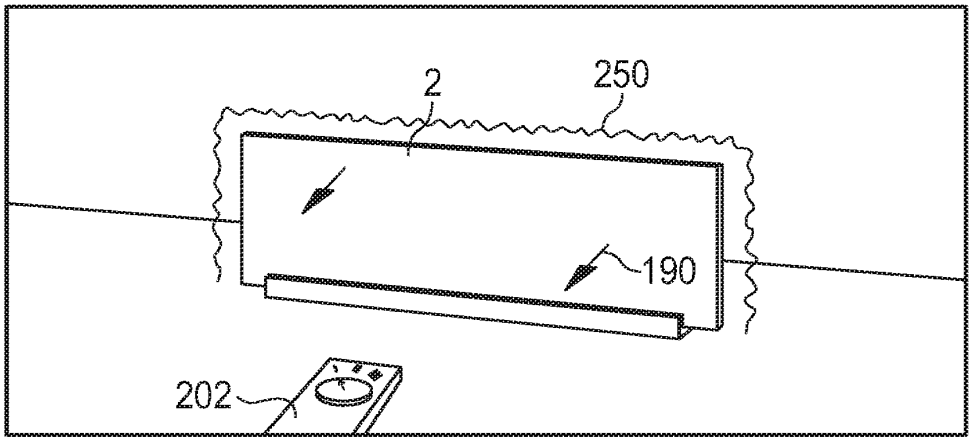


FIG 49B

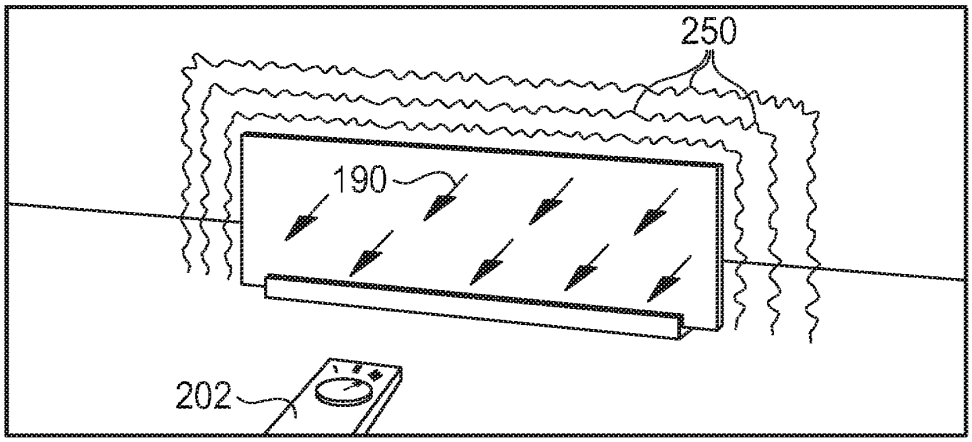


FIG 50A

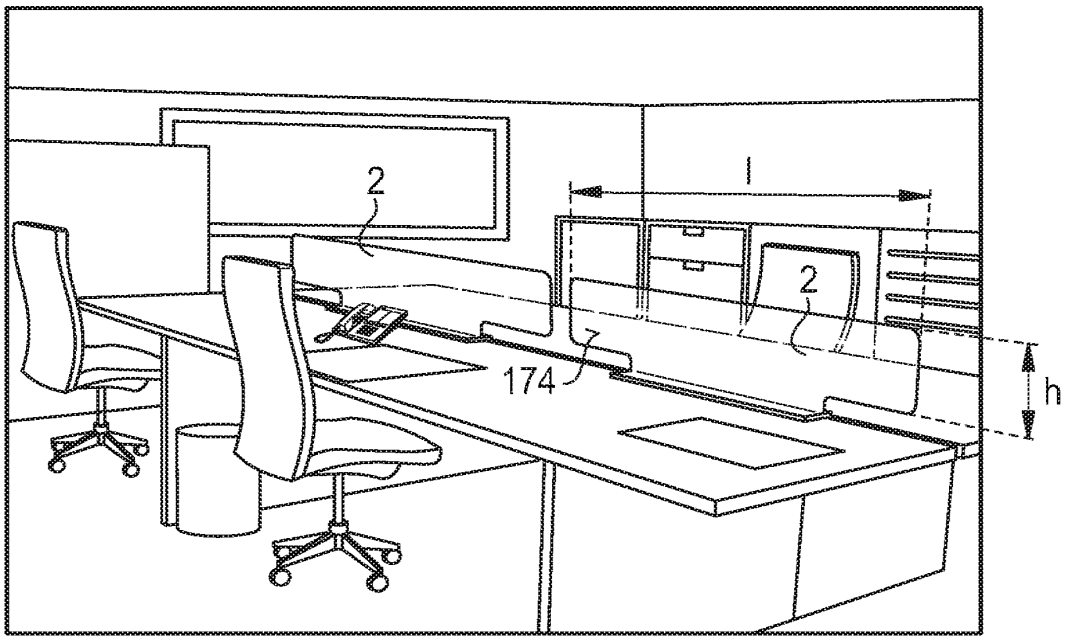


FIG 50B

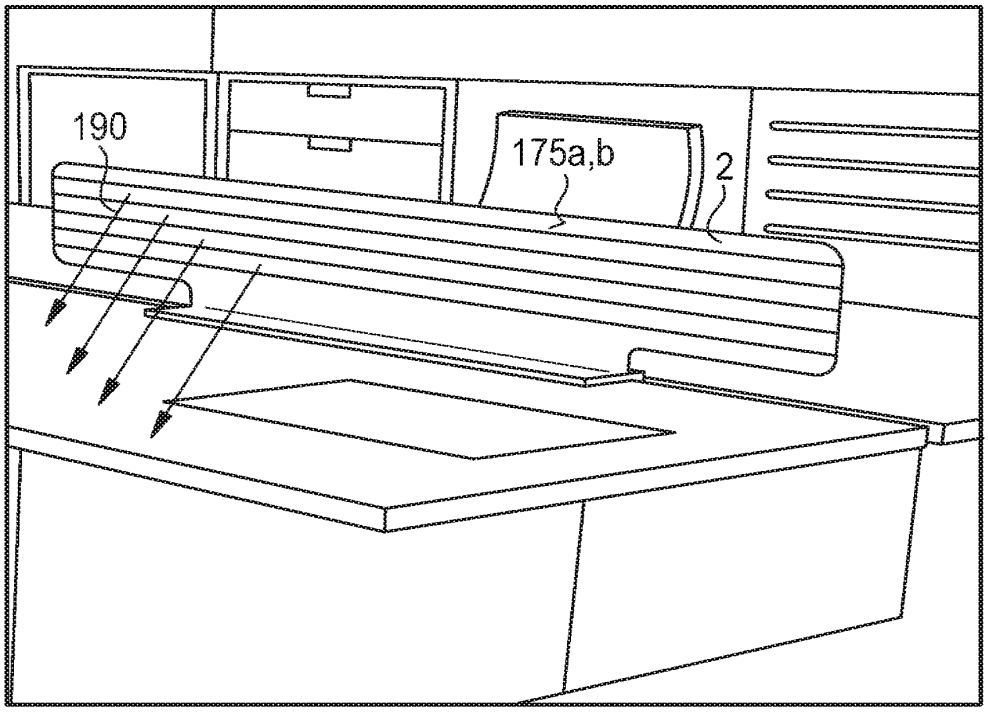


FIG 50C

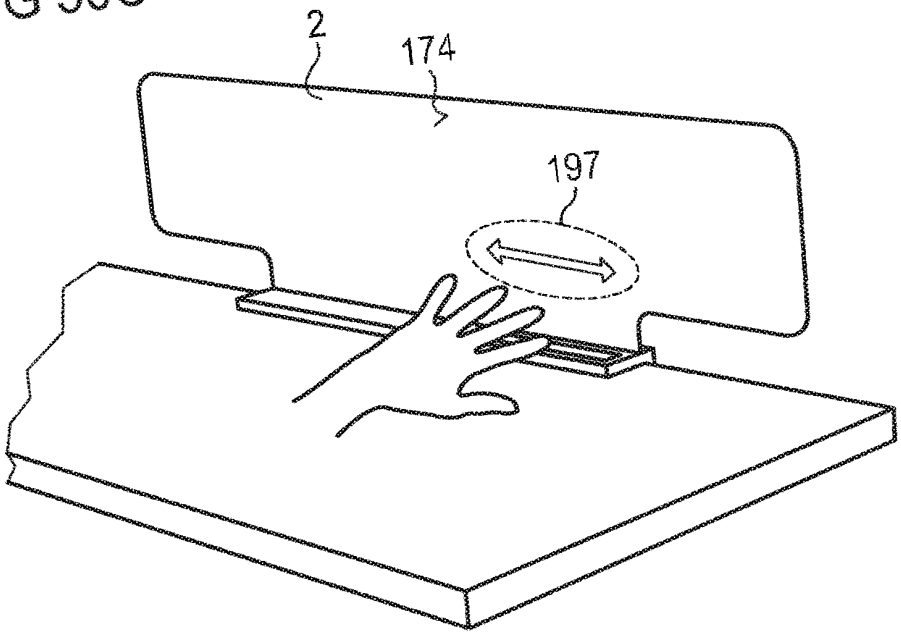


FIG 50D

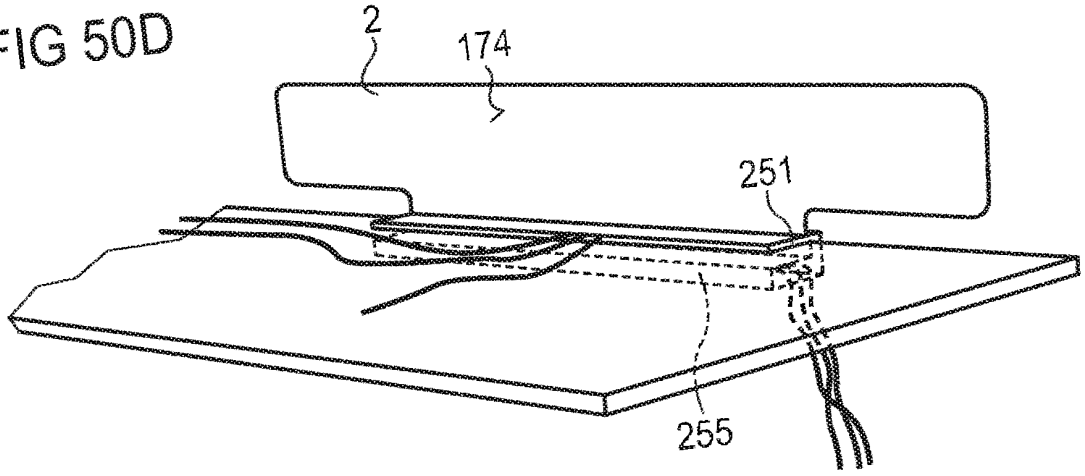


FIG 51A

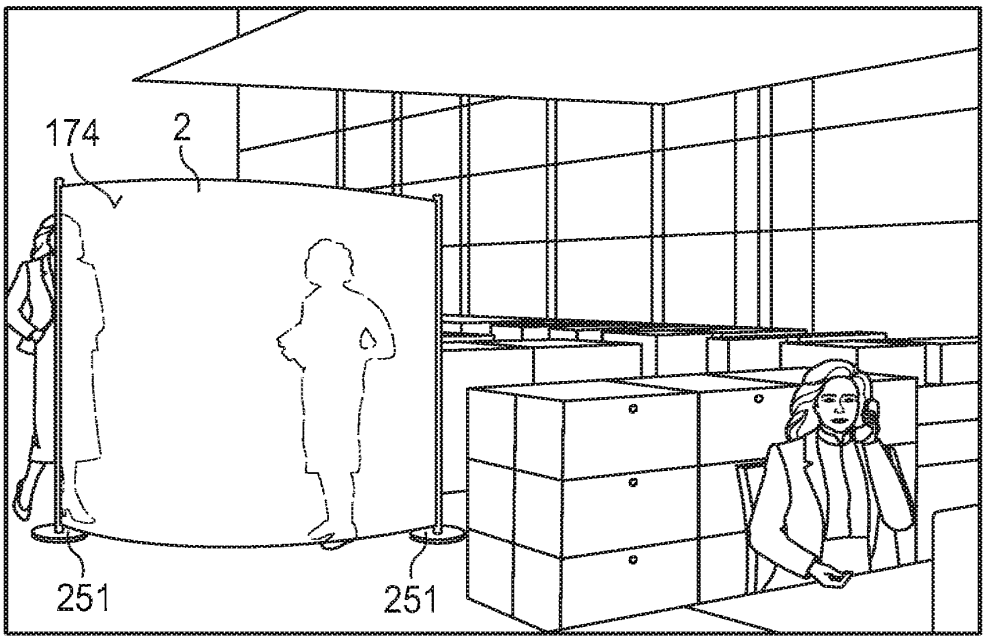


FIG 51B

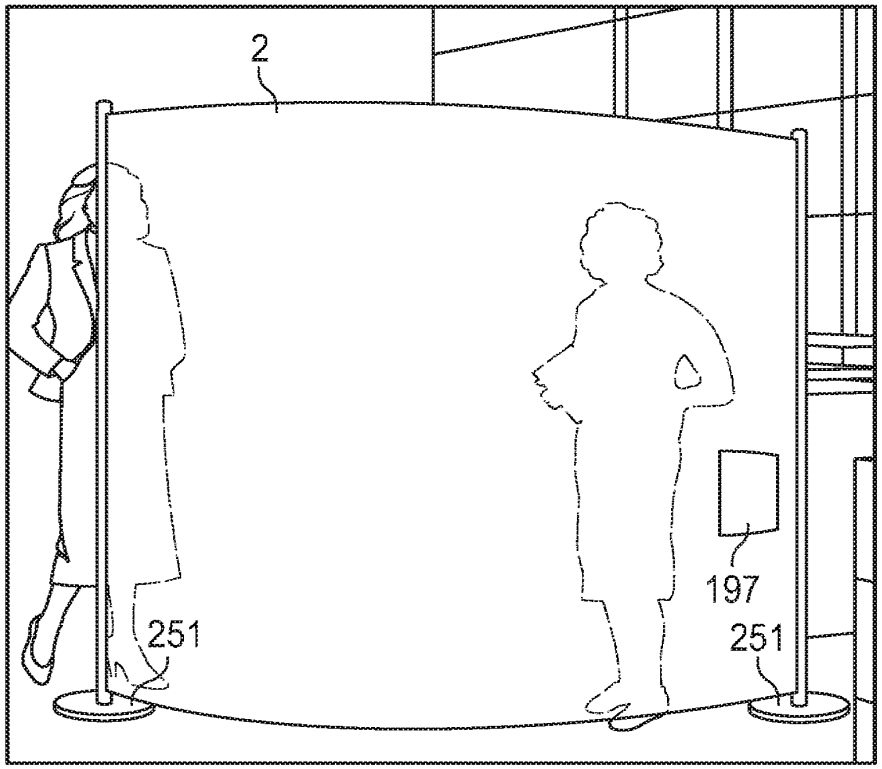


FIG 52A

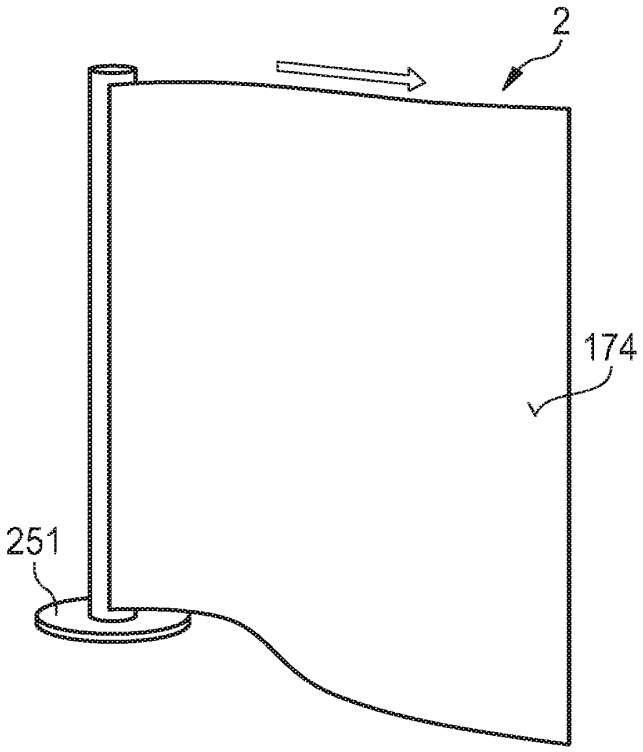


FIG 52B

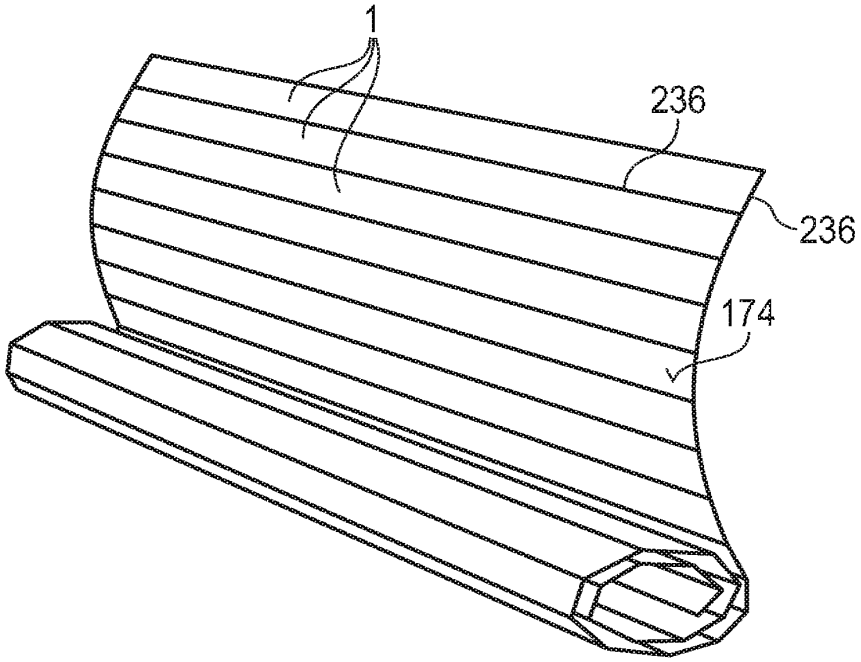


FIG 52C

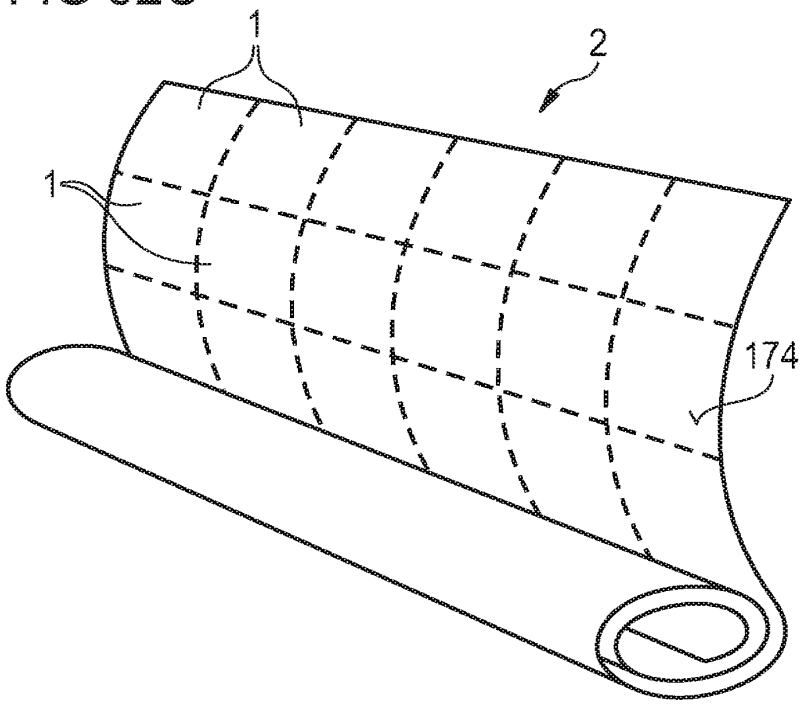


FIG 53

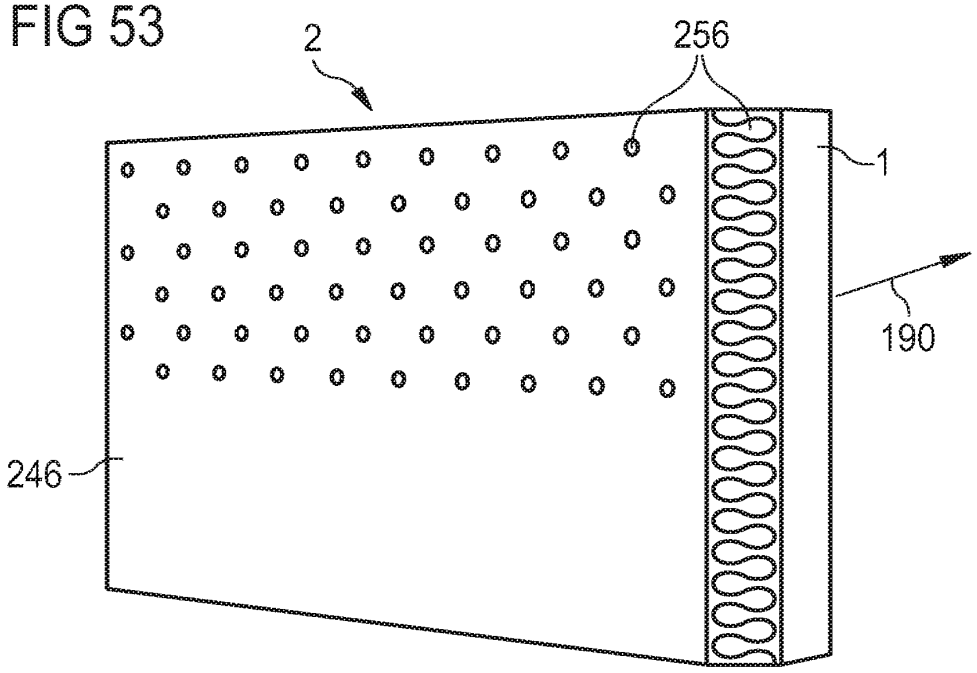


FIG 54A

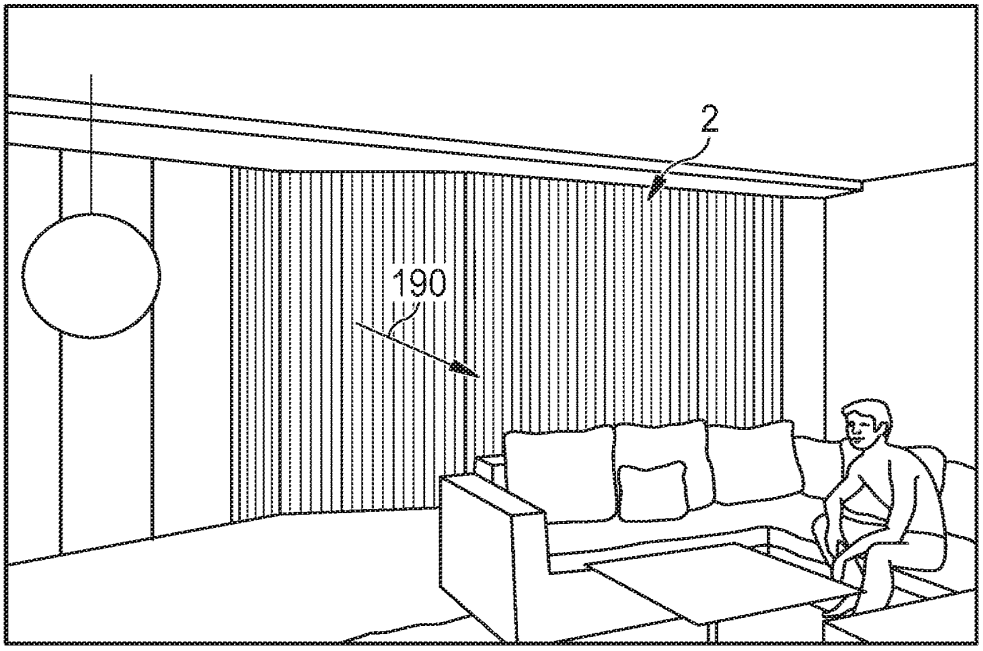


FIG 54B

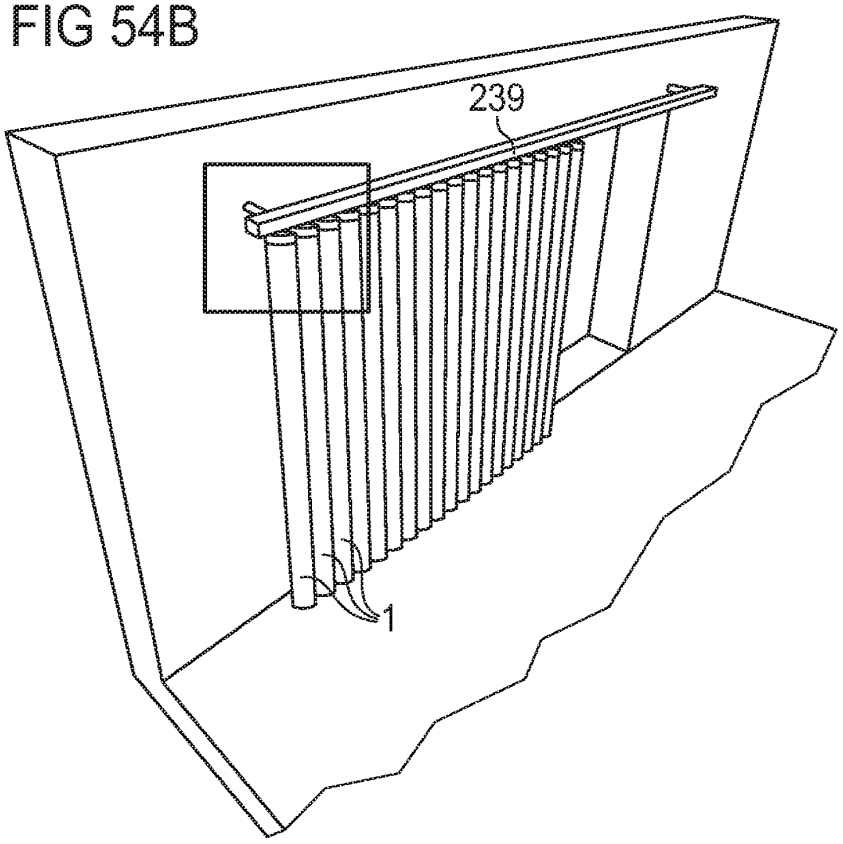


FIG 54C

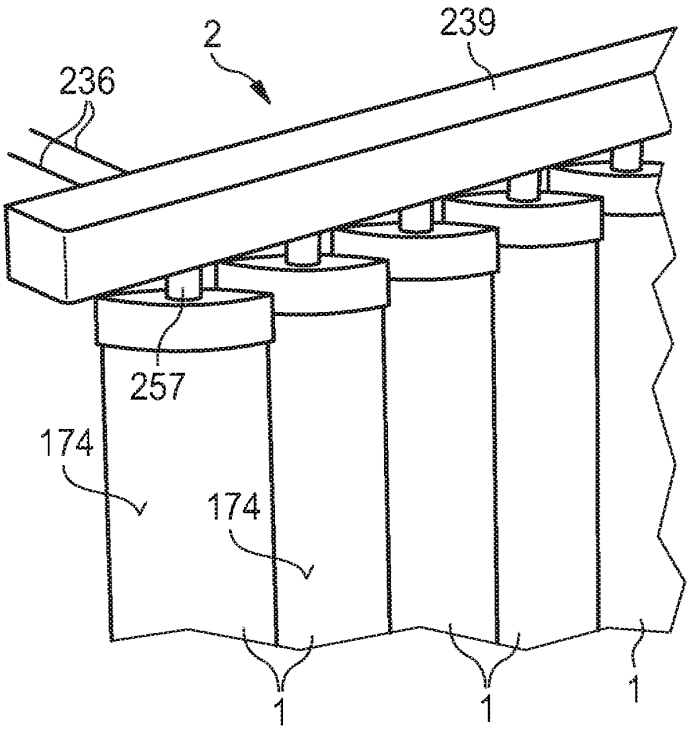


FIG 55A

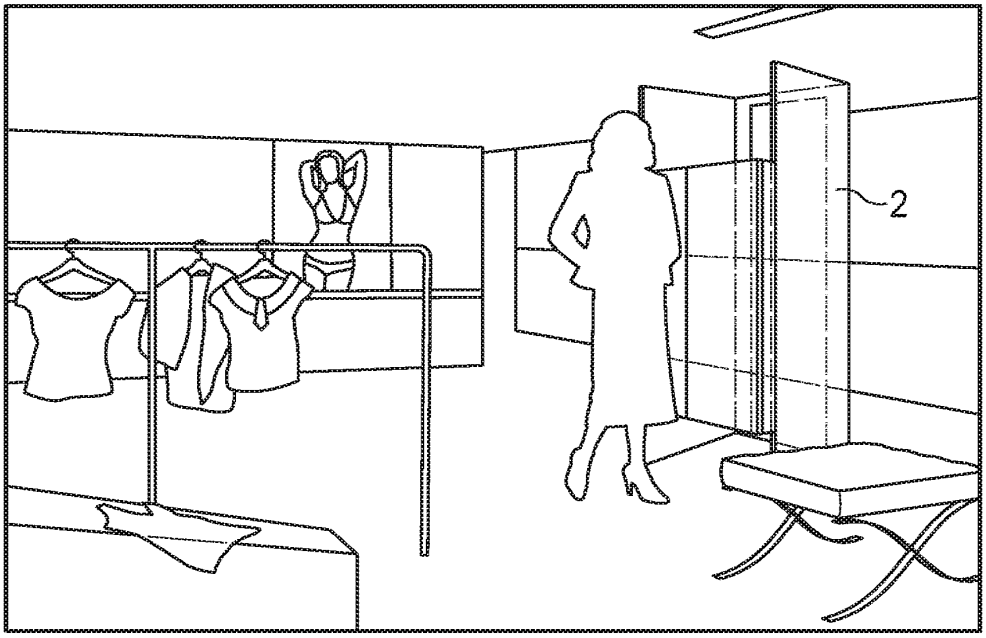


FIG 55B

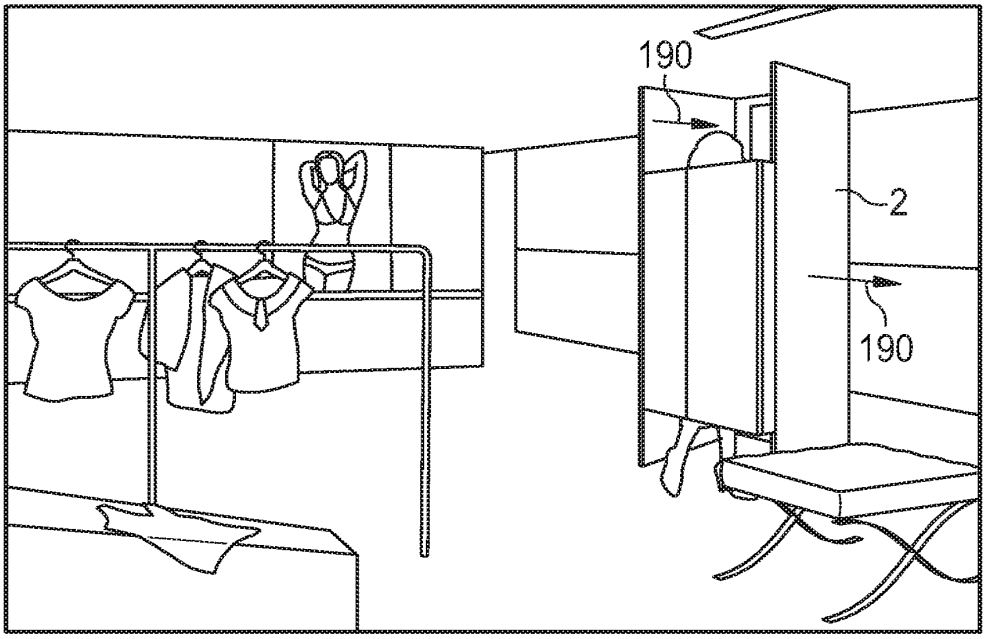


FIG 55C

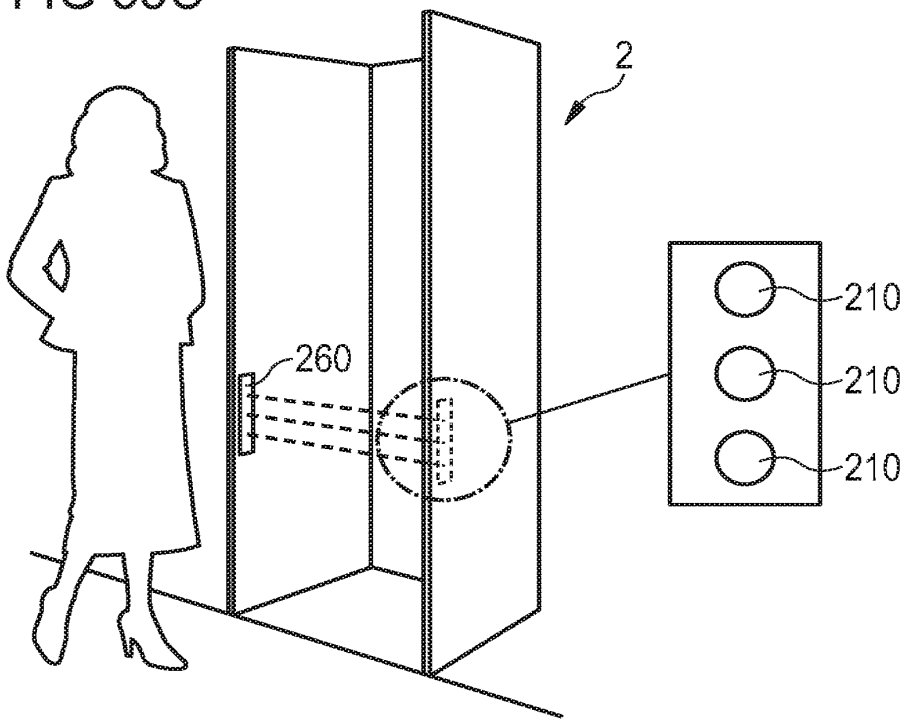


FIG 55D

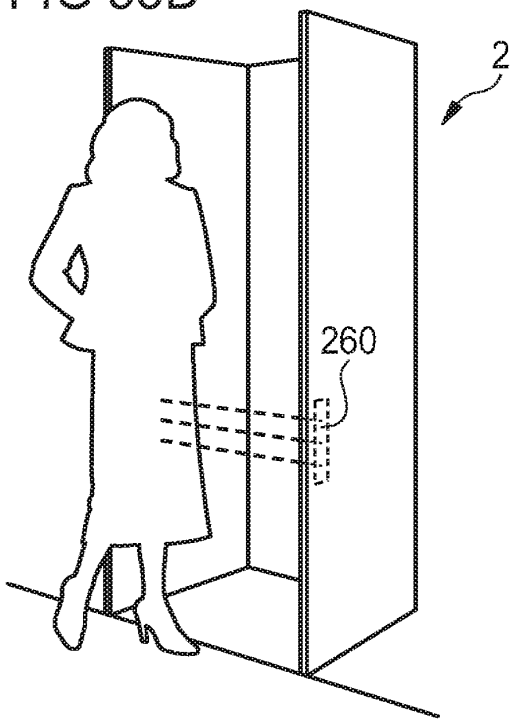


FIG 56A

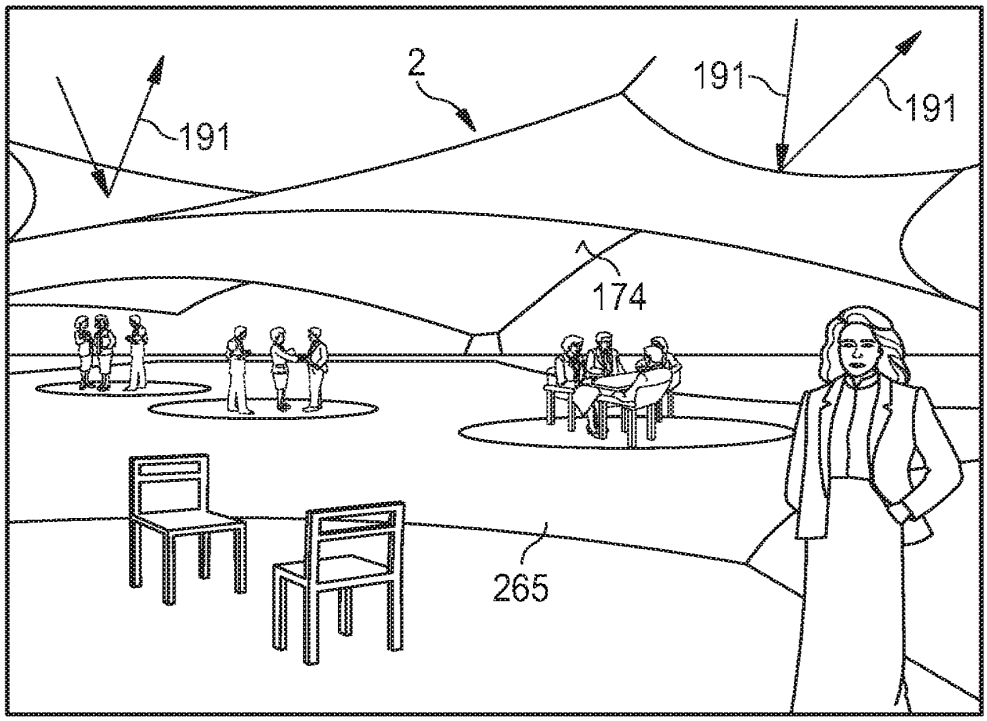


FIG 56B

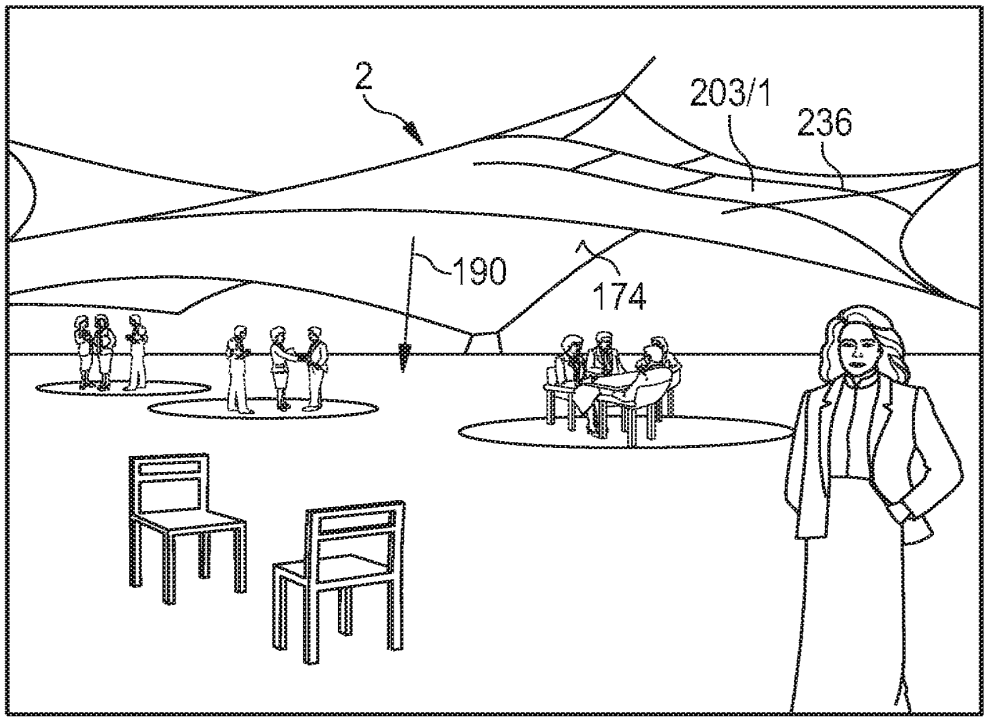


FIG 56C

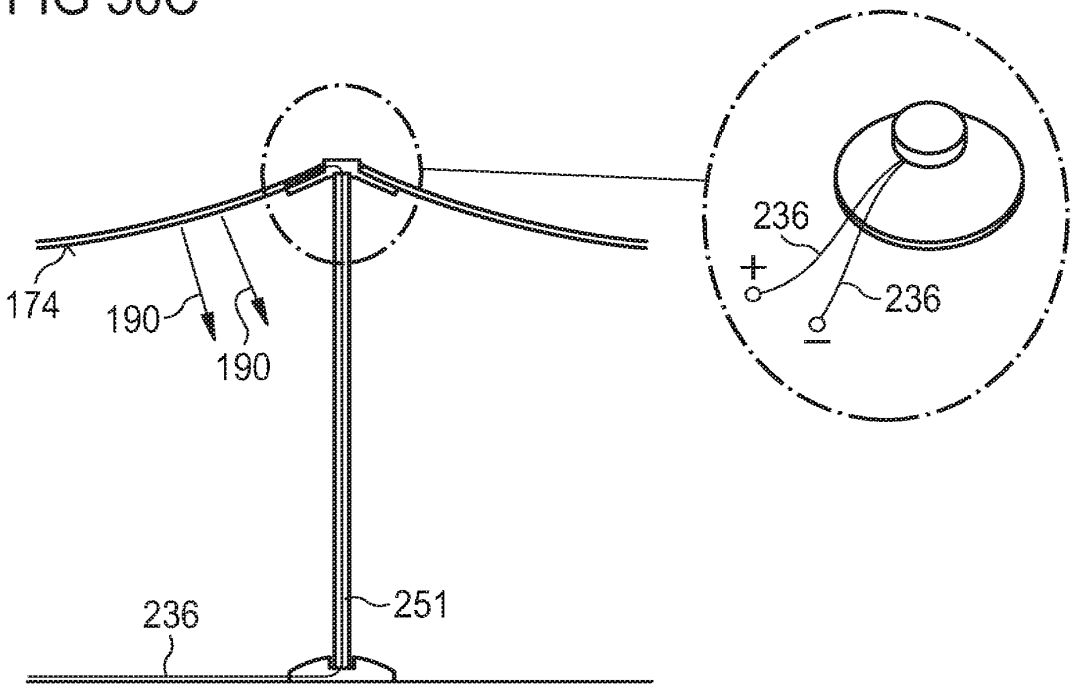


FIG 57A

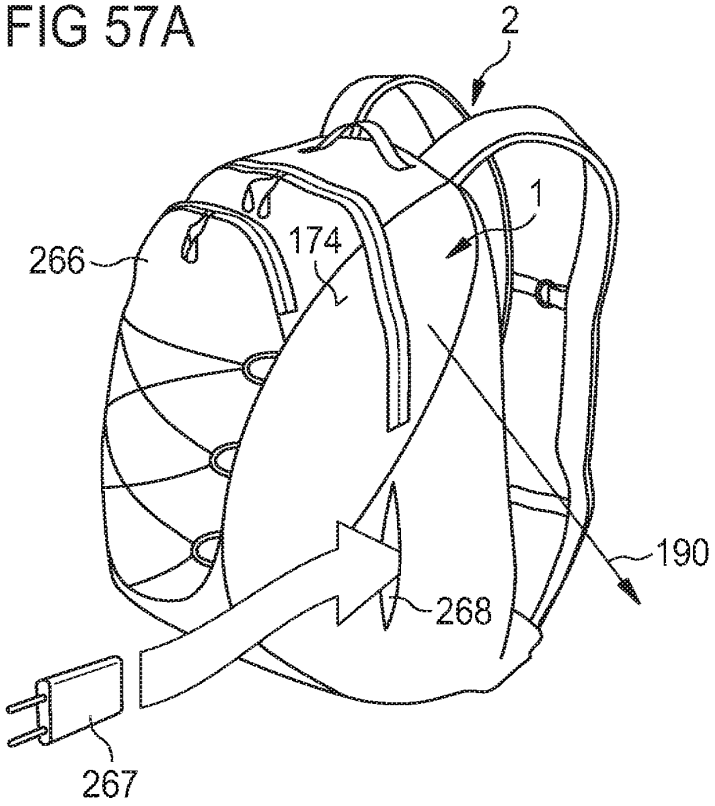


FIG 57B

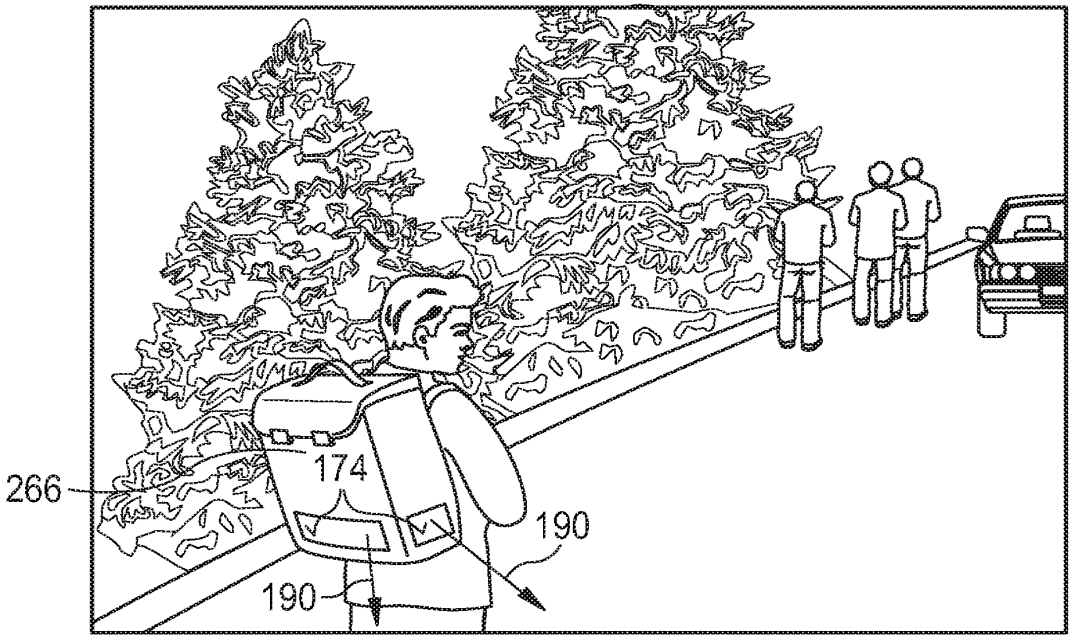


FIG 58A

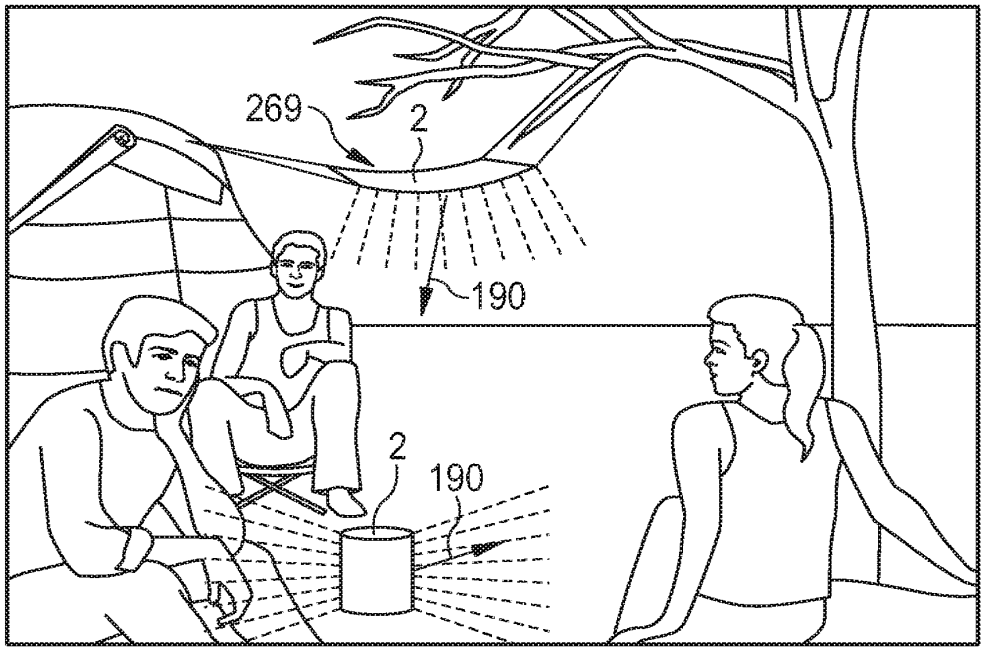


FIG 58B

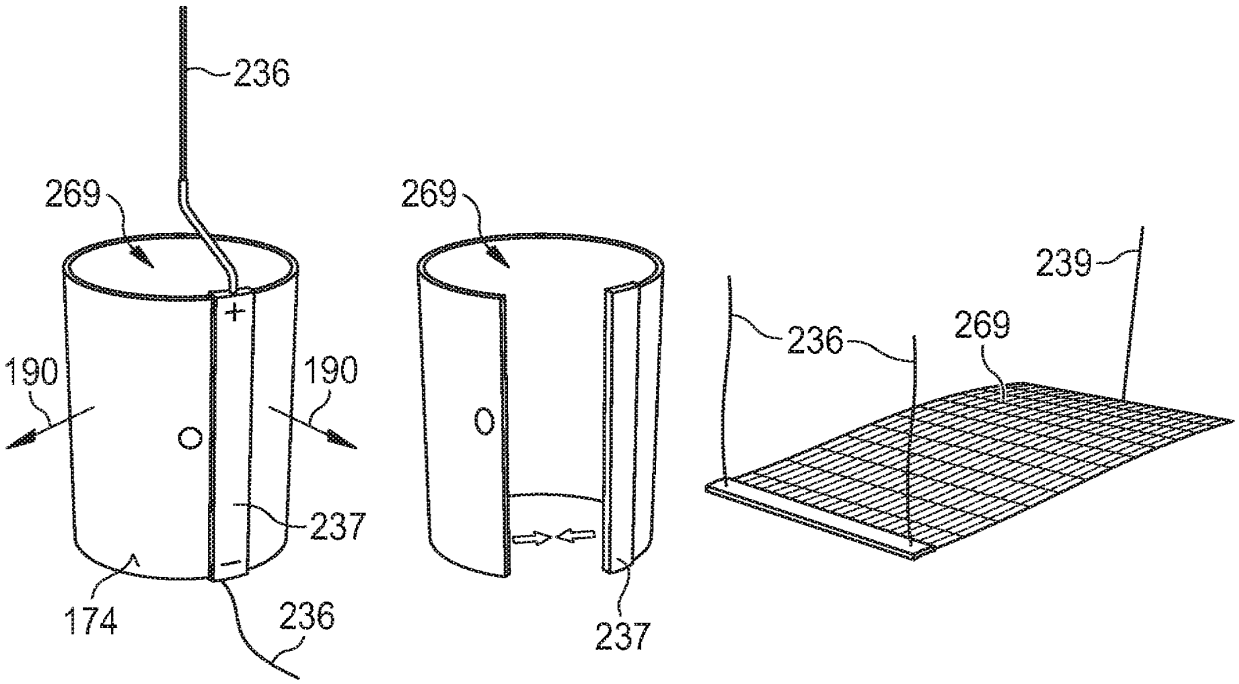


FIG 59

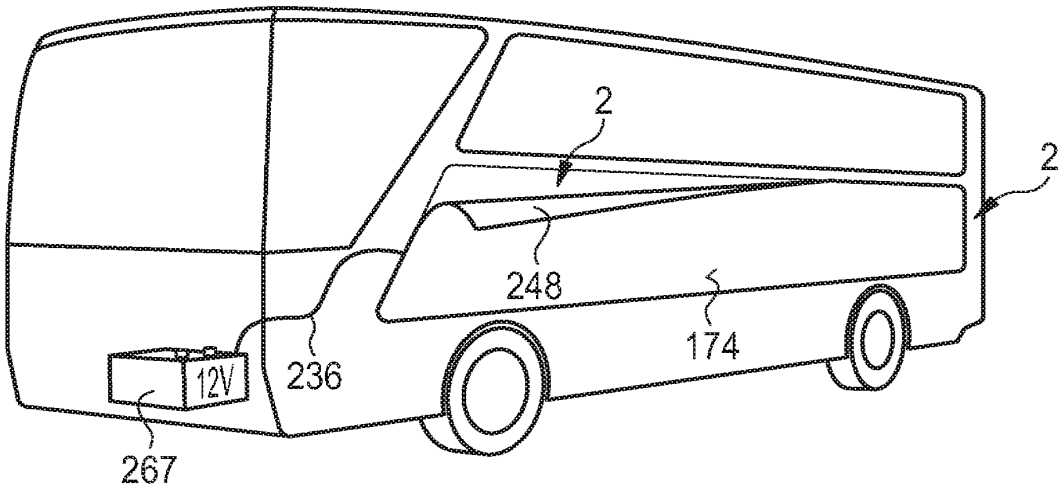


FIG 60A

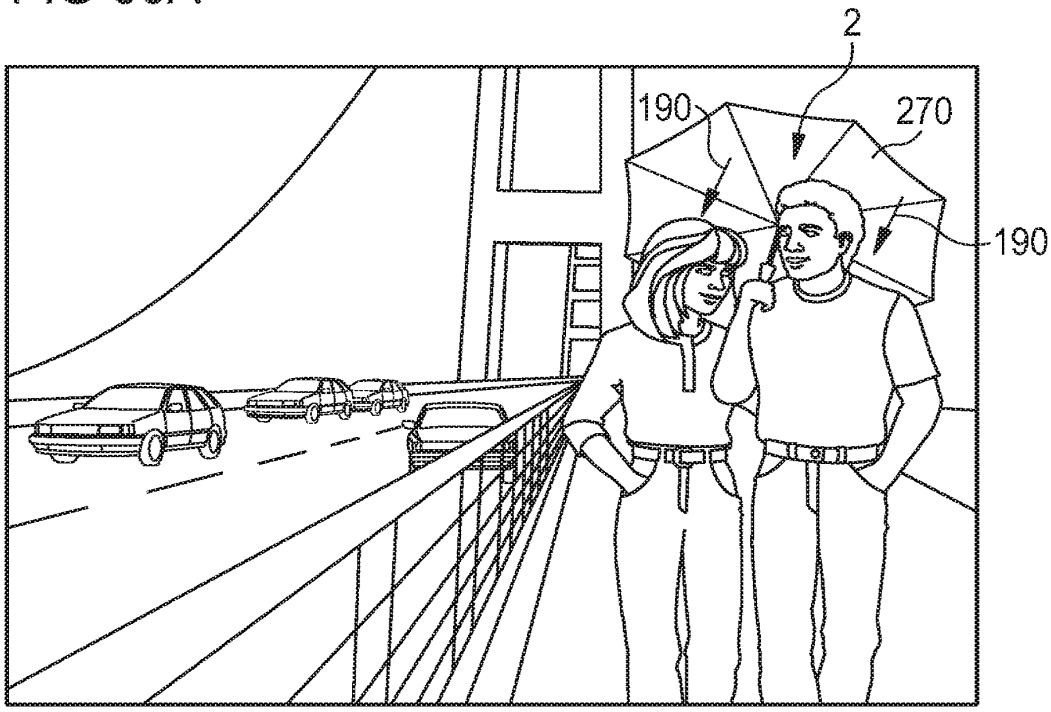


FIG 60B

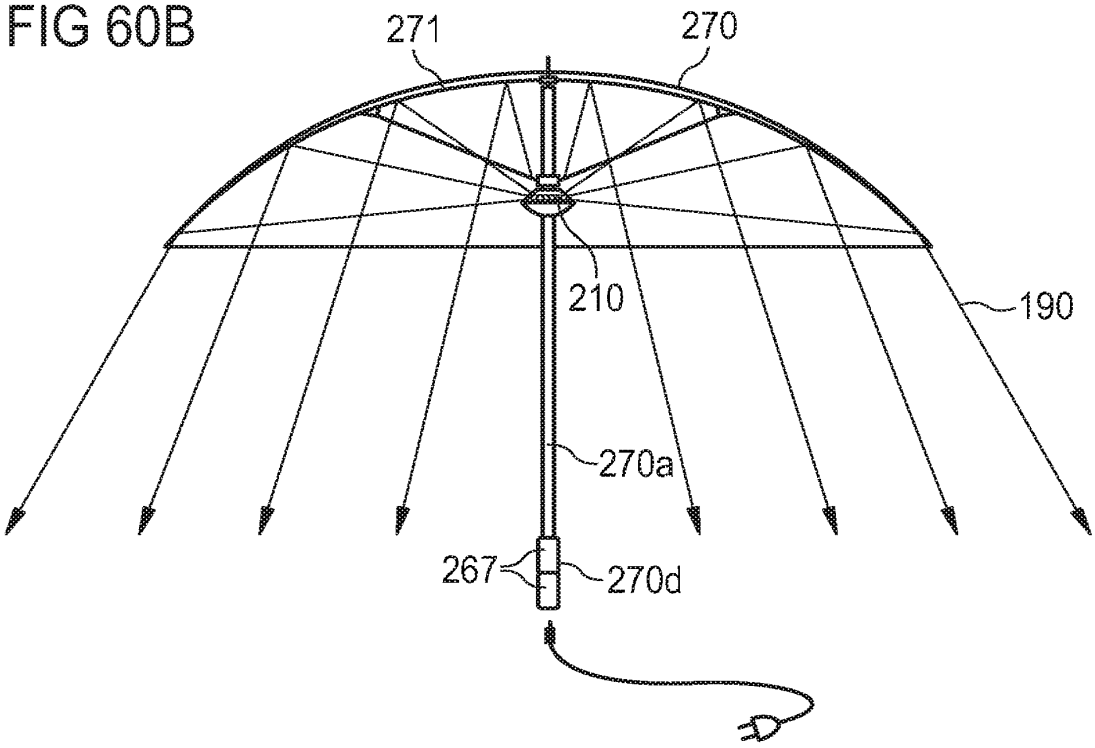


FIG 60C

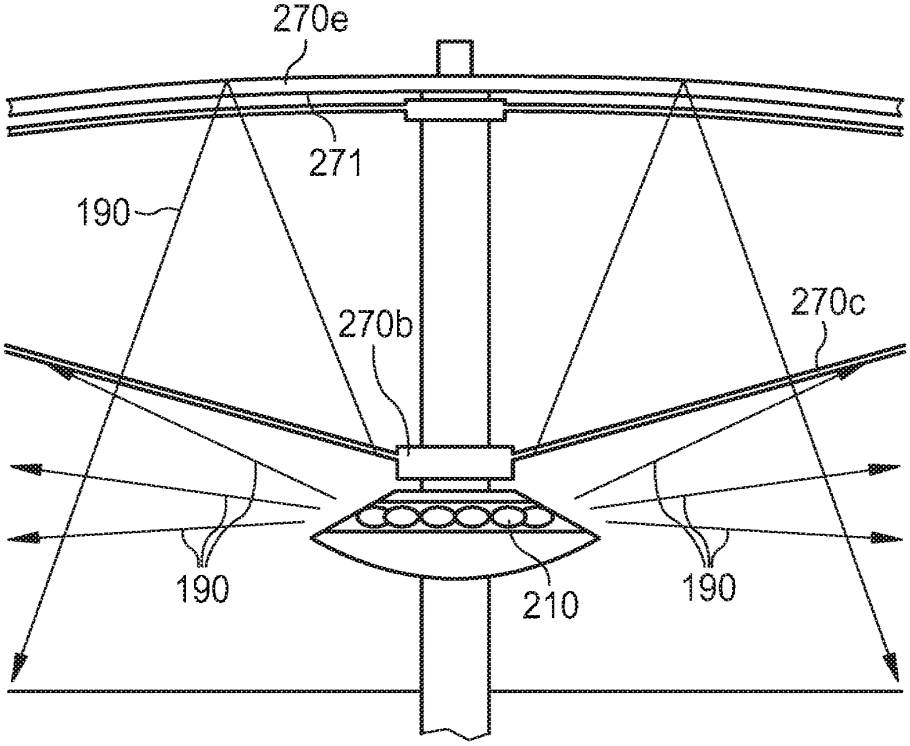


FIG 60D

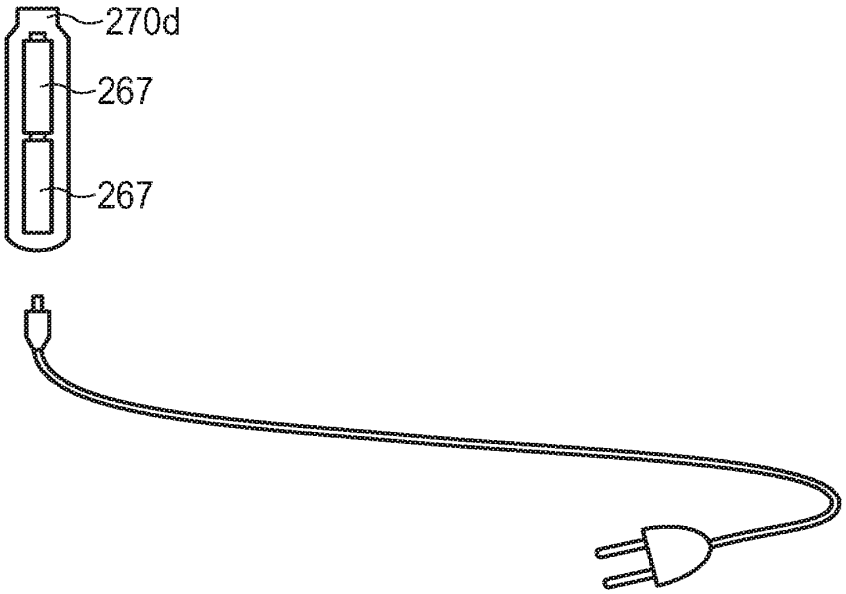


FIG 61A

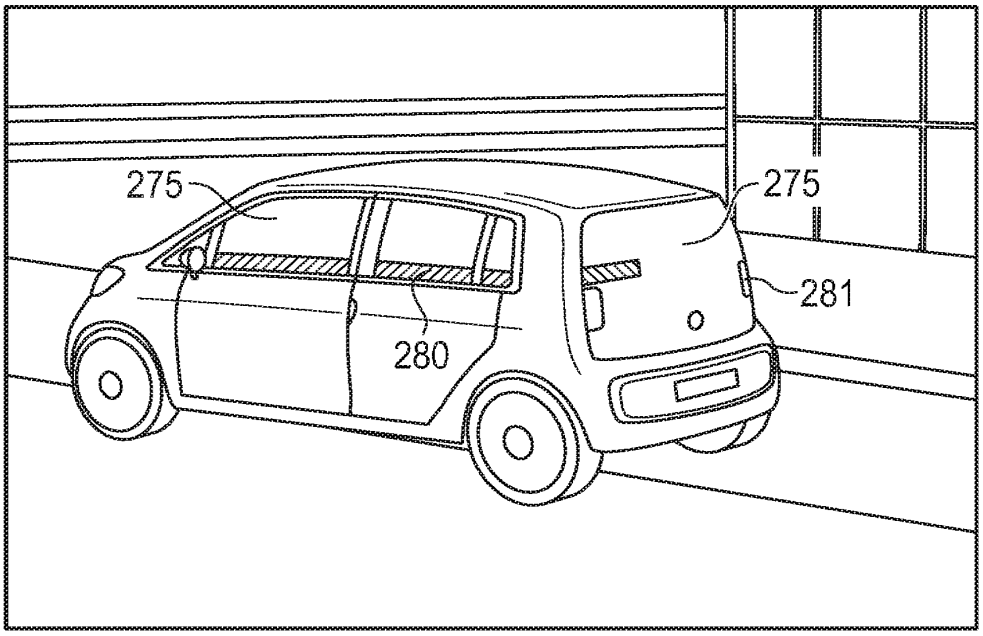


FIG 61B

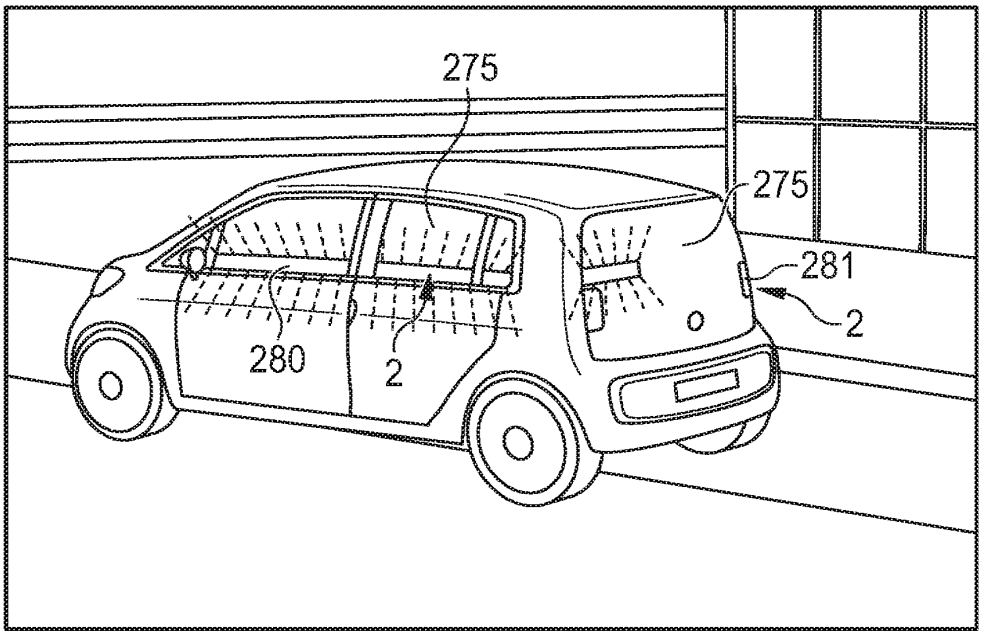


FIG 61C

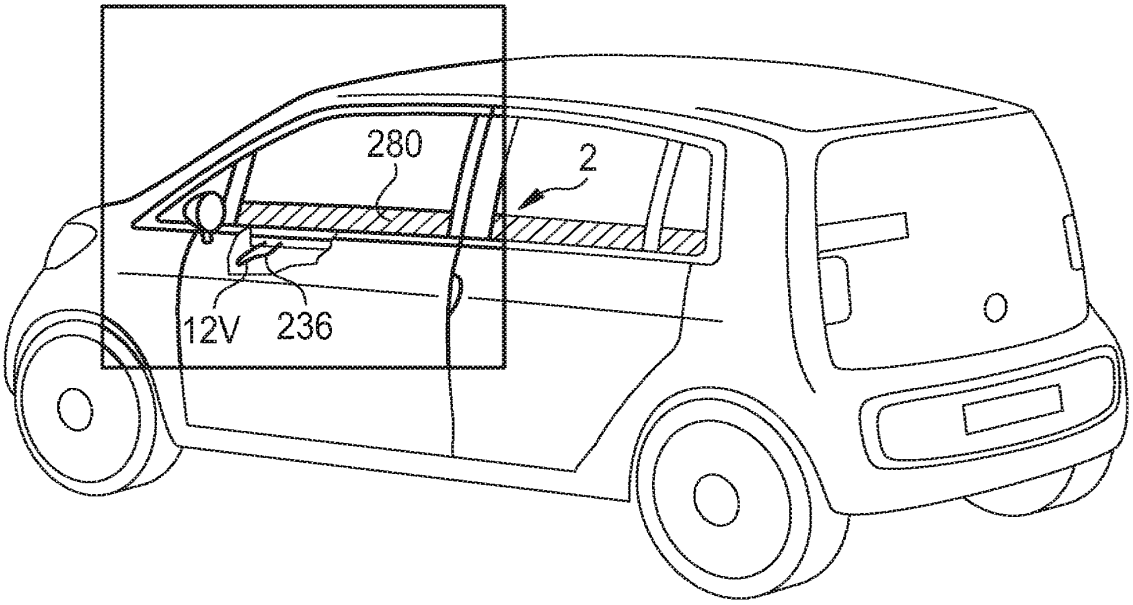


FIG 62

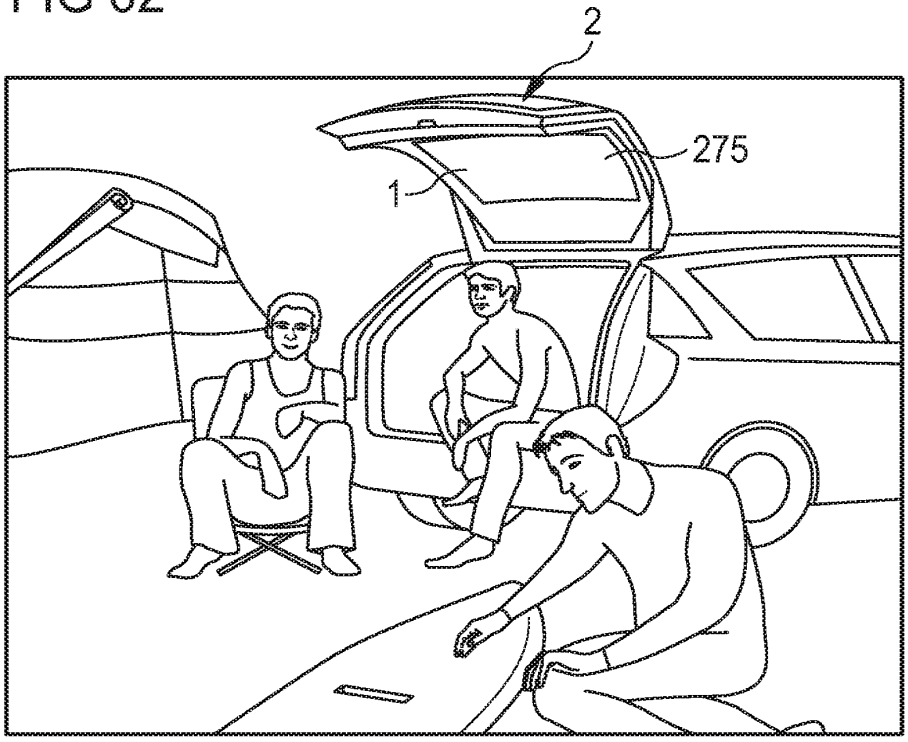


FIG 63

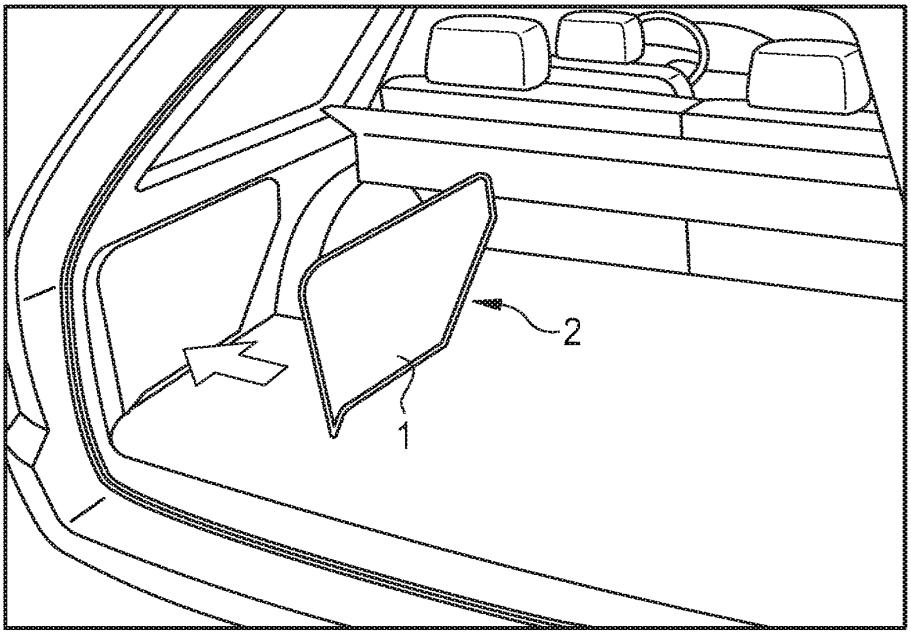


FIG 64A

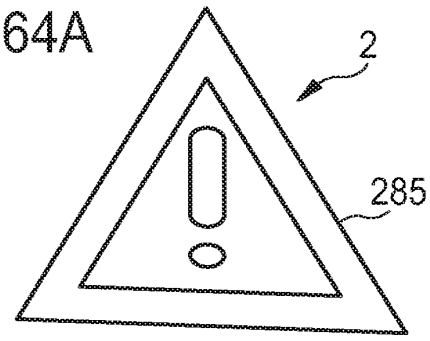
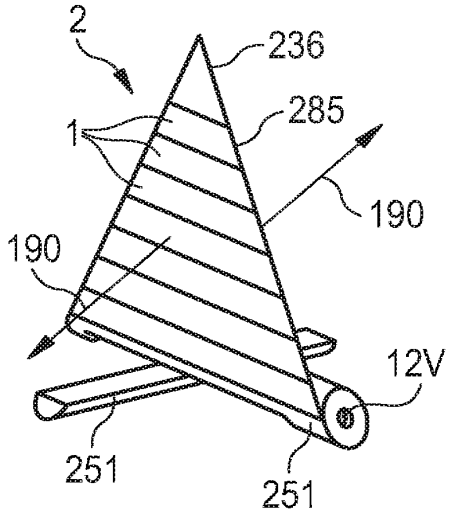


FIG 64B



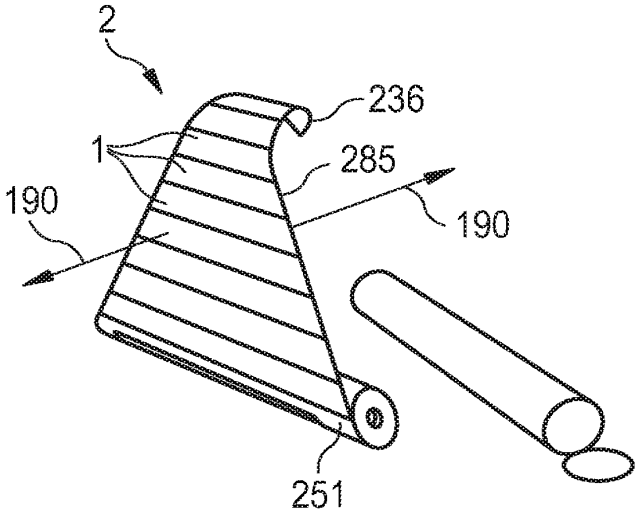
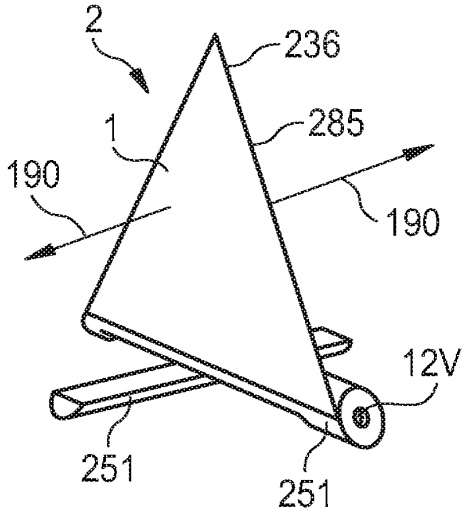


FIG 64C



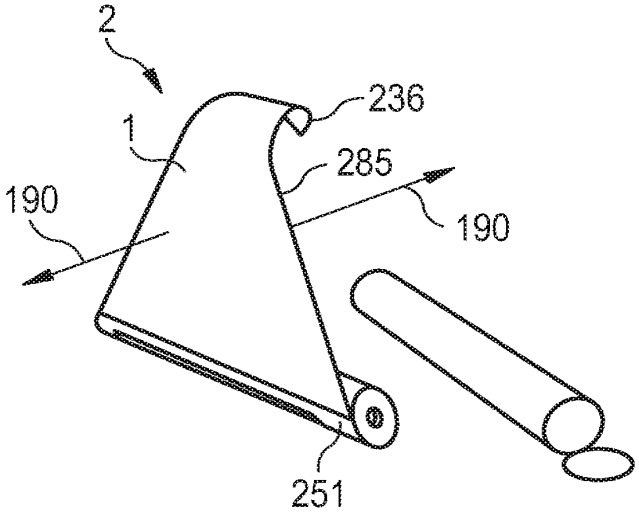


FIG 65A

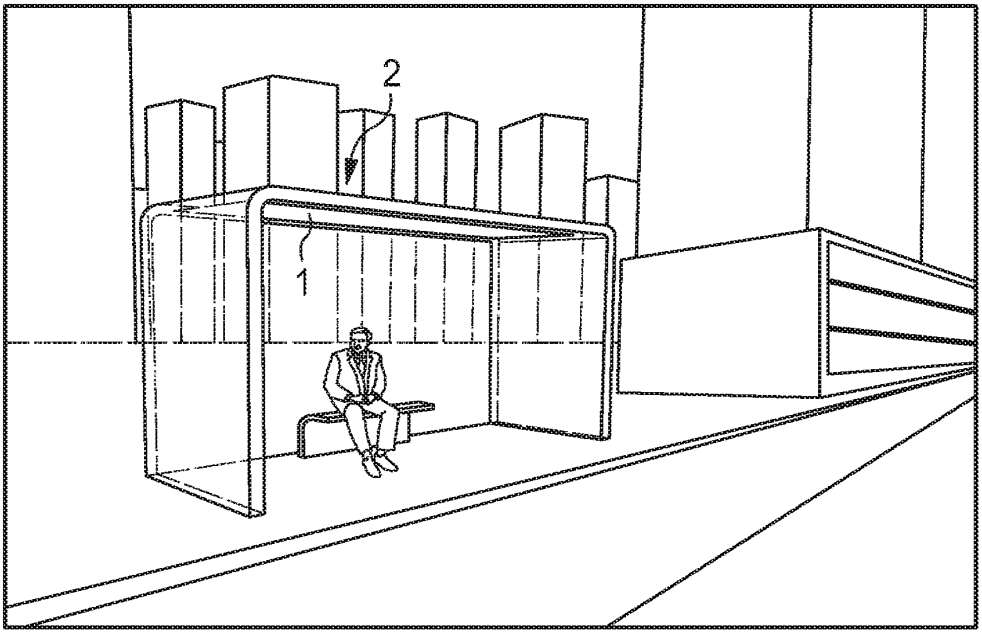


FIG 65B

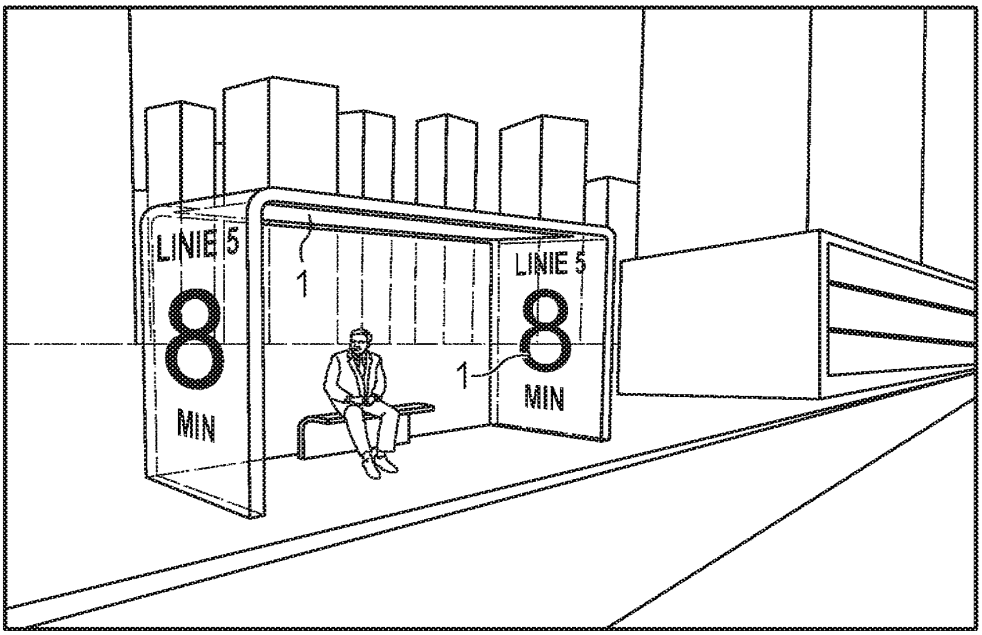
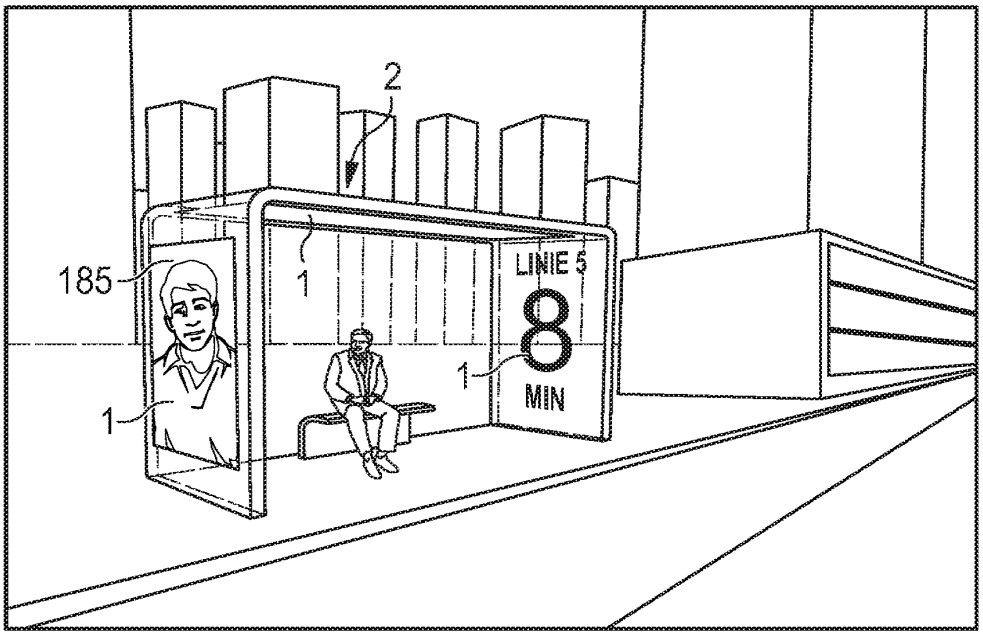


FIG 65C



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Continuation Application of
Ulrich KASTNER-JUNG et al.
Serial No.: TO BE ASSIGNED
Filing Date: CONCURRENTLY
For: Organic-Light-Emitting Diode

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

S I R:

In compliance with the duty of disclosure under 37 C.F.R. § 1.56 and in accordance with the practice under 37 C.F.R. §§ 1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a.

Because (1) the parent application of this continuation application is identified as U.S. Application Serial No. 13/139,514 filed on January 3, 2012; and (2) the information cited herein was cited or discussed in the parent application, copies of the cited documents are not enclosed pursuant to 37 C.F.R. § 1.98(d).

It is respectfully requested that the above information be considered by the Examiner and that the copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document listed or attached

is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicants reserve the right to prove that the date of publication is in fact different.

If any fees or charges are deemed required at this time in connection with the application, the same may be charged to our Patent and Trademark Office Deposit Account No. 503111.

Respectfully submitted,
Cozen O'Connor

By /Thomas Langer/
Thomas Langer
Reg. No. 27,264
277 Park Avenue
New York, New York 10172
(212) 883-4900

Dated: July 17, 2017

PTO/SB/08A (04-03)
Approved for use through 04/30/2003. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for Form 1449/PTO	**Complete if Known**	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)	Application Number	
	Filing Date	
	First Named Inventor	Ulrich KASTNER-JUNG
	Art Unit	
	Examiner Name	
Sheet 1 of 3	Attorney Docket No.	5367-694PCON

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number Number-Kind-Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-2007/0278937	12-06-2007	Forrest et al.	
		US-2003/0064540	04-03-2003	Auch et al.	
		US-7,280,439	10-09-2007	Shaddox	
		US-2003/0231495	12-18-2003	Searfoss, III	
		US-6,236,622	05-22-2001	Blackman	
		US-2008/0219013	09-11-2008	Budinger et al.	
		US-7,317,210	01-08-2008	Osram Opto Semiconductors GmbH	
		US-2009/0039272	02-12-2009	Osram Opto Semiconductors GmbH	
		US-7,922,358	04-12-2011	Osram Opto Semiconductors GmbH	
		US-2001/0052752	12-2001	Ghosh	
		US-2002/0125822	09-2002	Graff	
		US-2002/0167270	11-2002	Siwinski	
		US-2003/0071804	04-2003	Yamazaki	
		US-2003/0121767	07-2003	Caldwell	
		US-2003/0175553	09-2003	Thompson	
		US-2003/0222577	12-2003	Lu	
		US-2004/0113542	06-2004	Hsiao	
		US-2005/0099824	05-2005	Dowling	
		US-2006/0049381	03-2006	Klein	
		US-2007/0278937	12-2007	Forrest	
		US-2008/0248191	10-2008	Daniels	
		US-2010/0157585	06-2010	Diekmann	
		US-2012/0258294	10-2012	Leyder	
		US-5,734,225	03-1998	Biebuyck et al.	
		US-5,895,228	04-1999	Biebuyck	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, Washington, DC 20231.**

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Approved for use through 04/30/2003. OMB 0651-0031
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Substitute for Form 1449/PTO	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)	Application Number	
	Filing Date	
	First Named Inventor	Ulrich KASTNER-JUNG
	Art Unit	
	Examiner Name	
Sheet 2 of 3	Attorney Docket No.	5367-694PCON

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Document: Country Code[3] Number[4] Kind-Code [5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		DE 10 2006 037 222	02-14-2008	Swoboda et al.		
		JP 2007-294143	11-08-2007	Matsuura		
		WO 2008/110959	09-18-2008	Van Woudenberg et al.		
		WO 2008/146232	12-04-2008	Schlangen et al.		
		DE 10308514	09-09-2004	Schott Glas		
		DE 10332956	02-10-2005	Woehr Richard GmbH		
		KR 20080081255	09-09-2008	Osram Opto Semiconductors GmbH		
		KR 20020079438	10-19-2002	Eastman Kodak Co.		
		DE 102008051132	01-21-2010	Osram Opto Semiconductors GmbH		
		WO 2009/040401	04-02-2009	Osram Opto Semiconductors GmbH		
		WO 2009/074127	06-18-2009	Osram Opto Semiconductors GmbH		
		WO 2009/095005	08-06-2009	Osram Opto Semiconductors GmbH		
		WO 2009/106067	09-03-2009	Osram Opto Semiconductors GmbH		
		WO 2010/006571	01-21-2010	Osram Opto Semiconductors GmbH		
		WO 2008/040323	04-2008	Diekmann		
		WO 2008/146232	12-2008	Schlangen		

Examiner Signature		Date Considered	

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Substitute for Form 1449/PTO	**Complete if Known**	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)	Application Number	
	Filing Date	
	First Named Inventor	Ulrich KASTNER-JUNG
	Art Unit	
	Examiner Name	
Sheet 3 of 3	Attorney Docket No.	5367-694PCON

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		Boffi Wedge. Stylepark, May 25, 2011. (1 page). Retrieved from http://www.stylepark.com/en/boffi/wedge.	
		Bus stop shelter intelligent series. May 25, 2011. (2 pages). Retrieved from http://www.wall.de/en/street_furniture/products?category_scope=bus_stop_shelter	
		Cristina Rubinetterie sandwich shower head – new electronic LED shower head, May 12, 2007. (3 pages). Retrieved from http://www.trendir.com/archives/001435.html.	
		Dornbracht RainSky E Showers by Rixson & Green Shortlands Ltd. September 2000. (1 page). Retrieved from http://www.rixson-green.co.uk/dornbracht_showers.htm.	
		Marketing-displays. Illuminated box CLP-S I freetstanding unit, one-sided (1200 x 1760 mm). May 25, 2011. (1 page). Retrieved from http://www.md-displayshop.de/ProductDetails.aspx?id=24&prodi...	
		LCD-Glass; Glass with LCD Film (max height 300 – max width 120). 2009. (2 pages). Retrieved from http://www.vetroin.co.uk/en/TECHNOLOGY/LDC-Glass.html	
		ThinkGeek:Lumadot LED Umbrella. May 25, 2011. (2 pages). Retrieved from http://www.thinkgeek.com/interests/moms/d16b/	
		Luceplan. Strip D22/4 – D22/4 EL. May 25, 2011. Retrieved from http://www.luceplan.com/Dynamic/Prodotti.php?intLangID=1&intC...	
		Multifunctional shower cabin- WELL BOX- Megius SpA. 2011. (1 page). Retrieved from http://www.archiexpo.com/prod/megius-spa/multifunctional-shower...	
		The General Properties of Si, Ge, SiGe, SiO2 and Si3N4 (June 2002, Virginia Semiconductor, Retrieved from the Internet: <URL www.virginiasemi.com/pdf/generalpropertiesSi62002.pdf>)	
		Edgar S. Zaus et al., "Design of Highly Transparent Organic Photodiodes, IEEE Transactions of Electron Devices, Vo. 55, No. 2, February 2008	
		N. R. Mowrer, "Polysiloxanes, Ameron International Performance Coatings and Finishes, November 2003	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, Washington, DC 20231.**

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	Attorney's Docket No. 5367-694PUS

As a below named inventor, I hereby declare that:

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I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

ORGANIC-LIGHT-EMITTING DIODE AND LUMINAIRE

the specification of which (check only one item below)

[] is attached hereto

[x] was filed as United States application

Serial No. 13/139,514

on June 13, 2011

and was amended by Preliminary Amendment filed concurrently with the application

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Country (if PCT, indicate "PCT")	Application Number	Date of Filing (day, month, year)	Priority Claimed Under 35 U.S.C. 119	
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			[] YES	[] NO
			[] YES	[] NO
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Send correspondence to: *COHEN PONTANI LIEBERMAN & PAVANE LLP* at the address for the following customer Number: 27799	Direct Telephone calls to: (name and telephone number) Thomas Langer (212) 687-2770
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.	

201	Primary Citizenship Country::	Germany
	Given Name::	Ulrich
	Middle Name::	
	Family Name::	KASTNER-JUNG
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	Country of Residence::	Germany
	Street of mailing address::	~~Postweg 2~~ Ripheimer Str. 2
	City of mailing address::	~~Taufkirchen~~ Munich
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	~~82024~~ 81247

202	Primary Citizenship Country::	Germany
	Given Name::	Markus
	Middle Name::	
	Family Name::	KLEIN
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	Country of Residence::	Germany
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	City of mailing address::	Tegernheim
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	93105

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COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
203	**Primary Citizenship Country::**	Belgium
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	Middle Name::	
	Family Name::	MAES
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	Country of Residence::	Belgium
	Street of mailing address::	Zonnestraat 31
	City of mailing address::	Dilsen-Stokkem
	Country of mailing address::	Belgium
	Postal or Zip Code of mailing address::	3650

204	**Primary Citizenship Country::**	Austria
	Given Name::	Romana
	Middle Name::	
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	Country of Residence::	Austria
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	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5020

SDC EX. 1016 - 260/959

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	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5020

206	**Primary Citizenship Country::**	Germany
	Given Name::	Stephan
	Middle Name::	
	Family Name::	LINTNER
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Uferstrasse 30 D
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5026

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE 22.09.2011	DATE	DATE
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	SIGNATURE OF INVENTOR 206
DATE	DATE	DATE
Additional inventor(s) name(s) & address(es) attached? [x] Yes [ ] No		

SDC EX. 1016 - 261/959

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207	**Primary Citizenship Country::**	Germany
	Given Name::	Julian
	Middle Name::	
	Family Name::	HERGET
	City of Residence::	Marktschellenberg
	Country of Residence::	Germany
	Street of mailing address::	Mehlweg 7
	City of mailing address::	Marktschellenberg
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	83487

208	**Primary Citizenship Country::**	Austria
	Given Name::	Gregor
	Middle Name::	
	Family Name::	MATJAN
	City of Residence::	Bergheim
	Country of Residence::	Austria
	Street of mailing address::	Wickenburgalee 6
	City of mailing address::	Bergheim
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5101

SIGNATURE OF INVENTOR 207	SIGNATURE OF INVENTOR 208	SIGNATURE OF INVENTOR 209
DATE	DATE	DATE
SIGNATURE OF INVENTOR 210	SIGNATURE OF INVENTOR 211	SIGNATURE OF INVENTOR 212
DATE	DATE	DATE

SDC EX. 1016 - 262/959

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SDC EX. 1016 - 263/959

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Send correspondence to: *COHEN PONTANI LIEBERMAN & PAVANE LLP* at the address for the following customer Number: **27799**	Direct Telephone calls to: (name and telephone number) Thomas Langer (212) 687-2770
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206	Primary Citizenship Country::	Germany
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COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203 STAN MAES
DATE	DATE	DATE 02/08/2011
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	SIGNATURE OF INVENTOR 206
DATE	DATE	DATE
Additional inventor(s) name(s) & address(es) attached? [x] Yes [ ] No		

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	Country of mailing address::	Germany
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	Family Name::	MATJAN
	City of Residence::	Bergheim
	Country of Residence::	Austria
	Street of mailing address::	Wickenburgalee 6
	City of mailing address::	Bergheim
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5101

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DATE	DATE	DATE
SIGNATURE OF INVENTOR 210	SIGNATURE OF INVENTOR 211	SIGNATURE OF INVENTOR 212
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SDC EX. 1016 - 272/959

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ORGANIC-LIGHT-EMITTING DIODE AND LUMINAIRE

the specification of which (check only one item below)

[] is attached hereto

[x] was filed as United States application

Serial No. 13/139,514

on June 13, 2011

and was amended by Preliminary Amendment filed concurrently with the application

[] was filed as PCT international application

Number PCT/DE2009/001741

on 9 December 2009

and was amended under PCT Article 19

on _ (if applicable).

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PRIOR FOREIGN/PCT APPLICATIONS AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

Country (if PCT, indicate "PCT")	Application Number	Date of Filing (day, month, year)	Priority Claimed Under 35 U.S.C. 119	
Germany	10 2008 061 563.3	11 December 2008	[x] YES	[] NO
PCT	PCT/DE2009/001741	9 December 2009	[] YES	[x] NO
			[] YES	[] NO
			[] YES	[] NO
			[] YES	[] NO
			[] YES	[] NO
			[] YES	[] NO

SDC EX. 1016 - 273/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	Attorney's Docket No. 5367-694PUS
POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) at *Cohen, Pontani, Lieberman & Pavane* to prosecute this application and transact all business in the Patent and Trademark Office connected therewith **Customer number 27799**	
Send correspondence to: *COHEN PONTANI LIEBERMAN & PAVANE LLP* at the address for the following customer Number: **27799**	Direct Telephone calls to: (name and telephone number) Thomas Langer (212) 687-2770
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.	

201	**Primary Citizenship Country::**	Germany
	Given Name::	Ulrich
	Middle Name::	
	Family Name::	KASTNER-JUNG
	City of Residence::	~~Taufkirchen~~ Munich
	Country of Residence::	Germany
	Street of mailing address::	~~Postweg 2~~ Rißheimer Str. 2
	City of mailing address::	~~Taufkirchen~~ Munich
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	~~82024~~ 81247

202	**Primary Citizenship Country::**	Germany
	Given Name::	Markus
	Middle Name::	
	Family Name::	KLEIN
	City of Residence::	Tegernheim
	Country of Residence::	Germany
	Street of mailing address::	Bienenweg 2b
	City of mailing address::	Tegernheim
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	93105

SDC EX. 1016 - 274/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
203	Primary Citizenship Country::	Belgium
	Given Name::	Stan
	Middle Name::	
	Family Name::	MAES
	City of Residence::	Dilsen-Stokkem
	Country of Residence::	Belgium
	Street of mailing address::	Zonnestraat 31
	City of mailing address::	Dilsen-Stokkem
	Country of mailing address::	Belgium
	Postal or Zip Code of mailing address::	3650

204	Primary Citizenship Country::	Austria
	Given Name::	Romana
	Middle Name::	
	Family Name::	SIGL
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Herrengasse 24 /9
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5020

SDC EX. 1016 - 275/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
205	**Primary Citizenship Country::**	Germany
	Given Name::	Annette
	Middle Name::	
	Family Name::	HAID
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Grillparzer Str. 4
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5020

206	**Primary Citizenship Country::**	Germany
	Given Name::	Stephan
	Middle Name::	
	Family Name::	LINTNER
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Uferstrasse 30 D
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5026

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE	DATE	DATE
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	SIGNATURE OF INVENTOR 206
DATE 11.05.2011	DATE	DATE
Additional inventor(s) name(s) & address(es) attached? [x] Yes [ ] No		

SDC EX. 1016 - 276/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
207	**Primary Citizenship Country::**	Germany
	Given Name::	Julian
	Middle Name::	
	Family Name::	HERGET
	City of Residence::	Marktschellenberg
	Country of Residence::	Germany
	Street of mailing address::	Mehlweg 7
	City of mailing address::	Marktschellenberg
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	83487

208	**Primary Citizenship Country::**	Austria
	Given Name::	Gregor
	Middle Name::	
	Family Name::	MATJAN
	City of Residence::	Bergheim
	Country of Residence::	Austria
	Street of mailing address::	Wickenburgalee 6
	City of mailing address::	Bergheim
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5101

SIGNATURE OF INVENTOR 207	SIGNATURE OF INVENTOR 208	SIGNATURE OF INVENTOR 209
DATE	DATE	DATE
SIGNATURE OF INVENTOR 210	SIGNATURE OF INVENTOR 211	SIGNATURE OF INVENTOR 212
DATE	DATE	DATE

SDC EX. 1016 - 277/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	Attorney's Docket No. 5367-694PUS

As a below named inventor, I hereby declare that:

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the specification of which (check only one item below)

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Serial No. 13/139,514

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			[] YES	[] NO
			[] YES	[] NO
			[] YES	[] NO
			[] YES	[] NO

SDC EX. 1016 - 278/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	Attorney's Docket No. 5367-694PUS
POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) at *Cohen, Pontani, Lieberman & Pavane* to prosecute this application and transact all business in the Patent and Trademark Office connected therewith **Customer number 27799**	
Send correspondence to: *COHEN PONTANI LIEBERMAN & PAVANE LLP* at the address for the following customer Number: **27799**	Direct Telephone calls to: (name and telephone number) Thomas Langer (212) 687-2770
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.	

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	Postal or Zip Code of mailing address::	~~82024~~ 81247

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	Given Name::	Markus
	Middle Name::	
	Family Name::	KLEIN
	City of Residence::	Tegernheim
	Country of Residence::	Germany
	Street of mailing address::	Bienenweg 2b
	City of mailing address::	Tegernheim
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	93105

SDC EX. 1016 - 279/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
203	Primary Citizenship Country::	Belgium
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	Middle Name::	
	Family Name::	MAES
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	Country of Residence::	Belgium
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	City of mailing address::	Dilsen-Stokkem
	Country of mailing address::	Belgium
	Postal or Zip Code of mailing address::	3650

204	Primary Citizenship Country::	Austria
	Given Name::	Romana
	Middle Name::	
	Family Name::	SIGL
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Herrengasse 24 /9
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5020

SDC EX. 1016 - 280/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
205	Primary Citizenship Country::	Germany
	Given Name::	Annette
	Middle Name::	
	Family Name::	HAID
	City of Residence::	~~Salzburg~~ ISNY
	Country of Residence::	~~Austria~~ GERMANY
	Street of mailing address::	~~Grillparzer Str. 4~~ ROSER 1
	City of mailing address::	~~Salzburg~~ ISNY / BEUREN
	Country of mailing address::	~~Austria~~ GERMANY
	Postal or Zip Code of mailing address::	~~5020~~ 88316

A.H. 28. Juli 2011 Annette Haid

206	Primary Citizenship Country::	Germany
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	Middle Name::	
	Family Name::	LINTNER
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Uferstrasse 30 D
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	Postal or Zip Code of mailing address::	5026

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE	DATE	DATE
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205 Annette Haid	SIGNATURE OF INVENTOR 206
DATE	DATE 28. Juli 2011	DATE
Additional inventor(s) name(s) & address(es) attached? [x] Yes [ ] No		

SDC EX. 1016 - 281/959

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	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5101

SIGNATURE OF INVENTOR 207	SIGNATURE OF INVENTOR 208	SIGNATURE OF INVENTOR 209
DATE	DATE	DATE
SIGNATURE OF INVENTOR 210	SIGNATURE OF INVENTOR 211	SIGNATURE OF INVENTOR 212
DATE	DATE	DATE

SDC EX. 1016 - 282/959

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			[] YES	[] NO
			[] YES	[] NO
			[] YES	[] NO
			[] YES	[] NO

SDC EX. 1016 - 283/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	Attorney's Docket No. 5367-694PUS
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Send correspondence to: *COHEN PONTANI LIEBERMAN & PAVANE LLP* at the address for the following customer Number: **27799**	Direct Telephone calls to: (name and telephone number) Thomas Langer (212) 687-2770
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	Country of mailing address::	Germany
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	Middle Name::	
	Family Name::	KLEIN
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	Country of Residence::	Germany
	Street of mailing address::	Bienenweg 2b
	City of mailing address::	Tegernheim
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	93105

SDC EX. 1016 - 284/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
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	Family Name::	MAES
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	Given Name::	Romana
	Middle Name::	
	Family Name::	SIGL
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Herrengasse 24 /9
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5020

SDC EX. 1016 - 285/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
205	**Primary Citizenship Country::**	Germany
	Given Name::	Annette
	Middle Name::	
	Family Name::	HAID
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Grillparzer Str. 4
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5020

206	**Primary Citizenship Country::**	Germany
	Given Name::	Stephan
	Middle Name::	
	Family Name::	LINTNER
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Uferstrasse 30 D
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5026

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE	DATE	DATE
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	SIGNATURE OF INVENTOR 206
DATE	DATE	DATE 07/27/2011
Additional inventor(s) name(s) & address(es) attached? [x] Yes [ ] No		

SDC EX. 1016 - 286/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
207	**Primary Citizenship Country::**	Germany
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	Middle Name::	
	Family Name::	HERGET
	City of Residence::	Marktschellenberg
	Country of Residence::	Germany
	Street of mailing address::	Mehlweg 7
	City of mailing address::	Marktschellenberg
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	83487

208	**Primary Citizenship Country::**	Austria
	Given Name::	Gregor
	Middle Name::	
	Family Name::	MATJAN
	City of Residence::	Bergheim
	Country of Residence::	Austria
	Street of mailing address::	Wickenburgalee 6
	City of mailing address::	Bergheim
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5101

SIGNATURE OF INVENTOR 207	SIGNATURE OF INVENTOR 208	SIGNATURE OF INVENTOR 209
DATE	DATE	DATE
SIGNATURE OF INVENTOR 210	SIGNATURE OF INVENTOR 211	SIGNATURE OF INVENTOR 212
DATE	DATE	DATE

SDC EX. 1016 - 287/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	Attorney's Docket No. 5367-694PUS

As a below named inventor, I hereby declare that:

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SDC EX. 1016 - 288/959

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	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	93105

SDC EX. 1016 - 289/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
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	Postal or Zip Code of mailing address::	3650

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	Middle Name::	
	Family Name::	SIGL
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Herrengasse 24 /9
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5020

SDC EX. 1016 - 290/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
205	**Primary Citizenship Country::**	Germany
	Given Name::	Annette
	Middle Name::	
	Family Name::	HAID
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Grillparzer Str. 4
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5020

206	**Primary Citizenship Country::**	Germany
	Given Name::	Stephan
	Middle Name::	
	Family Name::	LINTNER
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Uferstrasse 30 D
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5026

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE	DATE	DATE
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	SIGNATURE OF INVENTOR 206
DATE	DATE	DATE
Additional inventor(s) name(s) & address(es) attached? [x] Yes [ ] No		

SDC EX. 1016 - 291/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
207	**Primary Citizenship Country::**	Germany
	Given Name::	Julian
	Middle Name::	
	Family Name::	HERGET
	City of Residence::	Marktschellenberg
	Country of Residence::	Germany
	Street of mailing address::	Mehlweg 7
	City of mailing address::	Marktschellenberg
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	83487

208	**Primary Citizenship Country::**	Austria
	Given Name::	Gregor
	Middle Name::	
	Family Name::	MATJAN
	City of Residence::	Bergheim
	Country of Residence::	Austria
	Street of mailing address::	Wickenburgallee 6
	City of mailing address::	Bergheim
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5101

SIGNATURE OF INVENTOR 207 JULIAN HERGET	SIGNATURE OF INVENTOR 208	SIGNATURE OF INVENTOR 209
DATE 10-18-2011	DATE	DATE
SIGNATURE OF INVENTOR 210	SIGNATURE OF INVENTOR 211	SIGNATURE OF INVENTOR 212
DATE	DATE	DATE

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	Attorney's Docket No. 5367-694PUS

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

ORGANIC-LIGHT-EMITTING DIODE AND LUMINAIRE

the specification of which (check only one item below)

[] is attached hereto

[x] was filed as United States application

Serial No. 13/139,514

on June 13, 2011

and was amended by Preliminary Amendment filed concurrently with the application

[] was filed as PCT international application

Number PCT/DE2009/001741

on 9 December 2009

and was amended under PCT Article 19

on _ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

PRIOR FOREIGN/PCT APPLICATIONS AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

Country (if PCT, indicate "PCT")	Application Number	Date of Filing (day, month, year)	Priority Claimed Under 35 U.S.C. 119	
Germany	10 2008 061 563.3	11 December 2008	[x] YES	[] NO
PCT	PCT/DE2009/001741	9 December 2009	[] YES	[x] NO
			[] YES	[] NO
			[] YES	[] NO
			[] YES	[] NO
			[] YES	[] NO
			[] YES	[] NO

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)	Attorney's Docket No. 5367-694PUS
POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) at *Cohen, Pontani, Lieberman & Pavane* to prosecute this application and transact all business in the Patent and Trademark Office connected therewith **Customer number 27799**	
Send correspondence to: *COHEN PONTANI LIEBERMAN & PAVANE LLP* at the address for the following customer Number: **27799**	Direct Telephone calls to: (name and telephone number) Thomas Langer (212) 687-2770
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under §1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.	

201	Primary Citizenship Country::	Germany
	Given Name::	Ulrich
	Middle Name::	
	Family Name::	KASTNER-JUNG
	City of Residence::	~~Taufkirchen~~ Munich
	Country of Residence::	Germany
	Street of mailing address::	~~Postweg 2~~ Ribheimerstr. 2
	City of mailing address::	~~Taufkirchen~~ Munich
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	~~82024~~ 81247

202	Primary Citizenship Country::	Germany
	Given Name::	Markus
	Middle Name::	
	Family Name::	KLEIN
	City of Residence::	Tegernheim
	Country of Residence::	Germany
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	City of mailing address::	Tegernheim
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	93105

SDC EX. 1016 - 294/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
203	Primary Citizenship Country::	Belgium
	Given Name::	Stan
	Middle Name::	
	Family Name::	MAES
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	Country of Residence::	Belgium
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	City of mailing address::	Dilsen-Stokkem
	Country of mailing address::	Belgium
	Postal or Zip Code of mailing address::	3650

204	Primary Citizenship Country::	Austria
	Given Name::	Romana
	Middle Name::	
	Family Name::	SIGL
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Herrengasse 24 /9
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5020

SDC EX. 1016 - 295/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
205	**Primary Citizenship Country::**	Germany
	Given Name::	Annette
	Middle Name::	
	Family Name::	HAID
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Grillparzer Str. 4
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5020

206	**Primary Citizenship Country::**	Germany
	Given Name::	Stephan
	Middle Name::	
	Family Name::	LINTNER
	City of Residence::	Salzburg
	Country of Residence::	Austria
	Street of mailing address::	Uferstrasse 30 D
	City of mailing address::	Salzburg
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5026

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
SIGNATURE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
DATE	DATE	DATE
SIGNATURE OF INVENTOR 204	SIGNATURE OF INVENTOR 205	SIGNATURE OF INVENTOR 206
DATE	DATE	DATE
Additional inventor(s) name(s) & address(es) attached? [x] Yes [ ] No		

SDC EX. 1016 - 296/959

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Includes Reference to PCT International Applications)		Attorney's Docket No. 5367-694PUS
207	**Primary Citizenship Country::**	Germany
	Given Name::	Julian
	Middle Name::	
	Family Name::	HERGET
	City of Residence::	Marktschellenberg
	Country of Residence::	Germany
	Street of mailing address::	Mehlweg 7
	City of mailing address::	Marktschellenberg
	Country of mailing address::	Germany
	Postal or Zip Code of mailing address::	83487

208	**Primary Citizenship Country::**	Austria
	Given Name::	Gregor
	Middle Name::	
	Family Name::	MATJAN
	City of Residence::	Bergheim
	Country of Residence::	Austria
	Street of mailing address::	Wickenburgallee 6
	City of mailing address::	Bergheim
	Country of mailing address::	Austria
	Postal or Zip Code of mailing address::	5101

SIGNATURE OF INVENTOR 207	SIGNATURE OF INVENTOR 208	SIGNATURE OF INVENTOR 209
DATE	DATE 07/27/2011	DATE
SIGNATURE OF INVENTOR 210	SIGNATURE OF INVENTOR 211	SIGNATURE OF INVENTOR 212
DATE	DATE	DATE

SDC EX. 1016 - 297/959

UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER SECRETARY OF COMMERCE FOR INTELLECTUAL PROPERTY AND
DIRECTOR OF THE UNITED STATES PATENT AND TRADEMARK OFFICE

JANUARY 26, 2016

PTAS

COZEN O'CONNOR
277 PARK AVENUE
NEW YORK, NY 10172

503658323

UNITED STATES PATENT AND TRADEMARK OFFICE
NOTICE OF RECORDATION OF ASSIGNMENT DOCUMENT

THE ENCLOSED DOCUMENT HAS BEEN RECORDED BY THE ASSIGNMENT RECORDATION BRANCH OF THE U.S. PATENT AND TRADEMARK OFFICE. A COMPLETE COPY IS AVAILABLE AT THE ASSIGNMENT SEARCH ROOM ON THE REEL AND FRAME NUMBER REFERENCED BELOW.

PLEASE REVIEW ALL INFORMATION CONTAINED ON THIS NOTICE. THE INFORMATION CONTAINED ON THIS RECORDATION NOTICE REFLECTS THE DATA PRESENT IN THE PATENT AND TRADEMARK ASSIGNMENT SYSTEM. IF YOU SHOULD FIND ANY ERRORS OR HAVE QUESTIONS CONCERNING THIS NOTICE, YOU MAY CONTACT THE ASSIGNMENT RECORDATION BRANCH AT 571-272-3350. PLEASE SEND REQUEST FOR CORRECTION TO: U.S. PATENT AND TRADEMARK OFFICE, MAIL STOP: ASSIGNMENT RECORDATION BRANCH, P.O. BOX 1450, ALEXANDRIA, VA 22313.

RECORDATION DATE: 01/21/2016 REEL/FRAME: 037567/0993
NUMBER OF PAGES: 7

BRIEF: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

DOCKET NUMBER: 5367-0

ASSIGNOR:
OSRAM OPTO SEMICONDUCTORS GMBH DOC DATE: 12/16/2015

ASSIGNEE:
OSRAM OLED GMBH
WERNERWERKSTRASSE 2
REGENSBURG, GERMANY 93049

APPLICATION NUMBER: 10447988 FILING DATE: 05/29/2003
PATENT NUMBER: 6946319 ISSUE DATE: 09/20/2005
TITLE: ELECTRODE FOR AN ELECTRONIC DEVICE

APPLICATION NUMBER: 10555982 FILING DATE: 05/18/2006
PATENT NUMBER: 7951874 ISSUE DATE: 05/31/2011
TITLE: NON-CONJUGATED POLYMERIC PERARYLATED BORANES, USE THEREOF AS ORGANICALLY SEMICONDUCTOR TRANSMITTERS AND/OR TRANSPORT MATERIALS, METHODS FOR PRODUCING SAME AND USES THEREOF

APPLICATION NUMBER: 10843803 FILING DATE: 05/11/2004
PATENT NUMBER: 7550915 ISSUE DATE: 06/23/2009
TITLE: ORGANIC ELECTRONIC DEVICE WITH HOLE INJECTION

APPLICATION NUMBER: 10951479 FILING DATE: 09/27/2004
PATENT NUMBER: 7242141 ISSUE DATE: 07/10/2007
TITLE: INTEGRATED FUSES FOR OLED LIGHTING DEVICE

APPLICATION NUMBER: 10952601 FILING DATE: 09/28/2004
PATENT NUMBER: 7157928 ISSUE DATE: 01/02/2007
TITLE: DETERMINING LEAKAGE IN MATRIX-STRUCTURED ELECTRONIC DEVICES

APPLICATION NUMBER: 10952602 FILING DATE: 09/28/2004
PATENT NUMBER: 7489074 ISSUE DATE: 02/10/2009
TITLE: REDUCING OR ELIMINATING COLOR CHANGE FOR MICROCAVITY OLED DEVICES

APPLICATION NUMBER: 11052943 FILING DATE: 02/07/2005
PATENT NUMBER: 7589465 ISSUE DATE: 09/15/2009
TITLE: NOVEL GETTER MATERIAL

APPLICATION NUMBER: 11159557 FILING DATE: 06/22/2005
PATENT NUMBER: 7554257 ISSUE DATE: 06/30/2009
TITLE: NOVEL METHOD TO GENERATE HIGH EFFICIENT DEVICES WHICH EMIT HIGH QUALITY LIGHT FOR ILLUMINATION

APPLICATION NUMBER: 11268338 FILING DATE: 11/07/2005
PATENT NUMBER: 7329560 ISSUE DATE: 02/12/2008
TITLE: METHOD FOR ENCAPSULATING AT LEAST ONE ORGANIC LIGHT-EMITTING (OLED) DEVICE AND OLED DEVICE

APPLICATION NUMBER: 11292038 FILING DATE: 11/30/2005
PATENT NUMBER: 7521856 ISSUE DATE: 04/21/2009
TITLE: OLED DEVICE

APPLICATION NUMBER: 11645971 FILING DATE: 12/26/2006
PATENT NUMBER: 7710365 ISSUE DATE: 05/04/2010
TITLE: DETERMINING LEAKAGE IN MATRIX-STRUCTURED ELECTRONIC DEVICES

APPLICATION NUMBER: 11658772 FILING DATE: 03/10/2008
PATENT NUMBER: ISSUE DATE:
TITLE: ORGANIC LIGHT EMITTING DIODE WITH INCREASED RADICAL ANION STABIILTY AND APPLICATIONS THEREOF

APPLICATION NUMBER: 11992992 FILING DATE: 05/05/2009
PATENT NUMBER: 8193070 ISSUE DATE: 06/05/2012
TITLE: METHOD FOR BONDING LAYERS, CORRESPONDING DEVICE AND ORGANIC LIGHT-EMITTING DIODE

APPLICATION NUMBER: 12011437 FILING DATE: 01/25/2008
PATENT NUMBER: 7970036 ISSUE DATE: 06/28/2011
TITLE: ORGANIC SEMICONDUCTOR LASER AND METHOD FOR PRODUCING IT

APPLICATION NUMBER: 12148294 FILING DATE: 04/16/2008
PATENT NUMBER: 8400054 ISSUE DATE: 03/19/2013
TITLE: ORGANIC OPTOELECTRONIC COMPONENT

APPLICATION NUMBER: 12157054 FILING DATE: 06/06/2008
PATENT NUMBER: 7982387 ISSUE DATE: 07/19/2011
TITLE: OPTOELECTRONIC COMPONENT

APPLICATION NUMBER: 12157061 FILING DATE: 06/06/2008
PATENT NUMBER: 8173998 ISSUE DATE: 05/08/2012
TITLE: RADIATION EMITTING DEVICE

APPLICATION NUMBER: 12240248 FILING DATE: 09/29/2008
PATENT NUMBER: 8791633 ISSUE DATE: 07/29/2014
TITLE: RADIATION-EMITTING DEVICE

APPLICATION NUMBER: 12240392 FILING DATE: 09/29/2008
PATENT NUMBER: 7922358 ISSUE DATE: 04/12/2011
TITLE: ILLUMINATION DEVICE, LUMINAIRE AND DISPLAY DEVICE

APPLICATION NUMBER: 12290708 FILING DATE: 11/03/2008
PATENT NUMBER: 8154200 ISSUE DATE: 04/10/2012
TITLE: ENCAPSULATION OF ORGANIC DEVICES

APPLICATION NUMBER: 12373504 FILING DATE: 08/12/2009
PATENT NUMBER: 8232393 ISSUE DATE: 07/31/2012
TITLE: NOVEL AROMATIC AZA HETEROCYCLES, METHOD OF PRODUCTION AND USE OF THE MATERIAL IN ORGANIC ELECTRONICS

APPLICATION NUMBER: 12375875 FILING DATE: 08/12/2009
PATENT NUMBER: ISSUE DATE:
TITLE: RADIATION-EMITTING COMPONENT

APPLICATION NUMBER: 12443672 FILING DATE: 01/11/2010
PATENT NUMBER: 8328375 ISSUE DATE: 12/11/2012
TITLE: ORGANIC LIGHTING DEVICE AND LIGHTING EQUIPMENT

APPLICATION NUMBER: 12514986 FILING DATE: 12/22/2009
PATENT NUMBER: 8309284 ISSUE DATE: 11/13/2012
TITLE: NOVEL HIGHLY CONDUCTIVE ORGANIC CHARGE CARRIER TRANSPORT MATERIAL

APPLICATION NUMBER: 12601520 FILING DATE: 04/20/2010
PATENT NUMBER: 8734962 ISSUE DATE: 05/27/2014
TITLE: PHOSPHORESCENT METAL COMPLEX COMPOUND RADIATION EMITTING COMPONENT COMPRISING A PHOSPHORESCENT METAL COMPLEX COMPOUND AND METHOD FOR PRODUCTION OF A PHOSPHORESCENT METAL COMPLEX COMPOUND

APPLICATION NUMBER: 12665934 FILING DATE: 06/07/2010
PATENT NUMBER: 8513702 ISSUE DATE: 08/20/2013
TITLE: USE OF A METAL COMPLEX AS A P-DOPANT FOR AN ORGANIC SEMICONDUCTIVE MATRIX MATERIAL, ORGANIC SEMICONDUCTOR MATERIAL, AND ORGANIC LIGHT-EMITTING DIODES

APPLICATION NUMBER: 12679138 FILING DATE: 11/23/2010
PATENT NUMBER: 8314547 ISSUE DATE: 11/20/2012
TITLE: OPTO-ELECTRONIC COMPONENT

APPLICATION NUMBER: 12679472 FILING DATE: 08/09/2010
PATENT NUMBER: 8974679 ISSUE DATE: 03/10/2015
TITLE: METHOD FOR MANUFACTURING AN OPTO-ELECTRONIC COMPONENT

APPLICATION NUMBER: 12680190 FILING DATE: 09/02/2010
PATENT NUMBER: 8441004 ISSUE DATE: 05/14/2013
TITLE: RADIATION EMITTING DEVICE AND METHOD FOR THE PRODUCTION THEREOF

APPLICATION NUMBER: 12680324 FILING DATE: 09/26/2011
PATENT NUMBER: 8987708 ISSUE DATE: 03/24/2015
TITLE: OPTOELECTRONIC COMPONENT

APPLICATION NUMBER: 12680610 FILING DATE: 07/19/2010
PATENT NUMBER: 8487329 ISSUE DATE: 07/16/2013
TITLE: LIGHT-EMITTING COMPONENT HAVING A WAVELENGTH CONVERTER AND PRODUCTION METHOD

APPLICATION NUMBER: 12680618 FILING DATE: 09/07/2010
PATENT NUMBER: 9139764 ISSUE DATE: 09/22/2015
TITLE: ORGANIC RADIATION-EMITTING COMPONENT

APPLICATION NUMBER: 12808156 FILING DATE: 09/07/2010
PATENT NUMBER: 8653548 ISSUE DATE: 02/18/2014
TITLE: LIGHT-EMITTING DEVICE

APPLICATION NUMBER: 12865346 FILING DATE: 11/29/2010
PATENT NUMBER: 8916397 ISSUE DATE: 12/23/2014
TITLE: METHOD FOR PRODUCING AN ELECTRONIC COMPONENT AND ELECTRONIC COMPONENT

APPLICATION NUMBER: 12865358 FILING DATE: 11/29/2010
PATENT NUMBER: 8658442 ISSUE DATE: 02/25/2014
TITLE: METHOD FOR PRODUCING AN ELECTRONIC COMPONENT AND ELECTRONIC COMPONENT

APPLICATION NUMBER: 12865646 FILING DATE: 11/17/2010
PATENT NUMBER: 8633585 ISSUE DATE: 01/21/2014
TITLE: DEVICE COMPRISING AN ENCAPSULATION UNIT

APPLICATION NUMBER: 12867241 FILING DATE: 11/15/2010
PATENT NUMBER: 8791490 ISSUE DATE: 07/29/2014
TITLE: ORGANIC LIGHT-EMITTING DIODE, CONTACT ARRANGEMENT AND METHOD FOR PRODUCING AN ORGANIC LIGHT-EMITTING DIODE

APPLICATION NUMBER: 12919752 FILING DATE: 02/14/2011
PATENT NUMBER: 8314541 ISSUE DATE: 11/20/2012
TITLE: RADIATION-EMITTING ARRANGEMENT

APPLICATION NUMBER: 12919989 FILING DATE: 01/13/2011
PATENT NUMBER: 8841153 ISSUE DATE: 09/23/2014
TITLE: METHOD FOR PRODUCING A DOPED ORGANIC SEMICONDUCTING LAYER

APPLICATION NUMBER: 12921313 FILING DATE: 12/20/2010
PATENT NUMBER: 8653509 ISSUE DATE: 02/18/2014
TITLE: OPTOELECTRONIC COMPONENT

APPLICATION NUMBER: 12995182 FILING DATE: 02/17/2011
PATENT NUMBER: 8686440 ISSUE DATE: 04/01/2014
TITLE: ORGANIC LIGHT EMITTING COMPONENT AND ILLUMINATION MEANS COMPRISING A COMPONENT OF THIS TYPE

APPLICATION NUMBER: 12995457 FILING DATE: 02/18/2011
PATENT NUMBER: 8723164 ISSUE DATE: 05/13/2014
TITLE: ELECTRONIC DEVICE

APPLICATION NUMBER: 13054397 FILING DATE: 05/04/2011
PATENT NUMBER: 8530928 ISSUE DATE: 09/10/2013
TITLE: ENCAPSULATED OPTOELECTRONIC COMPONENT AND METHOD FOR THE PRODUCTION THEREOF

APPLICATION NUMBER: 13055901 FILING DATE: 04/21/2011
PATENT NUMBER: 8772818 ISSUE DATE: 07/08/2014
TITLE: RADIATION-EMITTING DEVICE AND METHOD FOR PRODUCING A RADIATION-EMITTING DEVICE

APPLICATION NUMBER: 13062449 FILING DATE: 05/23/2011
PATENT NUMBER: 8927325 ISSUE DATE: 01/06/2015
TITLE: METHOD FOR PRODUCING AN ORGANIC RADIATION-EMITTING COMPONENT AND ORGANIC RADIATION-EMITTING COMPONENT

APPLICATION NUMBER: 13081634 FILING DATE: 04/07/2011
PATENT NUMBER: 8294161 ISSUE DATE: 10/23/2012
TITLE: RADIATION EMITTING DEVICE

APPLICATION NUMBER: 13121060 FILING DATE: 08/22/2011
PATENT NUMBER: 8492973 ISSUE DATE: 07/23/2013
TITLE: ORGANIC OPTOELECTRONIC COMPONENT HAVING A RADIATION-EMITTING LAYER CONTAINING AN ORGANIC MATERIAL

APPLICATION NUMBER: 13121090 FILING DATE: 09/08/2011
PATENT NUMBER: 8558223 ISSUE DATE: 10/15/2013
TITLE: ORGANIC ELECTRONIC COMPONENT AND METHOD FOR THE PRODUCTION THEREOF

APPLICATION NUMBER: 13127208 FILING DATE: 07/25/2011
PATENT NUMBER: 9172042 ISSUE DATE: 10/27/2015
TITLE: ORGANIC, RADIATION-EMITTING COMPONENT AND METHOD FOR PRODUCING SUCH A COMPONENT

APPLICATION NUMBER: 13127229 FILING DATE: 10/11/2011
PATENT NUMBER: 8461579 ISSUE DATE: 06/11/2013
TITLE: ORGANIC RADIATION-EMITTING COMPONENT AND METHOD FOR PRODUCING AN ORGANIC RADIATION-EMITTING COMPONENT

APPLICATION NUMBER: 13127231 FILING DATE: 08/23/2011
PATENT NUMBER: 8816329 ISSUE DATE: 08/26/2014
TITLE: RADIATION-EMITTING DEVICE

APPLICATION NUMBER: 13128375 FILING DATE: 08/08/2011
PATENT NUMBER: 8734196 ISSUE DATE: 05/27/2014
TITLE: METHOD FOR PRODUCING AN ORGANIC RADIATION-EMITTING COMPONENT AND ORGANIC RADIATION-EMITTING COMPONENT

APPLICATION NUMBER: 13139514 FILING DATE: 01/03/2012
PATENT NUMBER: ISSUE DATE:
TITLE: ORGANIC-LIGHT-EMITTING DIODE AND LUMINAIRE

APPLICATION NUMBER: 13260560 FILING DATE: 12/14/2011
PATENT NUMBER: ISSUE DATE:
TITLE: THIN-LAYER ENCAPSULATION FOR AN OPTOELECTRONIC COMPONENT, METHOD FOR THE PRODUCTION THEREOF, AND OPTOELECTRONIC COMPONENT

APPLICATION NUMBER: 13260982 FILING DATE: 01/26/2012
PATENT NUMBER: ISSUE DATE:
TITLE: ORGANIC OPTOELECTRONIC COMPONENT AND METHOD FOR PRODUCING AN ORGANIC OPTOELECTRONIC COMPONENT

APPLICATION NUMBER: 13262776 FILING DATE: 04/02/2012
PATENT NUMBER: 8808402 ISSUE DATE: 08/19/2014
TITLE: ARRANGEMENT FOR HOLDING A SUBSTRATE IN A MATERIAL DEPOSITION APPARATUS

APPLICATION NUMBER: 13266095 FILING DATE: 04/10/2012
PATENT NUMBER: 8441187 ISSUE DATE: 05/14/2013
TITLE: RADIATION-EMITTING DEVICE

APPLICATION NUMBER: 13318341 FILING DATE: 02/02/2012
PATENT NUMBER: 8680563 ISSUE DATE: 03/25/2014
TITLE: OPTOELECTRONIC COMPONENT AND METHOD FOR THE PRODUCTION THEREOF

APPLICATION NUMBER: 13375207 FILING DATE: 02/06/2012
PATENT NUMBER: 9203042 ISSUE DATE: 12/01/2015
TITLE: ELECTRONIC COMPONENT AND METHOD FOR PRODUCING AN ELECTRONIC COMPONENT

APPLICATION NUMBER: 13375214 FILING DATE: 03/21/2012
PATENT NUMBER: 8618729 ISSUE DATE: 12/31/2013
TITLE: ORGANIC LIGHT-EMITTING DIODE CONFIGURED SUCH THAT LIGHT IS EFFICIENTLY DECOUPLED FROM PLASMON MODES OF A METAL ELECTRODE.

APPLICATION NUMBER: 13378919 FILING DATE: 03/28/2012
PATENT NUMBER: ISSUE DATE:
TITLE: RADIATION EMITTING DEVICE

APPLICATION NUMBER: 13387690 FILING DATE: 03/29/2012
PATENT NUMBER: 9059423 ISSUE DATE: 06/16/2015
TITLE: ELECTRONIC COMPONENT AND ELECTRICAL CONTACT

APPLICATION NUMBER: 13387978 FILING DATE: 05/15/2012
PATENT NUMBER: 8829496 ISSUE DATE: 09/09/2014
TITLE: ORGANIC COMPONENT AND METHOD FOR THE PRODUCTION THEREOF

APPLICATION NUMBER: 13388275 FILING DATE: 06/11/2012
PATENT NUMBER: 8866181 ISSUE DATE: 10/21/2014
TITLE: METHOD FOR PRODUCING A COMPONENT WITH AT LEAST ONE ORGANIC MATERIAL AND COMPONENT WITH AT LEAST ONE ORGANIC MATERIAL

APPLICATION NUMBER: 13390289 FILING DATE: 08/06/2012
PATENT NUMBER: 9052094 ISSUE DATE: 06/09/2015
TITLE: SEMICONDUCTOR LIGHT SOURCE

APPLICATION NUMBER: 13407558 FILING DATE: 02/28/2012
PATENT NUMBER: 8610114 ISSUE DATE: 12/17/2013
TITLE: RADIATION EMITTING DEVICE

APPLICATION NUMBER: 13434323 FILING DATE: 03/29/2012
PATENT NUMBER: 8552644 ISSUE DATE: 10/08/2013
TITLE: ENCAPSULATION OF ORGANIC DEVICES

APPLICATION NUMBER: 13498307 FILING DATE: 06/05/2012
PATENT NUMBER: 9203029 ISSUE DATE: 12/01/2015
TITLE: METHOD FOR PRODUCING AN ELECTRONIC COMPONENT

APPLICATION NUMBER: 13499542 FILING DATE: 07/27/2012
PATENT NUMBER: ISSUE DATE:
TITLE: ORGANIC ELECTRONIC DEVICE AND METHOD FOR THE PRODUCTION THEREOF

APPLICATION NUMBER: 13499608 FILING DATE: 06/12/2012
PATENT NUMBER: 8785916 ISSUE DATE: 07/22/2014
TITLE: OPTOELECTRONIC ORGANIC COMPONENT AND METHOD FOR THE PRODUCTION THEREOF

APPLICATION NUMBER: 13669222 FILING DATE: 11/05/2012
PATENT NUMBER: 8946986 ISSUE DATE: 02/03/2015
TITLE: ORGANIC LIGHTING DEVICE AND LIGHTING EQUIPMENT

APPLICATION NUMBER: 14150291 FILING DATE: 01/08/2014
PATENT NUMBER: ISSUE DATE:
TITLE: DEVICE COMPRISING AN ENCAPSULATION UNIT

APPLICATION NUMBER: 14152608 FILING DATE: 01/10/2014
PATENT NUMBER: 9130189 ISSUE DATE: 09/08/2015
TITLE: OPTOELECTRONIC COMPONENT AND METHOD FOR THE PRODUCTION THEREOF

APPLICATION NUMBER: 14163240 FILING DATE: 01/24/2014
PATENT NUMBER: ISSUE DATE:
TITLE: METHOD FOR PRODUCING AN ELECTRONIC COMPONENT AND ELECTRONIC COMPONENT

APPLICATION NUMBER: 14211190 FILING DATE: 03/14/2014
PATENT NUMBER: ISSUE DATE:
TITLE: PHOSPHORESCENT METAL COMPLEX COMPOUND RADIATION EMITTING COMPONENT COMPRISING A PHOSPHORESCENT METAL COMPLEX COMPOUND AND METHOD FOR PRODUCTION OF A PHOSPHORESCENT METAL COMPLEX COMPOUND

APPLICATION NUMBER: 14540670 FILING DATE: 11/13/2014
PATENT NUMBER: ISSUE DATE:
TITLE: METHOD FOR PRODUCING AN ELECTRONIC COMPONENT AND ELECTRONIC COMPONENT

APPLICATION NUMBER: 14598685 FILING DATE: 01/16/2015
PATENT NUMBER: ISSUE DATE:
TITLE: ORGANIC LIGHTING DEVICE AND LIGHTING EQUIPMENT

APPLICATION NUMBER: 14885577 FILING DATE: 10/16/2015
PATENT NUMBER: ISSUE DATE:
TITLE: METHOD FOR PRODUCING AN ELECTRONIC COMPONENT AND ELECTRONIC COMPONENT

ASSIGNMENT RECORDATION BRANCH
PUBLIC RECORDS DIVISION

UNITED STATES PATENT AND TRADEMARK OFFICE
UNDER SECRETARY OF COMMERCE FOR INTELLECTUAL PROPERTY AND
DIRECTOR OF THE UNITED STATES PATENT AND TRADEMARK OFFICE

5367-694PUS

NOVEMBER 30, 2011

PTAS

COZEN O'CONNOR
277 PARK AVENUE
NEW YORK, NY 10172

501737711

UNITED STATES PATENT AND TRADEMARK OFFICE
NOTICE OF RECORDATION OF ASSIGNMENT DOCUMENT

THE ENCLOSED DOCUMENT HAS BEEN RECORDED BY THE ASSIGNMENT RECORDATION BRANCH OF THE U.S. PATENT AND TRADEMARK OFFICE. A COMPLETE COPY IS AVAILABLE AT THE ASSIGNMENT SEARCH ROOM ON THE REEL AND FRAME NUMBER REFERENCED BELOW.

PLEASE REVIEW ALL INFORMATION CONTAINED ON THIS NOTICE. THE INFORMATION CONTAINED ON THIS RECORDATION NOTICE REFLECTS THE DATA PRESENT IN THE PATENT AND TRADEMARK ASSIGNMENT SYSTEM. IF YOU SHOULD FIND ANY ERRORS OR HAVE QUESTIONS CONCERNING THIS NOTICE, YOU MAY CONTACT THE ASSIGNMENT RECORDATION BRANCH AT 571-272-3350. PLEASE SEND REQUEST FOR CORRECTION TO: U.S. PATENT AND TRADEMARK OFFICE, MAIL STOP: ASSIGNMENT RECORDATION BRANCH, P.O. BOX 1450, ALEXANDRIA, VA 22313.

RECORDATION DATE: 11/29/2011 REEL/FRAME: 027296/0115
NUMBER OF PAGES: 18

BRIEF: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).

DOCKET NUMBER: 5367-694PUS-299930

ASSIGNOR:
KASTNER-JUNG, ULRICH DOC DATE: 10/26/2011

ASSIGNOR:
KLEIN, MARKUS DOC DATE: 07/22/2011

ASSIGNOR:
MAES, STAN DOC DATE: 08/02/2011

ASSIGNOR:
SIGL, ROMANA DOC DATE: 08/11/2011

ASSIGNOR:
HAID, ANNETTE DOC DATE: 07/28/2011

ASSIGNOR:
LINTNER, STEPHAN DOC DATE: 07/27/2011

ASSIGNOR:
HERGET, JULIAN DOC DATE: 10/18/2011

RF-684500

ASSIGNOR:
MATJAN, GREGOR DOC DATE: 07/27/2011

ASSIGNEE:
OSRAM OPTO SEMICONDUCTORS GMBH
LEIBNIZSTRASSE 4
REGENSBURG, GERMANY 93055

APPLICATION NUMBER: 13139514 FILING DATE:
PATENT NUMBER: ISSUE DATE:
TITLE: ORGANIC-LIGHT-EMITTING DIODE AND LUMINAIRE

ASSIGNMENT RECORDATION BRANCH
PUBLIC RECORDS DIVISION

PATENT ASSIGNMENT

Electronic Version v1.1
Stylesheet Version v1.1

SUBMISSION TYPE:	NEW ASSIGNMENT
NATURE OF CONVEYANCE:	ASSIGNMENT

CONVEYING PARTY DATA

Name	Execution Date
Ulrich KASTNER-JUNG	10/26/2011
Markus KLEIN	07/22/2011
Stan MAES	08/02/2011
Romana SIGL	08/11/2011
Annette HAID	07/28/2011
Stephan LINTNER	07/27/2011
Julian HERGET	10/18/2011
Gregor MATJAN	07/27/2011

RECEIVING PARTY DATA

Name:	OSRAM Opto Semiconductors GmbH
Street Address:	Leibnizstrasse 4
City:	Regensburg
State/Country:	GERMANY
Postal Code:	93055

PROPERTY NUMBERS Total: 1

Property Type	Number
Application Number:	13139514

CH $40.00 13139514

CORRESPONDENCE DATA

Fax Number: (212)986-0604
Phone: 2128834932
Email: SMENDEZ@COZEN.COM
Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent via US Mail.
Correspondent Name: Cozen O'Connor
Address Line 1: 277 Park Avenue
Address Line 4: New York, NEW YORK 10172

PATENT ASSIGNMENT

Electronic Version v1.1
Stylesheet Version v1.1

SUBMISSION TYPE:	NEW ASSIGNMENT
NATURE OF CONVEYANCE:	ASSIGNMENT

CONVEYING PARTY DATA

Name	Execution Date
Ulrich KASTNER-JUNG	10/26/2011
Markus KLEIN	07/22/2011
Stan MAES	08/02/2011
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Annette HAID	07/28/2011
Stephan LINTNER	07/27/2011
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Postal Code:	93055

PROPERTY NUMBERS Total: 1

Property Type	Number
Application Number:	13139514

CH $40.00 13139514

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Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent via US Mail.
Correspondent Name: Cozen O'Connor
Address Line 1: 277 Park Avenue
Address Line 4: New York, NEW YORK 10172

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Filer:	Thomas Langer/Evelyn Martinez
Attorney Docket Number:	5367-694P/CON\409926

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	280	280
UTILITY SEARCH FEE	1111	1	600	600
UTILITY EXAMINATION FEE	1311	1	720	720
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1600**

Electronic Acknowledgement Receipt

EFS ID:	29802872
Application Number:	15651508
International Application Number:	
Confirmation Number:	2349
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Customer Number:	27799
Filer:	Thomas Langer/Evelyn Martinez
Filer Authorized By:	Thomas Langer
Attorney Docket Number:	5367-694P/CON\409926
Receipt Date:	17-JUL-2017
Filing Date:	
Time Stamp:	15:48:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1600
RAM confirmation Number	071817INTEFSW15511800
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	TRA.pdf	40048 fe2d399710530fabeff64a1ee28503684482e72a	no	3
Warnings:					
Information:					
2	Application Data Sheet	ADS.pdf	94832 62b0874315c6eafc9ef2d5100907bb0cb7959499	no	7
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
3	Specification	SPEC.pdf	687184 81d1bd50443d032684378f8a38e3eb8b00254d96	no	182
Warnings:					
Information:					
4	Drawings-only black and white line drawings	DRAW2.pdf	3483111 bc0b624e69b1daf40901f49f5386bdaa189dd016	no	60
Warnings:					
Information:					
5	Information Disclosure Statement (IDS) Form (SB08)	ids.pdf	105246 705104f42217175f3b5f85aa0d0373866e93efae	no	5
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
6	Oath or Declaration filed	DEC.pdf	2089976 b9f6c274e39fb75120bb4f92480ea276265aff5f	no	40

Warnings:					
Information:					
7	Assignee showing of ownership per 37 CFR 3.73	ass1.pdf	823211 27bf86c9e8612b0cc2d951ce600b9ee2c995b24c	no	7
Warnings:					
Information:					
8	Assignee showing of ownership per 37 CFR 3.73	ass2.pdf	1500261 edb93481eb833a4f62153870a32e6edd20b86e06	no	4
Warnings:					
Information:					
9	Fee Worksheet (SB06)	fee-info.pdf	35148 3a423ecd33e529c2dc96387f48897ad89c1bc69c	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	8859017		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/651,508	07/17/2017	2811	1600	5367-694P/CON\409926	18	1

CONFIRMATION NO. 2349

27799
Cozen O'Connor
277 Park Avenue, 20th floor
NEW YORK, NY 10172

FILING RECEIPT



Date Mailed: 07/26/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)

Ulrich KASTNER-JUNG, Munich, GERMANY;
Markus KLEIN, Tegernheim, GERMANY;
Stan MAES, Dilsen-Stokken, BELGIUM;
Romana SIGL, Salzburg, AUSTRIA;
Annette HAID, Salzburg, AUSTRIA;
Stephan LINTNER, Salzburg, AUSTRIA;
Julian HERGET, Marktschellenberg, GERMANY;
Gregor MATJAN, Bergheim, AUSTRIA;

Applicant(s)

OSRAM OLED GmbH, Regensburg, GERMANY;

Assignment For Published Patent Application

OSRAM OLED GMBH

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 13/139,514 01/03/2012
which is a 371 of PCT/DE2009/001741 12/09/2009

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
GERMANY 10 2008 061 563.3 12/11/2008

Permission to Access Application via Priority Document Exchange: No

SDC EX. 1016 - 314/959

Permission to Access Search Results: No

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 07/24/2017
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/651,508**
Projected Publication Date: To Be Determined - pending completion of Missing Parts
Non-Publication Request: No
Early Publication Request: No
Title

Organic-Light-Emitting Diode

Preliminary Class

257

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

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NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

SDC EX. 1016 - 317/959

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/651,508

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	18 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						800
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2400

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/651,508	07/17/2017	Ulrich KASTNER-JUNG	5367-694P/CON\409926

CONFIRMATION NO. 2349

27799
Cozen O'Connor
277 Park Avenue, 20th floor
NEW YORK, NY 10172

FORMALITIES LETTER

OC0000000093001505

Date Mailed: 07/26/2017

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. No entity status discount is in effect. If applicant is qualified for small entity status, a written assertion of small entity status must be submitted to establish small entity status. (See 37 CFR 1.27). If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- $ **800** for **80** electronically equivalent pages in excess of **100** application size fee.
- $(**0**) previous unapplied payment amount.
- $ **800** TOTAL FEE BALANCE DUE.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

A new inventor's oath or declaration that identifies this application (e.g., by Application Number and filing date) is required. The inventor's oath or declaration does not comply with 37 CFR 1.63 in that it:

- does not state that the above-identified application was made or authorized to be made by the person executing the oath or declaration.
  Ulrich KASTNER-JUNG
  Markus KLEIN
  Stan MAES

SDC EX. 1016 - 319/959

Romana SIGL
Annette HAID
Stephan LINTNER
Julian HERGET
Gregor MATJAN

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice". https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

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If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/tgebre/

SDC EX. 1016 - 320/959

Electronic Patent Application Fee Transmittal

Application Number:	15651508
Filing Date:	17-Jul-2017
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Filer:	Thomas Langer/Evelyn Martinez
Attorney Docket Number:	5367-694P/CON\409926

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
UTILITY APPL SIZE FEE PER 50 SHEETS >100	1081	2	400	800
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**800**

Electronic Acknowledgement Receipt

EFS ID:	29904668
Application Number:	15651508
International Application Number:	
Confirmation Number:	2349
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Customer Number:	27799
Filer:	Thomas Langer/Evelyn Martinez
Filer Authorized By:	Thomas Langer
Attorney Docket Number:	5367-694P/CON\409926
Receipt Date:	27-JUL-2017
Filing Date:	17-JUL-2017
Time Stamp:	11:00:26
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$800
RAM confirmation Number	072717INTEFSW11010200
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Fee Worksheet (SB06)	fee-info.pdf	30708 c17688b218a626f6084d67fea265ae54bcb2b09c	no	2
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Information:					
		Total Files Size (in bytes):	30708		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Kastner-Jung, Ulrich et al. Serial No.: 15/651,508 Filed: July 17, 2017 For: Organic-Light-Emitting Diode	Examiner: Not Yet Assigned Art Unit: 2811

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

S I R:

In compliance with the duty of disclosure under 37 C.F.R. § 1.56 and in accordance with the practice under 37 C.F.R. §§ 1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a. Copies of the listed non-US documents are also enclosed.

Enclosed is a copy of a Notice of Allowance dated July 20, 2017 which issued in the corresponding Korean Patent Application No. 10-2011-7015909. The references cited in the Korean Notice of Allowance that are not listed on the enclosed Form PTO/SB/08a were submitted to the USPTO in a previously filed IDS.

Reference US 7,733,008 corresponds to JP 2005-510851.

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It is respectfully requested that the above information be considered by the Examiner and that the copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicants reserve the right to prove that the date of publication is in fact different.

If any fees or charges are deemed required at this time in connection with the application, the same may be charged to our Patent and Trademark Office Deposit Account No. 503111.

Respectfully submitted,
COZEN O'CONNOR

By: /Thomas Langer/
Thomas Langer
Reg. No. 27,264
277 Park Avenue
New York, New York 10172
(212) 883-4900

Dated: August 17, 2017

SDC EX. 1016 - 326/959

PTO/SB/08A (04-03)
Approved for use through 04/30/2003. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for Form 1449/PTO	*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)	Application Number	15/651,508
	Filing Date	July 17, 2017
	First Named Inventor	Kastner-Jung, Ulrich
	Art Unit	2811
	Examiner Name	Not Yet Assigned
Sheet 1 of 1	Attorney Docket	5367-694P/CON/409926

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number Number-Kind-Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	US-7,733,008	06-08-2010	Agency for Science, Technology and Research	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Document Country Code[3]- Number[4]- Kind-Code [5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
	2	JP 2005-510851	04-21-2005	Agency for Science, Technology and Research		See 1
	3	KR 100743545	07-23-2007	Lee Young Jong		Abs.
	4	KR 1020050065948	11-11-2013	LG Electronics Inc.		Abs.

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
	5	Notice of Allowance dated July 20, 2017 which issued in the corresponding Korean Patent Application No. 10-2011-7015909.	✓

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, Washington, DC 20231.

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Electronic Acknowledgement Receipt

EFS ID:	30108121
Application Number:	15651508
International Application Number:	
Confirmation Number:	2349
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Customer Number:	27799
Filer:	Thomas Langer/Sheri Michals/ Thomas Langer
Filer Authorized By:	Thomas Langer
Attorney Docket Number:	5367-694P/CON\409926
Receipt Date:	17-AUG-2017
Filing Date:	17-JUL-2017
Time Stamp:	14:06:20
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Non Patent Literature	noa.pdf	160726 d58937719dff7b8d56f868646d315d184c13f7b8	no	1

Warnings:

Information:					
2	Foreign Reference	JP_2005510851_A_abstract.pdf	100271 85ad1eea49e35cc6151f705b7e5b7237da1d16c2	no	1
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Information:					
3	Foreign Reference	JP_2005510851_A.pdf	1052091 88b29ce2d62f39c79ebfb715bf49a615b1b6c6fa	no	29
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Information:					
4	Foreign Reference	KR_100743545_B1_abstract.pdf	103119 c94783965d7cb8ab26331c27c05b53cd35cfda7d	no	2
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Information:					
5	Foreign Reference	KR_100743545_B1.pdf	39463 e68e5fe229a0bfcbcac01ed44004ed67e95da61d	no	1
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7	Foreign Reference	KR_1020050065948_B1.pdf	573357 fab9d5ff5ec3e72bc61dcbb217c5a2814eef876a	no	8
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Information:					
8	Information Disclosure Statement (IDS) Form (SB08)	5367_694pcon_ids_.pdf	125625 3f1caef695ef50e60ea9a5fd0752d7b73c1ceca0	no	3
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Information:					
This is not an USPTO supplied IDS fillable form					

Total Files Size (in bytes):	2383073

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New Applications Under 35 U.S.C. 111

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Espacenet

Bibliographic data: JP2005510851 (A) — 2005-04-21

ORGANIC LIGHT EMITTING DIODE (OLED)

Inventor(s):

Applicant(s):

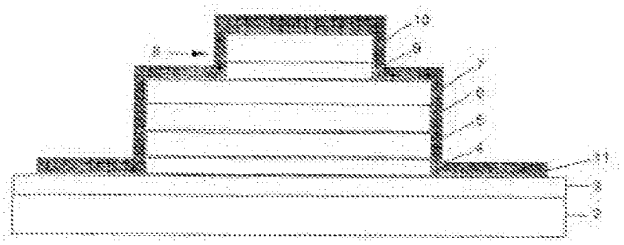
Classification: **- international:** ***H01L51/50; H01L51/52; H05B33/04; H05B33/22;*** (IPC1-7): H05B33/04; H05B33/14; H05B33/22
- cooperative: **H01L51/5253**; H01L51/5221; Y10S428/917

Application number: JP20030548594 20021127 Global Dossier

Priority number(s): SG20010007343 20011128 ; WO2002SG00276 20021127

Also published as: AU2002353758 (A1) CN100521289 (C) CN1596561 (A) JP4625911 (B2) SG114514 (A1) more

Abstract not available for JP2005510851 (A)
Abstract of corresponding document: WO03047317 (A1)



An Organic Light Emitting Diode (OLED) which is adapted to inhibit the formation and growth of non-emissive areas known as "dark spots". The OLED comprises an anode (3) disposed on a substrate (2), a cathode (8), an electroluminescent (EL) layer (6) disposed between the anode (3) and the cathode (8) and a hole transport layer (5) disposed between the anode (3) and the EL layer (6). The OLED has a number of oxygen/moisture barriers (4, 7) disposed between one or more of the OLED's layers. These barriers (4, 7) are made from an organic polymer and are adapted to resist permeation by oxygen and moisture and inhibit metal migration.

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(19)日本国特許庁(JP)　(12)公表特許公報(A)　(11)特許出願公表番号
特表2005-510851
(P2005-510851A)
(43)公表日　平成17年4月21日(2005.4.21)

(51)Int.Cl.[7]	F I			テーマコード（参考）
H05B 33/22	H05B	33/22	Z	3K007
H05B 33/04	H05B	33/04		
H05B 33/14	H05B	33/14	A	

審査請求 未請求　予備審査請求 有　（全 29 頁）

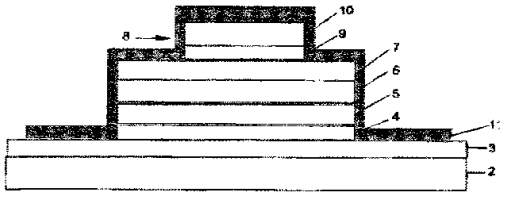
(21)出願番号　特願2003-548594 (P2003-548594)
(86)(22)出願日　平成14年11月27日 (2002.11.27)
(85)翻訳文提出日　平成16年5月28日 (2004.5.28)
(86)国際出願番号　PCT/SG2002/000276
(87)国際公開番号　WO2003/047317
(87)国際公開日　平成15年6月5日 (2003.6.5)
(31)優先権主張番号　200107343-6
(32)優先日　平成13年11月28日 (2001.11.28)
(33)優先権主張国　シンガポール(SG)

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最終頁に続く

(54)【発明の名称】有機発光ダイオード（ＯＬＥＤ）

(57)【要約】
“ダークスポット”として知られる非放射領域の形成及び成長を抑制する有機発光ダイオード（ＯＬＥＤ）は、基板上に配置されたアノードと、カソードと、前記アノードと前記カソードとの間に配置されるエレクトロルミネッセンス（ＥＬ）層と、前記アノードと前記ＥＬ層との間に配置されるホール移動層とを含む。前記ＯＬＥＤは、１以上のＯＬＥＤの層間に配置されたいくらかの酸素／水分バリアを有する。これらのバリアは有機ポリマーから形成され、酸素及び水分による透過を阻止、且つ、金属移動を抑制するように構成される。



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【特許請求の範囲】
【請求項1】
（ａ）基板上に配置されるアノードと；
（ｂ）カソードと；
（ｃ）前記アノードと前記カソードとの間に配置されるエレクトロルミネッセンス（ＥＬ）層と；
（ｄ）前記アノードと前記ＥＬ層との間に配置されるホール移動層と；
（ｅ）
（ｉ）前記アノードと前記ホール移動層；
（ｉｉ）前記ホール移動層と前記ＥＬ層；および
（ｉｉｉ）前記ＥＬ層と前記カソード；
のうちの１つ以上の間に配置される少なくとも１つの酸素／水分バリアと；
を具備し、
前記バリアは：
（Ａ）酸素による透過阻止；
（Ｂ）水分による透過阻止；および
（Ｃ）金属移動の抑制
のうちの少なくとも１つに適合された、有機発光ダイオード（ＯＬＥＤ）。
【請求項2】
当該ＯＬＥＤを少なくとも部分的に封止する封止層をさらに備え、前記封止層は、酸素および／または水分による透過を阻止すべく適合されている、請求項１に記載のＯＬＥＤ。
【請求項3】
前記アノードと前記ホール移動層との間に配置される誘電体層をさらに備え且つ前記少なくとも１つのバリアは：
（ｉ）前記アノードと前記誘電体層；および
（ｉｉ）前記誘電体層と前記ホール移動層；
のうちの１つ以上の間に配置される、請求項１または２に記載のＯＬＥＤ。
【請求項4】
前記ＥＬ層と前記カソードとの間に配置される電子注入層をさらに備え、且つ前記少なくとも１つのバリアは：
（ｉ）前記ＥＬ層と前記電子注入層；および
（ｉｉ）前記電子注入層と前記カソード；
のうちの１つ以上の間に配置される、前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項5】
前記バリアは有機バリアである前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項6】
前記有機バリアは少なくとも部分的にポリマーから作られている、請求項５に記載のＯＬＥＤ。
【請求項7】
前記バリアの厚みは、１から２０ｎｍの範囲内に存在する、前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項8】
前記バリアは：
（ｉ）スピンコート法；
（ｉｉ）真空蒸着法；または
（ｉｉｉ）化学蒸着法；
を含む従来のコーティング技術のいずれかによって被着される、前記請求項のいずれか一項に記載のＯＬＥＤ。

【請求項9】
前記封止層は、有機封止層である、請求項２から８のいずれか一項に記載のＯＬＥＤ。
【請求項10】
前記有機封止層は、少なくとも部分的にポリマーから作られる、請求項９に記載のＯＬＥＤ。
【請求項11】
前記封止層の厚みは、１ｎｍから３０μｍの範囲内に存在する、前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項12】
前記封止層は：
（ｉ）スピンコート法；
（ｉｉ）真空蒸着法；または
（ｉｉｉ）化学蒸着法；
を含む従来のコーティング技術のいずれかによって被着される、前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項13】
前記ポリマーは：
（ｉ）ポリイミド；
（ｉｉ）テフロン；および
（ｉｉｉ）パリレン；
から選択される、請求項６から１２のいずれか一項に記載のＯＬＥＤ。
【請求項14】
前記基板は、酸素および／または水分による透過を阻止すべく適合されており、且つ少なくとも部分的に、プラスティックまたはガラスを含む、剛体または可撓性材料から作られる、前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項15】
前記誘電体層の厚みは、トンネル現象範囲内である、請求項３から１４のいずれか一項に記載のＯＬＥＤ。
【請求項16】
前記誘電体層は、電子注入のために有効なバリア高さを低下させ、それによってＯＬＥＤのルミネッセンス量子効率を拡大するべく適合される、請求項１５に記載のＯＬＥＤ。
【請求項17】
前記カソードおよび／または前記アノードは：
（ｉ）有機金属；
（ｉｉ）無機金属；
（ｉｉｉ）有機金属酸化物；および
（ｉｖ）無機金属酸化物；
のうちの１つ以上のカソード材料から少なくとも部分的に作られる、前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項18】
前記カソード材料は、少なくとも部分的に、スパッタリングによって形成される、請求項１７に記載のＯＬＥＤ。
【請求項19】
前記カソード材料は、ほとんどまたは全くピンホールを有していない、請求項１８に記載のＯＬＥＤ。
【請求項20】
少なくとも１つの前記バリアは、前記ＥＬ層と前記カソードとの間に配置される保護バリアであり、そしてスパッタリングプロセスの影響による損傷から前記ＥＬ層を保護すべく適合されている、請求項１８または１９に記載のＯＬＥＤ。
【請求項21】

前記保護バリアは：
（ｉ）イオン衝撃；
（ｉｉ）放射線；および
（ｉｉｉ）金属移動；
のうちの１つ以上に起因する損傷から前記ＥＬ層を保護すべく適合されている、請求項２０に記載のＯＬＥＤ。
【請求項22】
（ａ）基板上に配置されるアノードと；
（ｂ）カソードと；
（ｃ）前記アノードと前記カソードとの間に配置されるエレクトロルミネッセンス（ＥＬ）層と；
（ｄ）前記アノードと前記ＥＬ層との間に配置されるホール移動層と；
（ｅ）
（ｉ）前記アノードと前記ホール移動層；
（ｉｉ）前記ホール移動層と前記ＥＬ層；および
（ｉｉｉ）前記ＥＬ層と前記カソード；
のうちの１つ以上の間に配置される少なくとも１つの酸素／水分バリアと；
を具備し、
前記バリアは：
（Ａ）酸素による透過阻止；
（Ｂ）水分による透過阻止；および
（Ｃ）金属移動の抑制
のうちの少なくとも１つに適合された、
非放射領域の成長を抑制すべく適合された有機発光ダイオード（ＯＬＥＤ）。
【請求項23】
当該ＯＬＥＤを少なくとも部分的に封止する封止層をさらに備え、前記封止層は、酸素および／または水分による透過を阻止すべく適合されている、請求項２２に記載のＯＬＥＤ。
【発明の詳細な説明】
【技術分野】
【0001】
本発明は、有機発光ダイオード（ＯＬＥＤ）に、そして特に、「ダークスポット」として知られる非放射領域の形成および成長を抑制すべく適合されたＯＬＥＤに関する。
【0002】
本発明は、特にフラットパネルディスプレイに使用されるＯＬＥＤに好適であり、そして、以下においては、この応用に関して説明される。しかしながら、本発明は、この特定の使用分野に限定されるものではないことが理解されよう。
【背景技術】
【0003】
典型的なＯＬＥＤは、２つの電極に加えてこれら電極の間に配置される１つ以上のポリマー層からなっている。図１に示されるように、これらのデバイスは、一般に、次の順序に配列された、次の各層：
（ｉ）多くの場合プラスティックまたはガラスから作られる基板２と；
（ｉｉ）基板上に配置され、且つ一般に、有機材料またはインジウムすず酸化物（ＩＴＯ）のような無機酸化物であり得る透明な伝導性材料から作られるアノード３と；
（ｉｉｉ）アノード上に配置されるホール移動層５と；
（ｉｖ）ホール移動層上に配置されるエレクトロルミネッセンス（ＥＬ）層６と；
（ｖ）ＥＬ層上に配置されるカソードであって、カルシウムまたはマグネシウムの第１の層９および銀またはアルミニウムの第２の層１０とからなるカソード８と；
を含む。
【0004】

アノード３は、カソードに関して、正にバイアスされている。使用においては、電子およびホールは、ＥＬ層６に注入され、そしてそこで、それらは、それらが再結合してフォトンが生成されるまで、電界内において移動する。有機層の全体の厚みは、通常は、５０から１５０ｎｍ程度であり、そしてバイアスは、約２から２０Ｖである。アノード３は、典型的には透明であり、そしてカソード材料の仕事関数は、アノードについてＨＯＭＯで且つカソードについてＬＵＭＯのポリマーのエネルギーレベルに合致すべく選定される。それゆえ、ＯＬＥＤカソードに最も広く使用されている材料は、カルシウム、マグネシウム、アルミニウムおよびリチウム合金である。

【0005】

近年、ＯＬＥＤの材料およびデバイスアーキテクチャーにおいて、かなりの改良がなされており、それは結果として、１００００００カンデラ（ｃｄ））／ｍ^{2}を超える輝度値および４％を超過する外部量子効率を有するデバイスを生ずるに至っている。これらの新たな世代のデバイスは、大面積の照明器およびフラットパネルディスプレイにおいて有用であることが見出されている。

【0006】

非常に安定したエレクトロルミネッセンス（ＥＬ）デバイスが、不活性環境において動作することが立証されているが、そのようなデバイスの耐用年数は、「ダークスポット」として知られる非放射領域の形成および成長によって制限される。

【0007】

いくらかの要因が、ダークスポットの形成および成長に寄与している。１つのそのような要因は、ピンホールのようなカソード欠陥である。これらのピンホールは、抵抗加熱蒸着の間にしばしば形成される。酸化されたカソードは、デバイスの電子注入効果を減弱し、そしてそれゆえ、より高い駆動バイアスが必要とされる。このことは、局所短絡の可能性を著しく増大させる。スパッタリングは、カソードの被着のために半導体産業において一般に使用される方法の１つであるが、この技術は、現在に至るまで、ＯＬＥＤには適していない。この理由は、ＯＬＥＤが極度に敏感であり、スパッタリングプロセスに含まれる放射線、荷電、加熱およびイオン衝撃によって損傷を受けるからである。スパッタリングは、ピンホールをほとんどまたは全く有していないカソードを生成するが、当該技術に起因する損傷のために、それは使用されていない。

【0008】

ダークスポット形成および成長の他の要因は、ＯＬＥＤ材料における酸素および水分の放出、ならびに操作中におけるデバイスを通してのその浸透である。ＯＬＥＤの層を通しての水分および酸素の拡散は、カソードにおけるダークスポットの成長の重大な原因である。マグネシウムおよびカルシウムは、それらの低い仕事関数を理由としてＯＬＥＤデバイスにおけるカソード材料としてしばしば使用される。しかしながら、カルシウムおよびマグネシウムは、酸素および水蒸気に対して非常に敏感である。ダークスポットおよび欠陥の成長は、その後に種々の層および基板を通して浸透し且つ電極に反応する、ＯＬＥＤ材料の内部に生成される酸素および水分に起因している。

【0009】

ダークスポットの成長における付加的な要因は、電気的ストレスの間における電極材料の移動である。この金属移動は、ＯＬＥＤの種々の部分において電気的短絡のピークおよび強い電界を生じさせる。

【0010】

ダークスポットの形成に寄与するさらなる要因は、局所加熱である。この加熱は、しばしば高電流に起因する。これは材料破損を促進し、有機層の相互拡散の可能性を増大させ、そしてダークスポットの成長へと導く。

【0011】

先行技術のＯＬＥＤによって直面されるさらなる問題は、それらが非常に良好なポリマー安定性を持たないことである。共役のポリマーにおけるより重大な劣化の仕組みの１つは、光酸化されることに見出される。そのような光酸化は、ポリマーバックボーンでのビ

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ニル二重結合の鎖の切断を誘発し、それによってカルボニル基の形成による結合長さを減縮し、結果としてより低い光ルミネッセンス効率を生じさせる。

【0012】

近年において、ＯＬＥＤの性能は、有機材料の適切な選択によるだけでなく、電極の効果的なキャリア注入および明確な区域内でのコントロールされた電子－ホール再結合により向上されることが見出されている。電荷注入およびキャリア閉じ込めの増大に焦点を当てた研究は、デバイス性能における重大な改善に導いている。

【0013】

図２は、多層高効率構造からなるそのような従来のＯＬＥＤの進歩した形態を示している。図１のそれらと共通の参照符号が付された層に加えて、進歩した従来のＯＬＥＤは、電子注入層１５および誘電体層１４をも含んでいる。

【0014】

電子注入層１５は、ＥＬ層６とカソード８との間に配置され、且つホールおよび電子の注入を効果的にコントロールする。

【0015】

誘電体層１４は、アノード３とホール移動層５との間に配置される。もし、誘電体層の厚みが、トンネル現象の厚み以内であれば、電子注入に対する有効なバリアは低下され、そして放出層へのホールの注入が、低減される。結果として、キャリア注入に対する有効なバリアのこの低下は、電子およびホールのよりバランスされた注入に導き、そしてＯＬＥＤの量子効果を増大させる。

【0016】

このより進歩した従来のＯＬＥＤデバイスは、それゆえ、優れた発光および効率を呈する。しかしながら、これらの進歩したＯＬＥＤも、ダークスポットの形成および成長を呈するため、それらは、それゆえ、比較的短い耐用年数を持つ。

【発明の開示】

【発明が解決しようとする課題】

【0017】

したがって、ダークスポットの形成および成長を抑制すべく適合された改善されたＯＬＥＤが必要とされる。

【課題を解決するための手段】

【0018】

第１の特徴において、本発明は、

（ａ）基板上に配置されるアノードと；

（ｂ）カソードと；

（ｃ）前記アノードと前記カソードとの間に配置されるエレクトロルミネッセンス（ＥＬ）層と；

（ｄ）前記アノードと前記ＥＬ層との間に配置されるホール移動層と；

（ｅ）

（ｉ）前記アノードと前記ホール移動層；

（ｉｉ）前記ホール移動層と前記ＥＬ層；および

（ｉｉｉ）前記ＥＬ層と前記カソード；

のうちの１つ以上の間に配置される少なくとも１つの酸素／水分バリアと；

を具備し、

前記バリアは：

（Ａ）酸素による透過阻止；

（Ｂ）水分による透過阻止；および

（Ｃ）金属移動の抑制

のうちの少なくとも１つに適合された、有機発光ダイオード（ＯＬＥＤ）を提供する。

【0019】

好ましくは、前記ＯＬＥＤは、さらに、当該ＯＬＥＤを少なくとも部分的に封止する封

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止層をさらに備え、前記封止層は、酸素および／または水分による透過を阻止すべく適合されている。

【0020】

１つの形態において、前記ＯＬＥＤは、さらに、前記アノードと前記ホール移動層との間に配置される誘電体層をさらに備え且つ前記少なくとも１つのバリア層は：

（ｉ）前記アノードと前記誘電体層；および

（ｉｉ）前記誘電体層と前記ホール移動層；

のうちの１つ以上の間に配置される。

【0021】

別の形態において、ＯＬＥＤはさらに、前記ＥＬ層と前記カソードとの間に配置される電子注入層をさらに備え、且つ前記少なくとも１つのバリア層は：

（ｉ）前記ＥＬ層と前記電子注入層；および

（ｉｉ）前記電子注入層と前記カソード；

のうちの１つ以上の間に配置される。

【0022】

好ましくは、前記バリアは、少なくとも部分的にポリマーから作られ、１～２０ｎｍの厚みを有する有機バリアである。さらに、好ましくは、前記バリアは、

（ｉ）スピンコート法；

（ｉｉ）真空蒸着法；または

（ｉｉｉ）化学蒸着（ＣＶＤ）法；

を含む従来のコーティング技術のいずれかによって被着される。

【0023】

好ましくは、前記封止層は、有機封止層であり、少なくとも部分的にポリマーから作られ、１ｎｍから３０μｍの厚みを有する。さらに好ましくは、前記封止層は、

（ｉ）スピンコート法；

（ｉｉ）真空蒸着法；または

（ｉｉｉ）化学蒸着（ＣＶＤ）法；

を含む従来のコーティング技術のいずれかによって被着される。

【0024】

好ましくは、前記ポリマーは、

（ｉ）ポリイミド；

（ｉｉ）テフロン（登録商標）；および

（ｉｉｉ）パリレン；

から選択される。

【0025】

本発明の第２の特徴において、本発明は、

（ａ）基板上に配置されるアノードと；

（ｂ）カソードと；

（ｃ）前記アノードと前記カソードとの間に配置されるエレクトロルミネッセンス（ＥＬ）層と；

（ｄ）前記アノードと前記ＥＬ層との間に配置されるホール移動層と；

（ｅ）

（ｉ）前記アノードと前記ホール移動層；

（ｉｉ）前記ホール移動層と前記ＥＬ層；および

（ｉｉｉ）前記ＥＬ層と前記カソード；

のうちの１つ以上の間に配置される少なくとも１つの酸素／水分バリアと；

を具備し、

前記バリアは：

（Ａ）酸素による透過阻止；

（Ｂ）水分による透過阻止；および

（Ｃ）金属移動の抑制
のうちの少なくとも１つに適合された、
非放射領域の成長を抑制すべく適合された有機発光ダイオード（ＯＬＥＤ）を提供する。

【0026】
好ましくは、前記ＯＬＥＤは、さらに、当該ＯＬＥＤを少なくとも部分的に封止する封止層をさらに備え、前記封止層は、酸素および／または水分による透過を阻止すべく適合されている。

【発明を実施するための最良の形態】

【0027】
図面を参照すると、図３は、本発明のＯＬＥＤの第１の好ましい実施の形態の概略的な断面図を示している。当該図において見られるように、ＯＬＥＤ１は、基板２の上に配置されるいくつかの層を含んでいる。この実施の形態においては、各層は、次の順序：アノード３、第１の酸素／水分バリア４、ホール移動層５、およびエレクトロルミネッセンス（ＥＬ）層６、第２の酸素／水分バリア７、ならびにカソード８、で構成されている。この実施の形態においては、カソード８は、カルシウムカソード層９および銀／アルミニウムカソード層１０を含んでいる。これらの層の全ては、封止層１１によって少なくとも部分的に保護されている。

【0028】
第１の酸素／水分バリア４は、酸素および水分による透過を阻止するように適合され、そして金属移動を抑制するようにも設計されている。この好ましい実施の形態においては、バリア４は、ポリイミド、テフロン（登録商標）およびパリレンの中から選択されたポリマーから作られた有機バリアである。それは、１ｎｍ～２０ｎｍの間の厚みであり、スピンコート法、真空蒸着法または化学蒸着（ＣＶＤ）法のような従来の任意のコーティングプロセスを用いてアノード上に被着されている。

【0029】
しかしながら、この好ましい実施の形態において、第１の酸素／水分バリアは、アノード３とホール移動層５との間に配置され、それがホール移動層５とＥＬ層６との間に配置されているときに効果的な結果もまた達成される。

【0030】
この第１の酸素／水分バリア４は、３９℃、ＲＨ（相対湿度）９５％で、０．１ｇ／ｍ^2／日から５０ｇ／ｍ^2／日の範囲内において、水分バリア特性を有している。それは、可視波長帯域において透明であり、そして電界下において金属移動に対して抵抗する。

【0031】
このバリアは、酸素および／または水分による透過を阻止すべく適合されているため、アノード３からホール移動層５およびＥＬ層６への酸素の拡散を防止することができる。それは、熱バリア膜としても作用し、そしてＯＬＥＤ１の動作中におけるアノードからＥＬ層への熱移動を効果的に低減することができる。このバリア４は、ホール移動層５の効果的な被着を可能とすべく平滑な形態を提供するために、ピンホールおよび他の欠陥が無いことが好ましい。

【0032】
このバリア４は、アノードスパイクにおいて生成される強い電界を低減させることもでき、層間にまたがる電位降下を通してバリア高さを低減することにより、キャリア注入効率を増大させるようにする。

【0033】
第２の酸素／水分バリア７は、第１の酸素／水分バリア４と実質的に同一の構成および特性を有しているが、それはＥＬ層６とカソード８の間に配置されている。

【0034】
その好ましい形態において、この第２のバリア７は、酸素および／または水分による透過を阻止すべく適合され、そしてそれゆえＥＬ層６へ酸素および水分が拡散し且つカソー

ドと反応するのを防止することができる。

【0035】

この第２のバリア７は、カソード８の被着のための平滑な形態を提供することができるよう、ピンホールおよび他の欠陥は無いべきである。

【0036】

先に論じたように、ＯＬＥＤ上へカソードを被着する好ましい方法は、「スパッタリング」として知られているプロセスによるものである。しかしながら、この技術は、ＥＬ層を損傷しがちであり、それゆえ当該デバイスのＥＬ効率を低下させる。この好ましい実施の形態において、第２の酸素／水分バリア７は、ＥＬ層６上に被着されているため、それはＥＬ層を保護し、スパッタリングによって、ＥＬ層の損傷なしに、カソード８が、被着されるのを可能とする。この方法において、第２のバリア７は、イオン衝撃、放射線および金属移動からＥＬ層６を保護することができる。スパッタリング技術を用いてカソードを被着することによって、ピンホールがほとんどまたは全くないカソードが生成され得る。

【0037】

図４に移って、そこには、封止層１１を明確に示した、本発明のＯＬＥＤの好ましい実施の形態の単純化された概略的な断面図が示されている。当該図において、ＯＬＥＤ１は、基板２上に配置され且つ封止層１１によって封止されている。一対のエポキシシール１２が、ＯＬＥＤ１を閉じ込めるために基板２とカバー基板１３の間に延びている。図３および図４の両方に示された封止層１１は、酸素および／または水分による透過を阻止すべく適合されている。この好ましい実施の形態において、ポリイミド、テフロン（登録商標）およびパリレンから選択されたポリマーによって、それは少なくとも部分的に作られた有機封止層１１である。これらのポリマーのうちで、パリレン列は、それが室温で被着され得るとともにそれがＯＬＥＤの電子的パラメーターを変更しないため、最も良い結果を生ずる。それはまた優秀な段差被覆性を有し且つそれゆえＯＬＥＤ１の等角被覆性を提供する。封止層１１は、スピンコート法、真空蒸着法またはＣＶＤ法のような従来の任意のコーティングプロセスによって被着されることが好ましく、そして１ｎｍ～３０μｍの厚み範囲に被着される。

【0038】

封止層の優秀な酸素および水分バリア特性から、それは、重量について０．１％よりも小さい水分吸収性を示すことができる。層１１は、水分透過に対する優秀なバリアを提供し、且つそれゆえ一旦それが封止されるとＯＬＥＤ１を保護する。この封止層１１は、ＯＬＥＤ１を密封でき、それによってＯＬＥＤが水分と酸素の浸透の結果として酸化されるであろう可能性は低減される。

【0039】

この、そして以下に述べる好ましい実施の形態において、基板２も、酸素および／または水分による透過を阻止すべく適合されており、プラスティックまたはガラスのような剛性または可撓性のある材料から少なくとも部分的に作られている。

【0040】

加えて、カソード（および多層ＯＬＥＤアーキテクチャーにおけるアノード）は、有機金属、無機金属、有機金属酸化物および無機金属酸化物を含むカソード材料から少なくとも部分的に作られている。カソード（および多層ＯＬＥＤアーキテクチャーにおけるアノード）は、それがほとんどまたは全くピンホールを持たないように、スパッタリングとして知られる技術によってＯＬＥＤ上に被着されることが好ましい。

【0041】

さて、図５に移り、そこには本発明のＯＬＥＤの第２の好ましい実施の形態が示されている。この実施の形態は、より進歩したＯＬＥＤにおいて使用される第１および第２の酸素／水分バリア４、７および封止層１１を示している。

【0042】

この図に用いられている数字付けは、図３において示された第１の好ましい実施の形態

を説明するために使用されたのと同様である。この第２の実施の形態は、２つの付加的な層、すなわちアノード３とホール移動層５との間に配置された誘電体層１４、およびＥＬ層６とカソード層８との間に配置された電子注入層１５、を有している。この好ましい実施の形態において、第１の酸素／水分バリア４は、アノード３と誘電体層１４との間に配置されている。第２の酸素／水分バリア７は、ＥＬ層６と電子注入層１５との間に配置されている。

【0043】

図６に示される第３の好ましい実施の形態は、第１の酸素／水分バリア４が誘電体層１４とホール移動層５との間に配置され、そして第２の酸素／水分バリア７が電子注入層１５とカソード８との間に配置されることを除いて第２の好ましい実施の形態と同様である。第１および第２の酸素／水分バリア４、７のこれらと他の配置との組合せによる他の実施の形態も、考えられる。２つよりも多くの酸素／水分バリアを含むさらなる実施の形態も考えられる。

【0044】

これらの好ましい実施の形態において、誘電体層の厚みは、トンネル現象の範囲内である。さらにまた、誘電体層は、電子注入のための有効なバリア高さを低下させるべく適合され、それゆえＯＬＥＤのルミネッセンス量子効率を向上させることができる。

【0045】

前述の議論から、ＯＬＥＤ内にいくつかの酸素／水分バリアを挿入し、且つＯＬＥＤのまわりに封止層を施すことによって、ダークスポットの形成および成長が著しく低減されることがわかるであろう。結果として、フラットパネルディスプレイの商業的生産を含む多くの応用に使用され得る著しく改善された性能および耐用年数を有するＯＬＥＤが実現される。

【0046】

本発明者らは、上述されたバリアおよび封止層を用いることによって、ＯＬＥＤ内に形成されるダークスポットの数が、１００倍も低減されることを見出した。

【0047】

本発明は、それゆえ、ダークスポット形成および成長の原因に取り組んだものである。ピンホールのようなカソード欠陥の問題が、ＥＬ層上の保護層として作用する第２の酸素／水分バリアによって扱われ、ＥＬ層を損傷することなくスパッタリングによって、カルシウム電極が被着されることを可能としている。

【0048】

ＯＬＥＤの層を通しての酸素および水分の拡散の問題は、第１および第２の酸素／水分バリアによって扱われる。それらは、カソードの下に存在する層からの酸素および水分の拡散を低減すべく作用し、それによって水分がＣａ電極と反応することによって生ずるガスの発生を低減させることができる。

【0049】

バリアは、また、金属移動の問題にも取り組んでいる。それらは、金属の移動を低減し、それによって鮮鋭なスパイクが形成されるであろうようなことを低減し、ポリマーの劣化を阻止し、短絡の発生を制限する。

【0050】

過度の加熱が確立される問題は、バリアが熱バリア膜として作用するので、ＯＬＥＤの動作の間におけるアノードからＥＬ層への熱伝導を効果的に低下させるよう取り組まれている。

【0051】

バリアは、また、後続層の被着のためによりなめらかな面を提供し、それによってＯＬＥＤの品質を向上させる。

【0052】

さらにまた、封止層は、水分および酸素の内在し且つ外部的な侵入からデバイスを保護させる。

【0053】
バリアの付加的な利点は、当該デバイスにおけるポリマーのＬＵＭＯまたはＨＯＭＯに対しデバイスの金属のエネルギー仕事関数をより厳密に合わせることによってそれらがデバイスの量子効率を増大させることである。
【0054】
広く記述された通りの本発明の範囲から逸脱せずに、特定の実施の形態に示された本発明に対し、多数の変形および／または修正がなされ得ることは、当該技術における当業者によって認められるであろう。本実施の形態は、それゆえ、全ての点において例示のものであり且つ限定するものではないと理解される。
【図面の簡単な説明】
【0055】
【図1】単純な従来のＯＬＥＤの概略的な断面図である。
【図2】進歩した従来のＯＬＥＤの概略的な断面図である。
【図3】本発明の第１の好ましい実施の形態の概略的な断面図である。
【図4】封止層を明確に示した、本発明の第１の好ましい実施の形態の単純化された概略的な断面図である。
【図5】本発明のＯＬＥＤの第２の好ましい実施の形態の概略的な断面図である。
【図6】本発明のＯＬＥＤの第３の好ましい実施の形態の概略的な断面図である。

【図1】

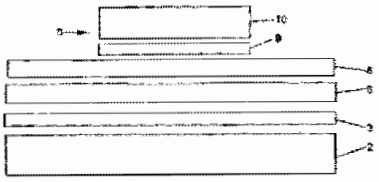


FIG. 1

【図2】

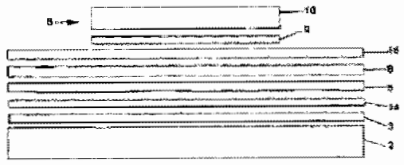


FIG. 2

【図3】

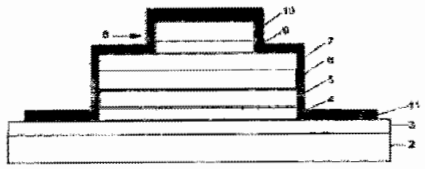


FIG. 3

【図4】

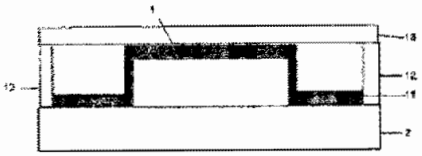


FIG. 4

【図5】

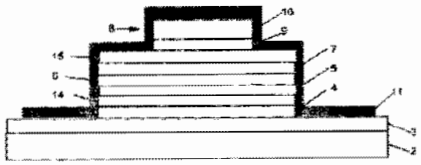


FIG. 5

【図6】

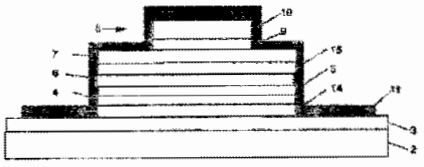


FIG. 6

【手続補正書】
【提出日】平成16年1月13日(2004.1.13)
【手続補正1】
【補正対象書類名】特許請求の範囲
【補正対象項目名】全文
【補正方法】変更
【補正の内容】
【特許請求の範囲】
【請求項1】
（ａ）基板上に配置されるアノードと；
（ｂ）カソードと；
（ｃ）前記アノードと前記カソードとの間に配置されるエレクトロルミネッセンス（ＥＬ）層と；
（ｄ）前記アノードと前記ＥＬ層との間に配置されるホール移動層と；
（ｅ）
（ｉ）前記アノードと前記ホール移動層；
（ｉｉ）前記ホール移動層と前記ＥＬ層；および
（ｉｉｉ）前記ＥＬ層と前記カソード；
のうちの１つ以上の間に配置される少なくとも１つの誘電体有機バリア層と；
を具備し、
前記バリア層は：
（Ａ）酸素による透過阻止；
（Ｂ）水分による透過阻止；および
（Ｃ）金属移動の抑制
のうちの少なくとも１つに適合された、有機発光ダイオード（ＯＬＥＤ）。
【請求項2】
前記少なくとも１つのバリア層は、前記ＥＬ層と前記カソードとの間に配置されるバリア層を含む、請求項１に記載のＯＬＥＤ。
【請求項3】
前記少なくとも１つのバリア層は：
（ｉ）前記アノードと前記ホール移動層か；または
（ｉｉ）前記ホール移動層と前記ＥＬ層か；
のいずれかの間に配置されるバリア層を含む、請求項１に記載のＯＬＥＤ。
【請求項4】
前記少なくとも１つのバリア層は、２つのバリア層を含み、一方のバリア層は、前記ＥＬ層と前記カソードとの間に配置され、そして他方のバリア層は：
（ｉ）前記アノードと前記ホール移動層か；または
（ｉｉ）前記ホール移動層と前記ＥＬ層か；
のいずれかの間に配置される、請求項１に記載のＯＬＥＤ。
【請求項5】
前記少なくとも１つのバリア層は、可視波長帯域において実質的に透明である、前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項6】
前記少なくとも１つのバリア層は、電界のもとにおいて金属イオン移動を阻止する、前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項7】
前記少なくとも１つのバリア層は、約３９℃において約０．１ｇ／ｍ^2／日から約５０ｇ／ｍ^2／日の範囲において水分バリア特性を有する、前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項8】

前記バリア層の厚みは、１から２０ｎｍの範囲内に存在する、前記請求項のいずれか一項に記載のＯＬＥＤ。

【請求項9】

前記アノードと前記ホール移動層との間に配置される誘電体層をさらに備え且つ前記少なくとも１つのバリア層は：

（ｉ）前記アノードと前記誘電体層；および

（ｉｉ）前記誘電体層と前記ホール移動層；

のうちの１つ以上の間に配置される、請求項１または請求項３から８のいずれか一項に記載のＯＬＥＤ。

【請求項10】

前記ＥＬ層と前記カソードとの間に配置される電子注入層をさらに備え、且つ前記少なくとも１つのバリア層は：

（ｉ）前記ＥＬ層と前記電子注入層；および

（ｉｉ）前記電子注入層と前記カソード；

のうちの１つ以上の間に配置される、前記請求項のいずれか一項に記載のＯＬＥＤ。

【請求項11】

前記バリア層は、少なくとも部分的にポリマーから作られている、請求項１０に記載のＯＬＥＤ。

【請求項12】

前記バリア層は：

（ｉ）スピンコート法；

（ｉｉ）真空蒸着法；または

（ｉｉｉ）化学蒸着（ＣＶＤ）法；

を含む従来のコーティング技術のいずれかによって被着される、前記請求項のいずれか一項に記載のＯＬＥＤ。

【請求項13】

当該ＯＬＥＤを少なくとも部分的に封止する封止層をさらに備え、前記封止層は、酸素および／または水分による透過を阻止すべく適合されている、前記請求項のいずれか一項に記載のＯＬＥＤ。

【請求項14】

前記封止層は、有機封止層である、請求項１３に記載のＯＬＥＤ。

【請求項15】

前記有機封止層は、少なくとも部分的にポリマーから作られる、請求項１４に記載のＯＬＥＤ。

【請求項16】

前記封止層の厚みは、１ｎｍから３０μｍの範囲内に存在する、請求項１３から１５のいずれか一項に記載のＯＬＥＤ。

【請求項17】

前記封止層は：

（ｉ）スピンコート法；

（ｉｉ）真空蒸着法；または

（ｉｉｉ）化学蒸着（ＣＶＤ）法；

を含む従来のコーティング技術のいずれかによって被着される、請求項１３から１６のいずれか一項に記載のＯＬＥＤ。

【請求項18】

前記ポリマーは：

（ｉ）ポリイミド；

（ｉｉ）テフロン；および

（ｉｉｉ）パリレン；

から選択される、請求項１１または１５に記載のＯＬＥＤ。

【請求項19】
前記ポリマーは、パリレンである、請求項１８に記載のＯＬＥＤ。
【請求項20】
前記基板は、酸素および／または水分による透過を阻止すべく適合されており、且つ少なくとも部分的に剛体または可撓性材料から作られる、前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項21】
前記基板は、プラスティックまたはガラスから形成される、請求項２０に記載のＯＬＥＤ。
【請求項22】
前記誘電体層の厚みは、トンネル現象範囲内である、請求項９から２１のいずれか一項に記載のＯＬＥＤ。
【請求項23】
前記誘電体層は、電子注入のために有効なバリア高さを低下させ、それによってＯＬＥＤのルミネッセンス量子効率を拡大するべく適合される、請求項２２に記載のＯＬＥＤ。
【請求項24】
前記カソードおよび／または前記アノードは：
（ｉ）有機金属；
（ｉｉ）無機金属；
（ｉｉｉ）有機金属酸化物；および
（ｉｖ）無機金属酸化物；
のうちの１つ以上のカソード材料から少なくとも部分的に作られる、前記請求項のいずれか一項に記載のＯＬＥＤ。
【請求項25】
前記アノードは、インジウムすず酸化物（ＩＴＯ）から形成される、請求項２４に記載のＯＬＥＤ。
【請求項26】
前記カソードは、カルシウム、マグネシウム、銀、アルミニウム、これらの金属の２つ以上の合金、またはリチウム合金から形成される、請求項２４または２５に記載のＯＬＥＤ。
【請求項27】
前記カソードは、少なくとも部分的に、スパッタリングによって形成される、請求項２４から２６のいずれか一項に記載のＯＬＥＤ。
【請求項28】
前記カソードは、ほとんどまたは全くピンホールを有していない、請求項２７に記載のＯＬＥＤ。
【請求項29】
少なくとも１つの前記バリア層は、前記ＥＬ層と前記カソードとの間に配置される保護バリア層であり、そしてスパッタリングプロセスの影響による損傷から前記ＥＬ層を保護すべく適合されている、請求項２７または２８に記載のＯＬＥＤ。
【請求項30】
前記保護バリア層は：
（ｉ）イオン衝撃；
（ｉｉ）放射線；および
（ｉｉｉ）金属移動；
のうちの１つ以上に起因する損傷から前記ＥＬ層を保護すべく適合されている、請求項２９に記載のＯＬＥＤ。
【請求項31】
（ａ）基板上に配置されるアノードと；
（ｂ）カソードと；

（ｃ）前記アノードと前記カソードとの間に配置されるエレクトロルミネッセンス（ＥＬ）層と；
（ｄ）前記アノードと前記ＥＬ層との間に配置されるホール移動層と；
（ｅ）前記ＥＬ層と前記カソードとの間に配置される誘電体有機バリア層と；
を具備し、
前記バリア層は：
（Ａ）酸素による透過阻止；
（Ｂ）水分による透過阻止；および
（Ｃ）金属移動の抑制
のうちの少なくとも１つに適合された、
非放射領域の形成を抑制すべく適合された有機発光ダイオード（ＯＬＥＤ）。
【請求項32】
（ａ）基板上に配置されるアノードと；
（ｂ）カソードと；
（ｃ）前記アノードと前記カソードとの間に配置されるエレクトロルミネッセンス（ＥＬ）層と；
（ｄ）前記アノードと前記ＥＬ層との間に配置されるホール移動層と；
（ｅ）
（ｉ）前記アノードと前記ホール移動層か；または
（ｉｉ）前記ホール移動層と前記ＥＬ層か；
のいずれかの間に配置される誘電体有機バリア層と；
を具備し、
前記バリア層は：
（Ａ）酸素による透過阻止；
（Ｂ）水分による透過阻止；および
（Ｃ）金属移動の抑制
のうちの少なくとも１つに適合された、
非放射領域の成長を抑制すべく適合された有機発光ダイオード（ＯＬＥＤ）。
【請求項33】
当該ＯＬＥＤを少なくとも部分的に封止する封止層をさらに備え、前記封止層は、酸素および／または水分による透過を阻止すべく適合されている、請求項３１または３２に記載のＯＬＥＤ。
【請求項34】
（ａ）基板上にアノードを形成するステップと；
（ｂ）前記アノード上にホール移動層を形成するステップと；
（ｃ）前記ホール移動層上にエレクトロルミネッセンス（ＥＬ）層を形成するステップと；
（ｄ）前記ＥＬ層上にカソードを形成するステップと；
（ｅ）前記プロセスにおける適切なステップにおいて：
（ｉ）前記アノードと前記ホール移動層；
（ｉｉ）前記ホール移動層と前記ＥＬ層；および
（ｉｉｉ）前記ＥＬ層と前記カソード；
のうちの１つ以上の間に配置される少なくとも１つの誘電体有機バリア層を形成するステップと；
を有する有機発光ダイオード（ＯＬＥＤ）を製造する方法であって、
前記バリア層は：
（Ａ）酸素による透過阻止；
（Ｂ）水分による透過阻止；および
（Ｃ）金属移動の抑制
のうちの少なくとも１つに適合されている方法。

【請求項35】
第１のバリア層が、前記ＥＬ層の形成に先立って前記ホール移動層上に形成される、請求項３４に記載の方法。
【請求項36】
第２のバリア層が、前記カソードの形成に先立って前記ＥＬ層上に形成される、請求項３４に記載の方法。
【請求項37】
第１のバリア層が、前記アノード上に形成され且つ第２のバリア層が、前記ＥＬ層上に形成される、請求項３４または３６に記載の方法。
【請求項38】
第１のバリア層が、前記ホール移動層上に形成され且つ第２のバリア層が、前記ＥＬ層上に形成される、請求項３５または３６に記載の方法。
【請求項39】
前記各バリア層は：
（ｉ）スピンコート法；
（ｉｉ）真空蒸着法；または
（ｉｉ）化学蒸着（ＣＶＤ）法；
を含む従来のコーティング技術のいずれかによって被着される、請求項３４から３８のいずれか一項に記載の方法。
【請求項40】
前記バリア層は、少なくとも部分的にポリマーから作られている、請求項３４から３９のいずれか一項に記載の方法。
【請求項41】
前記バリア層は、約１から２０ｎｍの範囲内の厚みを有して形成される、請求項３４から４０のいずれか一項に記載の方法。
【請求項42】
当該ＯＬＥＤを少なくとも部分的に封止する封止層の形成をさらに含み、前記封止層は、酸素および／または水分による透過を阻止すべく適合されている、請求項３４から４１のいずれか一項に記載の方法。
【請求項43】
前記封止層は、少なくとも部分的にポリマーから形成される有機封止層である、請求項４２に記載の方法。
【請求項44】
前記有機封止層は、約１ｎｍから３０μｍの厚みを有して形成される、請求項４３に記載の方法。
【請求項45】
前記封止層は：
（ｉ）スピンコート法；
（ｉｉ）真空蒸着法；または
（ｉｉｉ）化学蒸着（ＣＶＤ）法；
から選択されたプロセスによって被着される、請求項４２から４４のいずれか一項に記載の方法。
【請求項46】
前記カソードは、スパッタリングによって形成される、請求項３４から４５のいずれか一項に記載の方法。
【手続補正2】
【補正対象書類名】明細書
【補正対象項目名】全文
【補正方法】変更
【補正の内容】

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、有機発光ダイオード（ＯＬＥＤ）に、そして特に、「ダークスポット」として知られる非放射領域の形成および成長を抑制すべく適合されたＯＬＥＤに関する。
【0002】
本発明は、特にフラットパネルディスプレイに使用されるＯＬＥＤに好適であり、そして、以下においては、この応用に関して説明される。しかしながら、本発明は、この特定の使用分野に限定されるものではないことが理解されよう。
【背景技術】
【0003】
典型的なＯＬＥＤは、２つの電極に加えてこれら電極の間に配置される１つ以上のポリマー層からなっている。図１に示されるように、これらのデバイスは、一般に、次の順序に配列された、次の各層：
（ｉ）多くの場合プラスティックまたはガラスから作られる基板２と；
（ｉｉ）基板上に配置され、且つ一般に、有機材料またはインジウムすず酸化物（ＩＴＯ）のような無機酸化物であり得る透明な伝導性材料から作られるアノード３と；
（ｉｉｉ）アノード上に配置されるホール移動層５と；
（ｉｖ）ホール移動層上に配置されるエレクトロルミネッセンス（ＥＬ）層６と；
（ｖ）ＥＬ層上に配置されるカソードであって、カルシウムまたはマグネシウムの第１の層９および銀またはアルミニウムの第２の層１０とからなるカソード８と；
を含む。
【0004】
アノード３は、カソードに関して、正にバイアスされている。使用においては、電子およびホールは、ＥＬ層６に注入され、そしてそこで、それらは、それらが再結合してフォトンが生成されるまで、電界内において移動する。有機層の全体の厚みは、通常は、５０から１５０ｎｍ程度であり、そしてバイアスは、約２から２０Ｖである。アノード３は、典型的には透明であり、そしてカソード材料の仕事関数は、アノードについてＨＯＭＯで且つカソードについてＬＵＭＯのポリマーのエネルギーレベルに合致すべく選定される。それゆえ、ＯＬＥＤカソードに最も広く使用されている材料は、カルシウム、マグネシウム、アルミニウムおよびリチウム合金である。
【0005】
近年、ＯＬＥＤの材料およびデバイスアーキテクチャーにおいて、かなりの改良がなされており、それは結果として、１００００カンデラ（ｃｄ））／ｍ^{2}を超える輝度値および４％を超過する外部量子効率を有するデバイスを生ずるに至っている。これらの新たな世代のデバイスは、大面積の照明器およびフラットパネルディスプレイにおいて有用であることが見出されている。
【0006】
非常に安定したエレクトロルミネッセンス（ＥＬ）デバイスが、不活性環境において動作することが立証されているが、そのようなデバイスの耐用年数は、「ダークスポット」として知られる非放射領域の形成および成長によって制限される。
【0007】
いくらかの要因が、ダークスポットの形成および成長に寄与している。１つのそのような要因は、ピンホールのようなカソード欠陥である。これらのピンホールは、抵抗加熱蒸着の間にしばしば形成される。酸化されたカソードは、デバイスの電子注入効果を減弱し、そしてそれゆえ、より高い駆動バイアスが必要とされる。このことは、局所短絡の可能性を著しく増大させる。スパッタリングは、カソードの被着のために半導体産業において一般に使用される方法の１つであるが、この技術は、現在に至るまで、ＯＬＥＤには適していない。この理由は、ＯＬＥＤが極度に敏感であり、スパッタリングプロセスに含まれる放射線、荷電、加熱およびイオン衝撃によって損傷を受けるからである。スパッタリン

グは、ピンホールをほとんどまたは全く有していないカソードを生成するが、当該技術に起因する損傷のために、それは使用されていない。

【0008】

ダークスポット形成および成長の他の要因は、ＯＬＥＤ材料における酸素および水分の放出、ならびに操作中におけるデバイスを通してのその浸透である。ＯＬＥＤの層を通しての水分および酸素の拡散は、カソードにおけるダークスポットの成長の重大な原因である。マグネシウムおよびカルシウムは、それらの低い仕事関数を理由としてＯＬＥＤデバイスにおけるカソード材料としてしばしば使用される。しかしながら、カルシウムおよびマグネシウムは、酸素および水蒸気に対して非常に敏感である。ダークスポットおよび欠陥の成長は、その後に種々の層および基板を通して浸透し且つ電極に反応する、ＯＬＥＤ材料の内部に生成される酸素および水分に起因している。

【0009】

ダークスポットの成長における付加的な要因は、電気的ストレスの間における電極材料の移動である。この金属移動は、ＯＬＥＤの種々の部分において電気的短絡のピークおよび強い電界を生じさせる。

【0010】

ダークスポットの形成に寄与するさらなる要因は、局所加熱である。この加熱は、しばしば高電流に起因する。これは材料破損を促進し、有機層の相互拡散の可能性を増大させ、そしてダークスポットの成長へと導く。

【0011】

先行技術のＯＬＥＤによって直面されるさらなる問題は、それらが非常に良好なポリマー安定性を持たないことである。共役のポリマーにおけるより重大な劣化の仕組みの１つは、光酸化されることに見出される。そのような光酸化は、ポリマーバックボーンでのビニル二重結合の鎖の切断を誘発し、それによってカルボニル基の形成による結合長さを減縮し、結果としてより低い光ルミネッセンス効率を生じさせる。

【0012】

近年において、ＯＬＥＤの性能は、有機材料の適切な選択によるだけでなく、電極の効果的なキャリア注入および明確な区域内でのコントロールされた電子－ホール再結合により向上されることが見出されている。電荷注入およびキャリア閉じ込めの増大に焦点を当てた研究は、デバイス性能における重大な改善に導いている。

【0013】

図２は、多層高効率構造からなるそのような従来のＯＬＥＤの進歩した形態を示している。図１のそれらと共通の参照符号が付された層に加えて、進歩した従来のＯＬＥＤは、電子注入層１５および誘電体層１４をも含んでいる。

【0014】

電子注入層１５は、エレクトロルミネッセンス（ＥＬ）層６とカソード８との間に配置され、且つホールおよび電子の注入を効果的にコントロールする。

【0015】

誘電体層１４は、アノード３とホール移動層５との間に配置される。もし、誘電体層の厚みが、トンネル現象の厚み以内であれば、電子注入に対する有効なバリアは低下され、そして放出層へのホールの注入が、低減される。結果として、キャリア注入に対する有効なバリアのこの低下は、電子およびホールのよりバランスされた注入に導き、そしてＯＬＥＤの量子効果を増大させる。

【0016】

このより進歩した従来のＯＬＥＤデバイスは、それゆえ、優れた発光および効率を呈する。しかしながら、これらの進歩したＯＬＥＤも、ダークスポットの形成および成長を呈するため、それらは、それゆえ、比較的短い耐用年数を持つ。

【発明の開示】

【発明が解決しようとする課題】

【0017】

したがって、ダークスポットの形成および成長を抑制すべく適合された改善されたＯＬＥＤが必要とされる。

【課題を解決するための手段】

【0018】

第１の特徴において、本発明は、

（ａ）基板上に配置されるアノードと；

（ｂ）カソードと；

（ｃ）前記アノードと前記カソードとの間に配置されるエレクトロルミネッセンス（ＥＬ）層と；

（ｄ）前記アノードと前記ＥＬ層との間に配置されるホール移動層と；

（ｅ）

（ｉ）前記アノードと前記ホール移動層；

（ｉｉ）前記ホール移動層と前記ＥＬ層；および

（ｉｉｉ）前記ＥＬ層と前記カソード；

のうちの１つ以上の間に配置される少なくとも１つの誘電体有機バリア層と；

を具備し、

前記バリア層は：

（Ａ）酸素による透過阻止；

（Ｂ）水分による透過阻止；および

（Ｃ）金属移動の抑制

のうちの少なくとも１つに適合された、有機発光ダイオード（ＯＬＥＤ）を提供する。

【0019】

好ましくは、前記ＯＬＥＤは前記ＥＬ層と前記カソードとの間に配置されたバリア層を含む。代わりにあるいは付加的に、前記ＯＬＥＤは、

（ｉ）前記アノードと前記ホール移動層か；または

（ｉｉ）前記ホール移動層と前記ＥＬ層か；

のいずれかの間に配置されるバリア層を含む。

【0020】

好ましくは、前記ＯＬＥＤは２つのバリア層を含み、一方のバリア層は、前記ＥＬ層と前記カソードとの間に配置され、そして他方のバリア層は：

（ｉ）前記アノードと前記ホール移動層か；または

（ｉｉ）前記ホール移動層と前記ＥＬ層か；

のいずれかの間に配置される。

【0021】

さらに好ましくは、前記少なくとも１つのバリア層の１つ以上は、可視波長帯域において実質的に透明である。

【0022】

さらに好ましくは、前記少なくとも１つのバリア層は、電界のもとにおいて金属イオン移動を阻止するよう適合される。各バリア層は、好ましくは、さらに、約３９℃において約０．１ｇ／ｍ^2／日から約５０ｇ／ｍ^2／日の範囲において水分バリア特性を有する。

各バリア層の厚みは、好ましくは、約１から２０ｎｍの範囲内に存在する。

【0023】

好ましくは、前記ＯＬＥＤは、さらに、当該ＯＬＥＤを少なくとも部分的に封止する封止層をさらに備え、前記封止層は、酸素および／または水分による透過を阻止すべく適合されている。

【0024】

１つの形態において、前記ＯＬＥＤは、さらに、前記アノードと前記ホール移動層との間に配置される誘電体層をさらに備え且つ前記少なくとも１つのバリア層は：

（ｉ）前記アノードと前記誘電体層；および

（ｉｉ）前記誘電体層と前記ホール移動層；

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のうちの１つ以上の間に配置される。

【0025】

前記誘電体層は、好ましくは、トンネル現象範囲内である厚みを有する。前記誘電体層は、電子注入のために有効なバリア高さを低下させ、それによってＯＬＥＤのルミネッセンス量子効率を拡大するべく適合される。

【0026】

別の形態において、ＯＬＥＤはさらに、前記ＥＬ層と前記カソードとの間に配置される電子注入層をさらに備え、且つ前記少なくとも１つのバリア層は：

（ｉ）前記ＥＬ層と前記電子注入層；および

（ｉｉ）前記電子注入層と前記カソード；

のうちの１つ以上の間に配置される。

【0027】

この別の形態は、さらに上で言及された前記誘電体層を含んでもよい。

【0028】

好ましくは、前記有機バリア層は少なくとも部分的にポリマーから作られ、１～２０ｎｍの厚みを有する。さらに好ましくは、前記バリア層は、

（ｉ）スピンコート法；

（ｉｉ）真空蒸着法；または

（ｉｉｉ）化学蒸着（ＣＶＤ）法；

を含む従来のコーティング技術のいずれかによって被着される。

【0029】

好ましくは、前記封止層は、有機封止層であり、少なくとも部分的にポリマーから作られ、１ｎｍから３０μｍの厚みを有する。さらに好ましくは、前記封止層は、

（ｉ）スピンコート法；

（ｉｉ）真空蒸着法；または

（ｉｉｉ）化学蒸着（ＣＶＤ）法；

を含む従来のコーティング技術のいずれかによって被着される。

【0030】

好ましくは、前記バリア層及び前記封止層の前記ポリマーは、

（ｉ）ポリイミド；

（ｉｉ）テフロン（登録商標）；および

（ｉｉｉ）パリレン；

から選択される。

【0031】

前記ポリマーとしては、特にパリレンが好ましい。

【0032】

前記ＯＬＥＤの前記基板は、酸素および／または水分による透過を阻止すべく適合されるべきである。また、前記基板は、少なくとも部分的に、プラスティックやガラスのような、剛体または可撓性材料から作られることが好ましい。

【0033】

前記ＯＬＥＤの前記カソードおよび／または前記アノードは：

（ｉ）有機金属；

（ｉｉ）無機金属；

（ｉｉｉ）有機金属酸化物；および

（ｉｖ）無機金属酸化物；

のうちの１つ以上のカソード材料から少なくとも部分的に作られることが好ましい。

【0034】

前記アノードは、インジウムすず酸化物（ＩＴＯ）から形成されることが好ましい。

【0035】

前記カソードは、カルシウム、マグネシウム、銀、アルミニウム、これらの金属の２つ

以上の合金、またはリチウム合金から形成されることが好ましい。
【0036】
さらなる特徴において、本発明は、
（ａ）基板上に配置されるアノードと；
（ｂ）カソードと；
（ｃ）前記アノードと前記カソードとの間に配置されるエレクトロルミネッセンス（ＥＬ）層と；
（ｄ）前記アノードと前記ＥＬ層との間に配置されるホール移動層と；
（ｅ）
（ｉ）前記アノードと前記ホール移動層；
（ｉｉ）前記ホール移動層と前記ＥＬ層；および
（ｉｉｉ）前記ＥＬ層と前記カソード；
のうちの１つ以上の間に配置される少なくとも１つの誘電体有機バリア層と；
を具備し、
前記バリア層は：
（Ａ）酸素による透過阻止；
（Ｂ）水分による透過阻止；および
（Ｃ）金属移動の抑制
のうちの少なくとも１つに適合された、
非放射領域の形成および／あるいは成長を抑制すべく適合された有機発光ダイオード（ＯＬＥＤ）を提供する。
【0037】
好ましくは、前記ＯＬＥＤは、さらに、当該ＯＬＥＤを少なくとも部分的に封止する封止層をさらに備え、前記封止層は、酸素および／または水分による透過を阻止すべく適合されている。
【0038】
本発明のさらなる特徴に従って、
（ａ）基板上にアノードを形成するステップと；
（ｂ）前記アノード上にホール移動層を形成するステップと；
（ｃ）前記ホール移動層上にエレクトロルミネッセンス（ＥＬ）層を形成するステップと；
（ｄ）前記ＥＬ層上にカソードを形成するステップと；
（ｅ）前記プロセスにおける適切なステップにおいて：
（ｉ）前記アノードと前記ホール移動層；
（ｉｉ）前記ホール移動層と前記ＥＬ層；および
（ｉｉｉ）前記ＥＬ層と前記カソード；
のうちの１つ以上の間に配置される少なくとも１つの誘電体有機バリア層を形成するステップと；
を有する有機発光ダイオード（ＯＬＥＤ）を製造する方法であって、
前記バリア層は：
（Ａ）酸素による透過阻止；
（Ｂ）水分による透過阻止；および
（Ｃ）金属移動の抑制
のうちの少なくとも１つに適合されている方法が提供される。
【0039】
好ましくは、第１のバリア層が、前記ＥＬ層の形成に先立って前記ホール移動層上に形成される。あるいは、第２のバリア層が、前記カソードの形成に先立って前記ＥＬ層上に形成され得る。
【0040】
特に、第１のバリア層が、前記アノード上に形成され且つ第２のバリア層が、前記ＥＬ

層上に形成されることが好ましい。さらなる代わりの実施形態において、第１のバリア層が、前記ホール移動層上に形成され且つ第２のバリア層が、前記ＥＬ層上に形成されてもよい。

【0041】

各バリア層は：

（ｉ）スピンコート法；

（ｉｉ）真空蒸着法；または

（ｉｉ）化学蒸着（ＣＶＤ）法；

を含む従来のコーティング技術のいずれかによって被着され得る。

【0042】

先述したように、前記バリア層は、少なくとも部分的にパリレンのようなポリマーから作られることが好ましい。好ましくは、前記バリア層は、約１～２０ｎｍの厚みを有する。

【0043】

前記方法は、好ましくは、さらに、当該ＯＬＥＤを少なくとも部分的に封止する封止層の形成をさらに含み、前記封止層は、酸素および／または水分による透過を阻止すべく適合される。典型的には、前記封止層は、少なくとも部分的にポリマーから形成される有機封止層である。前記封止層は、約１ｎｍから３０μｍの厚みを有し得る。前記封止層は典型的には：

（ｉ）スピンコート法；

（ｉｉ）真空蒸着法；または

（ｉｉｉ）化学蒸着（ＣＶＤ）法；

から選択されたプロセスによって被着される。

【0044】

バリア層が前記ＥＬ層上に形成される場合、前記バリア層がイオン衝撃から前記ＥＬ層を保護するため、前記カソードはスパッタリングによって形成され得る。

【発明を実施するための最良の形態】

【0045】

図面を参照すると、図３は、本発明のＯＬＥＤの第１の好ましい実施の形態の概略的な断面図を示している。当該図において見られるように、ＯＬＥＤ１は、基板２の上に配置されるいくつかの層を含んでいる。この実施の形態においては、各層は、次の順序：アノード３、第１の酸素／水分バリア４、ホール移動層５、およびエレクトロルミネッセンス（ＥＬ）層６、第２の酸素／水分バリア７、ならびにカソード８、で構成されている。この実施の形態においては、カソード８は、カルシウムカソード層９および銀／アルミニウムカソード層１０を含んでいる。これらの層の全ては、封止層１１によって少なくとも部分的に保護されている。

【0046】

第１の酸素／水分バリア４は、酸素および水分による透過を阻止するように適合され、そして金属移動を抑制するようにも設計されている。この好ましい実施の形態においては、バリア４は、ポリイミド、テフロン（登録商標）およびパリレンの中から選択されたポリマーから作られた有機バリアである。それは、１ｎｍ～２０ｎｍの間の厚みであり、スピンコート法、真空蒸着法または化学蒸着（ＣＶＤ）法のような従来の任意のコーティングプロセスを用いてアノード上に被着されている。

【0047】

しかしながら、この好ましい実施の形態において、第１の酸素／水分バリアは、アノード３とホール移動層５との間に配置され、それがホール移動層５とＥＬ層６との間に配置されているときに効果的な結果もまた達成される。

【0048】

この第１の酸素／水分バリア４は、３９℃、ＲＨ（相対湿度）９５％で、０．１ｇ／ｍ^2／日から５０ｇ／ｍ^2／日の範囲内において、水分バリア特性を有している。それは、可視波長帯域において透明であり、そして電界下において金属移動に対して抵抗する。

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【0049】
このバリアは、酸素および／または水分による透過を阻止すべく適合されているため、アノード３からホール移動層５およびＥＬ層６への酸素の拡散を防止することができる。それは、熱バリア膜としても作用し、そしてＯＬＥＤ１の動作中におけるアノードからＥＬ層への熱移動を効果的に低減することができる。このバリア４は、ホール移動層５の効果的な被着を可能とすべく平滑な形態を提供するために、ピンホールおよび他の欠陥が無いことが好ましい。
【0050】
このバリア４は、アノードスパイクにおいて生成される強い電界を低減させることもでき、層間にまたがる電位降下を通してバリア高さを低減することにより、キャリア注入効率を増大させるようにする。
【0051】
第２の酸素／水分バリア７は、第１の酸素／水分バリア４と実質的に同一の構成および特性を有しているが、それはＥＬ層６とカソード８の間に配置されている。
【0052】
その好ましい形態において、この第２のバリア７は、酸素および／または水分による透過を阻止すべく適合され、そしてそれゆえＥＬ層６へ酸素および水分が拡散し且つカソードと反応するのを防止することができる。
【0053】
この第２のバリア７は、カソード８の被着のための平滑な形態を提供することができるよう、ピンホールおよび他の欠陥は無いべきである。
【0054】
先に論じたように、ＯＬＥＤ上へカソードを被着する好ましい方法は、「スパッタリング」として知られているプロセスによるものである。しかしながら、この技術は、ＥＬ層を損傷しがちであり、それゆえ当該デバイスのＥＬ効率を低下させる。この好ましい実施の形態において、第２の酸素／水分バリア７は、ＥＬ層６上に被着されているため、それはＥＬ層を保護し、スパッタリングによって、ＥＬ層の損傷なしに、カソード８が、被着されるのを可能とする。この方法において、第２のバリア７は、イオン衝撃、放射線および金属移動からＥＬ層６を保護することができる。スパッタリング技術を用いてカソードを被着することによって、ピンホールがほとんどまたは全くないカソードが生成され得る。
【0055】
図４に移って、そこには、封止層１１を明確に示した、本発明のＯＬＥＤの好ましい実施の形態の単純化された概略的な断面図が示されている。当該図において、ＯＬＥＤ１は、基板２上に配置され且つ封止層１１によって封止されている。一対のエポキシシール１２が、ＯＬＥＤ１を閉じ込めるために基板２とカバー基板１３の間に延びている。図３および図４の両方に示された封止層１１は、酸素および／または水分による透過を阻止すべく適合されている。この好ましい実施の形態において、ポリイミド、テフロン（登録商標）およびパリレンから選択されたポリマーによって、それは少なくとも部分的に作られた有機封止層１１である。これらのポリマーのうちで、パリレン列は、それが室温で被着され得るとともにそれがＯＬＥＤの電子的パラメーターを変更しないため、最も良い結果を生ずる。それはまた優秀な段差被覆性を有し且つそれゆえＯＬＥＤ１の等角被覆性を提供する。封止層１１は、スピンコート法、真空蒸着法またはＣＶＤ法のような従来の任意のコーティングプロセスによって被着されることが好ましく、そして１ｎｍ～３０μｍの厚み範囲に被着される。
【0056】
封止層の優秀な酸素および水分バリア特性から、それは、重量について０．１％よりも小さい水分吸収性を示すことができる。層１１は、水分透過に対する優秀なバリアを提供し、且つそれゆえ一旦それが封止されるとＯＬＥＤ１を保護する。この封止層１１は、ＯＬＥＤ１を密封でき、それによってＯＬＥＤが水分と酸素の浸透の結果として酸化され

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るであろう可能性は低減される。

【0057】

この、そして以下に述べる好ましい実施の形態において、基板２も、酸素および／または水分による透過を阻止すべく適合されており、プラスティックまたはガラスのような剛性または可撓性のある材料から少なくとも部分的に作られている。

【0058】

加えて、カソード（および多層ＯＬＥＤアーキテクチャーにおけるアノード）は、有機金属、無機金属、有機金属酸化物および無機金属酸化物を含むカソード材料から少なくとも部分的に作られている。カソード（および多層ＯＬＥＤアーキテクチャーにおけるアノード）は、それがほとんどまたは全くピンホールを持たないように、スパッタリングとして知られる技術によってＯＬＥＤ上に被着されることが好ましい。

【0059】

さて、図５に移り、そこには本発明のＯＬＥＤの第２の好ましい実施の形態が示されている。この実施の形態は、より進歩したＯＬＥＤにおいて使用される第１および第２の酸素／水分バリア４、７および封止層１１を示している。

【0060】

この図に用いられている数字付けは、図３において示された第１の好ましい実施の形態を説明するために使用されたのと同様である。この第２の実施の形態は、２つの付加的な層、すなわちアノード３とホール移動層５との間に配置された誘電体層１４、およびＥＬ層６とカソード層８との間に配置された電子注入層１５、を有している。この好ましい実施の形態において、第１の酸素／水分バリア４は、アノード３と誘電体層１４との間に配置されている。第２の酸素／水分バリア７は、ＥＬ層６と電子注入層１５との間に配置されている。

【0061】

図６に示される第３の好ましい実施の形態は、第１の酸素／水分バリア４が誘電体層１４とホール移動層５との間に配置され、そして第２の酸素／水分バリア７が電子注入層１５とカソード８との間に配置されることを除いて第２の好ましい実施の形態と同様である。第１および第２の酸素／水分バリア４、７のこれらと他の配置との組合せによる他の実施の形態も、考えられる。２つよりも多くの酸素／水分バリアを含むさらなる実施の形態も考えられる。

【0062】

これらの好ましい実施の形態において、誘電体層の厚みは、トンネル現象の範囲内である。さらにまた、誘電体層は、電子注入のための有効なバリア高さを低下させるべく適合され、それゆえＯＬＥＤのルミネッセンス量子効率を向上させることができる。

【0063】

前述の議論から、ＯＬＥＤ内にいくつかの酸素／水分バリアを挿入し、且つＯＬＥＤのまわりに封止層を施すことによって、ダークスポットの形成および成長が著しく低減されることがわかるであろう。結果として、フラットパネルディスプレイの商業的生産を含む多くの応用に使用され得る著しく改善された性能および耐用年数を有するＯＬＥＤが実現される。

【0064】

本発明者らは、上述されたバリアおよび封止層を用いることによって、ＯＬＥＤ内に形成されるダークスポットの数が、１００倍も低減されることを見出した。

【0065】

本発明は、それゆえ、ダークスポット形成および成長の原因に取り組んだものである。ピンホールのようなカソード欠陥の問題が、ＥＬ層上の保護層として作用する第２の酸素／水分バリアによって扱われ、ＥＬ層を損傷することなくスパッタリングによって、カルシウム電極が被着されることを可能としている。

【0066】

ＯＬＥＤの層を通しての酸素および水分の拡散の問題は、第１および第２の酸素／水分

バリアによって扱われる。それらは、カソードの下に存在する層からの酸素および水分の拡散を低減すべく作用し、それによって水分がＣａ電極と反応することによって生ずるガスの発生を低減させることができる。

【0067】

バリアは、また、金属移動の問題にも取り組んでいる。それらは、金属の移動を低減し、それによって鮮鋭なスパイクが形成されるであろうようなことを低減し、ポリマーの劣化を阻止し、短絡の発生を制限する。

【0068】

過度の加熱が確立される問題は、バリアが熱バリア膜として作用するので、ＯＬＥＤの動作の間におけるアノードからＥＬ層への熱伝導を効果的に低下させるよう取り組まれている。

【0069】

バリアは、また、後続層の被着のためによりなめらかな面を提供し、それによってＯＬＥＤの品質を向上させる。

【0070】

さらにまた、封止層は、水分および酸素の内在し且つ外部的な侵入からデバイスを保護させる。

【0071】

バリアの付加的な利点は、当該デバイスにおけるポリマーのＬＵＭＯまたはＨＯＭＯに対しデバイスの金属のエネルギー仕事関数をより厳密に合わせることによってそれらがデバイスの量子効率を増大させることである。

【0072】

広く記述された通りの本発明の範囲から逸脱せずに、特定の実施の形態に示された本発明に対し、多数の変形および／または修正がなされ得ることは、当該技術における当業者によって認められるであろう。本実施の形態は、それゆえ、全ての点において例示のものであり且つ限定するものではないと理解される。

【図面の簡単な説明】

【0073】

【図1】単純な従来のＯＬＥＤの概略的な断面図である。

【図2】進歩した従来のＯＬＥＤの概略的な断面図である。

【図3】本発明の第１の好ましい実施の形態の概略的な断面図である。

【図4】封止層を明確に示した、本発明の第１の好ましい実施の形態の単純化された概略的な断面図である。

【図5】本発明のＯＬＥＤの第２の好ましい実施の形態の概略的な断面図である。

【図6】本発明のＯＬＥＤの第３の好ましい実施の形態の概略的な断面図である。

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG02/00276

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: H05B 33/22, 33/04, H01L 51/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Refer electronic data base consulted

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI, JAPIO IPC H05B 33/-, H01L 51/-, 33/- & keywords: organic; OLED, OELD, electroluminescen+; display, device; oxygen, moisture, metal migrat+; barrier, layer, film, sheet; dark spot, non emissi+, non emit+; encapsulat+, seal+, water tight; polymer+, polymide, teflon, parylene

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 10-214683 A (SANYO ELECTRIC CO LTD) 11 August 1998 See machine translation: [online], [retrieved on 2003-01-24]. Retrieved from the Internet: <URL:http://www6.ipdl.jpo.go.jp/Tokujitu/PAJdetail.ipdl?N0000=60&N0120=01&N2001=2&N3001=H10-214683> See Abstract; Figs. 1, 4; Paragraphs 12-13, 18, 31-32, 41-43 & 48-51	1, 2, 5-10, 12, 13, 17, 22, 23
X	JP 11-283752 A (FUTABA CORP) 15 October 1999 See machine translation: [online], [retrieved on 2003-01-24]. Retrieved from the Internet: <URL:http://www6.ipdl.jpo.go.jp/Tokujitu/PAJdetail.ipdl?N0000=60&N0120=01&N2001=2&N3001=H11-283752> See Abstract; Figs. 4-6; Paragraphs 16, 24-25	1, 2, 7, 8, 12, 17, 22, 23

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 January 2003	31 JAN 2003
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **RAJEEV DESHMUKH** Telephone No : (02) 6283 2145

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG02/00276

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Patent Abstracts of Japan, JP 2000-030871 A (FUTABA CORP) 28 January 2000 See Abstract	1, 5, 6, 8, 13, 17, 22
X	JP 2000-068067 A (TDK CORP) 3 March 2000 See machine translation: [online], [retrieved on 2003-01-24]. Retrieved from the Internet: <URL:http://www6.ipdl.jpo.go.jp/Tokujitu/PAJdetail.ipdl?N0000=60&N0120=01&N2001=2&N3001=2000-068067> See Abstract; Fig. 1; Paragraph 12	1, 7, 8, 17, 22
A	EP 0777280 A2 (MOTOROLA, INC) 4 June 1997 See the whole document	1-23
A	US 2001/0041268 A (ARAI et al.) 15 November 2001 See the whole document	1-23
A	US 6150187 A (ZYUNG et al.) 21 November 2000 See the whole document	1-23

Form PCT/ISA/210 (continuation of Box C) (July 1998)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/SG02/00276

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
JP	10214683	NONE					
JP	11283752	NONE					
JP	2000030871	NONE					
JP	2000068067	NONE					
EP	777280	JP	9161967	US	5686360	US	5757126
US	2001041268	JP	11195487	US	6399222		
US	6150187	NONE					

END OF ANNEX

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(81)指定国　　AP(GH,GM,KE,LS,MW,MZ,SD,SL,SZ,TZ,UG,ZM,ZW),EA(AM,AZ,BY,KG,KZ,MD,RU,TJ,TM),EP(AT,BE,BG,CH,CY,CZ,DE,DK,EE,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE,SK,TR),OA(BF,BJ,CF,CG,CI,CM,GA,GN,GQ,GW,ML,MR,NE,SN,TD,TG),AE,AG,AL,AM,AT,AU,AZ,BA,BB,BG,BR,BY,BZ,CA,CH,CN,CO,CR,CU,CZ,DE,DK,DM,DZ,EC,EE,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KP,KR,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,MZ,NO,NZ,OM,PH,PL,PT,RO,RU,SC,SD,SE,SI,SK,SL,TJ,TM,TN,TR,TT,TZ,UA,UG,US,UZ,VC,VN,YU,ZA,ZM,ZW

（特許庁注：以下のものは登録商標）
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Ｆターム(参考)　3KC07　AB08　AB12　AB13　DB03　EA00　EB00　FA02

Espacenet

Bibliographic data: KR100743545 (B1) — 2007-07-23

METHOD AND SYSTEM FOR PROVIDING TOUCH SENSING FUNCTION TO ORGANIC LIGHT EMITTING DIODE

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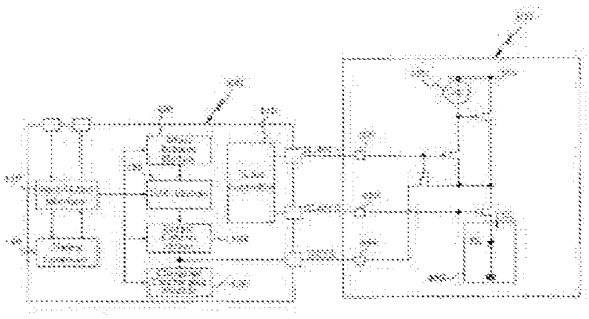
Classification: - international: *H05B33/02*
- cooperative: **G06F3/0412**; **G06F3/044**; **G06K9/0004**; **H05B33/02**; H01L27/323 more

Application number: KR20060060936 20060630 Global Dossier

Priority number(s): KR20060060936 20060630

Also published as: WO2008002043 (A1)

Abstract of KR100743545 (B1)



A method and a system for providing a touch sensing function to an OLED(Organic Light Emitting Diode) are provided to reduce the manufacturing cost of OLED display panels by providing the touch sensing function to the OLED display panels without a touch sensor film and a touch screen signal processor. A system for providing a touch sensing function to an OLED includes a standard voltage capacitor(510), an OLED drive driver(540), a comparison voltage capacitor(560), and a comparison detection module(570). The OLED drive driver(540) connects a driver A terminal(552) of a driver switch unit(550) to a driver B terminal(554) of the driver switch unit(550) for driving an OLED pixel. The capacitance of the standard voltage capacitor(510) and the capacitance of the comparison voltage capacitor(560) are the same. The voltage of both terminals of the standard voltage capacitor(510) and the comparison voltage capacitor(560) are the same by connecting the standard voltage capacitor(510) to OLED pixel equivalent resistance(512). The comparison detection module(570) outputs sensed voltage change with a voltage value corresponding to a logical value or with a digital level.

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(19) KOREAN INTELLECTUAL PROPERTY OFFICE

KOREAN PATENT ABSTRACTS

(11) Publication number: 100743545 B1
(44) Date of publication of specification: 23.07.2007

(21) Application number: 1020060060936
(22) Date of filing: 30.06.2006
(51) Int. Cl: *H05B 33/02 (2006.01);*

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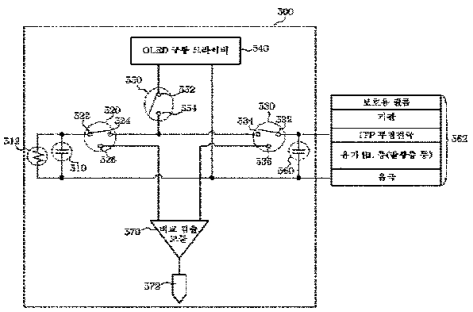
(54) **METHOD AND SYSTEM FOR PROVIDING TOUCH SENSING FUNCTION TO ORGANIC LIGHT EMITTING DIODE BY ADDING MEASURING CIRCUIT TO SENSE MICRO CHARGE ON DRIVE CIRCUIT**

(57) Abstract:

PURPOSE: A method and a system for providing a touch sensing function to an OLED(Organic Light Emitting Diode) are provided to reduce the manufacturing cost of OLED display panels by providing the touch sensing function to the OLED display panels without a touch sensor film and a touch screen signal processor.

CONSTITUTION: A system for providing a touch sensing function to an OLED includes a standard voltage capacitor(510), an OLED drive driver(540), a comparison voltage capacitor(560), and a comparison detection module(570). The OLED drive driver(540) connects a driver A terminal(552) of a driver switch unit(550) to a driver B terminal(554) of the driver switch unit(550) for driving an OLED pixel. The capacitance of the standard voltage capacitor(510) and the capacitance of the comparison voltage capacitor(560) are the same. The voltage of both terminals of the standard voltage capacitor(510) and the comparison voltage capacitor(560) are the same by connecting the standard voltage capacitor(510) to OLED pixel equivalent resistance(512). The comparison detection module(570) outputs sensed voltage change with a voltage value corresponding to a logical value or with a digital level.

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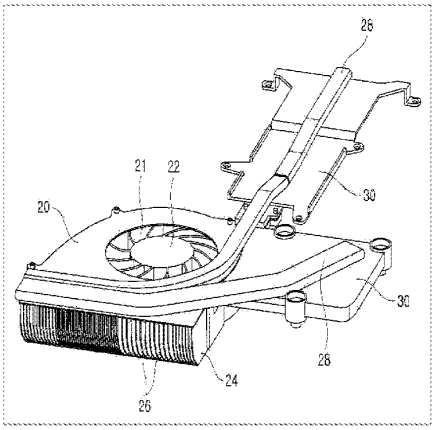


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전자기기의 방열장치

Heat radiating apparatus for electronic device

(51) Int. CL	G06F 1/20(2005.08.03) H05K 7/20(2013.04.15)
(52) CPC	
(21) Application No.(Date)	1020050065948 (2005.07.20)
(71) Applicant	LG Electronics Inc.
(11) Registration No.(Date)	1013277220000 (2013.11.04)
(65) Unex. Pub. No.(Date)	1020070010943 (2007.01.24)
(11) Publication No.(Date)	(2013.11.11)
(86) Int'l Application No.(Date)	
(87) Int'l Unex. Pub. No.(Date)	
(30) Priority info. (Country / No. / Date)	
Legal Status	Registered
Examination Status	Decision to grant (General)
Trial Info	
Kind/Right of Org. Application	/
Right of Org. Application No.(Date)	
Related Application No.	
Request for an examination(Date)	Y(2010.07.19)
Number of examination claims	4



Korea Patent Abstract

PURPOSE: A heat discharging device for an electronic device is provided to smoothly flow an air flow by forming a radiating fin unit according to property of the air flow formed by a heat discharging fan and minimize noise by forming intervals between radiating fins of the radiating fin unit according to the property of the air flow.CONSTITUTION: A fan housing(20) forms an inlet(21) for sucking air and an outlet at least one side. The heat discharging fan(22) forms the air flow for exchanging the heat at the inside of the fan housing. The radiating fin unit(24) exchanges the heat at the outlet of the fan housing by passing the air flow formed from the heat discharging fan and differently sets up the interval between the radiating fins(26) according to an air flow rate. The radiating fins are arranged by dividing into a few of sections having a different pitch. A heat pipe(28) transfers the heat of a heat source to the radiating fan unit. A heat sink(30) for transferring the heat of the heat source to the heat pipe is thermally contacted with the heat source.© KIPO 2007

SDC EX. 1016 - 364/959

(19) 대한민국특허청(KR)
(12) 등록특허공보(B1)

(45) 공고일자 2013년11월11일
(11) 등록번호 10-1327722
(24) 등록일자 2013년11월04일

(51) 국제특허분류(Int. Cl.)
G06F 1/20 (2006.01) *H05K 7/20* (2006.01)
(21) 출원번호 10-2005-0065948
(22) 출원일자 2005년07월20일
심사청구일자 2010년07월19일
(65) 공개번호 10-2007-0010943
(43) 공개일자 2007년01월24일
(56) 선행기술조사문헌
US06778390 B2*
US20030007327 A1
*는 심사관에 의하여 인용된 문헌

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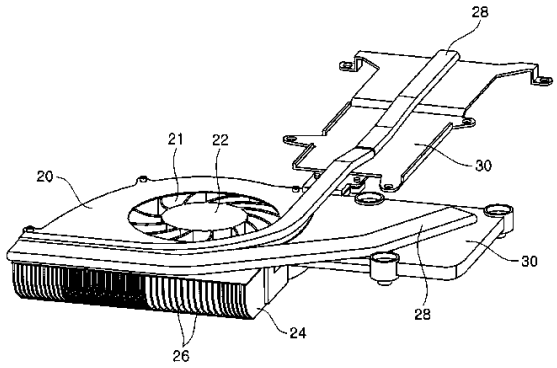
전체 청구항 수 : 총 4 항 심사관 : 박태식

(54) 발명의 명칭 **전자기기의 방열장치**

(57) 요 약

본 발명은 전자기기의 방열장치에 관한 것이다. 본 발명은 공기가 흡입되는 흡입구(21)가 형성되고 적어도 일측에 출구가 형성되는 팬하우징(20)과, 상기 팬하우징(20)의 내부에 설치되는 열교환을 위한 기류를 형성하는 방열팬(22)과, 상기 팬하우징(20)의 출구에 설치되어 방열팬(22)에 의해 형성된 기류가 통과하면서 열교환이 이루어지는 부분으로 다수개의 방열핀(26) 사이의 간격이 기류의 유속에 따라 달리 설정되는 방열핀유니트(24)를 포함하여 구성된다. 상기 방열핀유니트(24)를 구성하는 방열핀(26)은 각각 소정의 피치를 가지는 몇개의 구간으로 나누어져 배치된다. 이와 같은 구성을 가지는 본 발명에 의한 전자기기의 방열장치에 의하면, 방열핀의 간격을 방열팬에 의해 형성되는 기류의 특성에 맞게 달리 형성함에 의해 열방출특성이 높아지고, 소음이 낮아지는 이점을 얻을 수 있다.

대 표 도 - 도3



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특허청구의 범위

청구항 1

공기가 흡입되는 흡입구가 형성되고 적어도 일측에 출구가 형성되는 팬하우징과,

상기 팬하우징의 내부에 설치되는 열교환을 위한 기류를 형성하는 방열팬과,

상기 팬하우징의 출구에 설치되어 방열팬에 의해 형성된 기류가 통과하면서 열교환이 이루어지는 부분으로 다수개의 방열핀 사이의 간격이 기류의 유속에 따라 달리 설정되는 방열핀유니트를 포함하여 구성되며,

상기 방열핀유니트를 구성하는 각 방열핀들 사이의 간격은, 상기 방열팬에 의하여 형성되는 기류의 유속이 상대적으로 느린 부분에 비해 기류의 유속이 상대적으로 빠른 부분이 더욱 좁게 형성됨을 특징으로 하는 전자기기의 방열장치.

청구항 2

제 1 항에 있어서, 상기 방열핀유니트를 구성하는 방열핀은 각각 소정의 피치를 가지는 몇개의 구간으로 나누어져 배치됨을 특징으로 하는 전자기기의 방열장치.

청구항 3

삭제

청구항 4

제 1 항에 있어서, 상기 방열핀유니트로 열원의 열을 전달하기 위한 히트파이프가 더 구비됨을 특징으로 하는 전자기기의 방열장치.

청구항 5

제 4 항에 있어서, 상기 히트파이프로 열원의 열을 전도하는 히트싱크가 열원에 열적으로 접촉되게 더 구비됨을 특징으로 하는 전자기기의 방열장치.

명 세 서

발명의 상세한 설명

발명의 목적

발명이 속하는 기술 및 그 분야의 종래기술

[0011] 본 발명은 전자기기의 방열장치에 관한 것으로, 더욱 상세하게는 전자기기의 동작중 열원에서 발생하는 열을 외부로 방출하는 전자기기의 방열장치에 관한 것이다.

[0012] 도 1에는 종래 기술에 의한 방열장치가 채용된 전자기기인 노트북컴퓨터의 구성이 평면도로 도시되어 있고, 도 2에는 종래 기술에 의한 방열장치의 요부 구성이 사시도로 도시되어 있다.

[0013] 이에 따르면, 전자기기인 노트북컴퓨터의 본체부(1)의 외관을 구성하는 바텀케이스(3)의 외면 일측에는 내부에서 발생하는 열을 외부로 방출하기 위한 통기공(5)이 형성된다. 상기 통기공(5)을 통해서는 본체부(1)의 내부에서 발생된 열을 머금은 기류가 통과한다.

[0014] 상기 본체부(1)의 내부에는 메인기판(7)이 설치된다. 상기 메인기판(7) 상에는 마이크로프로세서(CPU)(9)가 실장된다. 상기 마이크로프로세서(9)는 명령어의 해석과 자료의 연산, 비교 등의 처리를 제어하는 것이다. 상기 마이크로프로세서(9)에서 발생하는 열을 외부로 방출하기 위해 방열장치가 상기 본체부(1)의 내부에 설치된다.

[0015] 상기 방열장치는 팬하우징(11)의 내부에 방열팬(13)이 설치되어 기류를 형성한다. 상기 방열팬(13)에 의해 형성되는 기류는 팬하우징(11)의 일측의 방열핀유니트(5)을 통과해 상기 통기공(5)으로 흐른다. 상기 방열핀유니트(15)에는 다수개의 방열핀(15')이, 도 2에 잘 도시된 바와 같이, 일정 간격으로 배치되어 있다.

[0016] 한편, 상기 마이크로프로세서(CPU)(9) 등의 열원에서 발생되는 열을 상기 방열핀유니트(15)로 전달하기 위해서

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히트파이프(16)가 사용된다. 상기 히트파이프(16)는 그 내부의 작동유체가 상변화를 하면서 열원측에서 열을 전달받고, 상기 방열핀유니트(15)로 열을 배출한다.

[0017] 그러나 상기한 바와 같은 종래 기술에서는 다음과 같은 문제점이 있다.

[0018] 즉, 종래 기술에서 상기 팬하우징(11) 내부의 방열팬(13)이 회전함에 의해 발생하는 기류는 상기 팬하우징(11)에서 나와서 상기 방열핀유니트(15)의 방열핀(15')사이를 통과하면서, 방열핀(15')의 표면에서 열교환을 수행하고, 상기 통기공(5)을 통해 외부로 배출된다.

[0019] 하지만, 상기 방열핀(15')사이의 간격이 모두 일정하게 배치되어 있지만, 실제로 상기 방열팬(13)에 의해 형성되는 기류는 상기 방열핀유니트(15)의 전체를 통해 일정한 속도로 유동되는 것은 아니다. 따라서, 상대적으로 상기 방열핀유니트(15)를 통과하는 기류의 유속이 상대적으로 빠른 부분에서는 열교환특성이 상대적으로 떨어진다. 이는 방열핀(15')사이를 통과하는 기류의 속도가 지나치게 빠르면 방열핀(15')의 표면과 열교환을 충분히 할 수 없기 때문이다.

[0020] 그리고, 종래 기술에서는 방열핀(15')사이의 간격이 기류의 유속에 상관없이 일정하게 형성되어 있어, 방열핀(15')사이의 간격에 비해 유속이 지나치게 빠르다던가 늦어지면 소음이 발생하는 문제점이 있다.

발명이 이루고자 하는 기술적 과제

[0021] 본 발명의 목적은 상기한 바와 같은 종래 기술의 문제점을 해결하기 위한 것으로, 방열팬에 의해 형성된 기류의 특성에 맞게 방열핀유니트를 구성하여 기류의 유동이 원활하게 되도록 하는 것이다.

[0022] 본 발명의 다른 목적은 방열핀유니트의 방열핀의 간격을 기규의 특성에 맞게 구성하여 소음을 최소화하는 것이다.

발명의 구성 및 작용

[0023] 상기한 바와 같은 목적을 달성하기 위한 본 발명의 특징에 따르면, 본 발명은 공기가 흡입되는 흡입구가 형성되고 적어도 일측에 출구가 형성되는 팬하우징과, 상기 팬하우징의 내부에 설치되는 열교환을 위한 기류를 형성하는 방열팬과, 상기 팬하우징의 출구에 설치되어 방열팬에 의해 형성된 기류가 통과하면서 열교환이 이루어지는 부분으로 다수개의 방열핀 사이의 간격이 기류의 유속에 따라 달리 설정되는 방열핀유니트를 포함하여 구성된다.

[0024] 상기 방열핀유니트를 구성하는 방열핀은 각각 소정의 피치를 가지는 몇개의 구간으로 나누어져 배치된다.

[0025] 상기 방열핀유니트를 구성하는 방열핀의 피치는 기류의 유속이 상대적으로 빠른 부분에서 상대적으로 좁고, 기류의 유속이 상대적으로 느린 부분에서 상대적으로 넓게 형성된다.

[0026] 상기 방열핀유니트로 열원의 열을 전달하기 위한 히트파이프가 더 구비된다.

[0027] 상기 히트파이프로 열원의 열을 전도하는 히트싱크가 열원에 열적으로 접촉되게 더 구비된다.

[0028] 이와 같은 구성을 가지는 본 발명에 의한 전자기기의 방열장치에 의하면, 방열핀의 간격을 방열팬에 의해 형성되는 기류의 특성에 맞게 달리 형성함에 의해 열방출특성이 높아지고, 소음이 낮아지는 이점을 얻을 수 있다.

[0029] 이하 본 발명에 의한 전자기기의 방열장치의 바람직한 실시예를 첨부된 도면을 참고하여 상세하게 설명한다.

[0030] 도 3에는 본 발명에 의한 전자기기의 방열장치의 바람직한 실시예가 사시도로 도시되어 있고, 도 4에는 본 발명 실시예의 요부 구성이 사시도로 확대도시되어 있다.

[0031] 이들 도면에 도시된 바에 따르면, 팬하우징(20)은 내부에 소정의 공간이 형성되는 납작한 박스 형상이다. 상기 팬하우징(20)의 상면 중앙에는 흡입구(21)가 형성되어 있다. 상기 흡입구(21)는 상기 팬하우징(20)의 내부로 공기가 흡입되는 통로이다.

[0032] 상기 팬하우징(20)의 내부에는 방열팬(22)이 설치된다. 상기 방열팬(22)은 방열을 위한 기류를 형성하는 역할을 한다. 즉, 상기 팬하우징(20)의 흡입구(21)를 통해 공기를 흡입해서, 아래에서 설명될 방열핀유니트(24)를 통과시켜 전자기기의 외부로 배출되도록 하는 것이다. 상기 방열팬(22)에 의해 형성되는 기류는 상기 팬하우징(20)에 형성된 출구(도시되지 않음)를 통해 배출되는데, 상기 출구에는 각각 방열핀유니트(24)가 설치된다. 본 실시예에서는 팬하우징(20)이 하나의 출구를 가져 하나의 방열핀유니트(24)가 사용되는 것이 도시되어 있다. 참고로

도 5에는 2개의 출구가 팬하우징(20)에 구비되고, 각각의 출구에 방열핀유니트(24)가 설치된 것이 도시되어 있다.

[0033] 방열핀유니트(24)는 다수개의 방열핀(26)이 소정의 피치를 두고 설치되고, 이 방열핀(26) 사이의 틈새를 통해 공기가 유동되면서 공기로 열을 방출하도록 하는 것이다. 본 발명에서는 상기 방열핀(26)의 피치를 방열핀유니트(24)의 각 위치를 통과하는 공기의 유속에 따라 달리하고 있다. 즉, 공기의 유속이 빠른 곳은 방열핀(26)사이의 간격, 즉 피치를 좁게 하고, 공기의 유속이 느린 곳은 방열핀(26)사이의 간격을 상대적으로 넓게 한다.

[0034] 본 실시예에서는 공기의 유속에 따라 방열핀(26)의 피치(P1,P2,P3)를 각각 달리한다. 먼저, 상대적으로 공기의 유속이 제일 느린 구간(W1)에서 방열핀(26)의 피치(P1)를 가장 크게 하고 있고, 공기의 유속이 제일 빠른 구간(W3)에서 방열핀(26)의 피치(P3)를 가장 작게 하고 있다. 그리고, 공기의 유속이 중간쯤 되는 구간(W2)에서는 방열핀(26)의 피치(P2)를 P1과 P2의 사이값으로 하고 있다.

[0035] 이와 같이 공기의 유속에 따라 방열핀(26)의 피치(P1,P2,P3)를 달리하는 것은, 방열핀(26)을 통과하는 공기의 속도를 조절하여 공기로 전달되는 열이 최대로 되도록 하기 위함이다. 즉, 상대적으로 유속이 빠른 부분에서는 방열핀(26)사이의 간격을 좁게 해서 유속이 줄어들게 만들어 방열핀(26)과 공기사이의 열교환이 충분히 이루어질 수 있도록 하는 것이다. 물론, 유속이 상대적으로 느린 곳에서의 방열핀(26)의 피치는 공기와 방열핀(26)사이의 열교환이 적절하게 일어날 수 있는 값으로 설정하는 것이 바람직하다.

[0036] 그리고, 상기 방열핀(26)의 피치(P1,P2,P3)는 다양하게 조합될 수 있다. 실제, 상기 방열핀유니트(24)를 통과하는 기류의 유속은 여러가지 요인에 의해 달리 설정되기 때문이다. 즉, 팬하우징(20)의 형상, 방열팬(22)의 특성 및 방열팬유니트(24)의 위치 등에 따라 달리 된다.

[0037] 한편, 상기 방열핀유니트(24)에서 열원을 향해 연장되게 히트파이프(28)가 구비된다. 상기 히트파이프(28)는 그 내부의 작동유체가 유동되면서, 일단부에서 열을 받아 상변화되고, 타단부로 가서 열을 방출하면서 상변화되는 것을 반복하는 것이다. 즉, 열원에서 열을 받아 상기 방열핀유니트(24)로 열을 전달하는 역할을 하는 것이다.

[0038] 상기 히트파이프(28)의 일단부는 열원과 직접 접촉될 수도 있고, 별도의 히트싱크(30)에 접촉될 수도 있다. 본 실시예에서는 상기 히트싱크(30)를 도시하고 있다. 상기 히트싱크(30)는 열원에 열적으로 접촉되어 열원의 열을 히트파이프(28)로 전도시키는 역할을 한다. 상기 히트싱크(30)는 열전도성이 좋은 금속재질로 형성되는 것이 바람직하다.

[0039] 이하 상기한 바와 같은 구성을 가지는 본 발명에 의한 전자기기의 방열장치의 작용을 상세하게 설명한다.

[0040] 전자기기가 동작되면 마이크로프로세서와 같은 열원에서 열이 발생되고, 상기 열원의 열은 외부로 방출시켜야 해당되는 부품의 동작이 원활하게 이루어질 수 있다. 따라서, 상기 열원의 열을 방출해야될 조건이 되면, 상기 방열팬(22)이 동작한다.

[0041] 상기 방열팬(22)이 동작되면, 상기 팬하우징(20)의 내부로 상기 흡입구(21)를 통해 공기가 유입되고, 상기 유입된 공기는 상기 방열팬(22)에 의해 상기 방열핀유니트(24)로 전달된다. 상기 방열핀유니트(24)로 전달된 공기는 상기 방열핀유니트(24)의 방열핀(26)사이를 통과한다.

[0042] 상기 공기가 방열핀(26)사이를 통과하면서, 방열핀(26)의 표면과 접촉하면서 열을 전달받는다. 상기 방열핀(26)의 열은 상기 히트파이프(28)를 통해 열원에서 상기 방열핀유니트(24)로 전달된 것이다.

[0043] 여기서 본 발명에서는 상기 방열핀(26)사이의 간격, 다시 말해 피치(P1,P2,P3)가 상기 방열핀유니트(24)를 통과하는 공기의 유속에 따라 달리 설정되어 있다. 즉, 공기의 유속이 빠른 곳에서는 피치를 상대적으로 좁게 하고, 유속이 느린 곳에서는 피치를 상대적으로 넓게 한다. 따라서, 방열핀유니트(24)의 어느 위치에서도 열교환이 효율적으로 일어나게 된다. 결국, 방열핀유니트(24) 전체 영역에서 열교환이 효율적으로 일어나면서, 방열장치의 방열특성이 상대적으로 좋아지는 것이다.

[0044] 한편, 상기 방열핀유니트(24)의 각각의 구간(W1,W2,W3)의 피치(P1,P2,P3)를 설정하는 것은 상기 방열핀유니트(24)의 위치, 팬하우징(20)의 구성 및 방열팬(22)의 특성 등에 따라 달리 된다. 예를 들어 도 5에는 방열핀유니트(24)가 팬하우징(20)의 2변에 걸쳐 형성되어 있는 것이 도시되어 있는데, 각각의 방열핀유니트(24)에서의 기류의 유속 분포가 달리 됨을 알 수 있다.

[0045] 따라서, 본 발명은 반드시 도 4에 도시된 방열핀유니트(24)의 구간(W1,W2,W3)과 같이 피치(P1,P2,P3)가 형성되어야 하는 것은 아니며, 각각의 방열핀유니트(24)에서 형성되는 기류의 유속에 맞게 피치가 형성되어야 한다.

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[0046] 본 발명의 권리는 위에서 설명된 실시예에 한정되지 않고 청구범위에 기재된 바에 의해 정의되며, 본 발명의 기술분야에서 통상의 지식을 가진 자가 청구범위에 기재된 권리범위 내에서 다양한 변형과 개작을 할 수 있다는 것은 자명하다.

[0047] 예를 들어, 도시된 실시예에서는 방열핀(26)의 피치를 몇개의 구간으로 나누어 각각 일정하게 형성하였으나, 각각의 방열핀(26)사이의 피치를 유속에 맞게 달리 형성하는 것이 열방출성능이 가장 좋다. 하지만, 방열핀유니트(24)을 제작 비용이나 수고를 생각할 때, 몇개의 구간으로 나누어 피치를 설정하는 것이 가장 바람직하다.

발명의 효과

[0048] 위에서 상세히 설명한 바와 같은 본 발명에 의한 전자기기의 방열장치에서는 다음과 같은 효과를 얻을 수 있다.

[0049] 본 발명에서는 방열장치를 구성하는 방열핀유니트에서 방열핀의 피치를 방열핀유니트를 통과하는 기류의 유속에 따라 달리 형성하였다. 즉, 기류의 유속이 빠른 곳에서는 방열핀의 피치를 좁게 하고 상대적으로 유속이 느린 부분에서는 방열핀의 피치를 넓게 하여 기류로의 열전달이 보다 효율적으로 이루어지도록 한다. 따라서, 본 발명에 의하면 방열장치의 방열효율이 상대적으로 높아지는 효과가 있다.

[0050] 또한, 본 발명에서는 기류가 통과하는 방열핀 사이의 간격, 즉 피치를 유속에 따라 달리 했으므로, 기류가 방열핀을 최적의 상태로 통과하게 되어 방열핀사이를 통과하는 기류에 의한 소음발생이 최소화되는 효과도 있다.

도면의 간단한 설명

[0001] 도 1은 종래 기술에 의한 방열장치가 채용된 전자기기의 내부 구성을 보인 평면도.

[0002] 도 2는 종래 기술에 의한 방열장치의 요부 구성을 보인 사시도.

[0003] 도 3은 본 발명에 의한 전자기기의 방열장치의 바람직한 실시예의 구성을 보인 사시도.

[0004] 도 4는 본 발명 실시예의 요부 구성을 보인 확대사시도.

[0005] 도 5는 본 발명에서 다양한 방열핀유니트를 통과하는 공기의 유속을 보인 설명도.

[0006] * 도면의 주요 부분에 대한 부호의 설명 *

[0007] 20: 팬하우징 21: 흡입구

[0008] 22: 방열팬 24: 방열핀유니트

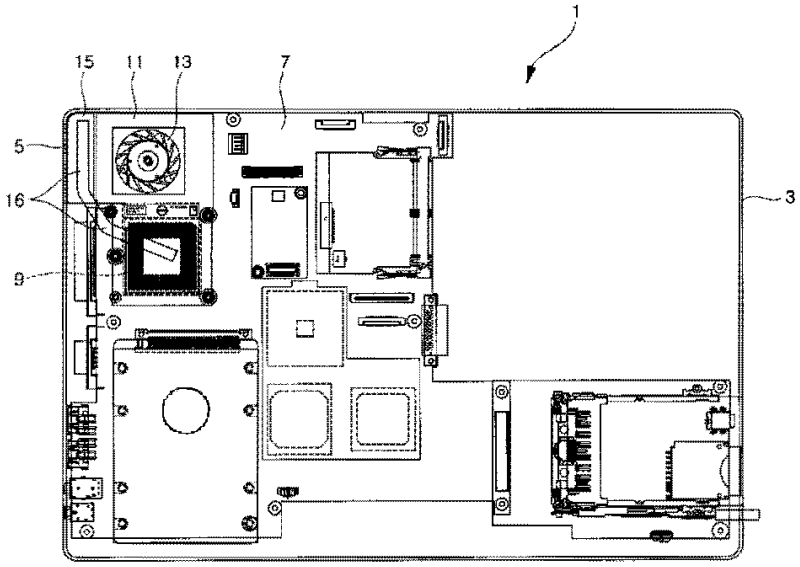
[0009] 26: 방열핀 28: 히트파이프

[0010] 30: 히트싱크

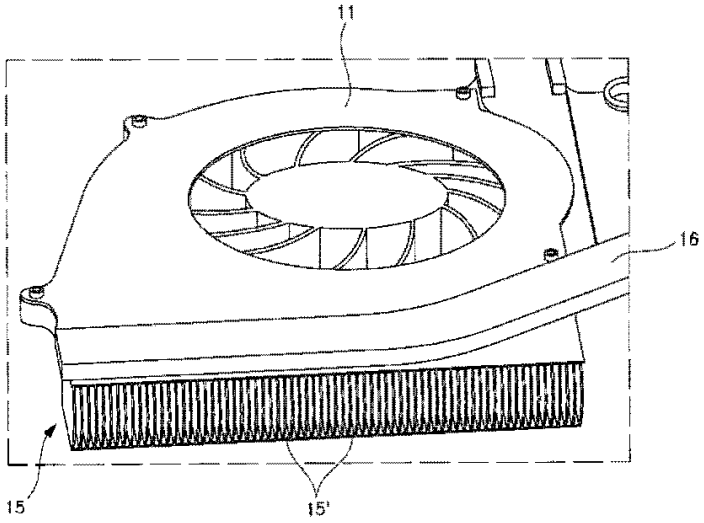
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도면

도면1

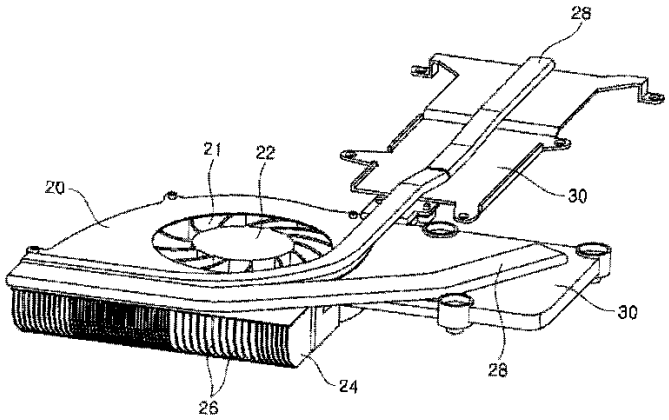


도면2

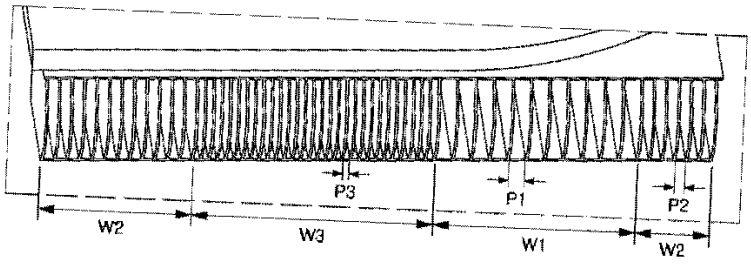


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도면3

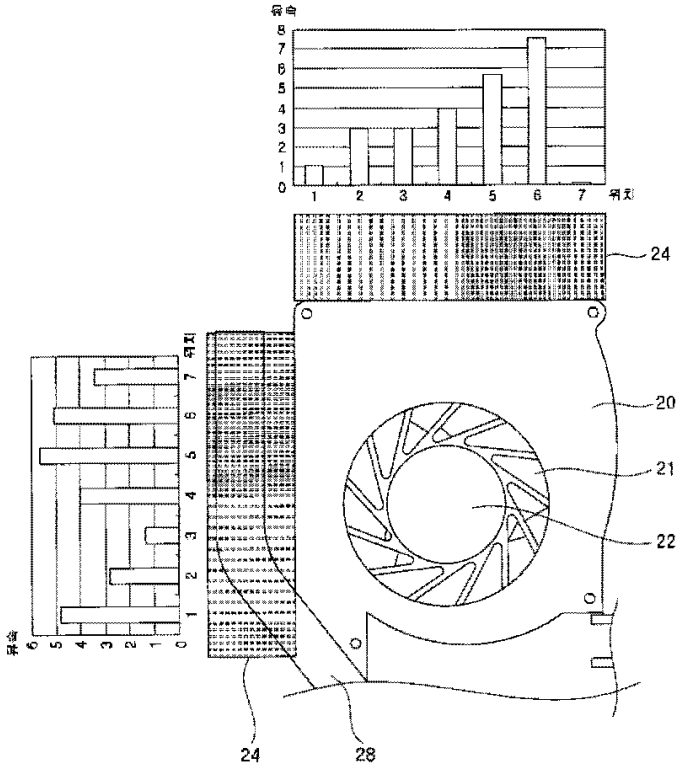


도면4



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도면5



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/651,508	07/17/2017	2811	2400	5367-694P/CON\409926	18	1

CONFIRMATION NO. 2349

UPDATED FILING RECEIPT

27799
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Date Mailed: 09/25/2017

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

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Stan MAES, Dilsen-Stokken, BELGIUM;
Romana SIGL, Salzburg, AUSTRIA;
Annette HAID, Salzburg, AUSTRIA;
Stephan LINTNER, Salzburg, AUSTRIA;
Julian HERGET, Marktschellenberg, GERMANY;
Gregor MATJAN, Bergheim, AUSTRIA;

Applicant(s)

OSRAM OLED GmbH, Regensburg, GERMANY;

Assignment For Published Patent Application

OSRAM OLED GMBH

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 13/139,514 01/03/2012
which is a 371 of PCT/DE2009/001741 12/09/2009

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)
GERMANY 10 2008 061 563.3 12/11/2008

Permission to Access Application via Priority Document Exchange: No

SDC EX. 1016 - 373/959

Permission to Access Search Results: No

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 07/24/2017
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/651,508**
Projected Publication Date: 01/04/2018
Non-Publication Request: No
Early Publication Request: No
Title

Organic-Light-Emitting Diode

Preliminary Class

257

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

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Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

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This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

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technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

SDC EX. 1016 - 376/959

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/651,508	07/17/2017	Ulrich KASTNER-JUNG	5367-694P/CON\409926

CONFIRMATION NO. 2349

27799
Cozen O'Connor
277 Park Avenue, 20th floor
NEW YORK, NY 10172

INFORMAL NOTICE

OC000000094287306

Date Mailed: 09/25/2017

INFORMATIONAL NOTICE TO APPLICANT

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

The item(s) indicated below are also required and should be submitted with any reply to this notice to avoid further processing delays.

A new inventor's oath or declaration that identifies this application (e.g., by Application Number and filing date) is required. The inventor's oath or declaration does not comply with 37 CFR 1.63 in that it:

- does not state that the above-identified application was made or authorized to be made by the person executing the oath or declaration.

  Ulrich KASTNER-JUNG
  Markus KLEIN
  Stan MAES
  Romana SIGL
  Annette HAID
  Stephan LINTNER
  Julian HERGET
  Gregor MATJAN

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/hkquach/

SDC EX. 1016 - 377/959

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 15/651,508

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	18 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						800
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2400

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	15/651,508
Filing Date	Juy 17, 2017
First Named Inventor	Ulrich KASTNER-JUNG
Title	Organic-Light-Emitting Diode
Art Unit	2844
Examiner Name	CHO, JAMES HYONCHOL
Attorney Docket Number	5367-694P/CON/409926

SIGNATURE of Applicant or Patent Practitioner

Signature	/Thomas Langer/	Date (Optional)	December 1, 2017
Name	Thomas Langer	Registration Number	27,264
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 2 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

■ Practitioners associated with Customer Number: 27799

OR

☐ Practitioner(s) named below (If more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignments documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

☐ The address associated with Customer Number:

OR

☐	Firm or Individual Name			
	Address			
	City		State	Zip
	Country			
	Telephone		Email	

Assignee Name and Address: OSRAM OLED GmbH
Leibnizstrasse 4
Regensburg, Germany 93055

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of the practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record
The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	ppa K Diekmann	Date	12.10.2017
Name	Dr. Marc Lünemann	Telephone	Dr. Karsten Diekmann
Title	CEO		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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Electronic Acknowledgement Receipt

EFS ID:	31102420
Application Number:	15651508
International Application Number:	
Confirmation Number:	2349
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Customer Number:	27799
Filer:	Thomas Langer/Christina Constantino
Filer Authorized By:	Thomas Langer
Attorney Docket Number:	5367-694P/CON\409926
Receipt Date:	01-DEC-2017
Filing Date:	17-JUL-2017
Time Stamp:	12:58:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	5367-694PCON-Decl.pdf	702964 09a0231fc8de856788b031b5321a0bc86af716e2	no	8

Warnings:

Information:					
2	Power of Attorney	5367-694PCON-POA.pdf	74528 aa0618b0fad4b21ed0c103dc79abb816990ae16e	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	777492	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/01 (06-12)
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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Organic-Light-Emitting Diode

As the below named inventor, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ☒ United States application or PCT international application number 15/651,508 filed on July 17, 2017

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Ulrich KASTNER-JUNG Date (Optional): 22/10/2017

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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- ▩ United States application or PCT international application number 15/651,508 filed on July 17, 2017

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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LEGAL NAME OF INVENTOR

Inventor: Markus KLEIN Date (Optional): _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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☒ United States application or PCT international application number 15/651,508

filed on July 17, 2017

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LEGAL NAME OF INVENTOR

Inventor: Stan MAES Date (Optional): 13/10/2017

Signature: [signature]

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	Organic-Light-Emitting Diode

As the below named inventor, I hereby declare that:

This declaration is directed to:

- ☐ The attached application, or
- ▩ United States application or PCT international application number 15/651,508 filed on July 17, 2017

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: Romana SIGL Date (Optional): 16.11.2017

Signature: [signature]

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LEGAL NAME OF INVENTOR

Inventor: Annette HAID Date (Optional): 08.11.2017

Signature: Annette Haid

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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LEGAL NAME OF INVENTOR

Inventor: Stephan LINTER Date (Optional): 8.11.2017

Signature: Stephan Linter

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LEGAL NAME OF INVENTOR

Inventor: Julian HERGET Date (Optional): 7.11.17

Signature: [signature]

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LEGAL NAME OF INVENTOR

Inventor: Gregor MATJAN Date (Optional): 10/22/2012

Signature:

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/651,508	07/17/2017	Ulrich KASTNER-JUNG	5367-694P/CON\409926

CONFIRMATION NO. 2349

27799
Cozen O'Connor
277 Park Avenue, 20th floor
NEW YORK, NY 10172

POA ACCEPTANCE LETTER

OC000000095875683

Date Mailed: 12/06/2017

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 12/01/2017.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/cvorachack/

SDC EX. 1016 - 391/959

Attorney Docket # 5367-694P/CON/409926 Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Kastner-Jung, Ulrich et al. Serial No.: 15/651,508 Filed: July 17, 2017 For: Organic-Light-Emitting Diode	Examiner: CHO, JAMES HYONCHOL Art Unit: 2811

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

S I R:

In compliance with the duty of disclosure under 37 C.F.R. § 1.56 and in accordance with the practice under 37 C.F.R. §§ 1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a. A copy of the listed non-US document is also enclosed.

Enclosed is a copy of an English translation of an Office Action dated November 29, 2017 which issued in the corresponding Korean Patent Application No. 10-2017-7026128.

It is respectfully requested that the above information be considered by the Examiner and that the copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or

SDC EX. 1016 - 392/959

that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicants reserve the right to prove that the date of publication is in fact different.

If any fees or charges are deemed required at this time in connection with the application, the same may be charged to our Patent and Trademark Office Deposit Account No. 503111.

Respectfully submitted,
COZEN O'CONNOR

By: /Alphonso A. Collins/
Alphonso A. Collins
Reg. No. 43,559
277 Park Avenue
New York, New York 10172
(212) 883-4900

Dated: December 18, 2017

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Substitute for Form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	15/651,508
Filing Date	July 17, 2017
First Named Inventor	Kastner-Jung, Ulrich
Art Unit	2811
Examiner Name	CHO, JAMES HYONCHOL
Attorney Docket	5367-694P/CON/409926

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number Number-Kind-Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-2001/0043046	11-22-2001	Fukunaga	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Document Country Code[3]- Number[4]- Kind-Code [5] (if known	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		JP 2002-033198	01-31-2002	Semiconductor Energy Lab		✓

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
		Office Action dated November 29, 2017 which issued in the corresponding Korean Patent Application No. 10-2017-7026128.	✓

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, Washington, DC 20231.

Espacenet

Bibliographic data: JP2002033198 (A) — 2002-01-31

LIGHT EMITTING DEVICE AND MANUFACTURING METHOD THEREOF

Inventor(s): FUKUNAGA KENJI ± (FUKUNAGA KENJI)

Applicant(s): SEMICONDUCTOR ENERGY LAB ± (SEMICONDUCTOR ENERGY LAB CO LTD)

Classification: - international: ***G09F9/30; H01L27/32; H01L51/50; H05B33/04; H05B33/10; H05B33/14; H05B33/24; H05B33/26; H05B33/28;*** (IPC1-7): G09F9/30; H05B33/04; H05B33/10; H05B33/14; H05B33/24; H05B33/26; H05B33/28

- cooperative: H01L27/3276

Application number: JP20010136190 20010507

Priority number(s): JP20010136190 20010507 ; JP20000135076 20000508

Also published as: JP4713010 (B2)

Abstract of JP2002033198 (A)

PROBLEM TO BE SOLVED: To provide a bright light emitting device with good image quality. SOLUTION: An EL element 105 consisting of an electrode 102 containing a reflecting surface, an organic EL layer 103 and a transparent electrode 104 is provided on an insulator 101, and an auxiliary electrode 107 is connected to the transparent electrode 104 through an anisotropic conductor 108. Accordingly, since the effective resistance value of the transparent electrode 104 can be reduced, and a uniform voltage can be applied to the organic EL layer 103, a display failure such as display unevenness or the like can be prevented.

SDC EX. 1016 - 395/959

Espacenet

Description: JP2002033198 (A) — 2002-01-31

LIGHT EMITTING DEVICE AND MANUFACTURING METHOD THEREOF

Description of JP2002033198 (A)

The EPO does not accept any responsibility for the accuracy of data and information originating from other authorities than the EPO; in particular, the EPO does not guarantee that they are complete, up-to-date or fit for specific purposes.

[0001] 【０００１】【発明の属する技術分野】本発明は、発光性材料からなる薄膜を用いた発光装置に関する。また、その発光装置を表示部として用いた電気器具に関する。なお、有機ＥＬディスプレイや有機発光ダイオード（ＯＬＥＤ：Organic Light Emitting Diode）は本発明の発光装置に含まれる。

[0002] 【０００２】また、本発明に用いることのできる発光性材料は、一重項励起もしくは三重項励起または両者の励起を経由して発光（燐光および／または蛍光）するすべての発光性材料を含む。

[0003] 【０００３】【従来の技術】近年、ＥＬ（Electro Luminescence）が得られる発光性材料からなる薄膜（以下、ＥＬ膜という）を用いた発光素子（以下、ＥＬ素子という）の開発が進んでいる。ＥＬ素子を有する発光装置（以下、ＥＬ発光装置という）は、陽極と陰極との間にＥＬ膜を挟んだ構造からなるＥＬ素子を有し、陽極と陰極との間に電圧を加えることで発光を得る。特に、ＥＬ膜として有機膜を用いたものを有機ＥＬ膜という。

[0004] 【０００４】陰極としては仕事関数の小さい金属（代表的には周期表の１族もしくは２族に属する金属）を用いることが多く、陽極としては可視光に対して透明な導電膜（以下、透明導電膜という）を用いることが多い。このような構造であるため、得られた発光は陽極を透過して視認される。

[0005] 【０００５】最近では、ＴＦＴ（薄膜トランジスタ）を用いて各画素に設けられたＥＬ素子の発光を制御するアクティブマトリクス型ＥＬ発光装置の開発が進められており、試作品が発表されるに至った。ここでアクティブマトリクス型ＥＬ発光装置の構造を図９（Ａ）、（Ｂ）に示す。

[0006] 【０００６】図９（Ａ）において、基板９０１上にはＴＦＴ９０２が形成され、ＴＦＴ９０２には陽極９０３が接続されている。陽極９０３の上には有機ＥＬ膜９０４、陰極９０５が形成され、陽極９０３、有機ＥＬ膜９０４および陰極９０５からなるＥＬ素子９０６が形成されている。

[0007] 【０００７】このとき、有機ＥＬ膜９０４で生成された発光は陽極９０３を透

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過して図中の矢印の方向に向かって放射される。従って、ＴＦＴ９０２は観測者から見て発光を遮る遮蔽物となってしまい、有効発光領域（観測者が発光を観測しうる領域）を狭める要因となっていた。また、有効発光領域が狭い場合、明るい画像を得るには発光輝度を上げる必要があったが、発光輝度を上げることは有機ＥＬ膜の劣化を早める結果となってしまっていた。

[0008] 【０００８】そこで、図９（Ｂ）に示すような構造のアクティブマトリクス型ＥＬ発光装置が提案されている。図９（Ｂ）において、基板９０１上にはＴＦＴ９０２が形成され、ＴＦＴ９０２には陰極９０７が接続されている。陰極９０７の上には有機ＥＬ膜９０８、陽極９０９が形成され、陰極９０７、有機ＥＬ膜９０８および陽極９０９からなるＥＬ素子９１０が形成されている。即ち、図９（Ａ）に示したＥＬ素子９０６とはちょうど逆向きの構造のＥＬ素子となる。

[0009] 【０００９】このとき、原理上はＥＬ膜９０８で生成された発光が陽極９０９を透過して図中の矢印の方向に向かって放射される。従って、ＴＦＴ９０１は観測者から見えない位置に設けられ、陰極９０３が設けられた領域すべてを有効発光領域とすることが可能である。

[0010] 【００１０】しかしながら、図９（Ｂ）に示す構造は、陽極９０９に均一な電圧を印加できないという問題を潜在的に抱えている。陽極として一般的に用いられる透明導電膜は金属膜に比べて抵抗値が高いが、熱処理により抵抗値を下げられることが知られている。ところが有機ＥＬ膜は耐熱性が低いため、有機ＥＬ膜を成膜した後に１５０℃を超える熱処理を行うことはできない。

[0011] 【００１１】従って、有機ＥＬ膜の上に陽極（透明導電膜）を積層する際には熱処理を行うことができず、抵抗値の低い陽極を形成することが困難である。即ち、陽極の端部と中心部とで印加される電圧が異なるといった問題が生じる可能性があり、この問題が画質不良を起こす要因となることが懸念される。

[0012] 【００１２】以上のように、有機ＥＬ膜を成膜した後に透明導電膜を用いる構造を含む発光装置では、透明導電膜の低抵抗化が困難という問題があった。

[0013] 【００１３】【発明が解決しようとする課題】本発明は上記問題点を解決するためになされたものであり、明るく画質の良好な発光装置を提供することを課題とする。また、そのような発光装置を表示部として用いた画質の良い電気器具を提供することを課題とする。

[0014] 【００１４】【課題を解決するための手段】本発明は有機ＥＬ膜を成膜した後で設けられた透明電極に対して並列に補助的な電極を接続することにより実質的に透明電極の低抵抗化を図る点に特徴がある。ここで本発明について図１を用いて説明する。

[0015] 【００１５】図１において、１０１は絶縁体、１０２は反射面を含む電極、１０３は有機ＥＬ層、１０４は可視光に対して透明もしくは半透明な電極（以下、透明電極という）であり、絶縁体１０１上には反射面を含む電極１０２、有機ＥＬ層１０３および透明電極１０４からなるＥＬ素子１０５が形成されている。

[0016] 【００１６】なお、可視光に対して透明とは可視光を８０～１００%の透過率で透過することをいい、可視光に対して半透明とは可視光を５０～８０%の透過率で透過することをいう。勿論、膜厚によって透過率は異なるが、膜厚は上記範囲内に収まるように適宜設計すれば良い。

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[0017] 【００１７】ここで絶縁体１０１は絶縁基板もしくは表面に絶縁膜を設けた基板であり、ＥＬ素子を支持できるものであれば良い。

[0018] 【００１８】また、反射面を含む電極１０２とは、金属電極または金属電極および透明電極の積層された電極を指す。即ち、電極の表面、裏面もしくは電極内部の界面に可視光を反射しうる面（反射面）を含む電極を指す。

[0019] 【００１９】また、有機ＥＬ層１０３は、有機ＥＬ膜または有機ＥＬ膜と有機材料との積層膜を用いることができる。即ち、有機ＥＬ膜を発光層として単層で設けても良いし、有機ＥＬ膜を発光層とし有機材料を電荷注入層もしくは電荷輸送層として積層して設けても良い。なお、無機材料の中には電荷注入層もしくは電荷輸送層として用いることのできる材料もあり、そのような無機材料を電荷注入層もしくは電荷輸送層として用いることも可能である。

[0020] 【００２０】また、透明電極１０４としては、透明導電膜からなる電極もしくは膜厚が５～７０ｎｍ（代表的には１０～５０ｎｍ）の金属膜（以下、半透明な金属膜という）からなる電極を用いることができる。透明導電膜としては、酸化物導電膜（代表的には酸化インジウム膜、酸化スズ膜、酸化亜鉛膜、酸化インジウムと酸化スズとの化合物膜もしくは酸化インジウムと酸化亜鉛との化合物膜）または酸化物導電膜に酸化ガリウムを添加したものを用いることができる。また、透明電極１０４として透明導電膜を用いる場合、１０～２００ｎｍ（好ましくは５０～１００ｎｍ）とすることで８０～９５%の可視光を透過することができる。

[0021] 【００２１】以上の構造からなるＥＬ素子１０５の上には、封止体１０６、封止体１０６の表面に設けられた補助電極１０７が設けられ、補助電極１０７は導電体１０８を介して透明電極１０４と電気的に接続されている。なお、導電体１０８は透明電極１０４上に点在して設けられるが、なるべく透明電極上の全面に分散させて設けることが好ましい。

[0022] 【００２２】ここで封止体１０６は可視光に対して透明な基板もしくはフィルムであり、ガラス基板、石英基板、結晶化ガラス基板、プラスチック基板もしくはプラスチックフィルムを用いることができる。但し、プラスチック基板もしくはプラスチックフィルムを用いる場合、表面もしくは裏面に酸素および水の透過を防止する保護膜（好ましくは炭素膜、具体的にはダイヤモンドライクカーボン膜）を設けておくことが望ましい。

[0023] 【００２３】また、補助電極１０７は透明電極１０４の抵抗値を下げる目的で補助的に設けられた電極であり、透明電極１０４と同様に透明導電膜からなる電極もしくは膜厚が半透明な金属膜からなる電極を用いることができる。また、補助電極１０７の膜厚を透明電極１０４と同様に１０～２００ｎｍ（好ましくは５０～１００ｎｍ）とすることで８０～９５%の可視光を透過することができる。

[0024] 【００２４】また、導電体１０８は異方導電性膜等と呼ばれる導電膜を用いて形成することができる。従って、異方導電膜と呼ぶこともできる。異方導電性膜とは導電粒子（代表的には金属粒子もしくはカーボン粒子）を均一に分散させた樹脂膜である。本発明では、異方導電性膜１０８をフォトリソグラフィによりパターン化して選択的に設けるか、インクジェット法もしくは印刷法により選択的に設けることが好ましい。なぜならば異方導電性膜は可視光に対する透過率が低いため、透明電極１０４の全面に設けてしまうと有機ＥＬ層１０３から発した光が吸収されてしまうからである。

[0025] 【００２５】以上のような構造を含む本発明の発光装置では、補助電極１０７

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が透明導電膜からなる透明電極１０４に並列に接続された電極として機能する。また、このとき補助電極１０７は封止体１０６側に形成されるため、従来例で説明したような有機ＥＬ膜の耐熱性の制約を受けずに抵抗値を低くすることができる。従って、本発明を実施することにより透明電極１０４に均一な電圧を加えることが可能となり、画質の良い画像を得ることが可能である。

[0026] 【００２６】【発明の実施の形態】本発明の実施の形態について図２を用いて説明する。図２において、２０１は素子を形成する側の基板である。本発明では基板２０１として如何なる材料を用いても良く、ガラス（石英ガラスを含む）、結晶化ガラス、単結晶シリコン、セラミックス、金属もしくはプラスチックを用いることが可能である。

[0027] 【００２７】基板２０１上には画素２０２が形成され、画素２０２はスイッチングＴＦＴ２０３及び電流制御ＴＦＴ２０４を含む構造となっている。なお、図２には三つの画素が示されており、各々赤、緑もしくは青に発光する画素が形成されている。スイッチングＴＦＴ２０３はビデオ信号を画素に取り込むためのスイッチとして機能し、電流制御ＴＦＴ２０４はＥＬ素子に流れる電流を制御するためのスイッチとして機能する。このとき、スイッチングＴＦＴ２０３のドレインは電流制御ＴＦＴ２０４のゲートに電気的に接続されている。

[0028] 【００２８】スイッチングＴＦＴ２０３及び電流制御ＴＦＴ２０４の構造に限定はなく、トップゲート型（代表的にはプレーナ型）もしくはボトムゲート型（代表的には逆スタガ型）を用いれば良い。また、どちらのＴＦＴもｎチャネル型ＴＦＴもしくはｐチャネル型を用いれば良い。

[0029] 【００２９】また、スイッチングＴＦＴ２０３及び電流制御ＴＦＴ２０４は層間絶縁膜２０５に覆われ、その上には導電体プラグ２０６を介して金属膜からなる画素電極２０７と電流制御ＴＦＴ２０４のドレインとが電気的に接続されている。また、画素電極２０７には第１の透明電極２０８が１０～２００ｎｍ（好ましくは５０～１００ｎｍ）の膜厚で積層されている。ここでは画素電極２０７と第１の透明電極２０８とで陽極２３０を形成している。

[0030] 【００３０】なお、本実施の形態では電流制御ＴＦＴ２０４のドレインと画素電極２０７とが接続されるコンタクトホールを導電体で埋め込む構造としている。このコンタクトホールを埋め込むように設けられた導電体を導電体プラグと呼ぶ。導電体プラグ２０６は異方導電性膜をエッチングして形成すれば良い。勿論、画素電極２０７を直接電流制御ＴＦＴ２０４のドレインと接続させても良い。

[0031] 【００３１】ところで、上記コンタクトホールに起因する凹部では有機ＥＬ層のカバレッジが悪く、陰極と陽極のショート（短絡）を招く恐れがあるため好ましいものではない。本実施の形態では導電体プラグ２０６を用いることで画素電極２０７にコンタクトホールに起因する凹部が形成されないようにできるため、陰極と陽極のショートを防ぐことができる。

[0032] 【００３２】また、画素電極２０７は反射率の高い金属膜を用いることが好ましく、アルミニウム膜（アルミニウム合金膜や添加物を含むアルミニウム膜を含む）もしくは銀薄膜を用いると良い。金属膜にアルミニウムメッキもしくは銀メッキを施した膜を用いても良い。

[0033] 【００３３】次に、２０９は陽極２３０の間に設けた絶縁膜（以下、バンクという）であり、陽極２３０の端部に形成される段差を覆うように形成される。本実施の形態ではバンク２０９を設けることで電界集中を起こしやすい陽極２３０の端部か

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ら有機ＥＬ層を遠ざけ、電界集中による有機ＥＬ層の劣化を防ぐ構造となっている。なお、バンク２０９としては樹脂膜を用いても珪素を含む絶縁膜（代表的には酸化珪素膜）を用いても良い。

[0034] 【００３４】次に、２１０は赤色に発光する有機ＥＬ層、２１１は緑色に発光する有機ＥＬ層、２１２は青色に発光する有機ＥＬ層である。有機ＥＬ層２１０～２１２の層構造は公知の技術を参考にすれば良い。

[0035] 【００３５】また、有機ＥＬ層２１０～２１２を覆うようにして設けられた第２の透明電極２１３は有機ＥＬ層に電子を注入するための電極である。この第２の透明電極２１３の仕事関数は２．５～３．５ｅＶであることが好ましく、周期表の１族もしくは２族に属する元素を含む金属膜を用いると良い。ここではアルミニウムとリチウムとを共蒸着した合金膜（以下、Ａｌ－Ｌｉ膜という）を用いる。また、Ａｌ－Ｌｉ膜は金属膜であるため、膜厚を１０～７０ｎｍ（代表的には２０～５０ｎｍ）とすることで透明電極とすることができる。

[0036] 【００３６】さらに、その上には１００～３００ｎｍ（好ましくは１５０～２００ｎｍ）の透明導電膜からなる第３の透明電極２１４が設けられている。第３の透明電極２１４は第２の透明電極２１３に電圧を加えるための役割を果たす電極である。ここでは第２の透明電極２１３と第３の透明電極２１４とで陰極２３１を形成している。

[0037] 【００３７】また、基板２０１（ここでは基板２０１に設けられた薄膜も含めて基板と呼んでいる）に対向させて設けられた封止体２１５には膜厚が１０～２００ｎｍ（好ましくは５０～１００ｎｍ）の透明導電膜からなる補助電極（第４の透明電極）２１６が形成されており、第３の透明電極２１４および補助電極２１６は異方導電性膜（金属粒子もしくはカーボン粒子を分散させた樹脂膜）からなる導電体２１７を介して電気的に接続されている。

[0038] 【００３８】導電体２１７は、第３の透明電極２１４の上に部分的に設けることが好ましい。即ち、異方導電性膜は黒色もしくは灰色であるため、少なくとも画素の発光領域に重ならないように設けることが望ましい。もちろん、画素間に設けることで積極的にブラックマトリクスとして用い、画素ごとの光の指向性を高めることも可能である。

[0039] 【００３９】なお、基板２０１および封止体２１５は基板２０１の外縁に設けられたシール材（図示せず）により貼り合わせられている。また、基板２０１および封止体２１５を貼り合わせる際、基板２０１と封止体２１５の間隔を決めるためのスペーサ（好ましくは１～３μｍ）を設けても良い。特に、このスペーサを導電体２１７で兼ねることは有効である。

[0040] 【００４０】また、基板２０１と封止体（対向基板）２１５との間に形成された空間２１８には窒素ガスもしくは希ガスを封入しておくことが好ましい。また、この空間２１８には吸湿性をもつ物質や脱酸素性をもつ物質を設けておくことが望ましい。

[0041] 【００４１】ここで領域２１９の詳細な構造を図２（Ｂ）に示す。図２（Ｂ）では陽極２３０、有機ＥＬ層２１２および陰極２３１がＥＬ素子２２０を形成している。図２（Ａ）に示した発光装置において最も特徴的な点は陰極２３１を透過して発光が観測される点にある。

[0042] 【００４２】ＥＬ素子２２０で生成された光のうち陽極２３０側へ向かった光

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は反射率の高い表面を有する画素電極２０７により反射され、陰極２３１側へ向かう。即ち、画素電極２０７は陽極２３０に電流を供給する（電子を引き抜く）電極であると同時に反射電極としての機能をも有する。

[0043] 【００４３】なお、第２の透明電極２１３は膜厚が非常に薄いため抵抗値が高い。そのため第３の透明電極２１４を積層して低抵抗化を図っている。しかしながら、第３の透明電極２１４として用いる透明導電膜は有機ＥＬ層２１２を成膜した後で形成することになるため、抵抗値を低くすることが困難である。そこで本実施の形態では透明導電膜からなる第３の透明電極２１４に並列に、透明導電膜からなる補助電極２１６を接続することにより第３の透明電極２１４の実質的な低抵抗化を図っている。

[0044] 【００４４】以上のような構造の発光装置は、画素２０２全体が有効発光領域となるため非常に明るい画像を得ることが可能である。また、本発明を実施することにより陰極２３１全体に均一な電圧を加えることができるため、画質の良い画像を得ることが可能である。

[0045] 【００４５】【実施例】〔実施例１〕本実施例では図２に示した発光装置の作製工程について図３～５を用いて説明する。なお、図３、４に示したのは画素部における作製工程を示す断面図である。また、本実施例によって作製される画素の上面図（但し陽極を形成した時点での上面図）を図５（Ａ）に、最終的な画素の回路図を図５（Ｂ）に示す。なお、図５に用いた符号は図３、４で用いた符号に対応している。

[0046] 【００４６】まず、図３（Ａ）に示すように、基板としてガラス基板３０１を用意し、その上に酸化珪素膜からなる下地膜３０２を２００ｎｍの厚さに形成する。下地膜３０２の形成は減圧熱ＣＶＤ法、プラズマＣＶＤ法、スパッタ法もしくは蒸着法を用いれば良い。

[0047] 【００４７】次に、下地膜３０２の上に結晶質珪素膜３０３を５０ｎｍの厚さに形成する。結晶質珪素膜３０３の形成方法としては公知の手段を用いることが可能である。固体レーザーもしくはエキシマレーザーを用いて非晶質珪素膜をレーザー結晶化させても良いし、非晶質珪素膜を加熱処理（ファーネスアニール）により結晶化させても良い。本実施例ではＸｅＣｌガスを用いたエキシマレーザーを照射することにより結晶化させる。

[0048] 【００４８】次に、図３（Ｂ）に示すように、結晶質珪素膜３０３をパターニングして島状の結晶質珪素膜３０４、３０５を形成する。そして島状の結晶質珪素膜３０４、３０５を覆って酸化珪素膜からなるゲート絶縁膜３０６を８０ｎｍの厚さに形成する。さらに、ゲート絶縁膜３０６の上にゲート電極３０７、３０８を形成する。なお、ゲート電極３０７は図面では二つに見えるが実際には二股に分かれた同一の電極である。

[0049] 【００４９】また、本実施例ではゲート電極３０７、３０８の材料として、３５０ｎｍ厚のタングステン膜もしくはタングステン合金膜を用いる。勿論、ゲート電極の材料としては他の公知の材料を用いることができる。さらに、本実施例ではこのとき同時に接続配線３０９も形成する。接続配線３０９は後に電流制御ＴＦＴのソースと電流供給線とを電気的に接続するための配線である。

[0050] 【００５０】次に、図３（Ｃ）に示すように、ゲート電極３０７、３０８をマスクとして周期表の１３族に属する元素（代表的にはボロン）を添加する。添加方法は公知の手段を用いれば良い。こうしてｐ型の導電型を示す不純物領域（以下、ｐ型不純物領域という）３１０～３１４が形成される。また、ゲート電極の直下にはチャ

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ネル形成領域３１５a、３１５b、３１６が画定する。なお、ｐ型不純物領域３１０～３１４はＴＦＴのソース領域もしくはドレイン領域となる。

[0051] 【００５１】次に、加熱処理を行って添加された周期表の１３族に属する元素の活性化を行う。この活性化工程まで行った島状の結晶質珪素膜からなるパターンを活性層と呼ぶ。なお、この活性化はファーネスアニール、レーザーアニールもしくはランプアニールにより行うか、又はそれらを組み合わせて行えば良い。本実施例では５００℃４時間の加熱処理を窒素雰囲気で行う。

[0052] 【００５２】但し、この活性化工程では処理雰囲気中の酸素濃度を１ｐｐｍ以下（好ましくは０．１ｐｐｍ以下）にすることが望ましい。酸素濃度が高いとゲート電極３０７、３０８、接続配線３０９の表面が酸化されてしまい、後に形成するゲート配線や電流供給線との電気的接触が難しくなってしまうからである。

[0053] 【００５３】なお、活性化が終了したら、水素化処理を行うと効果的である。水素化処理は公知の水素アニール技術もしくはプラズマ水素化技術を用いれば良い。

[0054] 【００５４】次に、図３（Ｄ）に示すように、接続配線３０９に接するようにして電流供給線３１７を形成する。このような構造（上面図は図５（Ａ）の５０１で示される領域に示す）とすることで接続配線３０９と電流供給線３１７が電気的に接続される。なお、図示していないが、このときゲート配線（図５（Ａ）の５０２で示される配線）も同時に形成され、ゲート電極３０７と電気的に接続される。この上面図は図５（Ａ）の５０３で示される領域に示す。

[0055] 【００５５】この５０３で示される領域において、ゲート配線５０２が凸部を有しているのはゲート電極３０７を乗り越えない部分を確保しておくための冗長設計である。こうすることでゲート配線５０２がゲート電極３０７を乗り越える部分で断線したとしてもゲート配線５０２がそこで電気的に断線してしまうことを避けることができる。また、ゲート電極３０７をコの字型に加工しているのも、確実に両方のゲート電極に電圧が印加されるようにするための冗長設計である。

[0056] 【００５６】この電流供給線３１７及びゲート配線５０２は接続配線３０９やゲート電極３０７よりも低抵抗な金属膜で形成される。好ましくはアルミニウム、銅もしくは銀を含む金属膜を用いると良い。即ち、微細なパターン精度を要求されるゲート電極には加工性の高い金属膜を用い、抵抗率の低さを要求されるバスライン（本実施例ではゲート配線や電流供給線）には低抵抗な金属膜を用いる。

[0057] 【００５７】ゲート配線５０２及び電流供給線３１７を形成したら、酸化珪素膜からなる第１層間絶縁膜３１８を８００ｎｍの厚さに形成する。形成方法としてはプラズマＣＶＤ法を用いれば良い。第１層間絶縁膜３１８としては他の無機絶縁膜を用いても良いし、樹脂（有機絶縁膜）を用いても良い。

[0058] 【００５８】次に、図３（Ｅ）に示すように、第１層間絶縁膜３１８にコンタクトホールを形成して配線３１９～３２２を形成する。本実施例では配線３１９～３２２としてチタン／アルミニウム／チタンの三層構造からなる金属配線を用いる。勿論、導電膜であれば如何なる材料を用いても良い。配線３１９～３２２はＴＦＴのソース配線もしくはドレイン配線となる。

[0059] 【００５９】また、電流制御ＴＦＴのドレイン配線３２２は接続配線３０９と電気的に接続される。その結果、電流制御ＴＦＴ４０２のドレインと電流供給線３１７とが電気的に接続される。

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[0060] 【００６０】この状態でスイッチングＴＦＴ４０１及び電流制御ＴＦＴ４０２が完成する。本実施例ではどちらのＴＦＴもｐチャネル型ＴＦＴで形成されるが、両方もしくはいずれか一方をｎチャネル型ＴＦＴとしても良い。

[0061] 【００６１】また、スイッチングＴＦＴ４０１はゲート電極が活性層を二カ所で横切るように形成されており、二つのチャネル形成領域が直列に接続された構造となっている。このような構造とすることでオフ電流値（ＴＦＴがオフされた時に流れる電流）を効果的に抑制することができる。

[0062] 【００６２】また、画素内では図５（Ａ）に示すように保持容量５０４が形成される。保持容量５０４の断面図（図５（Ａ）をＢ－Ｂ'で切断した断面図）を図６に示す。保持容量５０４は電流制御ＴＦＴ４０２のドレインに電気的に接続された半導体層５０５、ゲート絶縁膜３０６及び容量配線５０６で形成される。即ち、半導体層５０５と容量配線５０６はゲート絶縁膜３０６により絶縁され、コンデンサ（保持容量）を形成している。

[0063] 【００６３】容量配線５０６はゲート配線５０２や電流供給線３１７と同時に形成され、ゲート電極３０８と接続配線５０７とを電気的に接続する配線も兼ねる。なお、接続配線５０７はスイッチングＴＦＴ４０１のドレイン配線（ソース配線として機能する場合もある）３２０に電気的に接続されている。

[0064] 【００６４】本実施例に示す保持容量の利点は、容量配線５０６が活性層を形成した後に形成される点である。即ち、本実施例の場合、半導体層５０５がｐ型不純物領域となっているため、そのまま電極として用いることが可能である。

[0065] 【００６５】配線３１９～３２２を形成したら、窒化珪素膜もしくは窒化酸化珪素膜からなるパッシベーション膜３２３を２００ｎｍの厚さに形成する。このパッシベーション膜３２３を形成する前もしくは後に水素化処理を行うことでＴＦＴの電気特性を向上させることができる。

[0066] 【００６６】次に、図４（Ａ）に示すように、第２層間絶縁膜３２４としてアクリル樹脂を１μｍの厚さに形成し、コンタクトホール３２５を開けた後、異方導電性膜３２６を形成する。本実施例では異方導電性膜３２６として銀粒子を分散させたアクリル樹脂を用いる。また、異方導電性膜３２６はコンタクトホール３２５を平坦化することができる程度に十分な厚さで形成することが望ましい。本実施例では、１．５μｍの厚さでスピンコーティング法により形成する。

[0067] 【００６７】次に、異方導電性膜３２６を、酸素ガスを用いたプラズマによりエッチングする。このプロセスは第２層間絶縁膜３２４が露呈するまで続けられる。エッチングが終了すると、図３（Ｂ）に示すような形状で導電体プラグ３２７が形成されることになる。なお、第２層間絶縁膜３２４が露呈した時、導電体プラグ３２７は第２層間絶縁膜３２４とのエッチングレートの差により段差を生じる場合があるが、段差が１００ｎｍ以下（好ましくは５０ｎｍ以下）であれば特に問題とはならない。

[0068] 【００６８】導電体プラグ３２７を形成したら、スカンジウムもしくはチタンを添加したアルミニウム膜及びＩＴＯ膜（酸化インジウムと酸化スズとの化合物膜）を積層し、エッチングしてスカンジウムもしくはチタンを添加したアルミニウム膜からなる画素電極３２８及びＩＴＯ膜からなる第１の透明電極３２９を形成する。本実施例では画素電極３２８と第１の透明電極３２９とで陽極３４０が形成される。

[0069] 【００６９】本実施例では、アルミニウム膜の膜厚は２００ｎｍとし、ＩＴＯ

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膜の膜厚は１００ｎｍとする。また、ＩＴＯ膜はＩＴＯ−０４Ｎ（関東化学株式会社のＩＴＯ膜用エッチング溶液の商品名）でエッチング可能であり、アルミニウム膜は四塩化炭素（ＳｉＣｌ4）と塩素（Ｃｌ2）を混合したガスを用いたドライエッチング法によりエッチング可能である。

[0070] 【００７０】こうして得られた図４（Ｂ）の断面構造は、図５（Ａ）においてＡ−Ａ'で切断した断面構造に相当する。

[0071] 【００７１】次に、図４（Ｃ）に示すように、バンクとして絶縁膜３３０を形成する。本実施例ではアクリル樹脂を用いてバンク３３０を形成するが、酸化珪素膜を用いて形成することも可能である。バンク３３０を形成したら第１の透明電極３２９に対して酸素雰囲気中で紫外光を照射し、第１の透明電極３２９の表面処理を行う。これは第１の透明電極３２９の仕事関数を大きくする作用があり、さらに表面汚染を除去する作用もある。

[0072] 【００７２】そして、有機ＥＬ膜３３１、３３２を各々５０ｎｍの厚さに形成する。なお、有機ＥＬ膜３３１は青色に発光する有機ＥＬ膜であり、有機ＥＬ膜３３２は赤色に発光する有機ＥＬ膜である。なお、図示しないが同時に緑色に発光する有機ＥＬ膜も形成する。本実施例では、シャドーマスクを用いた蒸着法により画素ごとに有機ＥＬ膜を作り分ける。勿論、印刷法やインクジェット法を用いて作り分けることも可能である。

[0073] 【００７３】また、本実施例では有機ＥＬ膜３３１、３３２を単層で用いる例を示しているが、正孔注入層としてＣｕＰｃ（銅フタロシアニン）を用いた積層構造とすることも有効である。この場合、まず全面に銅フタロシアニン膜を形成し、その後、赤色、緑色及び青色に対応する画素ごとに各々赤色に発光する有機ＥＬ膜、緑色に発光する有機ＥＬ膜及び青色に発光する有機ＥＬ膜を形成する。

[0074] 【００７４】なお、緑色の有機ＥＬ膜を形成する時は、有機ＥＬ膜の母体材料としてＡｌｑ3（トリス−８−キノリノラトアルミニウム錯体）を用い、キナクリドンもしくはクマリン６をドーパントとして添加する。また、赤色の有機ＥＬ膜を形成する時は、有機ＥＬ膜の母体材料としてＡｌｑ3を用い、ＤＣＪＴ、ＤＣＭ１もしくはＤＣＭ２をドーパントとして添加する。また、青色の有機ＥＬ膜を形成する時は、発光層の有機ＥＬ膜としてＢＡｌｑ3（２−メチル−８−キノリノールとフェノール誘導体の混合配位子を持つ５配位の錯体）を用い、ペリレンをドーパントとして添加する。

[0075] 【００７５】勿論、本発明では上記有機ＥＬ膜に限定する必要はなく、公知の低分子系有機ＥＬ膜、高分子系有機ＥＬ膜を用いることが可能である。高分子系有機ＥＬ膜を用いる場合は塗布法（スピンコート法、インクジェット法もしくは印刷法）を用いることもできる。

[0076] 【００７６】以上のようにして有機ＥＬ膜３３１、３３２を形成したら、第２の透明電極３３３として２０ｎｍの厚さのＭｇＡｇ膜（マグネシウム（Ｍｇ）に１〜１０%の銀（Ａｇ）を添加した金属膜）を形成し、さらに第３の透明電極３３４として２５０ｎｍの厚さのＩＴＯ膜を形成する。本実施例では第２の透明電極３３３および第３の透明電極３３４で陰極３４１が形成される。

[0077] 【００７７】こうして陽極３４０、有機ＥＬ膜３３１（もしくは有機ＥＬ膜３３２）及び陰極３４１からなるＥＬ素子４００が形成される。本実施例ではこのＥＬ素子が発光素子として機能する。

[0078] 【００７８】次に、図４（Ｄ）に示すように、封止体３３５上に透明導電膜か

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らなる補助電極３３６を２５０ｎｍの厚さに設け、さらに、異方導電性膜からなる導電体３３７を第３の透明電極３３４上に設ける。そして、シール材（図示せず）を用いて基板３０１と封止体３３５とを貼り合わせる。

[0079] 【００７９】なお、貼り合わせ工程はアルゴン雰囲気中で行う。その結果、空間３３８にはアルゴンが封入される。勿論、封入するガスは不活性ガスであれば良く、窒素ガスもしくは希ガスを用いれば良い。また、空間３３８には酸素もしくは水を吸着する物質を設けることが好ましい。また、空間にするのではなく、樹脂を充填させることも可能である。

[0080] 【００８０】以上に示した作製工程によって、画素内にスイッチングＴＦＴ（本実施例ではｐチャネル型ＴＦＴ）４０１及び電流制御ＴＦＴ（本実施例ではｐチャネル型ＴＦＴ）４０２が形成される。本実施例では全てのＴＦＴをｐチャネル型ＴＦＴとするため、作製工程が非常に簡便である。

[0081] 【００８１】また、第２層間絶縁膜３２４により段差の平坦化を行い、さらに電流制御ＴＦＴ４０２のドレイン配線３２１と画素電極３２８とを、コンタクトホール３２５に埋め込まれた導電体プラグ３２７を用いて電気的に接続しているため、陽極３４０の平坦性が高い。従って、有機ＥＬ膜３３２の膜厚の均一性を高めることができるので画素の発光を均一なものとすることができる。

[0082] 【００８２】〔実施例２〕本実施例では、図２に示したＥＬ発光装置とは異なる構造の画素を有したＥＬ発光装置について図７を用いて説明する。なお、本実施例は図２の構造に多少の変更を加えるだけで作製可能であり、図２と異なる点に注目して説明する。従って、図２と同一の符号が付されている部分の説明は「発明の実施の形態」を参照すれば良い。

[0083] 【００８３】本実施例では層間絶縁膜２０５にコンタクトホールを形成したら、その状態で画素電極７０１及び第１の透明電極７０２を形成し、コンタクトホールによる凹部を埋めるように絶縁膜７０３を形成する。本実施例ではこの絶縁膜７０３を埋め込み絶縁膜と呼ぶ。埋め込み絶縁膜７０３はバンク２０９と同時に形成することができるため、特に工程を増加させることはない。

[0084] 【００８４】この埋め込み絶縁膜７０３は、図２の導電体プラグ２０６と同様にコンタクトホールによる凹部に起因する陰極と陽極のショートを防止するためのものである。このとき、埋め込み絶縁膜７０３の上面と第２の透明電極７０２の上面との間の高さは１００～３００ｎｍとすることが好ましい。この高さが３００ｎｍを超えるとその段差が陰極と陽極のショートを生じさせる原因となる場合がある。また、１００ｎｍ以下になると同時形成のバンク２０９の作用（画素電極のエッジ部における電界集中の影響を抑制する作用）が低下してしまう恐れがある。

[0085] 【００８５】本実施例では、第２の透明電極７０２を形成した後、スピンコーティング法によりアクリル樹脂を５００ｎｍの厚さに形成し、酸素ガスをプラズマ化してアクリルの膜厚（但しコンタクトホール外での膜厚）が２００ｎｍとなるまでエッチングする。こうして膜厚を薄くした後にパターニングしてバンク２０９及び埋め込み絶縁膜７０３を形成する。

[0086] 【００８６】ここで本実施例の画素の上面構造を図８に示す。図８において、Ａ－Ａ’で切断した断面図が図７に相当する。なお、図８に封止体２１５、導電体２１７は図示していない。また、基本的な画素構造は図５と同一であるので詳細な説明は省略する。

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[0087] 【００８７】図８において、バンク２０９は画素電極７０１、陽極７０２の端部の段差を隠すように形成され、埋め込み絶縁膜７０３はバンク２０９の一部が突出して形成されている。この突出した絶縁膜が画素電極７０１のコンタクトホールによる凹部を埋め込む構造となっている。

[0088] 【００８８】なお、本実施例のＥＬ発光装置は、実施例１の作製方法に上記埋め込み絶縁膜の形成方法を組み合わせることで容易に作製することができる。

[0089] 【００８９】〔実施例３〕発明の実施の形態および実施例１に示したＥＬ発光装置では、画素部の構造しか示していないが、画素部を駆動するための駆動回路を同一基板上に一体形成しても良い。その際、駆動回路をｎＭＯＳ回路、ｐＭＯＳ回路もしくはＣＭＯＳ回路で形成することが可能である。勿論、画素部のみをＴＦＴで形成し、外付けの駆動回路、典型的にはＩＣチップを含む駆動回路（ＴＣＰやＣＯＧなど）を用いても良い。

[0090] 【００９０】また、実施例１では画素部をｐチャネル型ＴＦＴだけで形成して作製工程を削減しているが、この場合はｐＭＯＳ回路で駆動回路を形成し、ｐＭＯＳで作製できない駆動回路としてＩＣチップを含む駆動回路を用いることもできる。

[0091] 【００９１】なお、本実施例の構成は実施例１または実施例２の構成と自由に組み合わせて実施することが可能である。

[0092] 【００９２】〔実施例４〕本実施例では、画素部に形成するスイッチングＴＦＴ及び電流制御ＴＦＴの活性層として非晶質珪素膜（アモルファスシリコン膜）を用いる例を示す。非晶質珪素膜を用いたＴＦＴとしては逆スタガ型ＴＦＴが知られているが、本実施例では逆スタガ型ＴＦＴを用いることもできる。

[0093] 【００９３】非晶質珪素膜を用いてＴＦＴは作製工程が簡便である一方、素子サイズが大きくなってしまうという欠点もあったが、本発明のＥＬ発光装置ではＴＦＴのサイズが画素の有効発光面積に影響しない。従って、非晶質珪素膜を活性層として用いることでより安価なＥＬ発光装置を作製することができる。

[0094] 【００９４】なお、本実施例の構成は実施例１～実施例３のいずれの構成とも自由に組み合わせて実施することが可能である。ただし、実施例３と組み合わせる場合、非晶質珪素膜を用いたＴＦＴで動作速度の速い駆動回路を作製することが困難であるため、ＩＣチップを含む駆動回路を外付けすることが望ましい。

[0095] 【００９５】〔実施例５〕実施例１～実施例４では、アクティブマトリクス型ＥＬ発光装置について説明してきたが、本発明はパッシブマトリクス型ＥＬ発光装置のＥＬ素子に対して実施することも可能である。

[0096] 【００９６】なお、本実施例の構成は実施例１～実施例３のいずれの構成とも自由に組み合わせて実施することが可能である。ただし、実施例３と組み合わせる場合はＩＣチップを含む駆動回路を外付けすることになる。

[0097] 【００９７】〔実施例６〕本発明を実施して形成した発光装置は様々な電気器具の表示部として用いることができる。なお、発光装置を筐体に組み込んだディスプレイには、パソコン用ディスプレイ、ＴＶ放送受信用ディスプレイ、広告表示用ディスプレイ等の全ての情報表示用ディスプレイが含まれる。

[0098] 【００９８】また、その他の本発明の電気器具としては、ビデオカメラ、デジタルカメラ、ゴーグル型ディスプレイ（ヘッドマウントディスプレイ）、ナビゲー

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ションシステム、音楽再生装置（カーオーディオ、オーディオコンポ等）、ノート型パーソナルコンピュータ、ゲーム機器、携帯情報端末（モバイルコンピュータ、携帯電話、携帯型ゲーム機または電子書籍等）、画像再生装置（記録媒体に記録された画像を再生し、その画像を表示する表示部を備えた装置）が挙げられる。それらの具体例を図１０、図１１に示す。

[0099] 【００９９】図１０（Ａ）はＥＬディスプレイであり、筐体２００１、支持台２００２、表示部２００３を含む。本発明の発光装置は表示部２００３に用いることができる。ＥＬディスプレイは自発光型であるためバックライトが必要なく、液晶ディスプレイよりも薄い表示部とすることができる。

[0100] 【０１００】図１０（Ｂ）はビデオカメラであり、本体２１０１、表示部２１０２、音声入力部２１０３、操作スイッチ２１０４、バッテリー２１０５、受像部２１０６を含む。本発明の発光装置は表示部２１０２に用いることができる。

[0101] 【０１０１】図１０（Ｃ）はデジタルカメラであり、本体２２０１、表示部２２０２、接眼部部２２０３、操作スイッチ２２０４を含む。本発明の発光装置は表示部２２０２に用いることができる。

[0102] 【０１０２】図１０（Ｄ）は記録媒体を備えた画像再生装置（具体的にはＤＶＤ再生装置）であり、本体２３０１、記録媒体（ＣＤ、ＬＤまたはＤＶＤ等）２３０２、操作スイッチ２３０３、表示部（ａ）２３０４、表示部（ｂ）２３０５を含む。表示部（ａ）は主として画像情報を表示し、表示部（ｂ）は主として文字情報を表示するが、本発明の発光装置はこれら表示部（ａ）、（ｂ）に用いることができる。なお、記録媒体を備えた画像再生装置には、ＣＤ再生装置、ゲーム機器なども含まれうる。

[0103] 【０１０３】図１０（Ｅ）は携帯型（モバイル）コンピュータであり、本体２４０１、表示部２４０２、受像部２４０３、操作スイッチ２４０４、メモリスロット２４０５を含む。本発明の電気光学装置は表示部２４０２に用いることができる。この携帯型コンピュータはフラッシュメモリや不揮発性メモリを集積化した記録媒体に情報を記録したり、それを再生したりすることができる。

[0104] 【０１０４】図１０（Ｆ）はパーソナルコンピュータであり、本体２５０１、筐体２５０２、表示部２５０３、キーボード２５０４を含む。本発明の発光装置は表示部２５０３に用いることができる。

[0105] 【０１０５】なお、将来的にＥＬ材料の発光輝度が高くなれば、出力した画像情報を含む光をレンズ等で拡大投影してフロント型若しくはリア型のプロジェクターに用いることも可能となる。

[0106] 【０１０６】また、上記電子装置はインターネットやＣＡＴＶ（ケーブルテレビ）などの電子通信回線を通じて配信された情報を表示することが多くなり、特に動画情報を表示する機会が増してきている。ＥＬ材料の応答速度は非常に高いため、そのような動画表示を行うに適している。

[0107] 【０１０７】また、発光装置は発光している部分が電力を消費するため、発光部分が極力少なくなるように情報を表示することが望ましい。従って、携帯情報端末、特に携帯電話やカーオーディオのような文字情報を主とする表示部に発光装置を用いる場合には、非発光部分を背景として文字情報を発光部分で形成するように駆動することが望ましい。

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[0108] 【０１０８】ここで図１１（Ａ）は携帯電話であり、本体２６０１、音声出力部２６０２、音声入力部２６０３、表示部２６０４、操作スイッチ２６０５、アンテナ２６０６を含む。本発明の発光装置は表示部２６０４に用いることができる。なお、表示部２６０４は黒色の背景に白色の文字を表示することで携帯電話の消費電力を抑えることができる。

[0109] 【０１０９】また、図１１（Ｂ）はカーオーディオであり、本体２７０１、表示部２７０２、操作スイッチ２７０３、２７０４を含む。本発明の発光装置は表示部２７０２に用いることができる。また、本実施例では車載用カーオーディオを示すが、据え置き型のカーオーディオに用いても良い。なお、表示部２７０４は黒色の背景に白色の文字を表示することで消費電力を抑えられる。

[0110] 【０１１０】さらに、光センサを内蔵させ、使用環境の明るさを検知する手段を設けることで使用環境の明るさに応じて発光輝度を変調させるような機能を持たせることは有効である。使用者は使用環境の明るさに比べてコントラスト比で１００～１５０の明るさを確保できれば問題なく画像もしくは文字情報を認識できる。即ち、使用環境が明るい場合は画像の輝度を上げて見やすくし、使用環境が暗い場合は画像の輝度を抑えて消費電力を抑えるといったことが可能である。

[0111] 【０１１１】以上の様に、本発明の適用範囲は極めて広く、あらゆる分野の電気器具に用いることが可能である。また、本実施例の電気器具は実施例１～５に示したいずれの構成の発光装置を用いても良い。

[0112] 【０１１２】【発明の効果】本発明では、有機ＥＬ膜を成膜した後で形成される透明導電膜からなる電極に対して、封止体側に設けられた透明導電膜からなる電極を異方導電性膜を用いて電気的に接続する点に特徴がある。これにより有機ＥＬ膜を成膜した後で形成される透明導電膜の抵抗値を実質的に下げることができ、均一な電圧の印加を可能とすることができる。

[0113] 【０１１３】また、本発明では陰極を透明もしくは半透明とし、且つ、ＥＬ素子の下に反射電極を設けることにより陰極側に光を取り出す構造とした発光装置と組み合わせることで、画素の有効発光面積が大幅に向上した明るく画質の良好な発光装置を得ることができる。また、本発明の発光装置を表示部として用いた良好な画質の電気器器具を得ることができる。

[0114] 図面の簡単な説明

[0115] 図１ 発光装置の断面構造を示す図。

[0116] 図２ 発光装置の断面構造を示す図。

[0117] 図３ 発光装置の作製工程を示す図。

[0118] 図４ 発光装置の作製工程を示す図。

[0119] 図５ 発光装置の画素の上面構造及び回路構成を示す図。

[0120] 図６ 保持容量の断面構造を示す図。

[0121] 図７ 発光装置の断面構造を示す図。

[0122] 図８ 発光装置の上面構造を示す図。

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[0123] 図９ 従来の発光装置の断面構造を示す図。

[0124] 図１０ 電気器具の具体例を示す図。

[0125] 図１１ 電気器具の具体例を示す図。

Espacenet

Claims: JP2002033198 (A) — 2002-01-31

LIGHT EMITTING DEVICE AND MANUFACTURING METHOD THEREOF

Claims of JP2002033198 (A)

- Original claims
- Claims tree

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1. 反射面を含む電極、有機ＥＬ層および透明電極を含むＥＬ素子を有し、前記透明電極に導電体を介して補助電極が接続されていることを特徴とする発光装置

2. 請求項１において、前記反射面を含む電極は金属膜からなり、前記透明電極は透明導電膜からなることを特徴とする発光装置。

3. 請求項１において、前記反射面を含む電極は金属膜および透明導電膜を積層してなり、前記透明電極は半透明な金属膜および透明導電膜を積層してなることを特徴とする発光装置。

4. 請求項３において、前記反射面を含む電極に含まれた透明導電膜および前記半透明な金属膜に接して有機ＥＬ層が設けられていることを特徴とする発光装置。

5. 請求項３または請求項４において、前記半透明な金属膜は膜厚が５～７０ｎｍであることを特徴とする発光装置。

6. 請求項１乃至請求項５のいずれか一において、前記補助電極は透明導電膜からなることを特徴とする発光装置。

7. 請求項１乃至請求項６のいずれか一に記載の発光装置を用いたことを特徴とする電気器具。

8. 絶縁体の上に反射面を含む電極を形成し、該反射面を含む電極の上に有機ＥＬ層を形成し、該有機ＥＬ層の上に透明電極を形成し、該透明電極の上に導電体を形成する過程と、封止体の表面に補助電極を形成する過程と、を有し、前記導電体と前記補助電極とが接続されるように前記絶縁体と前記封止体とを貼り合わせることを特徴とする発光装置の作製方法。

9. 請求項８において、前記反射面を含む電極を金属膜で形成し、前記透明電極を透明導電膜で形成することを特徴とする発光装置の作製方法。

10. 】請求項８において、前記反射面を含む電極を金属膜および透明導電膜を積層して

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形成し、前記透明電極を半透明な金属膜および透明導電膜を積層して形成することを特徴とする発光装置の作製方法。

11.】請求項１０において、前記半透明な金属膜の膜厚を５～７０ｎｍとすることを特徴とする発光装置の作製方法。

12.】請求項８乃至請求項１１のいずれか一において、前記補助電極を透明導電膜で形成することを特徴とする発光装置の作製方法。

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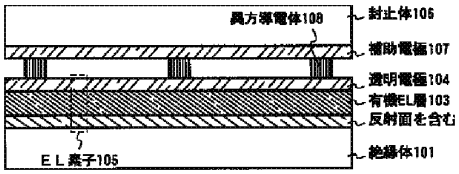
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CLAIMS

[Claim(s)]
[Claim 1]A luminescent device, wherein it has an EL element containing an electrode, an organic electroluminescence layer, and a transparent electrode including a reflective surface and an auxiliary electrode is connected to the aforementioned transparent electrode via a conductor [Claim 2]A luminescent device, wherein an electrode including the aforementioned reflective surface consists of metal films in Claim 1 and the aforementioned transparent electrode consists of transparent conducting films.
[Claim 3]A luminescent device which an electrode including the aforementioned reflective surface laminates a metal film and a transparent conducting film in Claim 1, and the aforementioned transparent electrode laminates a translucent metal film and a transparent conducting film, and is characterized by things.
[Claim 4]A luminescent device, wherein an organic electroluminescence layer is provided in contact with a transparent conducting film contained in an electrode including the aforementioned reflective surface in Claim 3, and said translucent metal film.
[Claim 5]A luminescent device with which said translucent metal film is characterized by film thickness being 5-70 nm in Claim 3 or Claim 4.
[Claim 6]A luminescent device, wherein the aforementioned auxiliary electrode consists of transparent conducting films in any 1 of Claim 5 to Claim 1.
[Claim 7]Electrical appliances using the luminescent device according to any one of claims 1 to 6.
[Claim 8]A process in which forms on an insulator an electrode including a reflective surface, forms an organic electroluminescence layer on an electrode including the reflective surface, form a transparent electrode on the organic electroluminescence layer, and it forms a conductor on the transparent electrode, A manufacturing method of a luminescent device pasting the aforementioned insulator and the aforementioned sealed body together so that it may have a process in which an auxiliary electrode is formed on the surface of a sealed body and the aforementioned conductor and the aforementioned auxiliary electrode may be connected.
[Claim 9]A manufacturing method of a luminescent device forming an electrode including the aforementioned reflective surface with a metal film in Claim 8, and forming the aforementioned transparent electrode with a transparent conducting film.
[Claim 10]A manufacturing method of a luminescent device laminating a metal film and a transparent conducting film, forming an electrode including the aforementioned reflective surface in Claim 8, laminating a translucent metal film and a transparent conducting film, and forming the aforementioned transparent electrode.
[Claim 11]A manufacturing method of a luminescent device film thickness of said translucent metal film being 5-70 nm in Claim 10.
[Claim 12]A manufacturing method of a luminescent device forming the aforementioned auxiliary electrode with a transparent conducting film in any 1 of Claim 11 to Claim 8.

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Representative drawing

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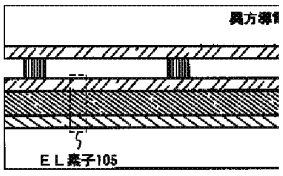
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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]The present invention relates to the luminescent device which used the thin film which consists of a luminescent material. It is related with electrical appliances using the luminescent device as a display part. An organic electroluminescence display and an organic light emitting diode (OLED:Organic Light Emitting Diode) are contained in the luminescent device of the present invention.
[0002]A luminescent material which can be used for the present invention includes all the luminescent materials which emit light via singlet excitation, triplet excitation, or both excitation (phosphorescence and/or fluorescence).
[0003]
[Description of the Prior Art]In recent years, development of the light emitting device (henceforth an EL element) using the thin film (henceforth EL film) which consists of a luminescent material in which EL (Electro Luminescence) is obtained is proceeding. The luminescent device (henceforth EL luminescence equipment) which has an EL element has an EL element which consists of the structure which sandwiched EL film between the cathode and the anode, and it obtains luminescence by applying voltage between a cathode and an anode. In particular, the thing using the organic film as an EL film is called organic EL film.
[0004]As an anode, a transparent conducting film (henceforth a transparent conducting film) is used to visible light in many cases as a cathode, using the small metal (metal which belongs to 1 group of the periodic table, or 2 group typically) of a work function in many cases. Since it is such a structure, obtained luminescence transmits a cathode and is recognized visually.
[0005]He can be proceeding development of the active-matrix type EL luminescence equipment which controls luminescence of the EL element provided by each pixel using TFT (thin film transistor) by these days, and a prototype came to be announced. The structure of active-matrix type EL luminescence equipment is shown in Fig.9 (A) and (B) here.
[0006]In Fig.9 (A), TFT902 is formed on the substrate 901 and the cathode 903 is connected to TFT902. On the cathode 903, the organic EL film 904 and the anode 905 are formed, and the cathode 903, the organic EL film 904, and EL element 906 which consists of the anode 905 are formed.
[0007]At this time, luminescence generated by the organic EL film 904 transmits the cathode 903, and is emitted toward the direction of the arrow in the figure. Therefore, TFT902 became a shelter which sees from a watcher and interrupts luminescence, and had become a factor which narrows an effective luminous region (region where a watcher can observe luminescence). When an effective luminous region was narrow, light emitting luminance needed to be raised for acquiring a bright image, but raising light emitting luminance had brought a result which brings degradation of an organic EL film forward.
[0008]Then, the active-matrix type EL luminescence equipment of structure as shown in Fig.9 (B) is proposed. In Fig.9 (B), TFT902 is formed on the substrate 901 and the anode 907 is connected to TFT902. On the anode 907, the organic EL film 908 and the cathode 909 are formed, and the anode 907, the organic EL film 908, and EL element 910 which consists of the

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cathode 909 are formed. That is, it becomes an EL element of a reverse structure exactly in EL element 906 shown in Fig.9 (A).
[0009]At this time, luminescence generated by the EL film 908 transmits the cathode 909, and a principle top is emitted toward the direction of the arrow in the figure. Therefore, it is possible to make into an effective luminous region all the regions where TFT901 was provided by the position which is not visible from a watcher, and the anode 903 was provided.
[0010]However, the structure shown in Fig.9 (B) is holding potentially the problem that uniform voltage cannot be applied in the cathode 909. Although the transparent conducting film generally used as a cathode has high resistance compared with a metal film, it is known that resistance can be lowered by heat treatment. However, since an organic EL film has low heat resistance, after forming an organic EL film, heat treatment over 150 degrees C cannot be performed.
[0011]Therefore, it is difficult to be unable to heat-treat, when laminating a cathode (transparent conducting film) on an organic EL film, but to form a cathode with low resistance. That is, the problem that the voltage applied in the end and the central part of a cathode differs may arise, and we are anxious about this problem becoming a factor which wakes up image quality defects.
[0012]As mentioned above, in the luminescent device which includes the structure of using a transparent conducting film after forming an organic EL film, there was a problem of difficulty in low-resistance-izing of a transparent conducting film.
[0013]
[Problem to be solved by the invention]It is made in order that the present invention may solve the above-mentioned problem, and let it be problem to provide the bright good luminescent device of image quality. Let it be problem to provide the good electrical appliances of image quality using such a luminescent device as a display part.
[0014]
[Means for solving problem]The present invention has the characteristics in the point of attaining low resistance-ization of a transparent electrode substantially, by connecting an electrode auxiliary in parallel to the transparent electrode provided after forming an organic EL film. It describes here using Fig.1 about the present invention.
[0015]The electrode in which 101 contains an insulator in and 102 includes a reflective surface in Fig.1, and 103 are organic electroluminescence layers. 104 is a transparent or translucent electrode (henceforth a transparent electrode) to visible light, and the electrode 102, the organic electroluminescence layer 103, and EL element 105 which consists of the transparent electrode 104 including a reflective surface are formed on the insulator 101.
[0016]To visible light, it says transmitting visible light with the transmissivity of 80 to 100%, and, as for transparence, that it is translucent means transmitting visible light with the transmissivity of 50 to 80% to visible light. Of course, although transmissivity changes with film thickness, film thickness may be designed as appropriate so that it may be settled in a mentioned range.
[0017]The insulator 101 is the substrate which provided the insulator layer on an insulating substrate or the surface, and just supports an EL element here.
[0018]The electrode on which the metal electrode or the metal electrode, and the transparent electrode were laminated is pointed out in the electrode 102 including a reflective surface. That is, the electrode which includes the surface (reflective surface) in which visible light may be reflected in the surface of an electrode, a back surface, or the interface inside an electrode is pointed out.
[0019]The laminate film of an organic EL film or an organic EL film, and an organic material can be used for the organic electroluminescence layer 103. That is, it may provide by a monolayer by making an organic EL film into a luminous layer, and an organic EL film may be made into a luminous layer, and an organic material may be laminated as a charge injection layer or a charge transport layer, and may be provided. It is also possible for the material which can be used as a charge injection layer or a charge transport layer to be also in an inorganic material, and to use such an inorganic material as a charge injection layer or a charge transport layer.
[0020]As the transparent electrode 104, the electrode or film thickness which consists of a transparent conducting film can use the electrode which consists of a 5-70 nm (typically 10-50 nm) metal film (henceforth a translucent metal film). What added gallium oxide can be used for an oxide conducting film (they are an indium oxide film, a tin-oxide film, a zinc oxide film, the compound membrane of indium oxide and the tin oxide, or the compound membrane of indium oxide and a zinc oxide typically), or an oxide conducting film as a transparent conducting film. When using a transparent conducting film as the transparent electrode 104, 80 to 95% of visible light can be transmitted by being referred to as 10-200 nm (preferably 50-100 nm).
[0021]On EL element 105 which consists of the above structure, the auxiliary electrode 107 provided by the surface of the sealed body 106 and the sealed body 106 is provided, and the auxiliary electrode 107 is electrically connected with the transparent electrode 104 via the conductor 108. Although it is dotted with the conductor 108 on the transparent electrode 104 and provides, it is preferable to make it distribute the whole surface on a transparent electrode if possible, and to provide.
[0022]To visible light, the sealed body 106 is a transparent substrate or a film, and can use a glass substrate, a quartz substrate, a crystallized glass substrate, a plastic plate, or a plastic film here. However, when using a plastic plate or a plastic film, it is desirable to provide the

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protective film (preferably it is the carbon film, specifically a diamond like carbon film) which prevents the penetration of oxygen and water at the surface or the back surface.
[0023]The auxiliary electrode 107 is an electrode provided auxiliary in order to lower the resistance of the transparent electrode 104, and can use the electrode which consists of a transparent conducting film, or the electrode which consists of a metal film with translucent film thickness like the transparent electrode 104. 80 to 95% of visible light can be transmitted because the film thickness of the auxiliary electrode 107 shall be 10-200 nm (preferably 50-100 nm) like the transparent electrode 104.
[0024]The conductor 108 can be formed using the conducting film called an anisotropic conductive film etc. Therefore, it can also be called an anisotropic conducting film. An anisotropic conductive film is a resin layer which dispersed uniformly electric conduction particles (typically metal particles or a carbon particle). It is preferable to patternize the anisotropic conductive film 108 by a photolithography, and to provide it selectively in the present invention, or to provide selectively by an ink jet method or print processes. It is because the transmissivity of an anisotropic conductive film to visible light is low, so the light emitted from the organic electroluminescence layer 103 will be absorbed if it provides all over the transparent electrode 104.
[0025]In the luminescent device of the present invention including the above structures, the auxiliary electrode 107 functions as an electrode connected in parallel with the transparent electrode 104 which consists of a transparent conducting film. At this time, since the auxiliary electrode 107 is formed in the sealed body 106 side, it can make resistance low, without receiving restrictions of the heat resistance of an organic EL film which was described by the conventional case. Therefore, it is possible by carrying out the present invention to become possible to apply uniform voltage to the transparent electrode 104, and to acquire the good image of image quality.
[0026]
[Mode for carrying out the invention]It describes using Fig.2 about an embodiment of the invention. In Fig.2, 201 is a substrate of the side which forms an element. It is possible to use what kind of material and to use glass (silica glass is included), glass ceramics, single crystal silicon, ceramics, metal, or a plastic as the substrate 201, in the present invention.
[0027]The pixel 202 is formed on the substrate 201 and the pixel 202 has structure containing switching TFT203 and current control TFT204. Three pixels are shown in Fig.2 and the pixel which emits light in red, green, or blue respectively is formed. Switching TFT203 functions as a switch for incorporating a video signal into a pixel, and current control TFT204 functions as a switch for controlling the current which flows into an EL element. At this time, the drain of switching TFT203 is electrically connected to the gate of current control TFT204.
[0028]There may be no limitation in the structure of switching TFT203 and current control TFT204, and it may use a top gate type (typically planar type) or a bottom gated mode (typically reverse stagger type). Both of the TFT(s) should just use n channel type TFT or a p channel type.
[0029]Switching TFT203 and current control TFT204 are covered with the interlayer insulation film 205, and the picture element electrode 207 which consists of a metal film and the drain of current control TFT204 are electrically connected via the conductor plug 206 on it. The first transparent electrode 208 is laminated on the picture element electrode 207 by 10-200 nm (preferably 50-100 nm) film thickness. Here, the cathode 230 is formed with the picture element electrode 207 and the first transparent electrode 208.
[0030]In this embodiment, it is considered as the structure which embeds with a conductor the contact hole where the drain and the picture element electrode 207 of current control TFT204 are connected. The conductor provided so that this contact hole might be embedded is called a conductor plug. The conductor plug 206 may etch an anisotropic conductive film, and it may form it. Of course, the picture element electrode 207 may be connected to the drain of direct current control TFT204.
[0031]By the way, the coverage of an organic electroluminescence layer is bad, and since there is a possibility of causing the short circuit (short circuit) of an anode and a cathode, it is not preferable in the concave part resulting from the above-mentioned contact hole. In this embodiment, since it can avoid forming the concave part resulting from a contact hole in the picture element electrode 207 by using the conductor plug 206, the short circuit of an anode and a cathode can be prevented.
[0032]As for the picture element electrode 207, it is preferable to use a metal film with high reflectance, and it is good to use an aluminum film (the aluminum film containing an aluminum alloy film and an additive is included) or a silver film. The film which gave aluminum plating or silver plating may be used for a metal film.
[0033]Next, 209 is the insulator layer (henceforth a bank) provided between the cathodes 230, and it is formed so that the level difference formed in the end of the cathode 230 may be covered. In this embodiment, an organic electroluminescence layer is kept away and it has structure which prevents degradation of the organic electroluminescence layer by electric field concentrates from the end of the cathode 230 which is easy to cause electric field concentrates by providing the bank 209. Even if it uses a resin layer as the bank 209, the insulator layer (typically oxidized silicon film) containing silicon may be used.
[0034]Next, the organic electroluminescence layer to which 210 emits light in red, the organic electroluminescence layer in which 211 emits light green, and 212 are organic electroluminescence layers which emit light blue. The layer system of the organic

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electroluminescence layers 210-212 should just refer to publicly known technology.
[0035]The second transparent electrode 213 provided as covered the organic electroluminescence layers 210-212 is an electrode for injecting an electron into an organic electroluminescence layer. As for the work function of this second transparent electrode 213, it is preferable that it is 2.5-3.5 eV, and it is good to use the metal film containing the element belonging to 1 group of the periodic table, or 2 group. Here, the alloy film (henceforth an Al-Li film) which carried out vapor codeposition of aluminum and the lithium is used. Since an Al-Li film is a metal film, it can use film thickness as a transparent electrode by being referred to as 10-70 nm (typically 20-50 nm).
[0036]On it, the 3rd transparent electrode 214 which consists of a 100-300 nm (preferably 150-200 nm) transparent conducting film is provided. The 3rd transparent electrode 214 is an electrode which performs the role for applying voltage to the second transparent electrode 213. Here, the anode 231 is formed with the second transparent electrode 213 and the 3rd transparent electrode 214.
[0037]The auxiliary electrode (the 4th transparent electrode) 216 which consists of a 10-200 nm (preferably 50-100 nm) transparent conducting film is formed in the sealed body 215 which made oppose to the substrate 201 (it is called the substrate also including the thin film provided by the substrate 201 here), and was provided for film thickness, The 3rd transparent electrode 214 and auxiliary electrode 216 are electrically connected via the conductor 217 which consists of an anisotropic conductive film (resin layer which dispersed metal particles or a carbon particle).
[0038]As for the conductor 217, it is preferable to provide partially on the 3rd transparent electrode 214. That is, since an anisotropic conductive film is black or gray, it is desirable to provide so that it may not lap with the luminous region of a pixel at least. Of course, it is also possible to use as a black matrix positively by providing between pixels, and to improve the directivity of the light for every pixel.
[0039]The substrate 201 and the sealed body 215 are pasted together with the sealing material (not shown) provided by the outer edge of the substrate 201. When pasting the substrate 201 and the sealed body 215 together, the spacer (preferably 1-3 micrometers) for deciding the interval of the substrate 201 and the sealed body 215 may be provided. In particular, it is effective to serve as this spacer with the conductor 217.
[0040]It is preferable to enclose nitrogen gas or rare gas with space 218 formed between the substrate 201 and the sealed body (counter substrate) 215. It is desirable to provide the substance which has hygroscopicity in this space 218, and a substance with deoxidization nature.
[0041]A detailed structure of the region 219 is shown in Fig.2 (B) here. In Fig.2 (B), the cathode 230, the organic electroluminescence layer 212, and the anode 231 form EL element 220. In the luminescent device shown in Fig.2 (A), the most characteristic point is one of the points that transmit the anode 231 and luminescence is observed.
[0042]It is reflected by the picture element electrode 207 which has the surface where reflectance is high, and the light which went to the cathode 230 side among the lights generated with EL element 220 goes to the anode 231 side. That is, while the picture element electrode 207 is an electrode (an electron is drawn out) which supplies current to the cathode 230, it also has a function as a reflector.
[0043]Since the second transparent electrode 213 has very thin film thickness, its resistance is high. Therefore, the 3rd transparent electrode 214 is laminated and low resistance-ization is attained. However, since the transparent conducting film used as the 3rd transparent electrode 214 will be formed after it forms the organic electroluminescence layer 212, it is difficult to make resistance low. So, in this embodiment, substantial low resistance-ization of the 3rd transparent electrode 214 is attained by connecting the auxiliary electrode 216 which consists of a transparent conducting film in parallel with the 3rd transparent electrode 214 which consists of a transparent conducting film.
[0044]Since the pixel 202 whole serves as an effective luminous region, the luminescent device of the above structures can acquire a very bright image. Since uniform voltage can be applied to the anode 231 whole by carrying out the present invention, it is possible to acquire the good image of image quality.
[0045]
[Working example][Example 1] In this example, it describes using Fig.3 - 5 about the making process of the luminescent device shown in Fig.2. What was shown in Fig.3 and 4 is a cross sectional view showing the making process in a picture element part. The circuit diagram of a final pixel is shown for the plan (however, plan in the time of forming a cathode) of the pixel produced by this example in Fig.5 (A) at Fig.5 (B). It is corresponding to the code which used the code used for Fig.5 by Fig.3 and 4.
[0046]First, as shown in Fig.3 (A), the glass substrate 301 is prepared as a substrate and the ground film 302 which consists of an oxidized silicon film is formed on it at a thickness of 200 nm. The formation of the ground film 302 should just use a decompression thermal CVD method, plasma CVD method, a sputtering method, or a vapor deposition method.
[0047]Next, the crystalline silicon film 303 is formed on the ground film 302 at a thickness of 50 nm. It is possible to use a publicly known means as a formation method of the crystalline silicon film 303. Laser crystallization of the amorphous silicon film may be carried out using a solid-state laser or an excimer laser, and an amorphous silicon film may be crystallized by heat-treatment (furnace annealing). It is made to crystallize in this example by irradiating the

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excimer laser which used XeCl gas.
[0048]Next, as shown in Fig.3 (B), the crystalline silicon film 303 is patterned and the crystalline silicon films 304 and 305 of island shape are formed. And the crystalline silicon films 304 and 305 of island shape are covered, and the gate dielectric film 306 which consists of an oxidized silicon film is formed in a thickness of 80 nm. The gate electrodes 307 and 308 are formed on the gate dielectric film 306. Although the gate electrode 307 is visible to two in Drawings, it is the same electrode actually divided into two forks.
[0049]In this example, the tungsten film or tungsten alloy film of 350-nm thickness is used as a material of the gate electrodes 307 and 308. Of course, other publicly known materials can be used as a material of a gate electrode. In this example, the connection wiring 309 is also simultaneously formed at this time. The connection wiring 309 is wiring for electrically connecting the source and current supply source line of the current control TFT behind.
[0050]Next, as shown in Fig.3 (C), the element (typically boron) which belongs to 13 group of the periodic table by using the gate electrodes 307 and 308 as a mask is added. The addition method should just use a publicly known means. In this way, the impurity ranges (henceforth a p type impurity region) 310-314 which show a p type conductivity type are formed. Directly under a gate electrode, the channel forming regions 315a, 315b, and 316 demarcate. The p type impurity regions 310-314 turn into the source region of TFT, or a drain area.
[0051]Next, the element belonging to 13 group of the periodic table heat-treated and added is activated. The pattern which consists of the crystalline silicon film of the island shape performed to this activation process is called an active layer. A furnace annealing, laser annealing, or lamp annealing may perform this activation, or it may carry out combining them. In this example, 500 degree-C heat-treatment for 4 hours is performed by a nitrogen atmosphere.
[0052]However, it is desirable for the oxygen density in a treatment atmosphere to be 1 ppm or less (preferably 0.1 ppm or less) in this activation process. It is because electric interengagement with the gate wire and current supply source line which the surface of the gate electrodes 307 and 308 and the connection wiring 309 will oxidize, and it forms behind will become difficult if an oxygen density is high.
[0053]It is effective if activation is completed, and hydrogen treatment is performed. The hydrogen treatment should just use publicly known hydrogen annealing technology or plasma hydrogenation technology.
[0054]Next, as are shown in Fig.3 (D), and the connection wiring 309 is touched, the current supply source line 317 is formed. The connection wiring 309 and the current supply source line 317 are electrically connected by considering it as such a structure (a plan is shown in the region shown by 501 of Fig.5 (A)). Although not illustrated, at this time, a gate wire (wiring shown by 502 of Fig.5 (A)) is also formed simultaneously, and is electrically connected with the gate electrode 307. Besides, a surface figure is shown in the region shown by 503 of Fig.5 (A).
[0055]In the region shown by this 503, it is the redundant design for securing the portion which does not get over the gate electrode 307 that the gate wire 502 has a protruding part. By carrying out like this, even if the gate wire 502 is disconnected in the portion which gets over the gate electrode 307, it is avoidable that the gate wire 502 is disconnected electrically there. Redundant design for voltage to be reliably applied to both of gate electrodes has also processed the gate electrode 307 in U-shape.
[0056]This current supply source line 317 and gate wire 502 are formed with a low resistance metal film rather than the connection wiring 309 or the gate electrode 307. It is good to use the metal film which contains aluminum, copper, or silver preferably. That is, a low resistance metal film is used for the gate electrode of which minute pattern accuracy is required at the bus line (this example a gate wire and a current supply source line) of which the lowness of resistivity is required using a metal film with high processability.
[0057]If the gate wire 502 and the current supply source line 317 are formed, the 1st interlayer insulation film 318 which consists of an oxidized silicon film will be formed in a thickness of 800 nm. Plasma CVD method may be used as a formation method. Other inorganic insulating films may be used as the 1st interlayer insulation film 318, and resin (organic compound insulator) may be used.
[0058]Next, as shown in Fig.3 (E), a contact hole is formed in the 1st interlayer insulation film 318, and the wiring 319-322 is formed. In this example, the metallic wiring which consists of three layer systems of titanium / aluminum / titanium is used as the wiring 319-322. Of course, as long as it is a conducting film, what kind of material may be used. The wiring 319-322 turns into source wiring of TFT, or drain wiring.
[0059]The drain wiring 322 of the current control TFT is electrically connected with the connection wiring 309. As a result, the drain and the current supply source line 317 of current control TFT402 are electrically connected.
[0060]Switching TFT401 and current control TFT402 are completed in this state. Although both of the TFT(s) are formed by p channel type TFT in this example, it is good also considering both or either as n channel type TFT.
[0061]Switching TFT401 is formed so that a gate electrode may cross an active layer at two places, and it has the structure where two channel forming regions were connected in series. An OFF state current value (current which flows when TFT is turned off) can be effectively inhibited by considering it as such a structure.
[0062]Within a pixel, as shown in Fig.5 (A), the retention volume 504 is formed. The cross sectional view (cross sectional view which cut Fig.5 (A) by B-B') of the retention volume 504 is

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shown in Fig.6. The retention volume 504 is formed with the semiconductor layer 505, the gate dielectric film 306, and the capacity wiring 506 which were electrically connected to the drain of current control TFT402. That is, it is insulated with the gate dielectric film 306, and the semiconductor layer 505 and the capacity wiring 506 form the capacitor (retention volume).
[0063]The capacity wiring 506 is formed simultaneously with the gate wire 502 or the current supply source line 317, and serves also as the wiring which electrically connects the gate electrode 308 and the connection wiring 507. The connection wiring 507 is electrically connected to the drain wiring (it may function as source wiring) 320 of switching TFT401.
[0064]The advantage of the retention volume shown in this example is a point formed after the capacity wiring 506 forms an active layer. That is, since the semiconductor layer 505 serves as a p type impurity region in the case of this example, using as an electrode as it is is possible.
[0065]If the wiring 319-322 is formed, the passivation film 323 which consists of a silicon nitride film or a nitriding oxidized silicon film will be formed in a thickness of 200 nm. Before forming this passivation film 323, the electrical property of TFT can be improved by performing hydrogen treatment behind.
[0066]Next, as shown in Fig.4 (A), after forming an acrylic resin in a thickness of 1 micrometer as the 2nd interlayer insulation film 324 and opening the contact hole 325, the anisotropic conductive film 326 is formed. In this example, the acrylic resin which distributed the silver granule child is used as the anisotropic conductive film 326. As for the anisotropic conductive film 326, it is desirable to form by sufficient thickness for the degree which can flatten the contact hole 325. In this example, it forms by the spin coating method by a thickness of 1.5 micrometers.
[0067]Next, the anisotropic conductive film 326 is etched by the plasma using oxygen gas. This process is continued until it is exposed of the 2nd interlayer insulation film 324. After etching is completed, the conductor plug 327 will be formed in form as shown in Fig.3 (B). When exposed of the 2nd interlayer insulation film 324, the conductor plug 327 may produce a level difference according to the difference of an etching rate with the 2nd interlayer insulation film 324, but if a level difference is 100 nm or less (preferably 50 nm or less), a problem in particular will not become.
[0068]If the conductor plug 327 is formed, the aluminum film and ITO film (compound membrane of indium oxide and the tin oxide) which added a scandium or titanium will be laminated, The picture element electrode 328 which consists of the aluminum film which etched and added a scandium or titanium, and the first transparent electrode 329 which consists of an ITO film are formed. In this example, the cathode 340 is formed with the picture element electrode 328 and the first transparent electrode 329.
[0069]In this example, the film thickness of an aluminum film sets to 200 nm, and the film thickness of an ITO film may be 100 nm. An ITO film can be etched by ITO-04N (trade name of the etching solution for ITO films of Kanto Kagaku, Inc.), and an aluminum film can be etched by the dry etching method using the gas which mixed a carbon tetrachloride ($SiCl_4$) and chlorine (Cl_2).
[0070]The section structure of the Fig.4 (B) obtained in this way correspond to the section structure cut by A-A' in Fig.5 (A).
[0071]Next, as shown in Fig.4 (C), the insulator layer 330 is formed as a bank. Although the bank 330 is formed using an acrylic resin in this example, forming using an oxidized silicon film is also possible. If the bank 330 is formed, ultraviolet radiation will be irradiated in oxygen environment to the first transparent electrode 329, and the surface treatment of the first transparent electrode 329 is performed. This has the working effect to which the work function of the first transparent electrode 329 is enlarged, and also has the working effect which removes surface contamination further.
[0072]And the organic EL films 331 and 332 are respectively formed in a thickness of 50 nm. The organic EL film 331 is an organic EL film which emits light blue, and the organic EL film 332 is an organic EL film which emits light in red. Although not illustrated, the organic EL film which emits light green simultaneously is also formed. An organic EL film is made from this example for every pixel with the vapor deposition method which used the shadow mask, and it divides. Of course, it is also possible to make and divide using print processes or an ink jet method.
[0073]Although this example shows the example which uses the organic EL films 331 and 332 by a monolayer, it is also effective to consider it as the laminated structure using CuPc (copper phthalocyanine) as a hole injection layer. In this case, a copper-phthalocyanine film is first formed in the whole surface.
Then, red, an organic EL film in which it corresponds green and blue and which emits light in red respectively for every pixel, an organic EL film which emits light green, and an organic EL film which emits light blue are formed.

[0074]When forming a green organic EL film, Quinacridone or the coumarin 6 is added as a dopant, using Alq_3 (tris-8-quinolinolato aluminium complex) as a base material of an organic EL film. When forming a red organic EL film, DCJT, DCM1, or DCM2 are added as a dopant, using Alq_3 as a base material of an organic EL film. When forming a blue organic EL film, perylene is added as a dopant, using $BAlq_3$ (complex of 5 coordination with 2-methyl-eight quinolinol and the mixed ligand of a phenol derivative) as an organic EL film of a luminous layer.
[0075]Of course, it is possible for it not to be necessary to limit to the above-mentioned organic EL film in the present invention, and to use a publicly known low molecule system organic EL film and a polymer system organic EL film. When using a polymer system organic EL

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film, the applying method (a spin coat method, an ink jet method, or print processes) can also be used.
[0076]If the organic EL films 331 and 332 are formed as mentioned above, a 20-nm-thick MgAg film (metal film which added 1 to 10% of silver (Ag) with magnesium (Mg)) will be formed as the second transparent electrode 333, Furthermore, a 250-nm-thick ITO film is formed as the 3rd transparent electrode 334. In this example, the anode 341 is formed with the second transparent electrode 333 and the 3rd transparent electrode 334.
[0077]In this way, the cathode 340, the organic EL film 331 (or organic EL film 332), and EL element 400 which consists of the anode 341 are formed. In this example, this EL element functions as a light emitting device.
[0078]Next, as shown in Fig.4 (D), the auxiliary electrode 336 which consists of a transparent conducting film is provided in thickness of 250 nm on the sealed body 335, and the conductor 337 which consists of an anisotropic conductive film is further provided on the 3rd transparent electrode 334. And the substrate 301 and the sealed body 335 are pasted together using a sealing material (not shown).
[0079]A lamination process is performed in argon atmosphere. As a result, argon is enclosed with space 338. Of course, the gas to enclose should just be inactive gas and should just use nitrogen gas or rare gas. It is preferable to provide the substance which adsorbs oxygen or water to space 338. It is possible for you not to use space but to also make it filled up with resin.
[0080]Switching TFT(this example p channel type TFT)401 and current control TFT(this example p channel type TFT)402 are formed in a pixel by the making process shown above. In this example, in order to set all the TFT(s) to p channel type TFT, a making process is dramatically simple.
[0081]Since the level difference was flattened with the 2nd interlayer insulation film 324 and the drain wiring 321 and the picture element electrode 328 of current control TFT402 are electrically further connected using the conductor plug 327 embedded in the contact hole 325, the surface smoothness of the cathode 340 is high. Therefore, since the homogeneity of the film thickness of the organic EL film 332 can be improved, luminescence of a pixel can be made uniform.
[0082][Example 2] In this example, it describes using Fig.7 about EL luminescence equipment with the pixel of a different structure from the EL luminescence equipment shown in Fig.2. This example can be produced only by adding some change to the structure of Fig.2, and is described paying attention to a different point from Fig.2. Therefore, just refer to the "embodiment of the invention" for the description of the portion to which the same code as Fig.2 is given.
[0083]In this example, if a contact hole is formed in the interlayer insulation film 205, the picture element electrode 701 and the first transparent electrode 702 will be formed in the state, and the insulator layer 703 will be formed so that the concave part by a contact hole may be filled. In this example, this insulator layer 703 is embedded and it is called an insulator layer. Since the embedding insulator layer 703 can be formed simultaneously with the bank 209, it does not make especially a process increase.
[0084]This embedding insulator layer 703 is for preventing the short circuit of the anode and cathode which originate in the concave part by a contact hole like the conductor plug 206 of Fig.2. As for the height between the top surface of the embedding insulator layer 703, and the top surface of the second transparent electrode 702, at this time, it is preferable to be referred to as 100-300 nm. If this height exceeds 300 nm, that level difference may become the cause of producing the short circuit of an anode and a cathode. When set to 100 nm or less, there is a possibility that a working effect (working effect which inhibits the influence of the electric field concentrates in the edge part of a picture element electrode) of the bank 209 of a simultaneously form may be deteriorated.
[0085]In this example, after forming the second transparent electrode 702, an acrylic resin is formed in a thickness of 500 nm by the spin coating method, and it etches until it converts oxygen gas into plasma and the film thickness (however, film thickness outside the contact hole) of an acrylic is set to 200 nm. In this way, it patterns, after making film thickness thin, and the bank 209 and the embedding insulator layer 703 are formed.
[0086]The top surface structure of the pixel of this example is shown in Fig.8 here. In Fig.8, the cross sectional view cut by A-A' is equivalent to Fig.7. The sealed body 215 and the conductor 217 are not illustrated to Fig.8. Since fundamental pixel structure is the same as that of Fig.5, a detailed description is omitted.
[0087]In Fig.8, the bank 209 is formed so that the level difference of the end of the picture element electrode 701 and the cathode 702 may be hidden, a part of bank 209 projects the embedding insulator layer 703, and it is formed. This projected insulator layer has structure which embeds the concave part by the contact hole of the picture element electrode 701.
[0088]The EL luminescence equipment of this example is easily producible by combining the formation method of the above-mentioned embedding insulator layer with the manufacturing method of Example 1.
[0089][Example 3] In the EL luminescence equipment shown in the embodiment of the invention and Example 1, although only the structure of the picture element part is shown, the drive circuit for driving a picture element part may be integrally formed on the same substrate. In that case, it is possible to form a drive circuit in a nMOS circuit, a pMOS circuit, or a CMOS circuit. Of course, only a picture element part may be formed by TFT and an external drive

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circuit and the drive circuits (TCP, COG, etc.) which contain an IC chip typically may be used.
[0090]Although a picture element part is formed only by p channel type TFT and making processes are reduced in Example 1, the drive circuit containing an IC chip can also be used as a drive circuit which forms a drive circuit in this case in a pMOS circuit, and cannot be produced by pMOS.
[0091]It combines with the composition and freedom of Example 1 or Example 2, and composition of this example can be carried out.
[0092][Example 4] This example shows the example using an amorphous silicon film (amorphous silicon film) as an active layer of the switching TFT formed in a picture element part, and the current control TFT. Although reverse stagger type TFT is known as TFT using an amorphous silicon film, reverse stagger type TFT can also be used in this example.
[0093]Using the amorphous silicon film, TFT also had the defect that element size will enlarge, while the making process was simple, but with the EL luminescence equipment of the present invention, the size of TFT does not influence the effective emission area of a pixel. Therefore, more inexpensive EL luminescence equipment is producible by using an amorphous silicon film as an active layer.
[0094]It combines with any composition of Example 1 - Example 3 freely, and composition of this example can be carried out. However, since it is difficult to produce the drive circuit where working speed is quick by TFT using an amorphous silicon film when combining with Example 3, it is desirable to carry out external [of the drive circuit containing an IC chip].
[0095][Example 5] Although described about active-matrix type EL luminescence equipment in Example 1 - Example 4, the present invention can also be carried out to the EL element of passive matrix type EL luminescence equipment.
[0096]It combines with any composition of Example 1 - Example 3 freely, and composition of this example can be carried out. However, when combining with Example 3, external [of the drive circuit containing an IC chip] will be carried out.
[0097][Example 6] The luminescent device which carried out and formed the present invention can be used as a display part of various electrical appliances. All the displays for information displays, such as a PC monitor, a display for TV broadcast reception, and a display for advertising displays, are included in the display which built the luminescent device into the housing.
[0098]As electrical appliances of the other present invention, they are a video camera and a digital camera. A goggles type display (head mount display), a navigation system, Music reproduction equipment (a car audio, an audio component stereo, etc.), a notebook type personal computer, A game machine machine, Personal Digital Assistants (a mobile computer, a mobile phone, a handheld game machine, or a digital book), and picture reproducer (equipment provided with the display part which reproduces the image recorded on the recording medium and displays the image) are mentioned. Those examples are shown in Fig.10 and Fig.11.
[0099]Fig.10 (A) is an EL display and contains the housing 2001, the support base 2002, and the display part 2003. The luminescent device of the present invention can be used for the display part 2003. Since it is a spontaneous light type, the backlight of an EL display is unnecessary, and it can be used as a display part thinner than a liquid crystal display.
[0100]Fig.10 (B) is a video camera and contains the main part 2101, the display part 2102, the voice input part 2103, the operation switch 2104, the battery 2105, and the television part 2106. The luminescent device of the present invention can be used for the display part 2102.
[0101]Fig.10 (C) is a digital camera and contains the main part 2201, the display part 2202, the eye contacting part part 2203, and the operation switch 2204. The luminescent device of the present invention can be used for the display part 2202.
[0102]Fig.10 (D) is the picture reproducer (specifically DVD reproducer) provided with the recording medium, and contains the main part 2301, the recording media (CD, LD, or DVD) 2302, the operation switch 2303, the display part (a) 2304, and the display part (b) 2305. Although a display part (a) mainly displays picture information and a display part (b) mainly displays text, the luminescent device of the present invention can be used for these display parts (a) and (b). CD reproduction equipment, a game machine machine, etc. may be contained in the picture reproducer provided with the recording medium.
[0103]Fig.10 (E) is a portable (mobile) computer and contains the main part 2401, the display part 2402, the television part 2403, the operation switch 2404, and the memory slot 2405. The electro-optic device of the present invention can be used for the display part 2402. This portable computer can record information on the recording medium which integrated a flash memory and nonvolatile memory, or can reproduce it.
[0104]Fig.10 (F) is a personal computer and contains the main part 2501, the housing 2502, the display part 2503, and the keyboard 2504. The luminescent device of the present invention can be used for the display part 2503.
[0105]If the light emitting luminance of an EL material will become high in the future, it will also become possible to carry out extended projection of the light containing the outputted picture information with a lens etc., and to use for the projector of a front type or a rear mold.
[0106]The above-mentioned electronic device displays more often the information distributed through electronic communication lines, such as the Internet and CATV (cable TV), and its opportunity to display especially moving image information is increasing. Since the speed of response of an EL material is very high, it is suitable for performing such animation display.
[0107]As for a luminescent device, in order that the portion which is emitting light may

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consume electric power, it is desirable to display information so that emitting parts may decrease as much as possible. Therefore, when using a luminescent device for the display part which is mainly concerned with text like a Personal Digital Assistant especially a mobile phone, or a car audio, it is desirable to drive so that text may be formed by emitting parts by making a nonluminescent portion into a background.

[0108]Fig.11 (A) is a mobile phone and contains the main part 2601, the voice output part 2602, the voice input part 2603, the display part 2604, the operation switch 2605, and the antenna 2606 here. The luminescent device of the present invention can be used for the display part 2604. The display part 2604 can stop the power consumption of a mobile phone by displaying a white character on a black background.

[0109]Fig.11 (B) is a car audio and contains the main part 2701, the display part 2702, and the operation switches 2703 and 2704. The luminescent device of the present invention can be used for the display part 2702. Although this example shows an in-vehicle car audio, it may use for a non-portable car audio. The display part 2704 can stop power consumption by displaying a white character on a black background.

[0110]It is effective to give a function which makes a photosensor build in and modulates light emitting luminance according to the luminosity of an operating environment by providing a means to detect the luminosity of an operating environment. The user can recognize an image or text satisfactorily, if the luminosity of 100-150 is securable by a contrast ratio compared with the luminosity of an operating environment. That is, it is possible to raise the luminance of an image, to make it legible, when an operating environment is bright, to stop the luminance of an image, when an operating environment is dark, and to stop power consumption.

[0111]As mentioned above, the scope of the present invention is very wide, and using for the electrical appliances of all fields is possible. The electrical appliances of this example may use the luminescent device of which [which showed Examples 1-5] composition.

[0112]

[Effect of the Invention]in the present invention, the characteristics are at the point of electrically connecting the electrode which consists of the transparent conducting film provided at the sealed body side to the electrode which consists of the transparent conducting film formed after [film-forming] carrying out in the organic EL film using an anisotropic conductive film. The resistance of the transparent conducting film formed after this forms an organic EL film can be lowered substantially, and the application of uniform voltage can be enabled.

[0113]By the present invention, the bright good luminescent device of image quality whose effective emission area of the pixel improved substantially can be obtained by combining an anode with the luminescent device made into the structure which takes out light to the anode side transparence or by supposing that it is translucent and providing a reflector under an EL element. The electric vessel instrument of good image quality using the luminescent device of the present invention as a display part can be obtained.

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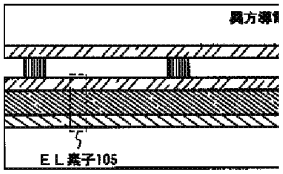
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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
A [FIG. 1] The figure showing the section structure of a luminescent device.
A [FIG. 2] The figure showing the section structure of a luminescent device.
A [FIG. 3] The figure showing the making process of a luminescent device.
A [FIG. 4] The figure showing the making process of a luminescent device.
A [FIG. 5] The figure showing the top surface structure and the circuit configuration of a pixel of a luminescent device.
A [FIG. 6] The figure showing the section structure of retention volume.
A [FIG. 7] The figure showing the section structure of a luminescent device.
A [FIG. 8] The figure showing the top surface structure of a luminescent device.
A [FIG. 9] The figure showing the section structure of the conventional luminescent device.
A [FIG. 10] The figure showing the example of electrical appliances.
A [FIG. 11] The figure showing the example of electrical appliances.

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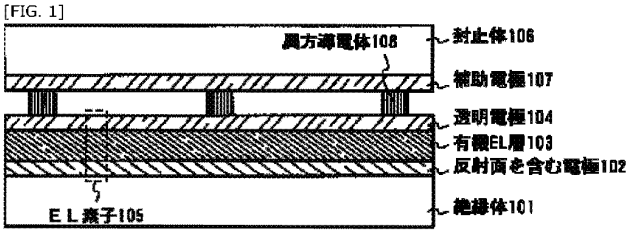
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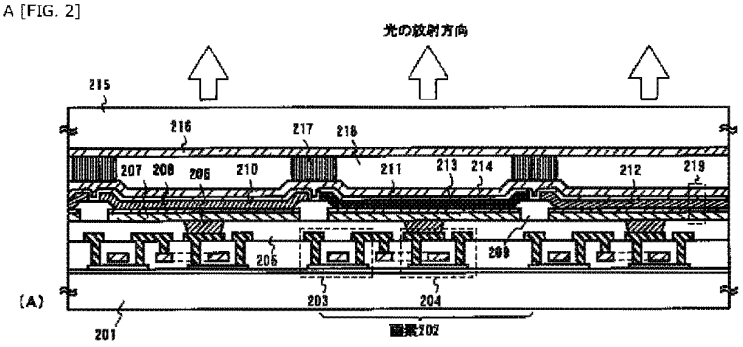
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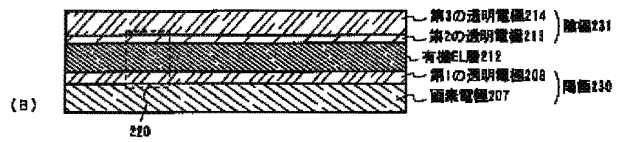
A [FIG. 1]



A [FIG. 2]

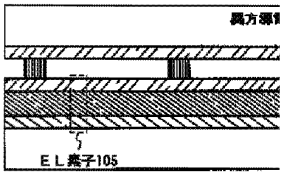


201:基板 202:画素 203:スイッチング TFT 204:電流制御TFT 205:層間絶縁膜 206:導電体アダ
207:画素電極 208:第1の透明電極 209:バンク 210～212:有機EL層 213:第2の透明電極
214:第3の透明電極 215:封止体 216:補助電極 217:異方導電体 218:空間 219:EL素子



A [FIG. 6]

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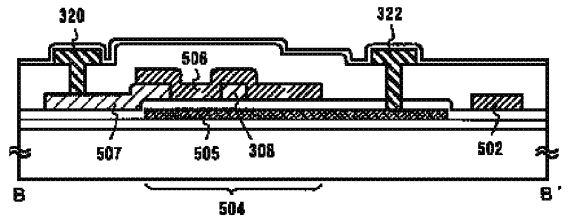


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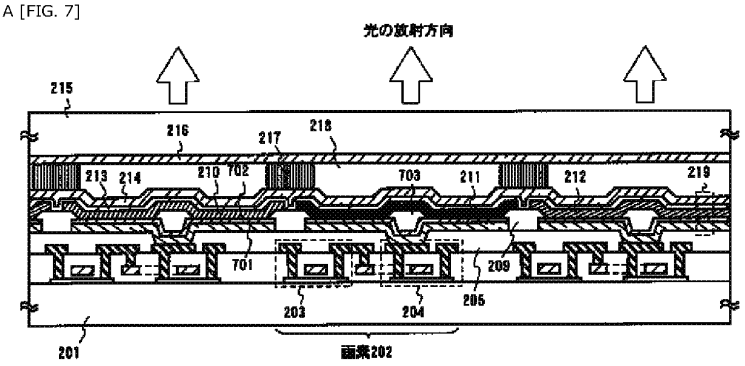
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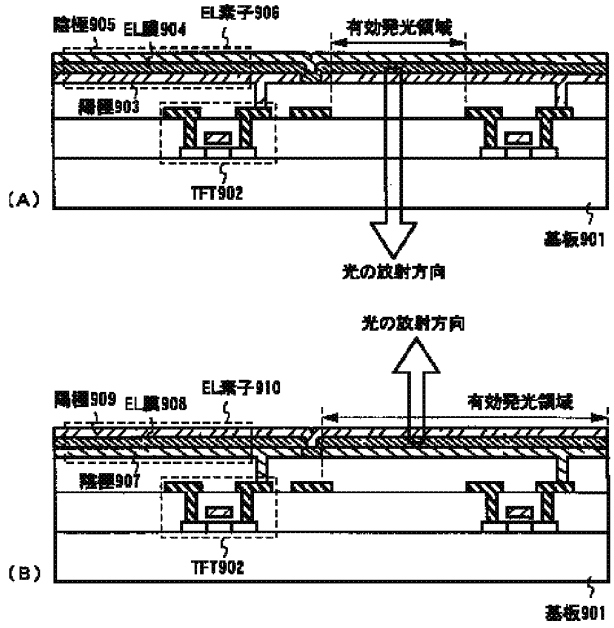
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A [FIG. 7]

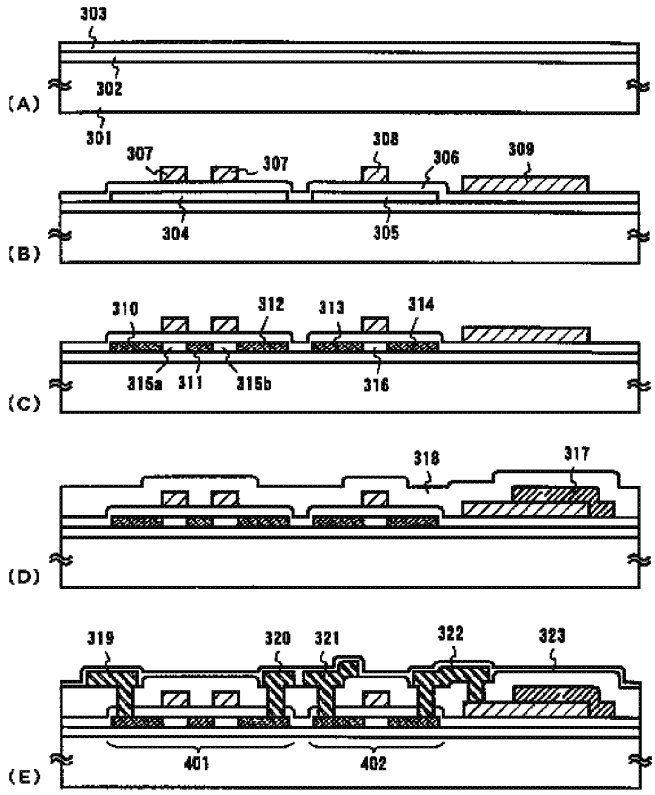


A [FIG. 9]



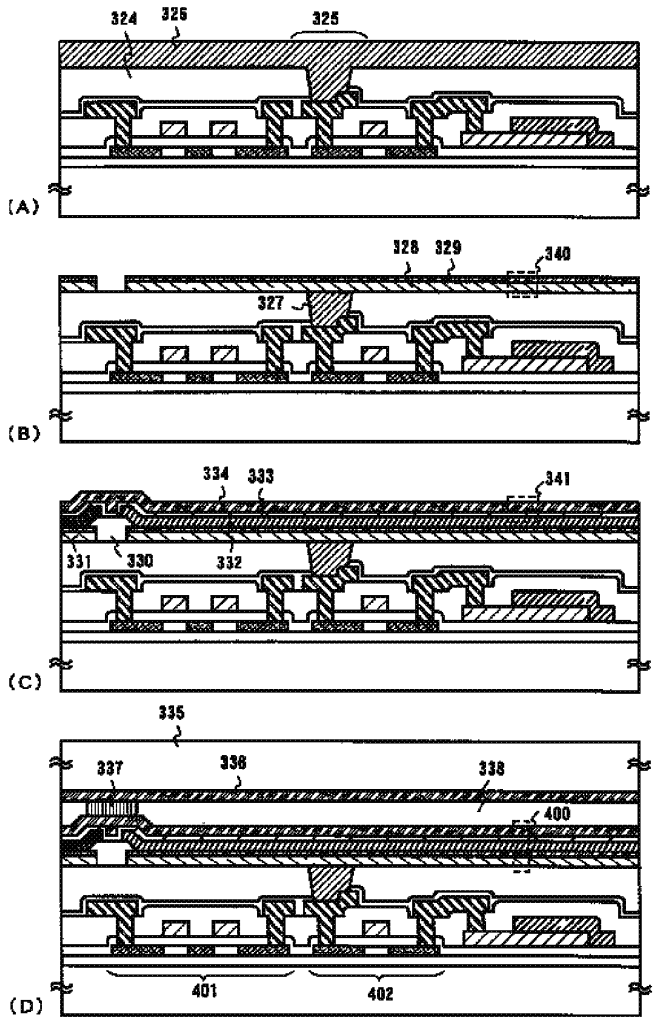
A [FIG. 3]

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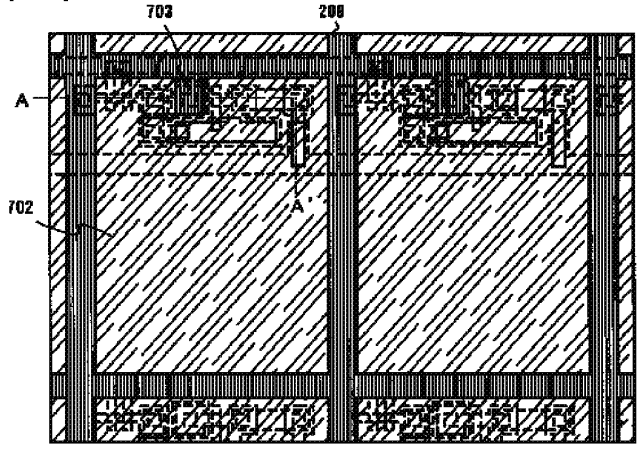


A [FIG. 4]

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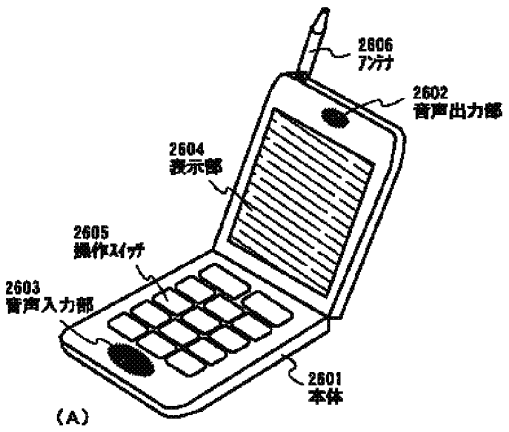


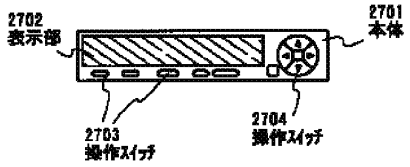
A [FIG. 8]



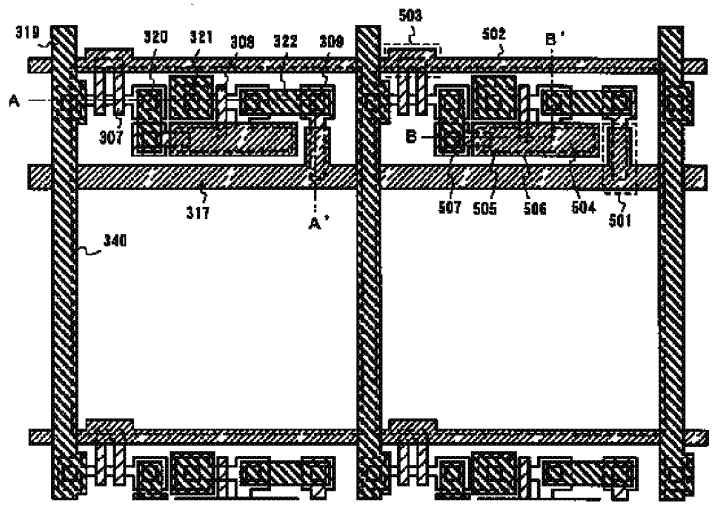
A [FIG. 11]

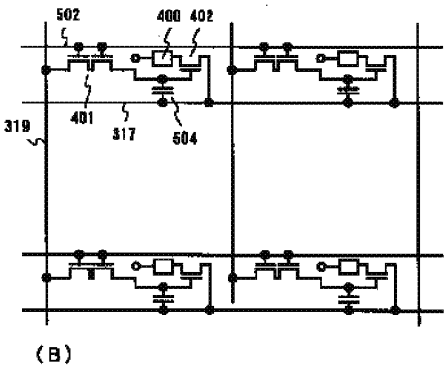
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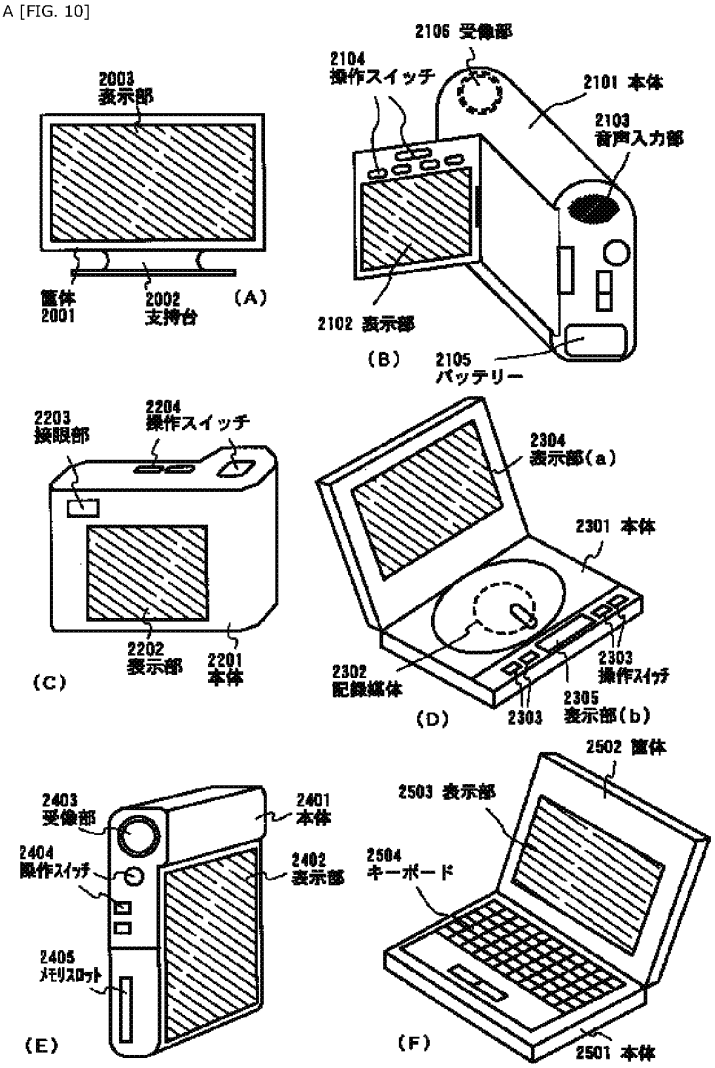
A [FIG. 5]





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A [FIG. 10]



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Confirmation Number:	2349
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First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Customer Number:	27799
Filer:	Thomas Langer/Sheri Michals/ Alphonso A. Collins
Filer Authorized By:	Thomas Langer
Attorney Docket Number:	5367-694P/CON\409926
Receipt Date:	18-DEC-2017
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2	Non Patent Literature	korean_office_action.pdf	85506 157ceb0c93cd9478ec4d5412ddfa924c9d259e1c	no	4
Warnings:					
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3	Foreign Reference	JP2002033198_with_abstract.pdf	408959 a05f1a90ccfe4f9678883f6a7dc6dae25acd803f	no	17
Warnings:					
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4	Foreign Reference	JP2002033198_english_translation__.pdf	389851 6e79823a311b64b2a6876c86f756ea3a5682d62e	no	19
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/651,508	07/17/2017	Ulrich KASTNER-JUNG	5367-694P/CON\409926

CONFIRMATION NO. 2349

27799
Cozen O'Connor
277 Park Avenue, 20th floor
NEW YORK, NY 10172

PUBLICATION NOTICE



Title: Organic-Light-Emitting Diode

Publication No.US-2018-0003354-A1
Publication Date:01/04/2018

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/651,508	07/17/2017	Ulrich KASTNER-JUNG	5367-694P/CON\409926	2349

27799 7590 02/09/2018

Cozen O'Connor
277 Park Avenue, 20th floor
NEW YORK, NY 10172

EXAMINER	
CHO, JAMES HYONCHOL	

ART UNIT	PAPER NUMBER
2844	

NOTIFICATION DATE	DELIVERY MODE
02/09/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patentsecretary@cozen.com
patentdocket@cozen.com
patentsorter@cozen.com

Office Action Summary	Application No. 15/651,508	Applicant(s) KASTNER-JUNG ET AL.	
	Examiner JAMES H. CHO	Art Unit 2844	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *7/17/2017*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-18* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-4,7-10, 12-18* is/are rejected.

8)☒ Claim(s) *5,6 and 11* is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☒ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *7/17/2017* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☒ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☒ Certified copies of the priority documents have been received in Application No. 13/139,514.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Specification

The disclosure is objected to because of the following informalities: in the cross-reference to related application, the parent application SN 13/139,514 is now issued as United States Patent Number 9,797,567 which is to be updated in the instant application specification.

Appropriate correction is required.

Priority

Acknowledgment is made of applicant's claim for foreign priority under 35 U.S.C. 119 (a)-(d). The certified copy has been filed in parent Application No. 13/139,514, filed on 1/3/2012.

Claim Objections

Claims are objected to because of the following informalities:

In claim 15, "the top side" on line 8 should be --a top side--.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 7-10 and 14-15 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 7 recites the limitations "the prisms" in line 2 and “the main plane” in line 10.

Claims 8-9 recites the limitations "the first areas and/or the second areas” in line 2 respectively.

Claim 10 recites the limitation “the first areas” in line 3.

Claim 14 recites the limitation “the carrier” in line 2.

Claim 15 recites the limitation “the carrier” in line 2.

There is insufficient antecedent base for these limitations in the claims.

Claim Rejections - 35 USC § 102

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of the appropriate paragraphs of pre-AIA 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 4, 8-10, 12-13 and 16-18 are rejected under pre-AIA 35 U.S.C. 102(b) as being anticipated by Garditz et al. (US2007/0114520 A1), hereinafter referred as Garditz.

Regarding claim 1, Garditz teaches an organic light-emitting diode (Figs. 1C and 2B, 2D, see paragraph [0046]) comprising an organic layer sequence (15 being at least one or more organic functional layers, see paragraph [0018]), a radiation exit area (top or bottom emitting area indicated with arrows, see paragraph [0045]) and an encapsulation (6),

wherein the organic layer sequence comprises at least one radiation-emitting region (15) which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation (the radiation emitted in the infrared or UV range, see paragraph [0018]),

wherein the radiation exit area is structured (microlens 20E or 20F at the bottom or top exit area as shown in Fig. 2A-2D where the microlens is for forming the light emission direction, see paragraphs [0046] -[0048]), so that the electromagnetic radiation has a directional emission profile, and

wherein the encapsulation (protection from environment influences, e.g. water and moisture when the OLED is encapsulated by a cap made of glass or ceramic is inherent, see paragraph [0018]) forms a seal of the organic layer sequence against environmental influences.

Regarding claim 4, Garditz teaches the organic light-emitting diode according to claim 1, wherein the emission profile is a symmetrical cardioid in one direction or asymmetrical in at least one of the directions (see the direction of light emission being one direction noted with arrow).

Regarding claim 8, Garditz teaches the organic light-emitting diode according to claim 1, wherein the first areas (areas for microarray 20F of a lot of microlenses 20F are nonplanar shown in Fig. 2D) and/or the second areas are nonplanar.

Regarding claim 9, Garditz teaches the organic light-emitting diode according to claim 1, wherein the first areas (areas of microarray 20F of a lot of mircrolenes are an arc which is in the form of the manner of cylinder sections) and/or a second areas are formed in the manner of cylinder sections.

Regarding claim 10, Garditz teaches the organic light-emitting diode according to claim 1, wherein the directional emission profile has a maximum in the direction perpendicular to the first areas (the lens 20E provides a focus the intensity of the emitted radiation in the emission direction in the optical path 100, see paragraph [0046]).

Regarding claim 12, Garditz teaches the organic light-emitting diode according to claim 1, wherein the structured radiation exit area is embodied as a separate

structured foil (a layer of 20F being separate from the substrate 5 shown in Figs. 2B and 2D), which is arranged on a carrier (a layer of 20F is formed from the radiation out-coupling material, see paragraph [0047]).

Regarding claim 13, Garditz teaches the organic light-emitting diode according to claim 1, wherein the organic light-emitting diode comprises a carrier which is structured (the radiation out-coupling material for 20F), wherein the radiation exit area (20F is formed using the radiation out-coupling material) is arranged on the carrier, and wherein the structuring of the radiation exit area is induced by the structuring of the carrier (the shaped structure of 20F is made with the radiation out-coupling material, see paragraph [0047]).

Regarding claim 16, Garditz teaches the organic light-emitting diode according to claim 1, wherein the structuring of the radiation exit area is produced by the structuring of the encapsulation (the microarray of lenses are being encapsulated, see paragraph [0047]).

Regarding claim 17, Garditz teaches the organic light-emitting diode according to claim 1, wherein the organic light-emitting diode is an organic light-emitting diode emitting on both sides (top-emitting and bottom-emitting as denoted by arrows 100 and 110 where 100 and 110 are opposite to each other as shown in Fig. 1C), which comprises two radiation exit areas, wherein the two radiation exit areas are arranged on

opposite sides of the organic light-emitting diode, and wherein the radiation exit areas are structured (see paragraph [0045]).

Regarding claim 18, Garditz teaches a luminaire having at least one light-emitting diode according to claim 1 as a light source, wherein the luminaire is one of the following devices or is at least part of one of the following devices (a luminaire using the OLED of Garditz for a particular apparatus such as in alarm clock,... waring light is an intended use. It has been held that a recitation directed to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. *Ex parte Masham*, 2 USPQ2d 1647 (1987)) : alarm clock, shower cubicle, shower head, solar protection, rain protection, lamp, bag, signaling light, changing cubicle, vision protection, housing, emergency lighting, mirror, tile, ceiling light, radiator cladding, louver, noise protection, umbrella, warning light.

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter

of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

Claims 2-3 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Garditz in view of Chen (US Pat No. 7,205,714).

Regarding claim 2, Garditz teaches the organic light-emitting diode according to claim 1, wherein the structured radiation exit area comprises a microarray of lenses (20F in Fig. 2D),

but does not teach the shape of the microarray of lenses being a multiplicity of prisms which are arranged parallel to one another.

However Chen teaches various structure arrangements of refractive lenses in parallel including arced, trapezoidal or rectangular (see Fig. 3a, 3b, 3c-1, 3c-2, 3d where trapezoidal and rectangular lens are considered as polyhedron prism or irregular prism) for the purpose of improving scatter phenomenon of light emission (see col. 3, lines 33-38).

Therefore it would have been obvious to one ordinary skill in the art to replace the microarray of lenses of Garditz with the trapezoidal or rectangular prism of Chen in order to provide various output radiation.

Regarding claim 3, Garditz in view of Chen teaches the organic light-emitting diode according to claim 2, wherein the prisms comprises a height and width which are arranged parallel to the main plane of the organic layer sequence, the width is bigger than the wavelength of the electromagnetic radiation which is induced by the organic light-emitting diode (a preferred width being 50000 Å = 5000 nm, see col. 3, lines 22-26, is bigger than a typical UV wavelength of 400 nm and IR wavelength of 800nm),

but does not teach the length of the prism being at least 1 cm.

However, it would have been obvious to one having ordinary skill in the art at the time the invention was made to specify the length of the OLED being at least 1 cm, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art.

Allowable Subject Matter

Claims 5-6 and 11 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter:

one of ordinary skill in the art would not have been motivated to modify the teaching of Garditz and/or Chen. to further includes, among other things, the specific of the structured radiation exit area comprising a multiplicity of first areas and second

areas where the first areas are tilted at an angle α to a plane which is arranged parallel to the main plane of the organic layer sequence, the second areas are tilted at an angle β to said plane, and the first areas are transparent and the second areas are reflective, so that the directional emission profile has a tilt angle which depends on the angle α (**claim 5**), the specific of the structured radiation exit area comprising a multiplicity of first areas and second areas where the first areas are tilted at an angle α to a plane which is arranged parallel to the main plane of the organic layer sequence, and wherein the second areas are tilted at an angle β to said plane, wherein the angles α and β are different from each other (**claim 6**).

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Ishikawa (US PAT No. 7,560,727) discloses an organic electroluminescent element having a prism structure.

Osato et al. (US 2007/0230244 A1) discloses an organic light emitting devicewith polarizing member, a prism member a phase member.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to James Cho whose telephone number is 571-272-1802. The examiner can normally be reached on Monday-Friday 8 AM - 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Douglas Owens can be reached on 571-272-1662. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

/James H. Cho/
Examiner, Art Unit 2844

/Douglas W Owens/
Supervisory Patent Examiner, Art Unit 2844
February 3, 2018

Notice of References Cited	Application/Control No. 15/651,508	Applicant(s)/Patent Under Reexamination KASTNER-JUNG ET AL.	
	Examiner JAMES H. CHO	Art Unit 2844	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2007/0114520 A1	05-2007	Garditz; Christoph	B82Y20/00	257/40
*	B	US-7,205,714 B2	04-2007	Chen; Jui-Hsing	H01L51/5275	313/501
*	C	US-7,560,727 B2	07-2009	Ishikawa; Shun-ichi	H01L51/5275	257/40
*	D	US-2007/0230211 A1	10-2007	Osato; Yoichi	G02B5/045	362/600
	E	US-				
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Attorney Docket # 5367-694PCON/409926 Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Continuation Application of
Ulrich KASTNER-JUNG et al.
Serial No.: TO BE ASSIGNED
Filing Date: CONCURRENTLY
For: Organic-Light-Emitting Diode

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

S I R:

In compliance with the duty of disclosure under 37 C.F.R. § 1.56 and in accordance with the practice under 37 C.F.R. §§ 1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a.

Because (1) the parent application of this continuation application is identified as U.S. Application Serial No. 13/139,514 filed on January 3, 2012; and (2) the information cited herein was cited or discussed in the parent application, copies of the cited documents are not enclosed pursuant to 37 C.F.R. § 1.98(d).

It is respectfully requested that the above information be considered by the Examiner and that the copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document listed or attached

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /JC/

is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicants reserve the right to prove that the date of publication is in fact different.

If any fees or charges are deemed required at this time in connection with the application, the same may be charged to our Patent and Trademark Office Deposit Account No. 503111.

Respectfully submitted,
Cozen O'Connor

By /Thomas Langer/
Thomas Langer
Reg. No. 27,264
277 Park Avenue
New York, New York 10172
(212) 883-4900

Dated: July 17, 2017

LEGAL\31330265\1

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PTO/SB/08A (04-03)
Approved for use through 04/30/2003. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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Substitute for Form 1449/PTO	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)	Application Number	
	Filing Date	
	First Named Inventor	Ulrich KASTNER-JUNG
	Art Unit	
	Examiner Name	
Sheet 1 of 3	Attorney Docket No.	5367-694PCON

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number Number-Kind-Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-2007/0278937	12-06-2007	Forrest et al.	
		US-2003/0064540	04-03-2003	Auch et al.	
		US-7,280,439	10-09-2007	Shaddox	
		US-2003/0231495	12-18-2003	Searfoss, III	
		US-6,236,622	05-22-2001	Blackman	
		US-2008/0219013	09-11-2008	Budinger et al.	
		US-7,317,210	01-08-2008	Osram Opto Semiconductors GmbH	
		US-2009/0039272	02-12-2009	Osram Opto Semiconductors GmbH	
		US-7,922,358	04-12-2011	Osram Opto Semiconductors GmbH	
		US-2001/0052752	12-2001	Ghosh	
		US-2002/0125822	09-2002	Graff	
		US-2002/0167270	11-2002	Siwinski	
		US-2003/0071804	04-2003	Yamazaki	
		US-2003/0121767	07-2003	Caldwell	
		US-2003/0175553	09-2003	Thompson	
		US-2003/0222577	12-2003	Lu	
		US-2004/0113542	06-2004	Hsiao	
		US-2005/0099824	05-2005	Dowling	
		US-2006/0049381	03-2006	Klein	
		US-2007/0278937	12-2007	Forrest	
		US-2008/0248191	10-2008	Daniels	
		US-2010/0157585	06-2010	Diekmann	
		US-2012/0258294	10-2012	Leyder	
		US-5,734,225	03-1998	Biebuyck et al.	
		US-5,895,228	04-1999	Biebuyck	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, Washington, DC 20231.**

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /JC/

PTO/SB/08A (04-03)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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Substitute for Form 1449/PTO	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)	Application Number	
	Filing Date	
	First Named Inventor	Ulrich KASTNER-JUNG
	Art Unit	
	Examiner Name	
Sheet 2 of 3	Attorney Docket No.	5367-694PCON

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Document: Country Code[3] Number[4] Kind-Code [5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		DE 10 2006 037 222	02-14-2008	Swoboda et al.		
		JP 2007-294143	11-08-2007	Matsuura		
		WO 2008/110959	09-18-2008	Van Woudenberg et al.		
		WO 2008/146232	12-04-2008	Schlangen et al.		
		DE 10308514	09-09-2004	Schott Glas		
		DE 10332956	02-10-2005	Woehr Richard GmbH		
		KR 20080081255	09-09-2008	Osram Opto Semiconductors GmbH		
		KR 20020079438	10-19-2002	Eastman Kodak Co.		
		DE 102008051132	01-21-2010	Osram Opto Semiconductors GmbH		
		WO 2009/040401	04-02-2009	Osram Opto Semiconductors GmbH		
		WO 2009/074127	06-18-2009	Osram Opto Semiconductors GmbH		
		WO 2009/095005	08-06-2009	Osram Opto Semiconductors GmbH		
		WO 2009/106067	09-03-2009	Osram Opto Semiconductors GmbH		
		WO 2010/006571	01-21-2010	Osram Opto Semiconductors GmbH		
		WO 2008/040323	04-2008	Diekmann		
		WO 2008/146232	12-2008	Schlangen		

Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)	Application Number	
	Filing Date	
	First Named Inventor	Ulrich KASTNER-JUNG
	Art Unit	
	Examiner Name	
Sheet 3 of 3	Attorney Docket No.	5367-694PCON

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
		Boffi Wedge. Stylepark, May 25, 2011. (1 page). Retrieved from http://www.stylepark.com/en/boffi/wedge.	
		Bus stop shelter intelligent series. May 25, 2011. (2 pages). Retrieved from http://www.wall.de/en/street_furniture/products?category_scope=bus_stop_shelter	
		Cristina Rubinetterie sandwich shower head – new electronic LED shower head, May 12, 2007. (3 pages). Retrieved from http://www.trendir.com/archives/001435.html.	
		Dornbracht RainSky E Showers by Rixson & Green Shortlands Ltd. September 2000. (1 page). Retrieved from http://www.rixson-green.co.uk/dornbracht_showers.htm.	
		Marketing-displays. Illuminated box CLP-S I freetstanding unit, one-sided (1200 x 1760 mm). May 25, 2011. (1 page). Retrieved from http://www.md-displayshop.de/ProductDetails.aspx?id=24&prodi...	
		LCD-Glass; Glass with LCD Film (max height 300 – max width 120). 2009. (2 pages). Retrieved from http://www.vetroin.co.uk/en/TECHNOLOGY/LDC-Glass.html no month	
		ThinkGeek:Lumadot LED Umbrella. May 25, 2011. (2 pages). Retrieved from http://www.thinkgeek.com/interests/moms/d16b/	
		Luceplan. Strip D22/4 – D22/4 EL. May 25, 2011. Retrieved from http://www.luceplan.com/Dynamic/Prodotti.php?intLangID=1&intC...	
		Multifunctional shower cabin- WELL BOX- Megius SpA. 2011. (1 page). Retrieved from http://www.archiexpo.com/prod/megius-spa/multifunctional-shower... no month	
		The General Properties of Si, Ge, SiGe, SiO2 and Si3N4 (June 2002, Virginia Semiconductor, Retrieved from the Internet: <URL www.virginiasemi.com/pdf/generalpropertiesSi62002.pdf>)	
		Edgar S. Zaus et al., "Design of Highly Transparent Organic Photodiodes, IEEE Transactions of Electron Devices, Vo. 55, No. 2, February 2008	
		N. R. Mowrer, "Polysiloxanes, Ameron International Performance Coatings and Finishes, November 2003	

Examiner Signature	/JAMES H CHO/	Date Considered	01/31/2018

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Attorney Docket # 5367-694P/CON/409926 Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Kastner-Jung, Ulrich et al. Serial No.: 15/651,508 Filed: July 17, 2017 For: Organic-Light-Emitting Diode	Examiner: Not Yet Assigned Art Unit: 2811

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

S I R:

In compliance with the duty of disclosure under 37 C.F.R. § 1.56 and in accordance with the practice under 37 C.F.R. §§ 1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a. Copies of the listed non-US documents are also enclosed.

Enclosed is a copy of a Notice of Allowance dated July 20, 2017 which issued in the corresponding Korean Patent Application No. 10-2011-7015909. The references cited in the Korean Notice of Allowance that are not listed on the enclosed Form PTO/SB/08a were submitted to the USPTO in a previously filed IDS.

Reference US 7,733,008 corresponds to JP 2005-510851.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /JC/

SDC EX. 1016 - 452/959

Attorney Docket # 5367-694P/CON/409926 Patent

It is respectfully requested that the above information be considered by the Examiner and that the copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicants reserve the right to prove that the date of publication is in fact different.

If any fees or charges are deemed required at this time in connection with the application, the same may be charged to our Patent and Trademark Office Deposit Account No. 503111.

Respectfully submitted,
COZEN O'CONNOR

By: /Thomas Langer/
Thomas Langer
Reg. No. 27,264
277 Park Avenue
New York, New York 10172
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Dated: August 17, 2017

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SDC EX. 1016 - 453/959

Attorney Docket # 5367-694P/CON/409926

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Substitute for Form 1449/PTO	*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use as many sheets as necessary)	Application Number	15/651,508
	Filing Date	July 17, 2017
	First Named Inventor	Kastner-Jung, Ulrich
	Art Unit	2811
	Examiner Name	Not Yet Assigned
Sheet 1 of 1	Attorney Docket	5367-694P/CON/409926

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number Number-Kind-Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	US-7,733,008	06-08-2010	Agency for Science, Technology and Research	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Document Country Code[3]- Number[4]- Kind-Code [5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
	2	JP 2005-510851	04-21-2005	Agency for Science, Technology and Research		See 1
	3	KR 100743545	07-23-2007	Lee Young Jong		Abs.
	4	KR 1020050065948	11-11-2013	LG Electronics Inc.		Abs.

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
	5	Notice of Allowance dated July 20, 2017 which issued in the corresponding Korean Patent Application No. 10-2011-7015909.	✓

Examiner Signature	/JAMES H CHO/	Date Considered	01/31/2018

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Attorney Docket # 5367-694P/CON/409926 Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Kastner-Jung, Ulrich et al. Serial No.: 15/651,508 Filed: July 17, 2017 For: Organic-Light-Emitting Diode	Examiner: CHO, JAMES HYONCHOL Art Unit: 2811

Commissioner for Patents
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Enclosed is a copy of an English translation of an Office Action dated November 29, 2017 which issued in the corresponding Korean Patent Application No. 10-2017-7026128.

It is respectfully requested that the above information be considered by the Examiner and that the copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or

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that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicants reserve the right to prove that the date of publication is in fact different.

If any fees or charges are deemed required at this time in connection with the application, the same may be charged to our Patent and Trademark Office Deposit Account No. 503111.

Respectfully submitted,
COZEN O'CONNOR

By: /Alphonso A. Collins/
Alphonso A. Collins
Reg. No. 43,559
277 Park Avenue
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Dated: December 18, 2017

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Attorney Docket # 5367-694P/CON/409926

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Substitute for Form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	15/651,508
Filing Date	July 17, 2017
First Named Inventor	Kastner-Jung, Ulrich
Art Unit	2811
Examiner Name	CHO, JAMES HYONCHOL
Attorney Docket	5367-694P/CON/409926

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number / Number-Kind-Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-2001/0043046	11-22-2001	Fukunaga	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Document / Country Code[3]- Number[4]- Kind-Code [5] (if known	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		JP 2002-033198	01-31-2002	Semiconductor Energy Lab		✓

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
		Office Action dated November 29, 2017 which issued in the corresponding Korean Patent Application No. 10-2017-7026128.	✓

Examiner Signature	/JAMES H CHO/	Date Considered	01/31/2018

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S91	1	("9797567").PN.	US-PGPUB; USPAT	OR	OFF	2018/01/31 14:36
S93	1	S91 and exit$4 adj3 area	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 14:55
S94	25	("20010052752" | "20020125822" | "20020167270" | "20030064540" | "20030071804" | "20030121767" | "20030175553" | "20030222577" | "20030231495" | "20040113542" | "20050099824" | "20060049381" | "20070278937" | "20080219013" | "20080248191" | "20090039272" | "20100157585" | "20120258294" | "5734225" | "6236622" | "7280439" | "7317120" | "7317210" | "7733008" | "7922358").PN. OR ("9797567").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/01/31 14:57
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S95	1	("8328375").PN.	US-PGPUB; USPAT	OR	OFF	2018/01/31 15:21
S97	43144	(F21S10/02 B60Q3/30,745 B05B1/18,268 B60Q7/00 F21V23/0442,0016,004,0052,006 F21Y2113/20,10 F21Y2115/15 F21S8/033,04,061 F21S9/03 F21Y2105/00).cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 15:39
S99	67558	(S97 S98)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 15:41
S98	26261	(G04C19/02 G04G11/00 G04G13/023	US-PGPUB;	OR	ON	2018/01/31

		H05B33/0896,22 H05B37/00,0281 H01L2251/5361 Y02B20/36,42).cpc.	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			15:41
S100	989	S99 and organic near4 (LED.u/c. light$3emit$4 diode) and (layer plane sequence) and encapsulat$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 15:43
S101	227	S100 and (infrared IR.u/c.) and (UV.u/c. ultra$2violet ultra adj2 violet)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 15:44
S102	42	S101 and (prism angle angular direction) near4 (radiat$4 electro$2magnetic$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 15:46
S104	15	S102 and S103	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 15:51
S103	58	S101 and @ad<"20091231"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 15:51
S105	30923	S99 and @ad<"20091231"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 16:20
S107	58	S106 and (infrared IR.u/c.) and (UV.u/c. ultra$2violet ultra adj2 violet)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 16:29
S106	344	S105 and organic near4 (LED.u/c. light$3emit$4 diode) and (layer plane sequence) and encapsulat$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2018/01/31 16:29

			IBM_TDB			
S108	15	S107 and encapsulat$4 with organic	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 16:33
S110	6	S109 and organic near4 (LED.u/c. light$3emit$4 diode) and (layer plane sequence) and encapsulat$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 16:44
S109	16	("20050224935" | "20060001040" | "6287639" | "4540763" | "5753374" | "6926572" | "20020003403" | "20050112282" | "6277448" | "7015640" | "20040046497" | "20040194691" | "6884465" | "20040232832" | "20080138538" | "5185391").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/01/31 16:44
S111	24710	organic near4 (LED.u/c. light$3emit$4 diode) and (layer plane sequence) and encapsulat$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 16:48
S113	1466	S112 and @ad<"20081231"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 16:49
S112	5063	S111 and (infrared IR.u/c.) and (UV.u/c. ultra$2violet ultra adj2 violet)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 16:49
S114	346	S113 and encapsulat$4 with organic	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 16:50
S115	46	S114 and (prism angl$3 angular direction$4) with ((radiat$4 electro$2magnetic$4) and (surface layer plane))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 16:52
S116	12	("20020192477" | "20030227249" | "20040094757" | "20050129957" | "20070024173" | "5637258" | "6113807" | "6160040" | "6726992" | "6734465" |	US-PGPUB; USPAT; USOCR	OR	ON	2018/01/31 17:37

		"7045956").PN. OR ("8723198").URPN.				
S118	24	(US-5734225-$ | US-5895228-$ | US-6236622-$ | US-7280439-$ | US-7317210-$ | US-7922358-$ | US-20010052752-$ | US-20020125822-$ | US-20020167270-$ | US-20030064540-$ | US-20030071804-$ | US-20030121767-$ | US-20030175553-$ | US-20030222577-$ | US-20030231495-$ | US-20040113542-$ | US-20050099824-$ | US-20060049381-$ | US-20070278937-$ | US-20080219013-$ | US-20080248191-$ | US-20090039272-$ | US-20100157585-$ | US-20120258294-$).DID.	US-PGPUB; USPAT; USOCR	OR	ON	2018/01/31 19:18
S119	2	(("20010043046") or ("7733008")).PN.	US-PGPUB; USPAT	OR	OFF	2018/01/31 19:20
S120	26	S118 S119	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 19:21
S122	4	S121 and encapsulat$4 with organic	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 19:23
S121	8	S120 and (infrared IR.u/c.) and (UV.u/c. ultra$2violet ultra adj2 violet)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 19:23
S123	448	S113 and (encapsulat$4 seal$4) with organic	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 19:43
S124	102	S123 not S114	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 19:44
S126	0	wo-2009-040323	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 19:50
S127	18	(US-20100157585-$ or US-20160238234-$ or US-20100076527-$ or	US-PGPUB; USPAT	OR	ON	2018/01/31 21:24

		US-20080138624-$ or US-20020003403-$ or US-20110133628-$ or US-20090173957-$ or US-20090091258-$ or US-20080188156-$ or US-20080138539-$ or US-20070114520-$ or US-20060128042-$ or US-20090039272-$ or US-20010043046-$).did. or (US-6926572-$ or US-6884465-$ or US-7922358-$ or US-7733008-$).did.				
S129	6	S128 and (lens prism angl$3 tilt$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 21:25
S128	8	S127 and (beam radiation light) near4 path	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/01/31 21:25
S131	13	("20050214556" | "6721257" | "20010033135" | "20050156520" | "20020128414" | "20050214556" | "20020128414" | "20040163570" | "20050238914" | "5102967" | "20040050816" | "20040054047" | "20040046497" | "20020113241" | "20040050816" | "20040054047" | "20020113241" | "5102967" | "6664024").PN.	US-PGPUB; USPAT	OR	ON	2018/02/01 10:08
S133	5721	(OLED.u/c. LED.u/c.) with (prism)	US-PGPUB; USPAT	OR	ON	2018/02/01 12:59
S132	54219	(OLED.u/c. LED.u/c.) with (lens prism)	US-PGPUB; USPAT	OR	ON	2018/02/01 12:59
S134	890	(LED.u/c. OLED.u/c.) and (encapsulat$4 seal$4) with prism	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/01 13:01
S135	342	S134 and @ad<"20081231"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/01 13:02
S136	90	S135 and (beam emission radiation) with direction	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/01 13:03
S137	25	S134 and prism with ((length width height) and wavelength)	US-PGPUB; USPAT; USOCR;	OR	ON	2018/02/01 14:03

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S138	35	("3234376" | "4432039" | "4576436" | "4874228" | "5128842" | "5418631" | "5485291" | "5485354" | "5512219" | "5648859" | "5649754" | "5664862" | "5700078" | "5729311" | "5764322" | "5779337" | "5833517" | "5947578" | "6014192" | "6069728" | "6152570" | "6234639").PN. OR ("6575584").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/01 14:43
S139	25	("20010052752" | "20020125822" | "20020167270" | "20030064540" | "20030071804" | "20030121767" | "20030175553" | "20030222577" | "20030231495" | "20040113542" | "20050099824" | "20060049381" | "20070278937" | "20080219013" | "20080248191" | "20090039272" | "20100157585" | "20120258294" | "5734225" | "6236622" | "7280439" | "7317120" | "7317210" | "7733008" | "7922358").PN. OR ("9797567").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/01 14:44
S140	19	("20010040717" | "20050036327" | "20050079324" | "20060232992" | "20070085476" | "20070145889" | "20070230211" | "6006404" | "6511198" | "6650045" | "6965197" | "7358663").PN. OR ("7922358").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/01 14:49
S141	15	("20040240070" | "20050142379" | "20050162743" | "20070171671" | "20070263412" | "20080305301" | "20090097234" | "20100087611" | "20100214507" | "20100245718" | "20110019426" | "20110090568" | "20110198987" | "7922358").PN. OR ("9431632").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/01 15:00
S142	38	("20030230980" | "20040174116" | "20070230211" | "20100201256" | "20100258821" | "20120138980" | "20120292652" | "20130244079" | "20140001448" | "20140021450" | "4769292" | "5247190" | "5284792" | "5609284" | "5703436" | "5707745" | "5834893" | "5844363" | "6013982" | "6087196" | "6091195" | "6097147" | "6294398" | "6303238" | "6337102" | "6468819" | "6984934" | "7279704" | "7368756" | "7431968" | "7560727" | "7922358" | "7968146" | "8125138" | "8563343" | "8584490" | "8716749" | "8987711").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/01 15:04
S143	12	("20130141652" | "4774435" | "6329041" | "6562440" | "6583935" | "6777070" | "7141298" | "7378136" | "7569269" | "7833607" | "8512801" | "8686630").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/01 15:05
S144	2	("20040217702" | "6516152").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/01 15:08

S145	5	("20030117067" | "20030141805" | "6590346" | "6787976" | "6984934").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/01 15:15
S147	6	("7358663").URPN.	USPAT	OR	ON	2018/02/01 15:16
S146	5	("20030117067" | "20030141805" | "6590346" | "6787976" | "6984934").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/01 15:16
S149	37	S134 and S148	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/01 15:28
S148	18131	diffractive adj2 optical adj2 element	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/02/01 15:28
S150	1	("7205714").PN.	US-PGPUB; USPAT	OR	OFF	2018/02/01 15:34
S151	10	("20030117067" | "20030141805" | "6590346" | "6617784" | "6777871" | "6787976" | "6984934").PN. OR ("7205714").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/02/01 15:35

2/1/2018 6:40:37 PM
C:\Users\jcho\Documents\EAST\Workspaces\15651508.wsp

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15651508	KASTNER-JUNG ET AL.
	Examiner	Art Unit
	JAMES H CHO	2844

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/01/2018								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	O								
	6	O								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	O								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	✓								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15651508	KASTNER-JUNG ET AL.
	Examiner	Art Unit
	JAMES H CHO	2844

CPC- SEARCHED		
Symbol	Date	Examiner
B60Q3/30,745 B05B1/18,268 B60Q7/00 F21S10/02 F21V23/0442,0016,004,0052,006 F21Y2113/20,10 F21Y2115/15 F21Y2105/00 (text search, see the search history printout)	2/1/2018	JC
F21S8/033,04,061 F21S9/03 G04C19/02 G04G11/00 G04G13/023 H05B33/0896,22 H05B37/00,0281 H01L2251/5361 Y02B20/36,42 (text search, see the search history printout)	2/1/201	JC

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES		
Search Notes	Date	Examiner
BRS text search, see the search history printout	2/1/2018	JC

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

Bibliographic Data

Application No: 15651508

Foreign Priority claimed: (●) Yes ( ) No

35 USC 119 (a-d) conditions met: [✓] Yes [ ] No [ ] Met After Allowance

Verified and Acknowledged: /JAMES H CHO/ (Examiner's Signature) [ ] (Initials)

Title: Organic-Light-Emitting Diode

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
07/17/2017	315	2844	5367-694P/CON\409926
RULE			

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CONTINUING DATA

This application is a CON of 13139514 01/03/2012 PAT 9797567

13139514 is a 371 of PCT/DE2009/001741 12/09/2009

FOREIGN APPLICATIONS

GERMANY 10 2008 061 563.3 12/11/2008

IF REQUIRED, FOREIGN LICENSE GRANTED**

07/24/2017

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PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/651,508	Filing Date 07/17/2017	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **04/05/2018**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 18	Minus	** 20	= 0	X $100 =	0
Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $460 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	**0**

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/CHRISTINE MOLLISH/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Kastner-Jung, Ulrich et al.

Serial No.: 15/651,508

Filed: July 17, 2017

For: Organic-Light-Emitting Diode

Examiner: CHO, James H.

Group Art Unit: 2811

Conf. No.: 2349

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT

SIR:

RESPONSE

In response to the Office Action dated February 9, 2018, please amend the above-identified application as follows:

Amendments to the Specifications begin on page 2 of this paper;

Amendments to the Claims are reflected in the listing of claims which begins on page 3 of this paper;

Remarks/Arguments begin on page 8 of this paper.

SDC EX. 1016 - 470/959

Amendments to the Specification:

Please amend paragraph [0001] as follows:

RELATED APPLICATIONS

[0001] This application is a continuation of U.S. Application Serial No. 13/139,514 filed January 3, 2012, now Patent No. 9,797,567 which issued on October 24, 2017, which claims the priority under 35 U.S.C. 371 of International application No. PCT/DE2009/001741 filed on December 9, 2009. Priority is also claimed of German application no. 10 2008 061 563.3 filed on December 11, 2008. The entire contents of all these applications is hereby incorporated by reference.

SDC EX. 1016 - 471/959

Listing of Claims:

1. (Currently Amended) An organic light-emitting diode comprising an organic layer sequence, a radiation exit area and an encapsulation,

wherein the organic layer sequence comprises at least one radiation-emitting region which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation,

wherein the radiation exit area is structured, so that the electromagnetic radiation has a directional emission profile, ~~and~~

wherein the encapsulation forms a seal of the organic layer sequence against environmental influences,

wherein the structured radiation exit area comprises a multiplicity of first areas and second areas,

wherein the first areas are tilted at an angle α to a plane which is arranged parallel to the main plane of the organic layer sequence,

wherein the second areas are tilted at an angle β to said plane, and

wherein the angles α and β are different from each other.

2. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the structured radiation exit area comprises a multiplicity of prisms which are arranged parallel to one another.

3. (Previously Presented) The organic light-emitting diode according to claim 2,

wherein the prisms comprises a length and width which are arranged parallel to the main plane of the organic layer sequence,

wherein the length is at least 1 cm, and

wherein the width is bigger than the wavelength of the electromagnetic radiation which is induced by the organic light-emitting diode.

4. (Previously Presented) The organic light-emitting diode according to claim 1,

SDC EX. 1016 - 472/959

wherein the emission profile is a symmetrical cardioid in one direction or asymmetrical in at least one of the directions.

5. (Currently Amended) The organic light-emitting diode according to claim 1,

~~wherein the structured radiation exit area comprises a multiplicity of first areas and second areas, wherein the first areas are tilted at an angle α to a plane which is arranged parallel to the main plane of the organic layer sequence,~~

~~wherein the second areas are tilted at an angle β to said plane, and~~

wherein the first areas are transparent and the second areas are reflective, so that the directional emission profile has a tilt angle which depends on the angle α.

6. (Cancelled)

7. (Currently Amended) The organic light-emitting diode according to claim 1,

wherein the structured radiation exit area comprises a multiplicity of prisms,

wherein the prisms comprise a length and width which are arranged parallel to the main plane of the organic layer sequence,

wherein the prisms forms in side view an isosceles triangle,

wherein the directional emission profile is symmetrical and has two main radiation directions, wherein the two main radiation directions are inclined from the z-axis by the angle $\alpha = \beta$ in positive and negative x-directions, and

wherein the main plane forms an x-y-plane.

8. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the first areas and/or the second areas are nonplanar.

9. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the first areas and/or the second areas are formed in the manner of cylinder sections.

SDC EX. 1016 - 473/959

10. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the directional emission profile has a maximum in the direction perpendicular to the first areas.

11. (Currently Amended) The organic light-emitting diode according to claim [[6]] 1, wherein the second areas are reflective, which is induced by metallization with metal particles.

12. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the structured radiation exit area is embodied as a separate structured foil, which is arranged on a carrier.

13. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the organic light-emitting diode comprises a carrier which is structured,

wherein the radiation exit area is arranged on the carrier, and

wherein the structuring of the radiation exit area is induced by the structuring of the carrier.

14. (Currently Amended) The organic light-emitting diode according to claim 1,

wherein the organic light-emitting diode comprises a carrier,

wherein the carrier comprises a multiplicity of parallel prisms having first areas and second areas which are arranged in a tilted manner with respect to one another,

wherein functional layers of the organic layer sequence are applied to the first and/or the second areas at the top side of the carrier, and

wherein the functional layers, which are arranged on different areas, are driven separately from one another.

15. (Currently Amended) The organic light-emitting diode according to claim 1,

wherein the organic light-emitting diode comprises a carrier,

wherein the carrier comprises a multiplicity of parallel prisms having first areas and

SDC EX. 1016 - 474/959

second areas,

wherein the areas are arranged in a tilted manner with respect to one another, and

wherein functional layers of the organic layer sequence are applied to the first and/or the second areas at ~~the~~ a top side of the carrier, and the respective other areas are free of the functional layers.

16. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the structuring of the radiation exit area is produced by the structuring of the encapsulation.

17. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the organic light-emitting diode is an organic light-emitting diode emitting on both sides, which comprises two radiation exit areas,

wherein the two radiation exit areas are arranged on opposite sides of the organic light-emitting diode, and

wherein the radiation exit areas are structured.

18. (Previously Presented) A luminaire having at least one light-emitting diode according to claim 1 as a light source,

wherein the luminaire is one of the following devices or is at least part of one of the following devices: alarm clock, shower cubicle, shower head, solar protection, rain protection, lamp, bag, signaling light, changing cubicle, vision protection, housing, emergency lighting, mirror, tile, ceiling light, radiator cladding, louver, noise protection, umbrella, warning light.

19. (New) An organic light-emitting diode comprising an organic layer sequence, a radiation exit area and an encapsulation,

wherein the organic layer sequence comprises at least one radiation-emitting region which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation,

wherein the radiation exit area is structured, so that the electromagnetic radiation has a directional emission profile,

SDC EX. 1016 - 475/959

wherein the encapsulation forms a seal of the organic layer sequence against environmental influences,

wherein the structured radiation exit area comprises a multiplicity of first areas and second areas, wherein the first areas are tilted at an angle α to a plane which is arranged parallel to the main plane of the organic layer sequence,

wherein the second areas are tilted at an angle β to said plane, and

wherein the first areas are transparent and the second areas are reflective, so that the directional emission profile has a tilt angle which depends on the angle α.

SDC EX. 1016 - 476/959

REMARKS/ARGUMENTS

Summary of Office Action

The specification was objected to because of an informality pointed out by the Examiner. That informality has been corrected in accordance with the Examiner's suggestion. Thus, this objection is now moot.

Claim 15 was objected to because of an informality pointed out by the Examiner. That informality has been corrected in accordance with the Examiner's suggestion. Thus, this objection is now moot.

Claims 7-10, 14, and 15 were rejected under 35 USC 112(b) or 35 USC 112(pre-AIA), second paragraph, as being indefinite for a number of specific deficiencies pointed out by the Examiner. Each of these deficiencies has been addressed in a self-explanatory manner by the claim changes being made hereinabove.

Dependent claims 5, 6, and 11 have been indicated by the Examiner as being allowable if suitably rewritten in independent form.

Remarks

Allowable dependent claim 6 has been incorporated into claim 1. Thus, amended independent claim 1 is now allowable. Claim 6 has been canceled, and the dependency of claim 11 has been changed from claim 6 to claim 1.

Claim 5 has been amended to delete subject matter which duplicates what is already recited in amended independent claim 1.

Each of claims 2-5 and 7-18 depends from claim 1 and, thus, is allowable therewith.

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New claim 19 is the independent version of dependent claim 5 which was found allowable by the Examiner in that it is a combination of claim 1 and claim 5.

Conclusion

Based on all of the above, the present application is now in proper condition for allowance. Prompt and favorable action to this effect and early passing of this application to issue are respectfully solicited.

It is believed that no additional fees or charges are required at this time in connection with the present application. However, if any additional fees or charges are required at this time, they may be charged to our U.S. Patent and Trademark Office Deposit Account No. 50-3111.

Respectfully submitted,
COZEN O'CONNOR

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Dated: April 5, 2018

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Electronic Acknowledgement Receipt

EFS ID:	32253299
Application Number:	15651508
International Application Number:	
Confirmation Number:	2349
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Customer Number:	27799
Filer:	Thomas Langer/Jennifer Colwell/Alphonso A. Collins
Filer Authorized By:	Thomas Langer
Attorney Docket Number:	5367-694P/CON\409926
Receipt Date:	05-APR-2018
Filing Date:	17-JUL-2017
Time Stamp:	11:54:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	Amendment.pdf	49489 33183607d16ca69d3ab428856602f608e66196c0	no	9

Warnings:

Information:	
Total Files Size (in bytes):	49489

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	Examiner: CHO, JAMES H.
Kastner-Jung, Ulrich et al.	Group Art: 2854
Serial No.: 15/651,508	
Filed: July 17, 2017	
For: Organic-Light-Emitting Diode	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

S I R:

In compliance with the duty of disclosure under 37 C.F.R. §1.56 and in accordance with the practice under 37 C.F.R. §§1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a. Copies of the listed non-US documents are also enclosed.

Enclosed is a copy of an Office Action dated June 28, 2018 which issued in the corresponding German Patent Application No. 112009003123.4.

This information is being submitted subsequent to the later of three months after the filing date of the present application or the mailing of the first Office Action on the merits, but before the mailing of a final Action or the Notice of Allowance.

STATEMENT

Each item of information contained in the Information Disclosure Statement was first cited in any communication received from a foreign Patent Office in a counterpart foreign application not more than three months prior to the filing of the Information Disclosure Statement.

In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document

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listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicant(s) reserve(s) the right to prove that the date of publication is in fact different.

It is believed that no additional fees or charges are required at this time in connection with the present application. However, if any fees or charges are required at this time, they may be charged to our Patent and Trademark Office Deposit Account No. 503111.

It is respectfully requested that the above information be considered by the Examiner and that a copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

Respectfully submitted,
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Dated: July 10, 2018

SDC EX. 1016 - 482/959

Attorney Docket # 5367-694P/CON/409926

PTO/SB/08A (04-03)
Approved for use through 04/30/2003. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	15/651,508
Filing Date	July 17, 2017
First Named Inventor	Kastner-Jung, Ulrich
Art Unit	2854
Examiner Name	CHO, JAMES H.
Attorney Docket	5367-694P/CON/409926

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number Number-Kind-Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Document Country Code[3]- Number[4]- Kind-Code [5] (if known	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		DE 102007059732	06-18-2009	OSRAM Opto Semiconductors GmbH		Abs.

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, Washington, DC 20231.** *If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.*.

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Espacenet

Bibliographic data: DE102007059732 (A1) — 2009-06-18

Lichtemittierende Vorrichtung

Inventor(s): KRUMMACHER BENJAMIN CLAUS [DE]; SCHINDLER FLORIAN [DE]; KLEIN MARKUS [DE] ± (KRUMMACHER, BENJAMIN CLAUS, ; SCHINDLER, FLORIAN, ; KLEIN, MARKUS)

Applicant(s): OSRAM OPTO SEMICONDUCTORS GMBH [DE] ± (OSRAM OPTO SEMICONDUCTORS GMBH)

Classification: - international:*H01L33/00; H01L51/52; H01L51/56*
- cooperative: **G02B5/045**; **H01L51/5262**; **H01L51/5271**; H01L51/0038; H01L51/005; H01L51/007; H01L51/0081; H01L51/5275

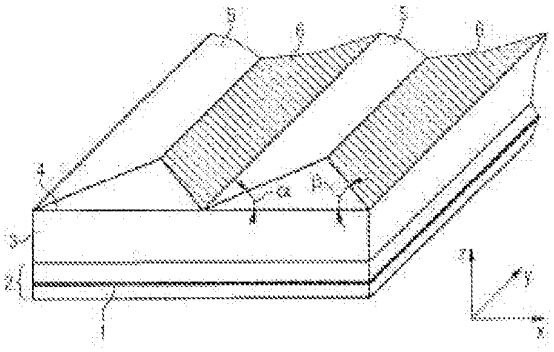
Application number: DE20071059732 20071212

Priority number(s): DE20071059732 20071212

Also published as: CN101896839 (A) CN101896839 (B) EP2220521 (A2) EP2220521 (B1) JP2011507164 (A) JP5349491 (B2) KR101600103 (B1) KR101702274 (B1) KR20100111685 (A) KR20160028502 (A) KR20170005520 (A) TW200931692 (A) TW201248907 (A) TWI389349 (B) TWI511324 (B) US2011018009 (A1) US8653548 (B2) WO2009074127 (A2) WO2009074127 (A3) less

Abstract of DE102007059732 (A1)

Eine Ausführungsform der Erfindung betrifft eine lichtemittierende Vorrichtung, die eine lichtemittierende Schicht (1) und eine Lichtaustrittsschicht (4) umfasst. Dabei weist die Lichtaustrittsschicht (4) eine Vielzahl von zueinander parallelen ersten Flächen (5) auf, die geneigt zur lichtemittierenden Schicht (1) angeordnet sind. Die Lichtaustrittsschicht (4) weist weiterhin eine Vielzahl von zueinander



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parallelen zweiten Flächen (6) auf, die geneigt zur lichtemittierenden Schicht (1) und geneigt zu den ersten Flächen (5) angeordnet sind. Die ersten Flächen (5) sind transparent und die zweiten Flächen (6) reflektierend für von der lichtemittierenden Schicht (1) emittiertes Licht.

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(19) Bundesrepublik Deutschland
Deutsches Patent- und Markenamt

(10) **DE 10 2007 059 732 A1** 2009.06.18

(12) # Offenlegungsschrift

(21) Aktenzeichen: **10 2007 059 732.2**
(22) Anmeldetag: **12.12.2007**
(43) Offenlegungstag: **18.06.2009**

(51) Int Cl.[8]: ***H01L 51/52*** (2006.01)
H01L 51/56 (2006.01)
H01L 33/00 (2006.01)

(71) Anmelder:
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(56) Für die Beurteilung der Patentfähigkeit in Betracht zu ziehende Druckschriften:

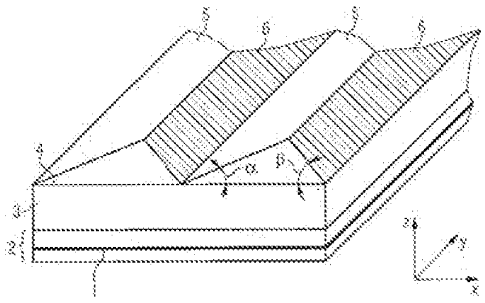
DE	10 2006 052029	A1
DE	103 12 219	A1
DE	102 55 933	A1
WO	07/1 02 390	A1
WO	04/0 13 921	A2
JP	09-1 15 667	A

Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

Rechercheantrag gemäß § 43 Abs. 1 Satz 1 PatG ist gestellt.

(54) Bezeichnung: **Lichtemittierende Vorrichtung**

(57) Zusammenfassung: Eine Ausführungsform der Erfindung betrifft eine lichtemittierende Vorrichtung, die eine lichtemittierende Schicht (1) und eine Lichtaustrittsschicht (4) umfasst. Dabei weist die Lichtaustrittsschicht (4) eine Vielzahl von zueinander parallelen ersten Flächen (5) auf, die geneigt zur lichtemittierenden Schicht (1) angeordnet sind. Die Lichtaustrittsschicht (4) weist weiterhin eine Vielzahl von zueinander parallelen zweiten Flächen (6) auf, die geneigt zur lichtemittierenden Schicht (1) und geneigt zu den ersten Flächen (5) angeordnet sind. Die ersten Flächen (5) sind transparent und die zweiten Flächen (6) reflektierend für von der lichtemittierenden Schicht (1) emittiertes Licht.



Beschreibung

[0001] Die Erfindung betrifft lichtemittierende Vorrichtungen mit einer lichtemittierenden Schicht oder einem lichtemittierenden Element. Die Erfindung betrifft weiterhin Verfahren zur Herstellung solcher lichtemittierenden Vorrichtungen.

[0002] Lichtemittierende Vorrichtungen, wie beispielsweise eine OLED (organic light emitting diode), weisen üblicherweise ein Lambertsches Abstrahlungsprofil auf. Für Beleuchtungszwecke ist jedoch meist ein davon abweichendes, gerichtetes Abstrahlungsprofil geeigneter.

[0003] Aufgabe der Erfindung ist es, eine lichtemittierende Vorrichtung zu schaffen, deren Abstrahlungsprofil von dem eines Lambertschen Strahlers abweicht.

[0004] Diese Aufgabe wird durch die lichtemittierenden Vorrichtungen gemäß den unabhängigen Ansprüchen gelöst. Vorteilhafte Ausgestaltungen und Weiterbildungen sind Gegenstand der jeweiligen abhängigen Ansprüche.

[0005] Eine lichtemittierende Vorrichtung gemäß eines ersten Aspekts der Erfindung umfasst eine lichtemittierende Schicht und eine Lichtaustrittsschicht. Dabei weist die Lichtaustrittsschicht eine Vielzahl von zueinander parallelen ersten Flächen auf, die geneigt zur lichtemittierende Schicht angeordnet sind. Die Lichtaustrittsschicht weist weiterhin eine Vielzahl von zueinander parallelen zweiten Flächen auf, die geneigt zur lichtemittierende Schicht und geneigt zu den ersten Flächen angeordnet sind. Die ersten Flächen sind transparent und die zweiten Flächen reflektierend für von der lichtemittierende Schicht emittiertes Licht.

[0006] In erster Näherung weisen planare Lichtaustrittsschichten ein Lambertsches Abstrahlungsprofil mit einer Hauptstrahlungsrichtung senkrecht zur Lichtaustrittsfläche auf. Erfindungsgemäß stellen nur die ersten Flächen Lichtaustrittsflächen dar, wodurch das Abstrahlungsprofil eine Hauptstrahlungsrichtung aufweist, die nicht senkrecht zur lichtemittierenden Schicht und damit nicht senkrecht zu der Ebene ist, in der die lichtemittierende Vorrichtung flächig ausgebildet ist. Bezüglich dieser Ebene weicht das Abstrahlungsprofil von dem eines Lambertschen Strahlers ab.

[0007] In einer vorteilhaften Ausgestaltung weist die lichtemittierende Schicht der lichtemittierenden Vorrichtung ein organisches Material auf. Auf organischen Materialien basierende lichtemittierende Schichten lassen sich großflächig herstellen und sind daher besonders gut für lichtemittierende Vorrichtungen, die als Flächenstrahler ausgebildet sind.

[0008] In einer weiteren vorteilhaften Ausgestaltung der lichtemittierenden Vorrichtung weisen die ersten Flächen und die zweiten Flächen in jeder Richtung eine Ausdehnung auf, die größer als eine Wellenlänge des von der lichtemittierenden Schicht ausgestrahlten Lichts ist.

[0009] Bevorzugt ist diese Ausdehnung jedoch kleiner als 1 mm und besonders bevorzugt kleiner als 100 µm.

[0010] In einer weiteren vorteilhaften Ausgestaltung der lichtemittierenden Vorrichtung ist eine von der lichtemittierenden Schicht abweisende Oberfläche der Lichtaustrittsschicht durch parallel angeordneten Prismen strukturiert, wobei die ersten Flächen und die zweiten Flächen durch Flächen der Prismen gebildet werden. Alternativ ist es auch möglich, eine von der lichtemittierenden Schicht abweisende Oberfläche der Lichtaustrittsschicht durch kegel- oder pyramiden- oder linsen- oder zylinderförmige Elemente zu strukturieren, wobei analog die ersten Flächen und die zweiten Flächen durch Flächen dieser Elemente gebildet werden.

[0011] Vorteilhafterweise kann die Lichtaustrittsschicht der lichtemittierenden Vorrichtung durch ein Substrat oder eine Passivierungsschicht gebildet werden.

[0012] Eine lichtemittierende Vorrichtung gemäß eines zweiten Aspekts der Erfindung umfasst einen Träger und eine Mehrzahl lichtemittierender Elemente. Dabei weist der Träger eine Mehrzahl von zueinander parallelen ersten Flächen und eine Mehrzahl von zueinander parallelen zweiten Flächen, die geneigt zu den ersten Flächen angeordnet sind, auf. Die lichtemittierenden Elemente sind auf den ersten Flächen angeordnet. Erfindungsgemäß stellen somit nur die ersten Flächen lichtemittierende Flächen dar. Diese Flächen sind geneigt bezüglich der Ebene, in der die lichtemittierende Vorrichtung flächig ausgebildet ist. Dadurch weist das Abstrahlungsprofil eine Hauptstrahlungsrichtung auf, die nicht senkrecht zu der Ebene ist, in der die lichtemittierende Vorrichtung flächig ausgebildet ist.

[0013] Bezüglich dieser Ebene weicht das Abstrahlungsprofil wie bei einer lichtemittierenden Vorrichtung gemäß dem ersten Aspekt der Erfindung von dem eines Lambertschen Strahlers ab.

[0014] Bevorzugt weisen lichtemittierenden Elemente eine OLED auf. Weiter ist bevorzugt, dass der Träger der lichtemittierenden Vorrichtung durch parallel angeordnete Prismen strukturiert ist, wobei die ersten Flächen und die zweiten Flächen durch Flächen der Prismen gebildet werden.

[0015] Eine lichtemittierende Vorrichtung gemäß ei-

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nes dritten Aspekts der Erfindung umfasst ein Substrat und eine auf eine Oberfläche des Substrats aufgebrachte Schichtenfolge mit mindestens einer lichtemittierenden Schicht, wobei die Oberfläche des Substrats in einer lateralen Richtung periodisch höhenstrukturiert ist. Bei einer Vorrichtung gemäß diesem Aspekt der Erfindung übernimmt das höhenstrukturierte Substrat neben seiner Funktion als Substrat für eine lichtemittierende Schichtenfolge die Funktion oben genannten Trägers. Die lichtemittierende Vorrichtung weist somit eine lichtemittierende Fläche auf, die wie die Oberfläche des Substrats höhenstrukturiert ist. Die Höhenstrukturierung der Oberfläche kann so ausgeführt werden, dass Bereiche der Oberfläche geneigt zur Ebene der flächigen Ausdehnung der lichtemittierenden Vorrichtung sind. Entsprechend ergeben sich die Vorteile des zweiten Aspekts der Erfindung.

[0016] In einer vorteilhaften Ausgestaltung weist die lichtemittierende Schicht ein organisches Material auf.

[0017] In einer weiteren vorteilhaften Ausgestaltung der lichtemittierenden Vorrichtung ist die Höhenstrukturierung in der einen lateralen Richtung linear steigend und fallend und die Oberfläche des Substrats weist im Wesentlichen plane Flächen auf.

[0018] In einer weiteren vorteilhaften Ausgestaltung der lichtemittierenden Vorrichtung ist die Höhenstrukturierung in der einen lateralen Richtung nichtlinear steigend und/oder fallend und die Oberfläche des Substrats weist gebogene Flächen auf. Das Abstrahlungsprofil einer solchen lichtemittierenden Vorrichtung kann in weiten Grenzen eingestellt werden.

[0019] Bevorzugt kann das Substrat aus Kunststoff in einem Spritzgussverfahren hergestellt werden oder besteht aus Metall, das durch ein Prägeverfahren strukturiert ist.

[0020] Eine lichtemittierende Vorrichtung gemäß eines vierten Aspekts der Erfindung umfasst eine lichtemittierende Schicht, die in einer lateralen Richtung abwechselnd angeordnete streifenförmige erste Bereiche und zweite Bereiche aufweist, wobei die ersten Bereiche und die zweiten Bereiche verschiedene Brechungszahlen haben. Bei einer solchen lichtemittierenden Vorrichtung führen Beugungseffekte zu einem Abstrahlprofil, das von dem eines Lambertschen Strahlers abweicht.

[0021] Bevorzugt ist dabei die Abmessung der ersten Bereiche und der zweiten Bereiche in der lateralen Richtung von der Größenordnung einer Wellenlänge des von der lichtemittierenden Schicht ausgestrahlten Lichtes. Besonders bevorzugt ist sie kleiner als das 5-fache der Wellenlänge.

[0022] In einer vorteilhaften Ausgestaltung weist die lichtemittierenden Schicht ein organisches Material auf.

[0023] In einem Herstellungsverfahren für eine lichtemittierende Vorrichtung mit einer lichtemittierenden Schicht gemäß einem fünften Aspekt der Erfindung werden Bereiche der lichtemittierenden Schicht zur Veränderung des Brechungsindex in den Bereichen mit UV-Licht bestrahlt. Dieses Herstellungsverfahren ermöglicht die Herstellung einer lichtemittierenden Vorrichtung gemäß dem vierten Aspekt der Erfindung. Es ist zur Herstellung großflächiger Vorrichtungen geeignet und fügt sich insbesondere gut in bekannte Herstellungsverfahren für flächige OLED ein.

[0024] Eine lichtemittierende Vorrichtung gemäß eines sechsten Aspekts der Erfindung umfasst eine lichtemittierende Schicht und eine Lichtaustrittsschicht, wobei in oder auf der Lichtaustrittsschicht eine Vielzahl von anisotropen Streupartikeln angeordnet ist, die entlang einer lateralen Richtung der lichtemittierenden Vorrichtung ausgerichtet sind. Die Ausrichtung der Streupartikel führt in Verbindung mit ihrer Anisotropie zu einer anisotropen Streuung des Lichtes beim Austritt aus der lichtemittierenden Vorrichtung. Dieses führt zu einer von dem Lambertschen Abstrahlungsprofil abweichenden Abstrahlungsprofil der lichtemittierenden Vorrichtung, wobei das Abstrahlprofil vom Streuverhalten und Grad der Anisotropie der Streupartikeln abhängt.

[0025] Bevorzugt weist die lichtemittierende Schicht ein organisches Material auf. Weiterhin ist bevorzugt, dass die Streupartikel bezüglich ihrer Abmessungen anisotrop sind und/oder bezüglich ihres Streuverhaltens.

[0026] Weiter ist bevorzugt, dass die Streupartikel (16) ein von Null verschiedenes permanentes oder induzierbares elektrisches oder ein magnetisches Dipol- oder Quadrupolmoment aufweisen oder dass die Streupartikel selbstanordnende Moleküle sind oder in einer dehnbaren Folie angeordnet sind.

[0027] In einem Herstellungsverfahren für eine lichtemittierende Vorrichtung mit einer lichtemittierenden Schicht gemäß einem siebten Aspekt der Erfindung werden Streupartikel mit einem von Null verschiedenen permanenten oder induzierbaren elektrischen oder magnetischen Dipol- oder Quadrupolmoment in eine Lichtaustrittsschicht eingebracht und durch ein angelegtes elektrisches oder magnetisches Feld ausgerichtet. Dieses Herstellungsverfahren ermöglicht die Herstellung einer lichtemittierenden Vorrichtung gemäß dem vierten Aspekt der Erfindung.

[0028] Die Erfindung wird im Folgenden anhand von Ausführungsbeispielen mit Hilfe von 7 Figuren näher erläutert. Es zeigt:

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[0029] Fig. 1 eine dreidimensionale schematische Darstellung einer lichtemittierenden Vorrichtung,

[0030] Fig. 2 verschiedene Abstrahlungsprofile von lichtemittierenden Vorrichtungen,

[0031] Fig. 3 und Fig. 4 weitere lichtemittierende Vorrichtungen, jeweils in einer dreidimensionalen schematischen Darstellung und einer Aufsicht,

[0032] Fig. 5 drei weitere lichtemittierende Vorrichtungen im Querschnitt,

[0033] Fig. 6 eine weitere lichtemittierende Vorrichtung im Querschnitt zu zwei verschiedenen Zeitpunkten ihres Herstellungsprozesses und

[0034] Fig. 7 eine Aufsicht auf eine weitere lichtemittierende Vorrichtung.

[0035] In Fig. 1 ist ein erstes Ausführungsbeispiel einer lichtemittierenden Vorrichtung in einer dreidimensionalen Schemazeichnung dargestellt.

[0036] Eine lichtemittierende Schicht **1** ist innerhalb eines OLED(organic light emitting diode)-Schichtaufbaus **2** angeordnet. Der OLED-Schichtaufbau **2** befindet sich auf einer ersten Seite eines flächigen Substrats **3**. Auf der dem OLED-Schichtaufbau **2** gegenüberliegenden Seite des Substrats **3** ist eine Lichtaustrittsschicht **4** vorgesehen. Auf der dem Substrat **3** abgewandten Seite weist die Lichtaustrittsschicht **4** eine Vielzahl von ersten Flächen **5** auf, die um einen Winkel α gegenüber dem Substrat **3** geneigt sind, sowie eine Vielzahl von zweiten Flächen **6**, die um einen Winkel β gegenüber dem Substrat **3** geneigt sind.

[0037] Die lichtemittierende Vorrichtung der Fig. 1 ist als eine "bottom emission" OLED ausgeführt. Das Substrat **3** ist bei einer solchen Ausführungsform transparent, sodass das von der lichtemittierenden Schicht **1** emittierte Licht durch das Substrat **3** zur Lichtaustrittsschicht **4** gelangt. Alternativ ist eine Ausführung als "top emission" OLED möglich, bei der der OLED-Schichtaufbau **2** auf ein nichttransparentes Substrat aufgebracht wird. Auf der dem nichttransparenten Substrat abgewandten Seite des OLED-Schichtaufbaus **2** ist dann anstelle des in der Fig. 1 gezeigten transparenten Substrats **3** eine transparente Passivierungsschicht vorgesehen. Alle in der Anmeldung beschriebenen Ausführungsbeispiele einer lichtemittierenden Vorrichtung können durch eine entsprechende Modifikation entweder auf Basis einer "bottom emission" oder einer "top emission" OLED aufgebaut werden.

[0038] Der OLED-Schichtaufbau **2** umfasst neben der lichtemittierenden Schicht **1** mindestens eine erste und eine zweite Elektrode und eine oder mehrere Schichten, die der Injektion von Ladungsträgern in die lichtemittierende Schicht **1** dienen und diese so im Betrieb zum Leuchten anregen. Die Elektrodenschichten können beispielsweise aus transparenten leitenden Materialien wie etwa Indium-Zinn-Oxid (ITO) oder Indium-Zink-Oxid, Zink-Oxid oder Zinn-Oxid gebildet werden.

[0039] Die lichtemittierende Schicht **1** weist ein organisches material als optisch aktives, strahlungserzeugendes Material auf. Dieses kann beispielsweise ein organisches Material mit geringem Molekulargewicht, auch kleinmolekülliges organisches Material genannt, ein Polymer oder eine Kombination dieser beiden Materialien sein.

[0040] Kleinmolekülige organische Materialien werden typischerweise durch thermisches Verdampfen unter Vakuumbedingungen aufgebracht. Beispiele für strahlungserzeugende kleinmolekülige organische Materialien sind Tris(8-hydroxychinolinato)aluminium (Alq), 1,3-Bis(N,N-dimethylaminophenyl)-1,3,4-oxidazol (OXD-8), Oxo-bis(2-methyl-8-chinolinato)aluminium, Bis(2-methyl-8-hydroxychinolinato)aluminium; Bis(hydroxybenzochinolinato)beryllium (BeQ. sub. 2), Bis(diphenylvinyl)biphenylen (DPVBI) und Arylaminsubstituiertes Distyrylarylen (DSA-Amin).

[0041] Polymere werden üblicherweise durch ein Aufschleuderverfahren, auch Spincasting oder Spincoating genannt, aufgetragen. Alternativ kann auch ein räumlich selektives Abscheiden erfolgen, z. B. durch Tintenstrahldrucken. Beispiele für strahlungserzeugende Polymere sind Poly(p-phenylenvinylen) und Polyarylenvinylen sowie Copolymere von Arylen-Vinylen-Oligomeren, Polyarylene, Polychinolin sowie jeweils deren Derivate und Mischungen.

[0042] Die Lichtaustrittsschicht **4** ist eine auf das Substrat **3** aufgebrachte Schicht, die eine Vielzahl von parallel zueinander angeordneten Prismen aufweist, wobei die ersten Flächen **5** und die zweiten Flächen **6**, die der OLED-Schichtfolge **2** abgewandte Oberfläche der lichtemittierenden Vorrichtung bilden. Aus Gründen der Übersichtlichkeit sind in der Fig. 1 nur jeweils zwei der Vielzahl von ersten Flächen **5** und zweiten Flächen **6** dargestellt.

[0043] Weder die ersten Flächen **5** noch die zweiten Flächen **6** sind parallel zur lichtemittierenden Schicht **1** angeordnet. Somit sind sie auch nicht parallel zu der Ebene, in der die lichtemittierende Vorrichtung flächig ausgebildet ist. In allen gezeigten Ausführungsbeispielen wird diese Ebene, in der die lichtemittierende Vorrichtung flächig ausgebildet ist, als XY-Ebene definiert.

[0044] Die Ausdehnung der Prismen in Y-Richtung (Länge) liegt dabei bevorzugt in makroskopischen

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Größenordnungen, also beispielsweise im Bereich von Millimetern bis Dezimetern. Bevorzugt wird die gesamte Oberfläche der lichtemittierenden Vorrichtung von in Y-Richtung durchgängigen Prismen bedeckt. Die Breite der Prismen in X-Richtung ist bevorzugt größer als die Wellenlänge des emittierten Lichts, sodass Beugungseffekte an den Prismen sich nicht bemerkbar machen. Die Breite liegt bevorzugt jedoch in mikroskopischen Größenordnungen, beispielsweise im Submillimeterbereich, sodass aus einem normalen Betrachterabstand der lichtemittierenden Vorrichtung die Strukturierung in X-Richtung nicht sichtbar ist.

[0045] Die ersten Flächen **5** der Lichtaustrittsschicht **4** sind transparent, wohingegen die zweiten Flächen **6** reflektierend für von der lichtemittierenden Schicht **1** abgestrahltes Licht sind. Die zweiten Flächen **6** können beispielsweise durch Bedampfen mit Metallpartikeln unter einem sehr flachen Einfallswinkel reflektierend gemacht werden.

[0046] In erster Näherung ergibt sich bei einer OLED mit einer planaren, parallel zu der lichtemittierenden Schicht angeordneten Lichtaustrittsschicht ein Lambertsches Abstrahlungsprofil mit einer Hauptstrahlungsrichtung senkrecht zur Lichtaustrittsfläche. Im gezeigten Ausführungsbeispiel stellen nur die ersten Flächen **5** Lichtaustrittsflächen dar, wodurch das Abstrahlungsprofil eine Hauptstrahlungsrichtung aufweist, die gegenüber der Z-Achse in Richtung der X-Achse geneigt ist. Der Neigungswinkel der Hauptstrahlungsrichtung der lichtemittierenden Vorrichtung wird dabei im Wesentlichen vom Winkel α bestimmt. Von der lichtemittierenden Schicht **1** ausgestrahltes Licht, das von den zweiten Flächen **6** reflektiert wird, kann nach einer oder mehreren internen Reflexionen ebenfalls durch die transparenten ersten Flächen **5** aus der lichtemittierenden Vorrichtung austreten. Der Winkel β beeinflusst dabei sowohl die Winkelverteilung des abgestrahlten Lichtes als auch die Häufigkeit interner Reflexionen. Durch geeignete Wahl des Winkels β kann die Gesamtintensität und damit die Effizienz der lichtemittierenden Vorrichtung optimiert werden.

[0047] Im gezeigten Ausführungsbeispiel ist die Strukturierung der separaten Lichtaustrittsschicht **4** vorgesehen. Die Lichtaustrittsschicht **4** kann in dem Fall eine entsprechend strukturierte Folie sein, die auf das Substrat **3** aufgebracht wird. Es ist auch möglich, auf eine separate Lichtaustrittsschicht **4** zu verzichten, in dem die Oberfläche des Substrats **3** selbst strukturiert wird.

[0048] Neben der dargestellten Strukturierung in Form von parallelen Prismen mit jeweils planaren ersten Flächen **5** und zweiten Flächen **6** ist auch eine Strukturierung mit nicht planaren Flächen denkbar, beispielsweise mit Zylinderflächen. Auch eine Strukturierung durch pyramiden-, kegel- oder linsenförmige Elemente beziehungsweise Flächenabschnitte ist denkbar.

[0049] In Fig. 2 sind verschiedene Abstrahlungsprofile (winkelabhängige Verteilung der abgestrahlten Intensität) der erfindungsgemäßen lichtemittierenden Vorrichtungen dargestellt.

[0050] In **Fig.** 2a ist zunächst das zugrunde liegende Koordinatensystem angegeben. Die lichtemittierende Vorrichtung bildet mit ihrer lateralen flächigen Ausdehnung die XY-Ebene des Koordinatensystems. Bekannte OLED-Strukturen mit einer ebenen, parallel zur lichtemittierenden Schicht angeordneten Lichtaustrittsfläche zeigen ein Lambertsches Abstrahlungsprofil in Richtung der Z-Achse. Für Beleuchtungszwecke sind jedoch häufig davon abweichende Abstrahlungsprofile gewünscht. Geeignete Abstrahlungsprofile sind in den **Fig.** 2b bis 2d dargestellt.

[0051] Die in den **Fig.** 2b und 2c gezeigten, Typ A-1 und Typ A-2 genannten Abstrahlungsprofile zeichnen sich durch eine symmetrische herzförmige Strahlungsrichtungsverteilung mit zwei Maxima sowohl in X- als auch in Y-Richtung (Typ A-1) oder in eine der beiden Richtungen (Typ A-2) aus. Diese Abstrahlungsmuster sind für allgemeine Beleuchtungszwecke in Räumen geeignet.

[0052] Das in **Fig.** 2d gezeigte Profil, Typ B genannt, ist stark asymmetrisch in zumindest einer der Richtungen X und Y und ist insbesondere für Signalisierungsanwendungen geeignet, zum Beispiel zur Kennzeichnung von Stufen in einer abgedunkelten Umgebung oder zur Realisierung von blendfreien flächigen Wandleuchten.

[0053] Mit der in Fig. 1 gezeigten lichtemittierenden Vorrichtung lässt sich ein Abstrahlungsmuster des Typs B realisieren.

[0054] In Fig. 3 ist ein weiteres Ausführungsbeispiel einer lichtemittierenden Vorrichtung in einer perspektivischen Ansicht (**Fig.** 3a) und einer Aufsicht (**Fig.** 3b) dargestellt.

[0055] Die Oberfläche eines Trägers **7** ist in Form einer Mehrzahl von parallel angeordneten Prismen mit ersten Flächen **5** und zweiten Flächen **6** strukturiert. Die laterale flächige Ausdehnung der lichtemittierenden Vorrichtung und des Trägers **7** liegt in der XY-Ebene. Gegenüber dieser XY-Ebene sind die ersten Flächen **5** um den Winkel α und die zweiten Flächen **7** um den Winkel β geneigt. Auf den ersten Flächen **5** sind Leuchtelemente **8** angeordnet.

[0056] Bezüglich seiner Oberfläche ist der Träger **7** vergleichbar strukturiert wie die Lichtaustrittsfläche **4**

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in dem in Fig. 1 gezeigten Ausführungsbeispiel. Gefertigt sein kann der Träger **7** beispielsweise aus Kunststoff, wobei die Strukturierung seiner Oberfläche bevorzugt durch ein Spritzguss- oder ein Tiefziehverfahren erreicht wird. Weiterhin ist möglich, den Träger **7** aus einer Metallfolie oder einem Metallblech herzustellen, das durch ein Prägeverfahren strukturiert wird.

[0057] Die Leuchtelemente **8** sind unabhängig vom Träger **7** funktionsfähige Elemente. Sie können zum Beispiel jeweils ein Substrat und einen OLED-Schichtaufbau mit mindestens einer lichtemittierenden Schicht umfassen. Bezüglich des Aufbaus und der Materialien des OLED-Schichtaufbau und der lichtemittierenden Schicht wird auf das im Zusammenhang mit dem Ausführungsbeispiel der Fig. 1 gesagte verwiesen.

[0058] Ähnlich zu dem in Fig. 1 dargestellten Ausführungsbeispiel stellt sich auch bei der Ausführungsform der Fig. 3 eine Abstrahlcharakteristik ein, deren Hauptstrahlungsrichtung im Wesentlichen um den Winkel α gegenüber der Z-Richtung geneigt ist. Das Abstrahlungsmuster ist ebenfalls vom Typ B.

[0059] Ein weiteres Ausführungsbeispiel einer lichtemittierenden Vorrichtung ist in Fig. 4 wiederum in einer perspektivischen Ansicht (**Fig.** 4a) und einer Aufsicht (**Fig.** 4b) dargestellt. Wie bei dem in Fig. 3 gezeigten Ausführungsbeispiel ist ein Träger **7** vorgesehen, dessen Oberfläche in Form von parallelen Prismen strukturiert ist. Im Unterschied zum Ausführungsbeispiel der Fig. 3 sind nicht nur die ersten Flächen **5** mit Leuchtelementen **8**, sondern auch die zweiten Flächen **6** mit Leuchtelementen **9** belegt.

[0060] Beim Ausführungsbeispiel der Fig. 4 ist die Oberfläche des Trägers **7** in Form von Prismen strukturiert, die den Querschnitt eines gleichschenkligen Dreiecks aufweisen. Die gezeigte Anordnung resultiert in einer symmetrischen Abstrahlcharakteristik vom Typ A-2, mit zwei Hauptstrahlungsrichtungen, die von der Z-Achse um den Winkel $\alpha \approx \beta$ in positive und negative X-Richtung geneigt sind. In Y-Richtung ergibt sich bei ausreichender Ausdehnung der lichtemittierenden Vorrichtung ein in erster Näherung Lambertsches Abstrahlungsprofil. Falls die Winkel α und β nicht gleich gewählt werden, sind die beiden Hauptstrahlungsrichtungen um unterschiedliche Winkel von der Z-Richtung geneigt. Gleichzeitig ist die Intensität, mit der in die Hauptstrahlungsrichtungen emittiert wird, aufgrund der sich ergebenden unterschiedlich großen Flächen der Leuchtelemente **8** und Leuchtelemente **9** verschieden.

[0061] Eine weitere lichtemittierende Vorrichtung ist in der **Fig.** 5a im Querschnitt dargestellt.

[0062] Auf einem Substrat **3**, dessen Oberfläche durch parallel angeordnete Prismen strukturiert ist, ist ein OLED-Schichtaufbau **2** aufgebracht. Gleiche Bezugszeichen in den Figuren bezeichnen gleiche oder gleich wirkende Elemente.

[0063] Im Unterschied zu den in Fig. 3 beziehungsweise **4** gezeigten Ausführungsbeispielen übernimmt beim Ausführungsbeispiel der **Fig.** 5a das Substrat **3** auch die Funktion des Trägers **7**. Daraus ergibt sich, dass nicht separate, ein Substrat aufweisende Leuchtelemente eingesetzt werden, sondern der OLED-Schichtaufbau **2** unmittelbar auf das strukturierte Substrat aufgebracht wird. Bezüglich des Aufbaus und der Materialien des OLED-Schichtaufbau und einer darin enthaltenen lichtemittierenden Schicht wird wiederum auf die Ausführungen im Zusammenhang mit dem Ausführungsbeispiel der Fig. 1 verwiesen.

[0064] Im gezeigten Ausführungsbeispiel sind die Winkel α und β unterschiedlich groß gewählt. Es ergibt sich eine Verteilung vom Typ A-2 mit unterschiedlichen Intensitäten in beiden Hauptstrahlungsrichtungen. Das Substrat **3** kann zum Beispiel aus Kunststoff hergestellt werden, dass durch einen Spritzguss- oder durch ein Tiefziehverfahren entsprechend strukturiert ist. Falls die lichtemittierende Vorrichtung in Form einer "bottom emitter" OLED aufgebaut wird, bei dem die Strahlung durch das Substrat **3** austritt, ist zum Erreichen einer entsprechenden Abstrahlcharakteristik notwendig, auch die dem OLED-Schichtaufbau **2** gegenüberliegende Oberfläche des Substrats **3** entsprechend zu strukturieren. In der **Fig.** 5a ist das durch die gestrichelte Linie angedeutet. Falls die lichtemittierende Vorrichtung dagegen als "top emitter" OLED aufgebaut wird, kann die der OLED gegenüberliegende Seite des Substrats eine beliebige Formgebung annehmen, zum Beispiel planar sein. Im Fall einer "top emitter" OLED kann das Substrat **3** auch nichttransparent sein und beispielsweise von einer Metallfolie oder einem Metallblech gebildet werden, in das die entsprechende Oberflächenstrukturierung eingeprägt ist.

[0065] In den **Fig.** 5b und 5c sind weitere Oberflächenstrukturierungen für lichtemittierende Vorrichtungen gezeigt, die im Zusammenhang mit dem in **Fig.** 5a dargestellten Ausführungsbeispiel eingesetzt werden können.

[0066] Insbesondere ist festzuhalten, dass die Oberfläche des Substrats **3** nicht zwingend aus verschiedenen planaren Flächen zusammengesetzt sein muss, sondern auch krummlinig begrenzte Flächen aufweisen kann. Durch die gewählte Formgebung der Oberfläche kann die Abstrahlcharakteristik in X-Richtung in weiten Grenzen variiert werden. Beispielsweise resultiert die in **Fig.** 5b gezeigte Geometrie in einer Intensitätsverteilung vom Typ A-2. Die Verteilung ist dabei symmetrisch zur Z-Achse und je

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nach Krümmungsradius und Tiefe der die Oberfläche bildenden Zylinderabschnitte kann erreicht werden, dass sich zwei voneinander getrennte Hauptstrahlungsrichtungen, von der Z-Achse geneigt in die Richtung der positiven beziehungsweise negativen X-Achse, ergeben oder eine Hauptstrahlungsrichtung in Richtung der Z-Achse, wobei das Abstrahlungsprofil gegenüber einer Lambertschen Abstrahlungsprofil jedoch keulenartig gerichtet ist. Mit einer Oberflächengeometrie wie in **Fig.** 5c gezeigt, kann eine Abstrahlungscharakteristik vom Typ B erreicht werden.

[0067] In **Fig.** 6a ist der Querschnitt einer weiteren lichtemittierenden Vorrichtung gezeigt.

[0068] Auf einem Substrat **3** ist ein OLED-Schichtaufbau **2** angeordnet. Dieser weist eine dem Substrat **3** zugewandte erste Elektrode **12**, eine lichtemittierende Schicht **1** und abschließend eine zweite Elektrode **13** auf. Die lichtemittierende Schicht **1** weist dabei alternierend in die Bildebene hinein verlaufende streifenförmige erste Bereiche **10** und zweite Bereiche **11** auf. Der OLED-Schichtaufbau **2** kann weitere, hier nicht gezeigte Schichten umfassen. Wiederum wird bezüglich seines Aufbaus und geeigneter Materialien auf die Ausführungen zu Fig. 1 verwiesen.

[0069] Bei dem Ausführungsbeispiel der **Fig.** 6a wird eine Änderung der Abstrahlcharakteristik der lichtemittierenden Vorrichtung nicht wie bei den zuvor gezeigten Ausführungsbeispielen durch die Ausrichtung der Lichtaustrittsflächen erreicht, sondern durch eine Beugung des Lichts innerhalb der lichtemittierenden Schicht **1**. Zu diesem Zweck ist die lichtemittierende Schicht **1** durch die verschiedenen streifenförmigen ersten Bereiche **10** und zweiten Bereiche **11** strukturiert, wobei sich die beiden Bereiche **10** beziehungsweise **11** durch ihre Brechungszahl unterscheiden. Da in diesem Ausführungsbeispiel im Gegensatz zu den zuvor gezeigten Beispielen Beugungseffekte des Lichts bedeutsam ist, sind die Abmessungen der ersten Bereiche **10** und zweiten Bereiche **11** in X-Richtung (Streifenbreite) von der Größenordnung des von der lichtemittierenden Schicht **1** ausgestrahlten Lichtes. Die entstehenden Beugungserscheinungen sind mit der Beugung an einem Gitter vergleichbar. Innerhalb der Kavität, die durch innere und/oder äußere Grenzflächen der lichtemittierenden Vorrichtung geformt wird, bildet sich ein Intensitätsmuster aus, das gegenüber einer Vorrichtung mit einer homogenen lichtemittierenden Schicht **1** größere Intensitätsanteile parallel zur X-Achse aufweist. Entsprechend verändert sich das Abstrahlungsprofil der lichtemittierenden Vorrichtung von dem eines Lambertschen Strahlers zu einem Strahler vom Typ A-2.

[0070] In **Fig.** 6b ist dargestellt, wie die Strukturierung der lichtemittierenden Schicht **1** während des Herstellungsprozesses erfolgen kann. Die zum Zeitpunkt der Strukturierung der lichtemittierenden Schicht **1** das Substrat **3**, die erste Elektrode **10** und die lichtemittierende Schicht **1** umfassende lichtemittierende Vorrichtung wird durch eine Maske **14** mit UV-Licht **15** bestrahlt. Dort wo die UV-Strahlung **15** auf die lichtemittierende Schicht **1** auftrifft, wird deren Struktur auf molekularer Ebene verändert, beispielsweise durch eine Veränderung des Polymerisierungsgrades eines organischen Polymers in der lichtemittierenden Schicht **1**. Mit der veränderten Molekularstruktur gehr eine Änderung der Brechungszahl einher.

[0071] Fig. 7 zeigt eine weitere lichtemittierende Vorrichtung in der Aufsicht. Bei dieser Ausführungsform sind auf oder in einer Lichtaustrittsschicht **4**, durch die das Licht einer lichtemittierenden Schicht austritt, Streupartikel **16** angeordnet.

[0072] Streupartikel sind transparente oder nichttransparente Partikel, deren Größenordnung im Bereich von einigen µm bis einigen 10 µm liegen kann. Die Partikel können innerhalb der Lichtaustrittsschicht **4** angeordnet sein oder auch ganz oder teilweise aus dieser Schicht herausragen. Die Lichtaustrittsschicht **4** kann dabei eine planare, parallel zu einem Substrat und einem OLED-Schichtaufbau liegende Schicht sein. Die Lichtaustrittsschicht **4** kann auch durch ein Substrats oder eine Passivierungsschicht für den OLED-Schichtstapel realisiert sein.

[0073] Die Streupartikel **16** zeichnen sich durch ein permanentes oder induzierbares elektrisches oder magnetisches, von Null verschiedenes Dipol- oder Quadropolmoment aus, durch das eine Hauptachse der Streupartikel definiert wird. Durch ein während des Herstellungsprozesses angelegtes elektrisches (E) und/oder magnetisches (B) ausgerichtetes Feld, in der Fig. 7 durch einen Vektorpfeil symbolisiert, werden die Streupartikel **16** bezüglich ihrer Hauptachse entlang einer vorgegebenen Richtung, hier der X-Achse, ausgerichtet. Beispielsweise ist es möglich, die Streupartikel in eine polymere Schicht einzubringen und vor dem Aushärten der Schicht entsprechend auszurichten. Die auf diese Weise eingefrorene Ausrichtung bleibt folglich auch ohne das ausrichtende elektrische und/oder magnetische Feld bestehen.

[0074] Weiterhin zeichnen sich die Streupartikel **16** durch eine Anisotropie in ihrer Geometrie und/oder in ihrem Brechungsindex aus, sodass relativ zur Orientierung ihrer Hauptachse ein anisotropes Streuverhalten für von der lichtemittierenden Schicht ausgestrahltes Licht zu beobachten ist. Die Anisotropie in der Geometrie und/oder dem Brechungsindex der ausgerichteten Streupartikel **16** bedingt eine anisotrope Streuung des Lichtes beim Austritt aus der lichtemittierenden Vorrichtung. Je nach Streuverhalten

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und Grad der Anisotropie führt dieses zu einer von dem Lambertschen Abstrahlungsprofil abweichenden Abstrahlungsprofil der lichtemittierenden Vorrichtung vom Typ A-1, A-2 oder B.

[0075] Auch Streupartikel, die kein von Null verschiedenes Dipol- oder Quadrupolmoment aufweisen, können ausgerichtet werden. Zum Beispiel können als Streupartikel **16** selbstanordnende Moleküle (self assembling molecules) eingesetzt werden, die sich während des Herstellungsprozesses unter geeigneten Bedingungen selbst ausrichten. Drüber hinaus ist es möglich, Streupartikel **16**, insbesondere solche, die eine geometrische Anisotropie aufweisen, in eine dehnbare Folie einzubetten und durch Dehnen der Folie entlang einer Richtung auszurichten.

[0076] Die Erläuterung der Erfindung anhand der Ausführungsbeispiele ist nicht als Beschränkung der Erfindung hierauf zu verstehen. Die Erfindung bezieht sich vielmehr auf sämtliche Anordnungen mit den in den Ansprüchen genannten Merkmalen. Weiterhin umfasst die Erfindung sämtliche in der Beschreibung genannten Merkmale sowie deren Kombination, auch wenn diese nicht in den Ansprüchen oder der Beschreibung explizit genannt sind.

Patentansprüche

1. Lichtemittierende Vorrichtung, umfassend
– eine lichtemittierende Schicht (**1**) und
– eine Lichtaustrittsschicht (**4**),
wobei die Lichtaustrittsschicht (**4**)
– eine Vielzahl von zueinander parallelen ersten Flächen (**5**), die geneigt zur lichtemittierende Schicht (**1**) angeordnet sind, und
– eine Vielzahl von zueinander parallelen zweiten Flächen (**6**), die geneigt zur lichtemittierende Schicht (**1**) und geneigt zu den ersten Flächen (**5**) angeordnet sind,
aufweist und wobei die ersten Flächen (**5**) transparent und die zweiten Flächen (**6**) reflektierend für von der lichtemittierenden Schicht (**1**) emittiertes Licht sind.

2. Lichtemittierende Vorrichtung nach Anspruch 1, bei der die lichtemittierende Schicht (**1**) ein organisches Material aufweist.

3. Lichtemittierende Vorrichtung nach einem der Ansprüche 1 oder 2, bei der die ersten Flächen (**5**) und die zweiten Flächen (**6**) in jeder Richtung eine Ausdehnung aufweisen, die größer als eine Wellenlänge des von der lichtemittierenden Schicht (**1**) ausgestrahlten Lichts ist.

4. Lichtemittierende Vorrichtung nach einem der Ansprüche 1 bis 3, bei der die ersten Flächen (**5**) und die zweiten Flächen (**6**) in einer Richtung eine Ausdehnung aufweisen, die kleiner als 1 mm und vorzugsweise kleiner als 100 µm ist.

5. Lichtemittierende Vorrichtung nach einem der Ansprüche 1 bis 4, bei der eine von der lichtemittierenden Schicht (**1**) abweisende Oberfläche der Lichtaustrittsschicht (**4**) durch parallel angeordneten Prismen strukturiert ist, wobei die ersten Flächen (**5**) und die zweiten Flächen (**6**) durch Flächen der Prismen gebildet werden.

6. Lichtemittierende Vorrichtung nach einem der Ansprüche 1 bis 4, bei der eine von der lichtemittierenden Schicht (**1**) abweisende Oberfläche der Lichtaustrittsschicht (**4**) durch kegel- oder pyramiden- oder linsen- oder zylinderförmige Elemente strukturiert ist, wobei die ersten Flächen (**5**) und die zweiten Flächen (**6**) durch Flächen dieser Elemente gebildet werden.

7. Lichtemittierende Vorrichtung nach einem der Ansprüche 1 bis 6, bei der die Lichtaustrittsschicht (**4**) durch ein Substrat (**3**) oder eine Passivierungsschicht gebildet wird.

8. Lichtemittierende Vorrichtung, umfassend
– einen Träger (**7**) und
– eine Mehrzahl lichtemittierender Elemente (**8**),
wobei der Träger (**7**)
– eine Mehrzahl von zueinander parallelen ersten Flächen (**5**) und
– eine Mehrzahl von zueinander parallelen zweiten Flächen (**6**), die geneigt zu den ersten Flächen (**5**) angeordnet sind, aufweist und wobei die lichtemittierenden Elemente (**8**) auf den ersten Flächen (**5**) angeordnet sind.

9. Lichtemittierende Vorrichtung nach Anspruch 8, bei der die lichtemittierenden Elemente (**8**) eine OLED aufweisen.

10. Lichtemittierende Vorrichtung nach einem der Ansprüche 8 oder 9, bei der Träger (**7**) durch parallel angeordnete Prismen strukturiert ist, wobei die ersten Flächen (**5**) und die zweiten Flächen (**6**) durch Flächen der Prismen gebildet werden.

11. Lichtemittierende Vorrichtung, umfassend
– ein Substrat (**3**) und
– eine auf eine Oberfläche des Substrats aufgebrachte Schichtenfolge (**2**) mit mindestens einer lichtemittierenden Schicht (**1**),
wobei die Oberfläche des Substrats (**3**) in einer lateralen Richtung periodisch höhenstrukturiert ist.

12. Lichtemittierende Vorrichtung nach Anspruch 11, bei der die lichtemittierende Schicht (**1**) ein organisches Material aufweist.

13. Lichtemittierende Vorrichtung nach einem der Ansprüche 11 oder 12, bei der die Höhenstrukturie-

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rung in der einen lateralen Richtung linear steigend und fallend ist und die Oberfläche des Substrats (3) im Wesentlichen plane Flächen aufweist.

14. Lichtemittierende Vorrichtung nach einem der Ansprüche 11 bis 13, bei der die Höhenstrukturierung in der einen lateralen Richtung nichtlinear steigend und/oder fallend ist und die Oberfläche des Substrats (3) gebogene Flächen aufweist.

15. Lichtemittierende Vorrichtung nach einem der Ansprüche 11 bis 14, bei der das Substrat (3) aus Kunststoff in einem Spritzgussverfahren hergestellt ist.

16. Lichtemittierende Vorrichtung nach einem der Ansprüche 11 bis 14, bei der das Substrat (3) aus Metall besteht und durch ein Prägeverfahren strukturiert ist.

17. Lichtemittierende Vorrichtung, umfassend eine lichtemittierende Schicht (1), die in einer lateralen Richtung abwechselnd angeordnete streifenförmige erste Bereiche (10) und zweite Bereiche (11) aufweist, wobei die ersten Bereiche (10) und die zweiten Bereiche (11) verschiedene Brechungszahlen haben.

18. Lichtemittierende Vorrichtung nach Anspruch 17, bei der die Abmessung der ersten Bereiche (10) und der zweiten Bereiche (11) in der lateralen Richtung von der Größenordnung einer Wellenlänge des von der lichtemittierenden Schicht (1) ausgestrahlten Lichtes ist und vorzugsweise kleiner als das 5-fache der Wellenlänge ist.

19. Lichtemittierende Vorrichtung nach einem der Ansprüche 17 oder 18, bei der die lichtemittierende Schicht (1) ein organisches Material aufweist.

20. Verfahren zur Herstellung einer lichtemittierenden Vorrichtung lichtemittierenden Schicht, bei dem Bereiche der lichtemittierenden Schicht (1) zur Veränderung des Brechungsindex in den Bereichen mit UV-Licht bestrahlt werden.

21. Lichtemittierende Vorrichtung, umfassend
– eine lichtemittierende Schicht (1) und
– eine Lichtaustrittsschicht (4),
wobei in oder auf der Lichtaustrittsschicht (4) eine Vielzahl von anisotropen Streupartikeln (16) angeordnet ist, die entlang einer lateralen Richtung der lichtemittierenden Vorrichtung ausgerichtet sind.

22. Lichtemittierende Vorrichtung nach Anspruch 21, bei der die lichtemittierende Schicht (1) ein organisches Material aufweist.

23. Lichtemittierende Vorrichtung nach einem der Ansprüche 21 oder 22, bei der die Streupartikel (16) bezüglich ihrer geometrischen Abmessungen und/oder ihrem Brechungsindex anisotrop sind.

24. Lichtemittierende Vorrichtung nach einem der Ansprüche 21 bis 23, bei der die Streupartikel (16) ein von Null verschiedenes permanentes oder induzierbares elektrisches oder ein magnetisches Dipol- oder Quadrupolmoment aufweisen.

25. Lichtemittierende Vorrichtung nach einem der Ansprüche 21 bis 23, bei der die Streupartikel (16) selbstanordnende Moleküle sind.

26. Lichtemittierende Vorrichtung nach einem der Ansprüche 21 bis 23, bei der die Streupartikel (16) in einer dehnbaren Folie angeordnet sind.

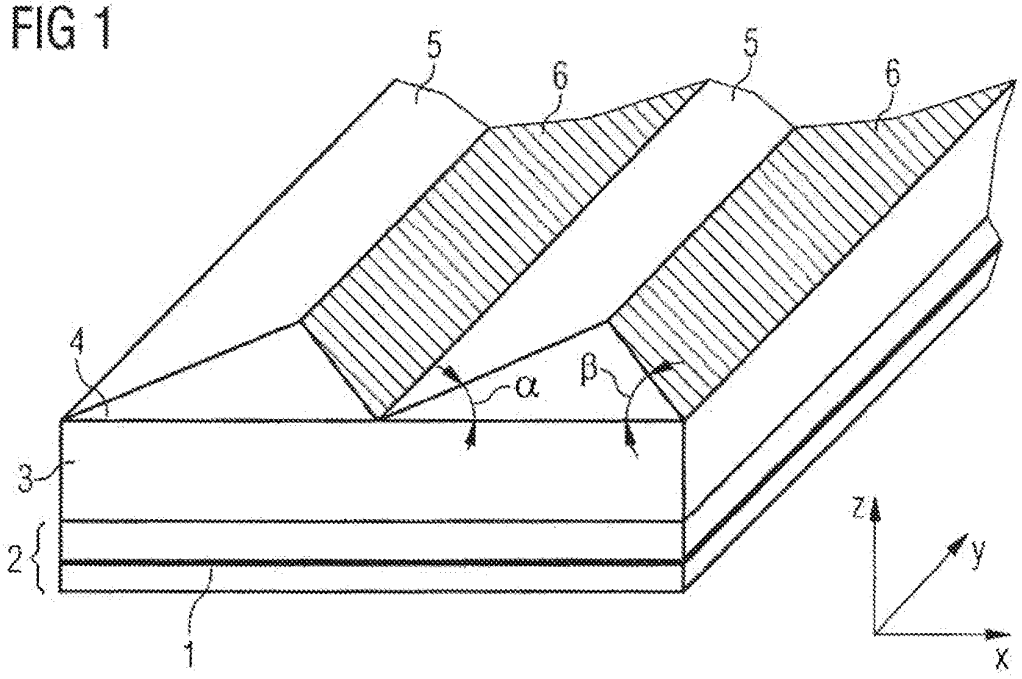
27. Verfahren zur Herstellung einer lichtemittierenden Vorrichtung, bei dem Streupartikel (16) mit einem von Null verschiedenen permanenten oder induzierbaren elektrischen oder magnetischen Dipol- oder Quadrupolmoment in eine Lichtaustrittsschicht (4) eingebracht und durch ein angelegtes elektrisches oder magnetisches Feld ausgerichtet werden.

Es folgen 6 Blatt Zeichnungen

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Anhängende Zeichnungen

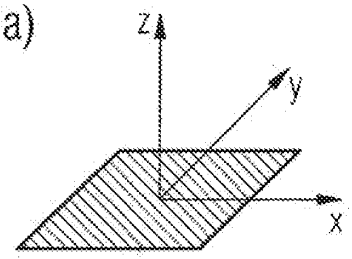
FIG 1



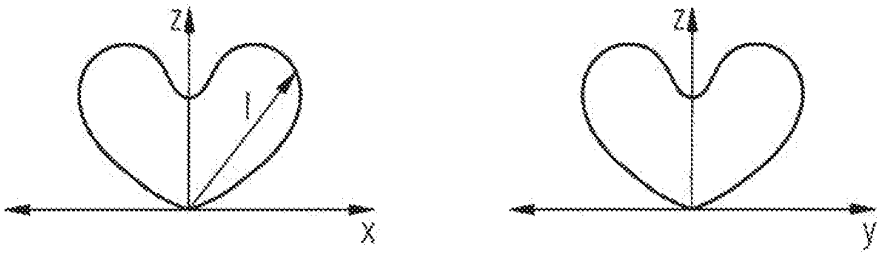
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FIG 2

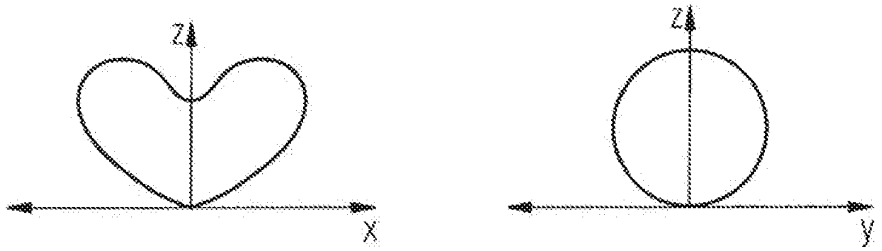
a)



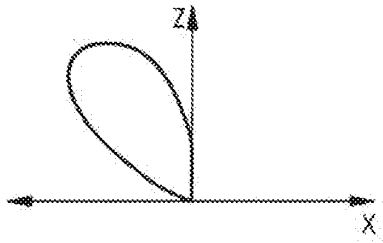
b) Typ A-1:



c) Typ A-2:



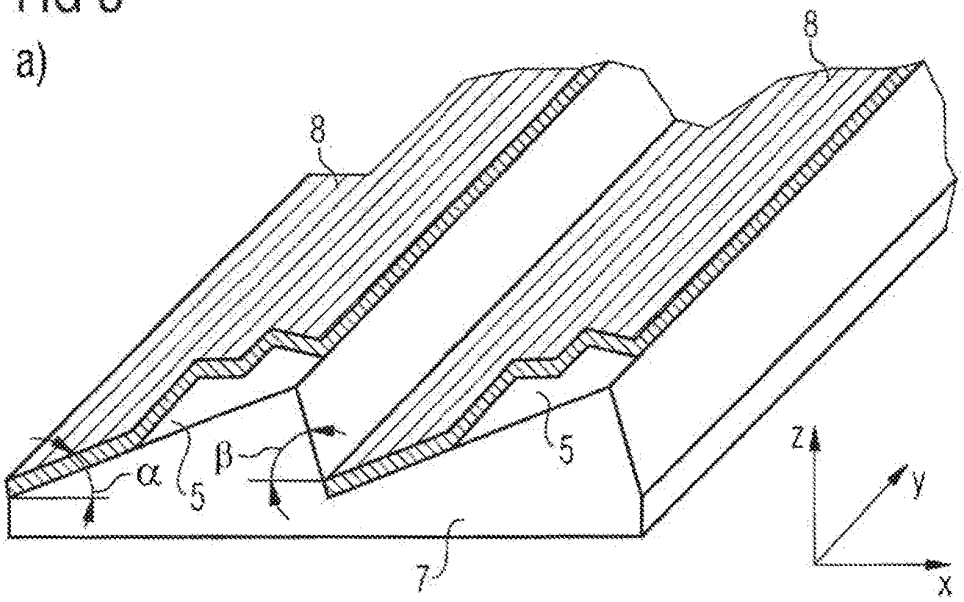
d) Typ B:



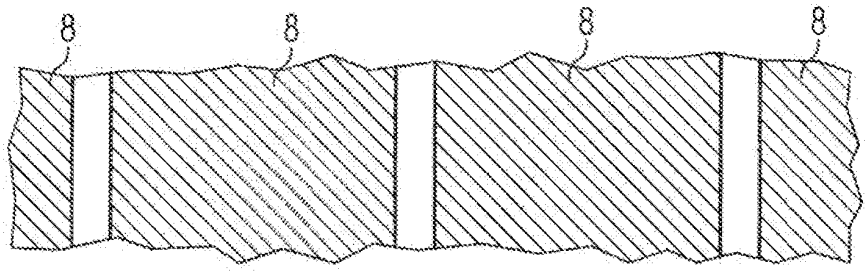
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FIG 3

a)



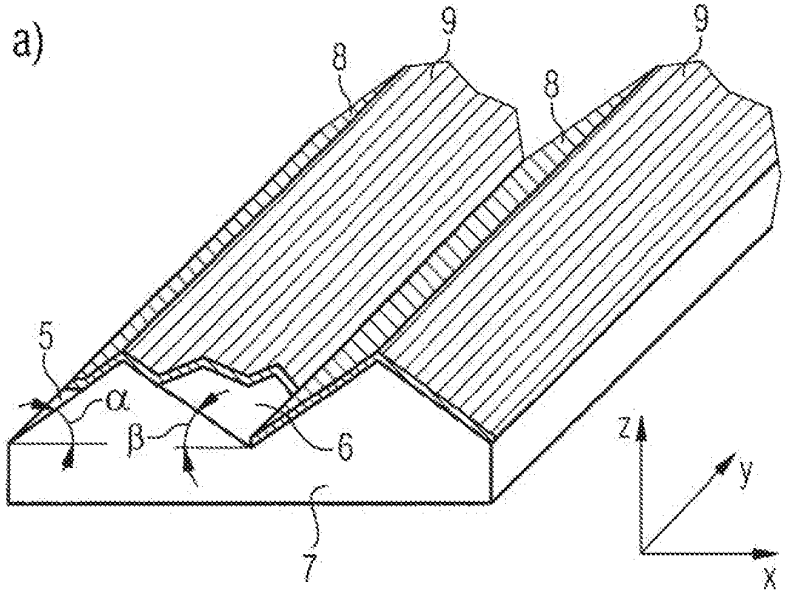
b)



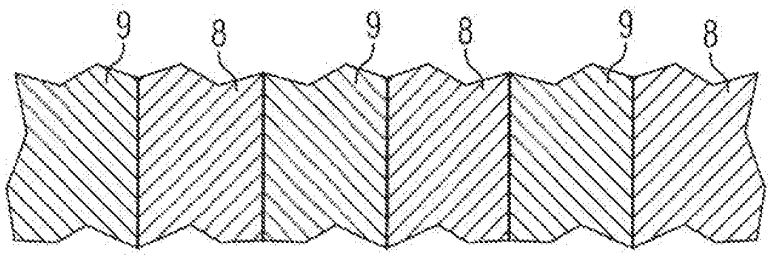
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FIG 4

a)

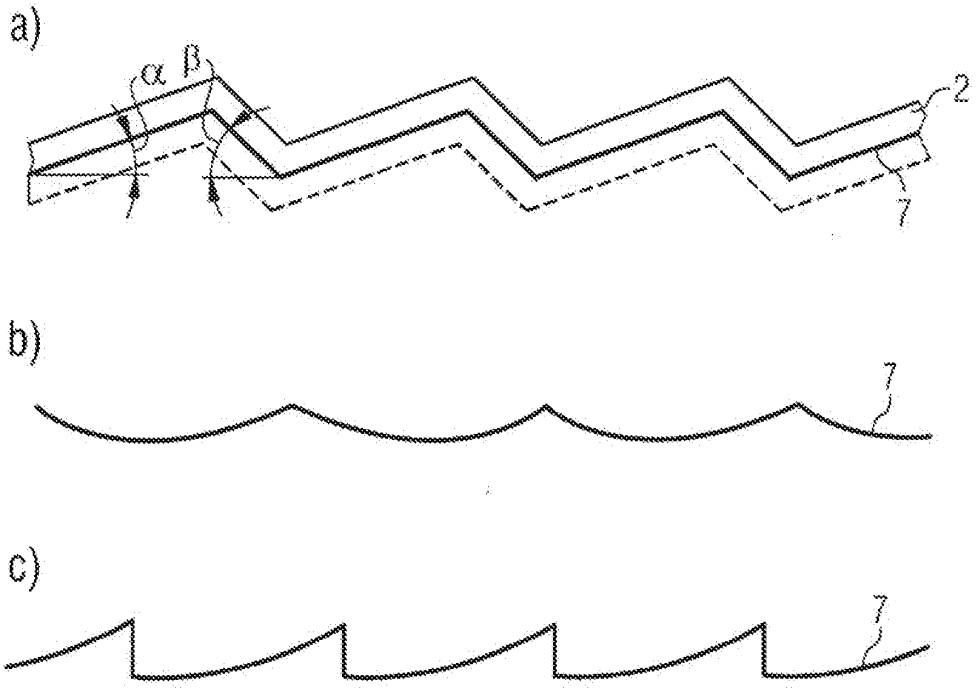


b)



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FIG 5



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FIG 6

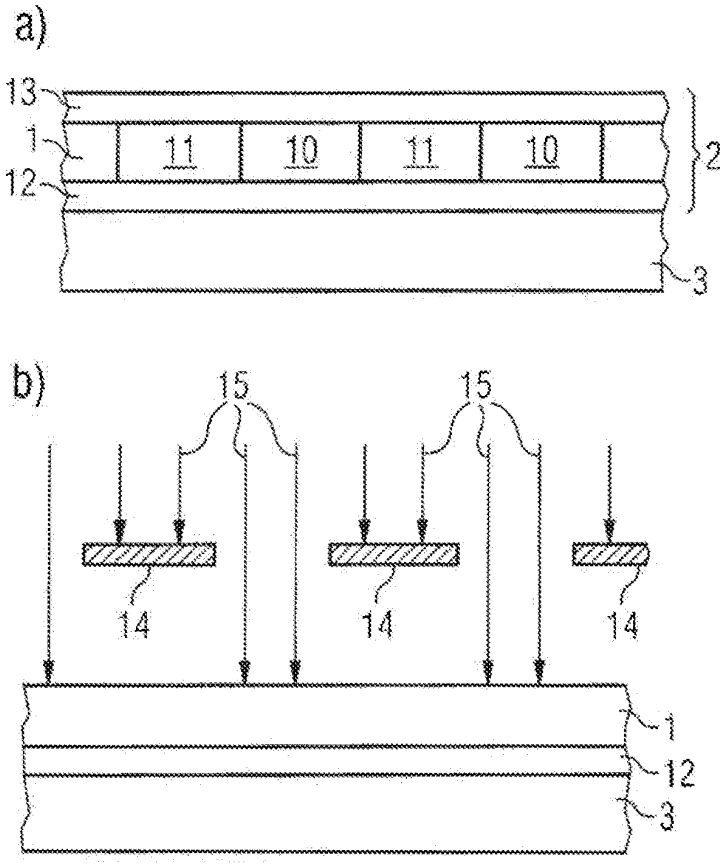
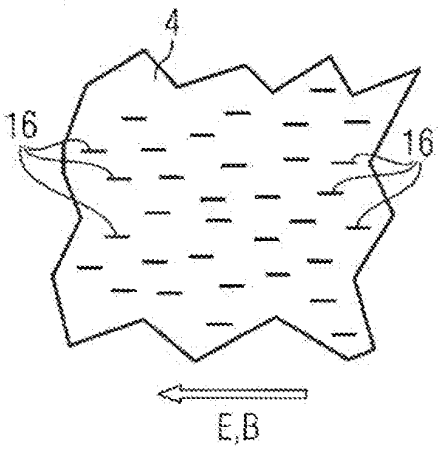


FIG 7



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Electronic Acknowledgement Receipt

EFS ID:	33137702
Application Number:	15651508
International Application Number:	
Confirmation Number:	2349
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Customer Number:	27799
Filer:	Thomas Langer/Sheri Michals/ Ian R. Blum
Filer Authorized By:	Thomas Langer
Attorney Docket Number:	5367-694P/CON\409926
Receipt Date:	10-JUL-2018
Filing Date:	17-JUL-2017
Time Stamp:	15:47:20
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	5367-694PCON-IDS.pdf	76073 2a5bc0d01cd4d8515e0f237e7635b17e63146491	no	3

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2	Foreign Reference	DE102007059732-WITH-ABS.pdf	3404786 42dd267af4b66866b04e065e36048b0139a07131	no	17
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3	Non Patent Literature	OA.pdf	189908 bce35a7ad32ffda61de7e4b79a52fce90b117f61	no	6
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/651,508	07/17/2017	Ulrich KASTNER-JUNG	5367-694P/CON\409926	2349

27799 7590 08/31/2018

Cozen O'Connor
277 Park Avenue, 20th floor
NEW YORK, NY 10172

EXAMINER
CHO, JAMES HYONCHOL

ART UNIT	PAPER NUMBER
2844	

NOTIFICATION DATE	DELIVERY MODE
08/31/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patentsecretary@cozen.com
patentdocket@cozen.com
patentsorter@cozen.com

Office Action Summary	Application No. 15/651,508	Applicant(s) KASTNER-JUNG ET AL.	
	Examiner JAMES H. CHO	Art Unit 2844	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *4/5/2018*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-5 and 7-19* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☒ Claim(s) *19* is/are allowed.

7)☒ Claim(s) *1-4,7-10,12,13 and 16-18* is/are rejected.

8)☒ Claim(s) *5,14 and 15* is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *7/17/2017* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☒ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☒ Certified copies of the priority documents have been received in Application No. 13/139,514.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date *7/10/18*.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Receipt is acknowledged of the Amendment filed 4/5/2018.

Claim Objections

Claim 7 is objected to because of the following informalities:

In claim 7, "forms " on line 5 should to be --form --;

Appropriate correction is required.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):

> (b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claim 7 is rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 7 recites “the angle α= β” on line 8 while the independent claim 1 defines “the angle α and β are different from each other”, which would contradict to each other.

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

Claims 1-4, 8-10, 12-13 and 16-18 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Garditz in view of Chen (US Pat No. 7,205,714).

Regarding claim 1, Garditz teaches an organic light-emitting diode (Figs. 1C and 2B, 2D, see paragraph [0046]) comprising an organic layer sequence (15 being at least one or more organic functional layers, see paragraph [0018]), a radiation exit area (top or bottom emitting area indicated with arrows, see paragraph [0045]) and an encapsulation (6),

wherein the organic layer sequence comprises at least one radiation-emitting region (15) which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation (the radiation emitted in the infrared or UV range, see paragraph [0018]),

wherein the radiation exit area is structured (microlens 20E or 20F at the bottom or top exit area as shown in Fig. 2A-2D where the microlens is for forming the light emission direction, see paragraphs [0046] -[0048]), so that the electromagnetic radiation has a directional emission profile, and

wherein the encapsulation (protection from environment influences, e.g. water and moisture when the OLED is encapsulated by a cap made of glass or ceramic is inherent, see paragraph [0018]) forms a seal of the organic layer sequence against environmental influences,

where the structured radiation exit area comprises arc shaped structure (microlens 20E or 20F),

but does not teach the structured radiation exit area comprises a multiplicity of first areas and second areas, wherein the first areas are tilted at an angle α to a plane which is arranged parallel to the main plane of the organic layer sequence, and wherein the second areas are tilted at an angle β to said plane, wherein the angles α and β are different from each other.

However, Chen teaches the structured radiation exit area comprises a multiplicity of first areas and second areas (first areas being one sides of 310 in Fig. 3c-1 and second areas being other sides of 310 in Fig. 3c-1), wherein the first areas are tilted at an angle α (angle of the one side of 310) to a plane (plane 320, 330, 340 being parallel) which is arranged parallel to the main plane of the organic layer sequence, and wherein the second areas (angle of other side of 310) are tilted at an angle β to said plane, wherein the angles α and β are different from each other (trapezoidal prism having

various angles, see col. 3, lines 22-32) for the purpose of providing directing light for glare reduction.

Therefore it would have been obvious to one ordinary skill in the art at the time of invention was made to replace the microarray of lenses of Garditz with the trapezoidal or rectangular prism of Chen in order to provide various output radiation with glare reduction.

Regarding claim 2, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the structured radiation exit area comprises a multiplicity of prisms which are arranged parallel to one another (see plurality of 310).

Regarding claim 3, Garditz in view of Chen teaches the organic light-emitting diode according to claim 2, wherein the prisms comprises a height and width which are arranged parallel to the main plane of the organic layer sequence, the width is bigger than the wavelength of the electromagnetic radiation which is induced by the organic light-emitting diode (a preferred width being 50000 Å = 5000 nm, see col. 3, lines 22-26, is bigger than a typical UV wavelength of 400 nm and IR wavelength of 800nm),

but does not teach the length of the prism being at least 1 cm.

However, it would have been obvious to one having ordinary skill in the art at the time the invention was made to specify the length of the OLED being at least 1 cm, since it has been held that where the general conditions of a claim are disclosed in the

prior art, discovering the optimum or workable ranges involves only routine skill in the art.

Regarding claim 4, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the emission profile is a symmetrical cardioid in one direction or asymmetrical in at least one of the directions (see the direction of light emission being one direction noted with arrow).

Regarding claim 8, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the first areas (areas for microarray 20F of a lot of microlenses 20F are nonplanar shown in Fig. 2D) and/or the second areas are nonplanar.

Regarding claim 9, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the first areas (areas of microarray 20F of a lot of mircrolenes are an arc which is in the form of the manner of cylinder sections) and/or a second areas are formed in the manner of cylinder sections.

Regarding claim 10, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the directional emission profile has a maximum in the direction perpendicular to the first areas (the lens 20E provides a focus the intensity of the emitted radiation in the emission direction in the optical path 100, see paragraph [0046]).

Regarding claim 12, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the structured radiation exit area is embodied as a separate structured foil (a layer of 20F being separate from the substrate 5 shown in Figs. 2B and 2D), which is arranged on a carrier (a layer of 20F is formed from the radiation out-coupling material, see paragraph [0047]).

Regarding claim 13, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the organic light-emitting diode comprises a carrier which is structured (the radiation out-coupling material for 20F), wherein the radiation exit area (20F is formed using the radiation out-coupling material) is arranged on the carrier, and wherein the structuring of the radiation exit area is induced by the structuring of the carrier (the shaped structure of 20F is made with the radiation out-coupling material, see paragraph [0047]).

Regarding claim 16, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the structuring of the radiation exit area is produced by the structuring of the encapsulation (the microarray of lenses are being encapsulated, see paragraph [0047]).

Regarding claim 17, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the organic light-emitting diode is an organic light-

emitting diode emitting on both sides (top-emitting and bottom-emitting as denoted by arrows 100 and 110 where 100 and 110 are opposite to each other as shown in Fig. 1C), which comprises two radiation exit areas, wherein the two radiation exit areas are arranged on opposite sides of the organic light-emitting diode, and wherein the radiation exit areas are structured (see paragraph [0045]).

Regarding claim 18, Garditz in view of Chen teaches a luminaire having at least one light-emitting diode according to claim 1 as a light source, wherein the luminaire is one of the following devices or is at least part of one of the following devices (a luminaire using the OLED of Garditz for a particular apparatus such as in alarm clock,... waring light is an intended use. It has been held that a recitation directed to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. *Ex parte Masham*, 2 USPQ2d 1647 (1987)) : alarm clock, shower cubicle, shower head, solar protection, rain protection, lamp, bag, signaling light, changing cubicle, vision protection, housing, emergency lighting, mirror, tile, ceiling light, radiator cladding, louver, noise protection, umbrella, warning light.

Claim 7 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Garditz in view of Chen (US Pat No. 7,205,714) and Ishikawa (US Pat No. 7,560,727).

Regarding claim 7, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the structured radiation exit area comprises a multiplicity of prisms (310s being trapezoidal prisms) wherein the prisms comprise a length and width (trapezoidal prisms have length and width being parallel to the plane of 320, 330 and 340) which arranged parallel to the main plane of the organic layer sequence,

but does not teach the prisms forms in side view an isosceles triangle, wherein the directional emission profile is symmetrical and has two main radiation directions, wherein the two main radiation directions are inclined from the z- axis by the angle a = β in positive and negative x- directions, and wherein the main plane forms an x-y-plane.

However, Ishikawa teaches a prism structure (see Fig. 1) where the prisms forms in side view an isosceles triangle (see Fig. 1), wherein the directional emission profile is symmetrical (prism structure having two side symmetrical radiating light) and has two main radiation directions, wherein the two main radiation directions are inclined from the z- axis (plane of ANODE) by the angle α= β (PRISM having the same angles) in positive and negative x-directions, and wherein the main plane forms an x-y-plane for the purpose of converging light alleviating the decrease in light output efficiency due to total reflection (see col. 1, lines 55-59).

Therefore it would have been obvious to one ordinary skill in the art at the time of invention was made to replace the microarray of lenses of Garditz as modified by Chen with a prism structure where the prisms forms in side view an isosceles triangle of

Ishikawa in order to converge light in alleviating the decrease in light output efficiency due to total reflection.

Allowable Subject Matter

Claims 5, 14-15 and 19 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter:

one of ordinary skill in the art would not have been motivated to modify the teaching of Garditz, Chen and/or Ishikawa to further includes, among other things, the specific of the first areas are transparent and the second areas are reflective, so that the directional emission profile has a tilt angle which depends on the angle α (**claims 5 and 19**), the specific of the carrier comprising a multiplicity of parallel prisms having first areas and second areas which are arranged in a tilted manner with respect to one another, wherein functional layers of the organic layer sequence are applied to the first and/or the second areas at the top side of the carrier, and wherein the functional layers, which are arranged on different areas, are driven separately from one another (**claim 14**), and the specific of the carrier comprising a multiplicity of parallel prisms having first areas and second areas, wherein the areas are arranged in a tilted manner with respect to one another, and wherein functional layers of the organic layer sequence are applied to the first and/or the second areas at the top side of the carrier, and the respective other areas are free of the functional layers (**claim 15**).

Response to Arguments

Applicant's arguments with respect to claims 1-5 and 7-19 have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to James Cho whose telephone number is 571-272-1802. The examiner can normally be reached on Monday-Friday 8 AM - 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Douglas Owens can be reached on 571-272-1662. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/James H. Cho/
Examiner, Art Unit 2844

/MINH D A/

Primary Examiner, Art Unit 2844

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15651508	KASTNER-JUNG ET AL.
	Examiner	Art Unit
	JAMES H CHO	2844

CPC- SEARCHED		
Symbol	Date	Examiner
B60Q3/30,745 B05B1/18,268 B60Q7/00 F21S10/02 F21V23/0442,0016,004,0052,006 F21Y2113/20,10 F21Y2115/15 F21Y2105/00 (text search, see the search history printout)	2/1/2018	JC
F21S8/033,04,061 F21S9/03 G04C19/02 G04G11/00 G04G13/023 H05B33/0896,22 H05B37/00,0281 H01L2251/5361 Y02B20/36,42 (text search, see the search history printout)	2/1/201	JC

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES		
Search Notes	Date	Examiner
BRS text search, see the search history printout	2/1/2018	JC

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

Attorney Docket # 5367-694P/CON/409926 Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	
Kastner-Jung, Ulrich et al.	
Serial No.:	15/651,508
Filed:	July 17, 2017
For:	Organic-Light-Emitting Diode

Examiner: CHO, JAMES H.

Group Art: 2854

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

S I R:

In compliance with the duty of disclosure under 37 C.F.R. §1.56 and in accordance with the practice under 37 C.F.R. §§1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a. Copies of the listed non-US documents are also enclosed.

Enclosed is a copy of an Office Action dated June 28, 2018 which issued in the corresponding German Patent Application No. 112009003123.4.

This information is being submitted subsequent to the later of three months after the filing date of the present application or the mailing of the first Office Action on the merits, but before the mailing of a final Action or the Notice of Allowance.

STATEMENT

Each item of information contained in the Information Disclosure Statement was first cited in any communication received from a foreign Patent Office in a counterpart foreign application not more than three months prior to the filing of the Information Disclosure Statement.

In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /JC/

SDC EX. 1016 - 517/959

listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicant(s) reserve(s) the right to prove that the date of publication is in fact different.

It is believed that no additional fees or charges are required at this time in connection with the present application. However, if any fees or charges are required at this time, they may be charged to our Patent and Trademark Office Deposit Account No. 503111.

It is respectfully requested that the above information be considered by the Examiner and that a copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

Respectfully submitted,
COZEN O'CONNOR

By: /Ian R. Blum/
Ian R. Blum
Reg. No. 42,336
277 Park Avenue
New York, New York 10172
(212) 883-4900

Dated: July 10, 2018

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /JC/

SDC EX. 1016 - 518/959

Attorney Docket # 5367-694P/CON/409926

PTO/SB/08A (04-03)
Approved for use through 04/30/2003. OMB 0651-0031
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Substitute for Form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	15/651,508
Filing Date	July 17, 2017
First Named Inventor	Kastner-Jung, Ulrich
Art Unit	2854
Examiner Name	CHO, JAMES H.
Attorney Docket	5367-694P/CON/409926

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number / Number-Kind-Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Document / Country Code[3]- Number[4]- Kind-Code [5] (if known	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		DE 102007059732	06-18-2009	OSRAM Opto Semiconductors GmbH		Abs.

Examiner Signature	/JAMES H CHO/	Date Considered	08/01/2018

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, Washington, DC 20231.** *If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2..*

LEGAL\37153969\1 14560.0001.000/409926.000

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /JC/

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15651508	KASTNER-JUNG ET AL.
	Examiner	**Art Unit**
	JAMES H CHO	2844

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/01/2018	08/03/2018							
	1	✓	✓							
	2	✓	✓							
	3	✓	✓							
	4	✓	✓							
	5	O	O							
	6	O	-							
	7	✓	✓							
	8	✓	✓							
	9	✓	✓							
	10	✓	✓							
	11	O	✓							
	12	✓	✓							
	13	✓	✓							
	14	✓	O							
	15	✓	O							
	16	✓	✓							
	17	✓	✓							
	18	✓	✓							
	19		=							

SDC EX. 1016 - 520/959

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/651,508	Filing Date 07/17/2017	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **11/28/2018**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 14	Minus	** 20	= 0	X $100 =	0
Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $460 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	**0**

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
ANTHONY WILLIAMS

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	34416500
Application Number:	15651508
International Application Number:	
Confirmation Number:	2349
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Customer Number:	27799
Filer:	Thomas Langer/Jennifer Colwell
Filer Authorized By:	Thomas Langer
Attorney Docket Number:	5367-694P/CON\409926
Receipt Date:	28-NOV-2018
Filing Date:	17-JUL-2017
Time Stamp:	10:29:55
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	Amendment.pdf	53136 2aaac98626753bb959b58d872dadb3cc3d7893e1	no	7

Warnings:

Information:	
Total Files Size (in bytes):	53136

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Kastner-Jung, Ulrich et al.

Serial No.: 15/651,508

Filed: July 17, 2017

For: Organic-Light-Emitting Diode

Examiner: CHO, James H.

Group Art Unit: 2811

Conf. No.: 2349

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT

SIR:

RESPONSE

In response to the Office Action dated August 31, 2018, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper;

Remarks/Arguments begin on page 6 of this paper.

SDC EX. 1016 - 524/959

Listing of Claims:

1. (Currently Amended) An organic light-emitting diode comprising an organic layer sequence, a ~~radiation exit area~~ carrier and an encapsulation,

wherein the organic layer sequence comprises at least one radiation-emitting region which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation,

wherein the carrier forms a radiation exit area,

wherein the radiation exit area is structured, so that the electromagnetic radiation has a directional emission profile,

wherein the encapsulation forms a seal of the organic layer sequence against environmental influences,

~~wherein the structured radiation exit area comprises a multiplicity of first areas and second areas,~~

~~wherein the first areas are tilted at an angle α to a plane which is arranged parallel to the main plane of the organic layer sequence,~~

~~wherein the second areas are tilted at an angle β to said plane, and~~

~~wherein the angles α and β are different from each other~~

wherein the carrier comprises a multiplicity of parallel prisms having first areas and second areas which are arranged in a tilted manner with respect to one another,

wherein functional layers of the organic layer sequence are applied to the first and/or the second areas at the top side of the carrier, and

wherein the functional layers, which are arranged on different areas, are driven separately from one another.

2. (Canceled)

3. (Currently Amended) The organic light-emitting diode according to claim [[2]] 1,

wherein the prisms comprises a length and width which are arranged parallel to the main plane of the organic layer sequence,

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wherein the length is at least 1 cm, and

wherein the width is bigger than the wavelength of the electromagnetic radiation which is induced by the organic light-emitting diode.

4. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the emission profile is a symmetrical cardioid in one direction or asymmetrical in at least one of the directions.

5. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the first areas are transparent and the second areas are reflective, so that the directional emission profile has a tilt angle which depends on the angle α.

6. (Cancelled)

7. (Currently Amended) The organic light-emitting diode according to claim 1,

wherein the structured radiation exit area comprises a multiplicity of prisms,

wherein the prisms comprise a length and width which are arranged parallel to the main plane of the organic layer sequence,

wherein the prisms ~~forms~~ form in side view an isosceles triangle,

wherein the directional emission profile is symmetrical and has two main radiation directions, wherein the two main radiation directions are inclined from the z-axis by the angle $\alpha = \beta$ in positive and negative x-directions, and

wherein the main plane forms an x-y-plane.

8. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the first areas and/or the second areas are nonplanar.

9. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the first areas and/or the second areas are formed in the manner of cylinder sections.

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10. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the directional emission profile has a maximum in the direction perpendicular to the first areas.

11. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the second areas are reflective, which is induced by metallization with metal particles.

12. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the structured radiation exit area is embodied as a separate structured foil, which is arranged on a carrier.

13. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the organic light-emitting diode comprises a carrier which is structured,

wherein the radiation exit area is arranged on the carrier, and

wherein the structuring of the radiation exit area is induced by the structuring of the carrier.

14. (Canceled)

15. (Canceled)

16. (Canceled)

17. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the organic light-emitting diode is an organic light-emitting diode emitting on both sides, which comprises two radiation exit areas,

wherein the two radiation exit areas are arranged on opposite sides of the organic light-emitting diode, and

wherein the radiation exit areas are structured.

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18. (Previously Presented) A luminaire having at least one light-emitting diode according to claim 1 as a light source,

wherein the luminaire is one of the following devices or is at least part of one of the following devices: alarm clock, shower cubicle, shower head, solar protection, rain protection, lamp, bag, signaling light, changing cubicle, vision protection, housing, emergency lighting, mirror, tile, ceiling light, radiator cladding, louver, noise protection, umbrella, warning light.

19. (Previously Presented) An organic light-emitting diode comprising an organic layer sequence, a radiation exit area and an encapsulation,

wherein the organic layer sequence comprises at least one radiation-emitting region which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation,

wherein the radiation exit area is structured, so that the electromagnetic radiation has a directional emission profile,

wherein the encapsulation forms a seal of the organic layer sequence against environmental influences,

wherein the structured radiation exit area comprises a multiplicity of first areas and second areas, wherein the first areas are tilted at an angle α to a plane which is arranged parallel to the main plane of the organic layer sequence,

wherein the second areas are tilted at an angle β to said plane, and

wherein the first areas are transparent and the second areas are reflective, so that the directional emission profile has a tilt angle which depends on the angle α.

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REMARKS/ARGUMENTS

Status of claims

Claims 1-5 and 7-19 were examined. Claims 1 and 19 are the only independent claims.

Claims 2, and 14-16 are being canceled, without prejudice.

Claims 5, 14 and 15 have been indicated by the Examiner as being allowable if suitably rewritten in independent form.

Claim 1 is being amended to incorporate the subject matter of claim 14.

The dependency of claim 3 is being changed from canceled claim 2 to claim 1.

Claim 7 is being modified to correct a typographical error.

Summary of Office Action

Claim 7 has been rejected under 35 USC 112(b) or 35 USC 112 (pre-AIA), second paragraph, as being indefinite because it contradicts claim 1. Claim 1 has been revised to eliminate this contradiction.

Claims 1-4, 8-10, 12, 13, and 16-18 have been rejected under pre-AIA 35 USC 103(a) as being unpatentable over Garditz in view of Chen.

Claim 7 has been rejected under pre-AIA 35 USC 103(a) as being unpatentable over Garditz in view of Chen and Ishikawa.

Reconsideration and withdrawal of these rejections are respectfully requested in view of the claim modifications made herein and in light of the following remarks.

Remarks

The subject matter of allowable dependent claim 14 has been incorporated into claim1. Thus, amended independent claim 1 is in condition for allowance.

Independent claim 19 has been allowed.

Each of the remaining dependent claims 3-5, 7-13, 17 and 18 depends, either directly or indirectly, on claim 1 and, thus, is allowable therewith.

Conclusion

Based on all of the above, the present application is now in proper condition for allowance. Prompt and favorable action to this effect and early passing of this application to issue are respectfully solicited.

It is believed that no additional fees or charges are required at this time in connection with the present application. However, if any additional fees or charges are required at this time, they may be charged to our U.S. Patent and Trademark Office Deposit Account No. 50-3111.

Respectfully submitted,
COZEN O'CONNOR

By /Thomas Langer/
Thomas Langer
Reg. No. 27,264
277 Park Avenue
New York, New York 10172
(212) 883-4900

Dated: November 28, 2018

SDC EX. 1016 - 530/959

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	Examiner: CHO, JAMES H.
Kastner-Jung, Ulrich et al.	Group Art: 2844
Serial No.: 15/651,508	
Filed: July 17, 2017	
For: Organic-Light-Emitting Diode	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

S I R:

In compliance with the duty of disclosure under 37 C.F.R. §1.56 and in accordance with the practice under 37 C.F.R. §§1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a.

Enclosed is a copy of an Office Action (and an English translation) dated November 29, 2018 which issued in the corresponding Korean Patent Application No. 10-2017-7026128.

This information is being submitted subsequent to the later of three months after the filing date of the present application or the mailing of the first Office Action on the merits, but before the mailing of a final Action or the Notice of Allowance.

STATEMENT

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SDC EX. 1016 - 531/959

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It is respectfully requested that the above information be considered by the Examiner and that a copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

Respectfully submitted,
COZEN O'CONNOR

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Dated: January 4, 2019

SDC EX. 1016 - 532/959

Attorney Docket # 5367-694P/CON/409926

PTO/SB/08A (04-03)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	15/651,508
Filing Date	July 17, 2017
First Named Inventor	Kastner-Jung, Ulrich
Art Unit	2844
Examiner Name	CHO, JAMES H.
Attorney Docket	5367-694P/CON/409926

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number Number-Kind-Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-2005/0231101	10-20-2005	Chen	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Document Country Code[3] Number[4] Kind-Code [5] (if known	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
		Office Action dated November 29, 2018 which issued in the corresponding Korean Patent Application No. 10-2017-7026128.	✓

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, Washington, DC 20231.** *If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.*.

LEGAL\39524095\1 14560.0001.000/409926.000

Electronic Acknowledgement Receipt

EFS ID:	34765025
Application Number:	15651508
International Application Number:	
Confirmation Number:	2349
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Customer Number:	27799
Filer:	Thomas Langer/Sheri Michals/ Ian R. Blum
Filer Authorized By:	Thomas Langer
Attorney Docket Number:	5367-694P/CON\409926
Receipt Date:	04-JAN-2019
Filing Date:	17-JUL-2017
Time Stamp:	15:01:09
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	5367-694PCON-IDS.pdf	80729 91dd8989244b67cecb17d2916fd024ad4156e481	no	3

Warnings:

Information:					
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2	Non Patent Literature	kroa-original.pdf	1803669 3d1555cd3c28020a36bec145efa8c6443be22164	no	6
Warnings:					
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			Total Files Size (in bytes):	2044164	

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/651,508	07/17/2017	Ulrich KASTNER-JUNG	5367-694P/CON\409926	2349

27799 7590 03/21/2019

Cozen O'Connor
277 Park Avenue, 20th floor
NEW YORK, NY 10172

EXAMINER
CHO, JAMES HYONCHOL

ART UNIT	PAPER NUMBER
2844	

NOTIFICATION DATE	DELIVERY MODE
03/21/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patentdocket@cozen.com
patentsecretary@cozen.com
patentsorter@cozen.com

SDC EX. 1016 - 536/959

Office Action Summary	Application No. 15/651,508	Applicant(s) KASTNER-JUNG et al.	
	Examiner James H Cho	Art Unit 2844	AIA (FITF) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 11/28/2018.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1,3-5,7-13 and 17-19 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☑ Claim(s) 19 is/are allowed.

7) ☑ Claim(s) 1,3-5,7-10,12-13 and 17-18 is/are rejected.

8) ☑ Claim(s) 11 is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 7/17/2017 is/are: a)☐ accepted or b)☑ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☑ Certified copies of the priority documents have been received in Application No. 13/139514.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Receipt is acknowledged of the Amendment filed November 28, 2018.

Drawings

The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, "the structured radiation exit area comprises a multiplicity of prisms" recited in the dependent claim 7 must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency. Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 5 and 7 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor, or for pre-AIA the applicant regards as the invention.

Claim 5 recites the limitation "the angle α" in line 3. There is insufficient antecedent basis for this limitation in the claim.

Claim 7 recites the limitation "the angle α=β" in line 8. There is insufficient antecedent basis for this limitation in the claim. Claim 7 also recites “the structured radiation exit area comprises a multiplicity of prisms” while the independent claim 1 recites “the carrier comprises a multiplicity of parallel prisms”. It is unclear whether the structured radiation area includes additional multiplicity of prisms in addition to the multiplicity of parallel prisms recited in claim 1.

Claim Rejections - 35 USC § 103

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

> invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.

2. Ascertaining the differences between the prior art and the claims at issue.

3. Resolving the level of ordinary skill in the pertinent art.

4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under pre-AIA 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of pre-AIA 35 U.S.C. 103(c) and potential pre-AIA 35 U.S.C. 102(e), (f) or (g) prior art under pre-AIA 35 U.S.C. 103(a).

Claims 1, 3-4, 8-10, 12-13 and 16-18 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Garditz (US 2007/0114520 A1) in view of Chen (US Pat No. 7,205,714).

Regarding claim 1, Garditz teaches an organic light-emitting diode (Figs. 2A, 2B, 2C, 2D, see paragraph [0046]) comprising an organic layer sequence (10A, 10B, 15 being at least one or more organic functional layers, see paragraph [0018]), a carrier (20E, 20F, 20E, 20F top or bottom areas carrying light as indicated with arrows, see paragraph [0045]) and an encapsulation (6),

wherein the organic layer sequence comprises at least one radiation-emitting region (15) which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation (the radiation emitted in the infrared or UV range, see paragraph [0018]),

wherein the carrier forms a radiation exit area (20E, 20F, top or bottom areas carrying light as indicated with arrows),

wherein the radiation exit area is structured (microlens 20E or 20F at the bottom or top exit area as shown in Fig. 2A-2D where the microlens is for forming the light emission direction, see paragraphs [0046] -[0048]), so that the electromagnetic radiation has a directional emission profile (denoted by an arrow),

wherein the encapsulation (protection from environment influences, e.g. water and moisture when the OLED is encapsulated by a cap made of glass or ceramic is inherent, see paragraph [0018]) forms a seal of the organic layer sequence against environmental influences,

where the carrier comprises a multiplicity of parallel arc shaped structure having first areas and second areas (microlens 20F having half side of arc and other half side of the arc),

wherein functional layers (10A , 10B) of the organic layer sequence (10A, 10B, 15) are applied to the first area and/or second areas at the top of the carrier (10A and 10B on the top of the arc shaped microlens 20F, see Fig. 2D)

wherein the functional layers (electrodes 10A, 10B), which are arranged on different areas, are driven separately from one another (the organic light emitting diode electrodes 10A, 10B being driven respectively is inherently required to activate the light emitting),

but does not teach the carrier comprising a multiplicity of parallel prisms having first areas and second areas which are arranged in a tilted manner with respect to one another.

However, Chen teaches the carrier comprising a multiplicity of parallel prisms having first areas and second areas (see Fig. 3c-1, trapezoidal prism having first areas being one sides of 310 in Fig. 3c-1

and second areas being other sides of 310 in Fig. 3c-1) which are arranged in a tilted manner with respect to one another (angle of the one side of 310 to other side of 310) providing different angles.

Therefore it would have been obvious to one ordinary skill in the art at the time of invention was made to replace the parallel array of microlenses of Garditz with the trapezoidal or rectangular prism of Chen in order to provide various output radiation for the purpose of controlling scattering phenomenon.

Regarding claim 3, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the prisms comprises a height and width which are arranged parallel to the main plane of the organic layer sequence, the width is bigger than the wavelength of the electromagnetic radiation which is induced by the organic light-emitting diode (a preferred width being 50000 A = 5000 nm, see col. 3, lines 22-26, is bigger than a typical UV wavelength of 400 nm and IR wavelength of 800nm),

but does not teach the length of the prism being at least 1 cm.

However, it would have been obvious to one having ordinary skill in the art at the time the invention was made to specify the length of the OLED being at least 1 cm, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art.

Regarding claim 4, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the emission profile is a symmetrical cardioid in one direction or asymmetrical in at least one of the directions (see the direction of light emission being one direction noted with arrow).

Regarding claim 8, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the first areas (areas for microarray 20F of a lot of microlenses 20F are nonplanar shown in Fig. 2D) and/or the second areas are nonplanar.

Regarding claim 9, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the first areas (areas of microarray 20F of a lot of microlens are an arc which is in the

form of the manner of cylinder sections) and/or a second areas are formed in the manner of cylinder sections.

Regarding claim 10, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the directional emission profile has a maximum in the direction perpendicular to the first areas (the lens 20E provides a focus the intensity of the emitted radiation in the emission direction in the optical path 100, see paragraph [0046]).

Regarding claim 12, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the structured radiation exit area is embodied as a separate structured foil (a layer of 20F being separate from the substrate 5 shown in Figs. 2B and 2D), which is arranged on a carrier (a layer of 20F is formed from the radiation out-coupling material, see paragraph [0047]).

Regarding claim 13, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the organic light-emitting diode comprises a carrier which is structured (the radiation out-coupling material for 20F), wherein the radiation exit area (20F is formed using the radiation out-coupling material) is arranged on the carrier, and wherein the structuring of the radiation exit area is induced by the structuring of the carrier (the shaped structure of 20F is made with the radiation out-coupling material, see paragraph [0047]).

Regarding claim 17, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the organic light-emitting diode is an organic light-emitting diode emitting on both sides (top-emitting and bottom-emitting as denoted by arrows 100 and 110 where 100 and 110 are opposite to each other as shown in Fig.1C), which comprises two radiation exit areas, wherein the two radiation exit areas are arranged on opposite sides of the organic light-emitting diode, and wherein the radiation exit areas are structured (see paragraph [0045]).

Regarding claim 18, Garditz in view of Chen teaches a luminaire having at least one light-emitting diode according to claim 1 as a light source, wherein the luminaire is one of the following

devices or is at least part of one of the following devices (a luminaire using the OLED of Garditz for a particular apparatus such as in alarm clock,... warning light is an intended use. It has been held that a recitation directed to the manner in which a claimed apparatus is intended to be employed does not differentiate the claimed apparatus from a prior art apparatus satisfying the claimed structural limitations. Ex parte Masham, 2 USPQ2d 1647 (1987)) : alarm clock, shower cubicle, shower head, solar protection, rain protection, lamp, bag, signaling light, changing cubicle, vision protection, housing, emergency lighting, mirror, tile, ceiling light, radiator cladding, louver, noise protection, umbrella, warning light.

Claim 7 is rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Garditz in view of Chen (US Pat No. 7,205,714) and Ishikawa (US Pat No. 7,560,727).

Regarding claim 7, Garditz in view of Chen teaches the organic light-emitting diode according to claim 1, wherein the structured radiation exit area (based on the examiner applied the broadest reasonable interpretation, the structured radiation exit area being a part of the carrier recited in claim 1) comprises a multiplicity of prisms (310s being trapezoidal prisms of Chen) wherein the prisms comprise a length and width (trapezoidal prisms have length and width being parallel to the plane of 320, 330 and 340) which arranged parallel to the main plane of the organic layer sequence,

but does not teach the prisms forms in side view an isosceles triangle, wherein the directional emission profile is symmetrical and has two main radiation directions, wherein the two main radiation directions are inclined from the z-axis by the angle $\alpha=\beta$ in positive and negative x- directions, and wherein the main plane forms an x-y-plane.

However, Ishikawa teaches a prism structure (see Fig. 1) where the prisms forms in side view an isosceles triangle (see Fig. 1), wherein the directional emission profile is symmetrical (prism structure having two side symmetrical radiating light) and has two main radiation directions, wherein the two main radiation directions are inclined from the z- axis (plane of ANODE) by the angle $\alpha=\beta$ (PRISM having

the same angles) in positive and negative x-directions, and wherein the main plane forms an x-y-plane for the purpose of converging light alleviating the decrease in light output efficiency due to total reflection (see col. 1, lines 55-59).

Therefore it would have been obvious to one ordinary skill in the art at the time of invention was made to replace the microarray of lenses of Garditz as modified by Chen with a prism structure where the prisms forms in side view an isosceles triangle of Ishikawa in order to converge light in alleviating the decrease in light output efficiency due to total reflection.

Response to Arguments

Applicant's arguments with respect to claims 1 have been considered but are moot because the arguments do not apply to any of the references being used in the current rejection. The applicant stated that the amended claim 1 includes the subject matter of allowable dependent claim 14. However the examiner notes that claim 1 does not include all the limitations of the base claim. Instead applicant deleted the limitations of "the structured radiation area comprising a multiplicity of first areas and second areas... wherein the angles α and β are different from each other", which made claims broader.

Allowable Subject Matter

Claim 19 is allowable over the prior art of record.

Claim 11 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The examiner's statement of reasons for allowance was indicated on the Office action mailed 2/9/2019 and 8/31/2018.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to James H Cho whose telephone number is (571)272-1802. The examiner can normally be reached on M-F 8-5.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Douglas W Owens can be reached on 571-272-1662. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-

direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JAMES H CHO/
Examiner, Art Unit 2844

/MINH D A/
Primary Examiner, Art Unit 2844

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/651,508	KASTNER-JUNG et al.
	Examiner	Art Unit
	James H Cho	2844

CPC - Searched*		
Symbol	Date	Examiner
B60Q3/30,745 B05B1/18,268 B60Q7/00 F21S10/02 F21V23/0442,0016,004,0052,006 F21Y2113/20,10 F21Y2115/15 F21Y2105/00 (text search, see the search history printout)	2/1/2018	JC
F21S8/033,04,061 F21S9/03 G04C19/02 G04G11/00 G04G13/023 H05B33/0896,22 H05B37/00,0281 H01L2251/5361 Y02B20/36,42 (text search, see the search history printout)	2/1/201	JC

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
BRS text search, see the search history printout	2/1/2018	JC
updated search	03/15/2019	JC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

SDC EX. 1016 - 548/959

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/651,508	KASTNER-JUNG et al.
	Examiner	**Art Unit**
	James H Cho	2844

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/01/2018	08/03/2018	03/15/2019						
	1	✓	✓	✓						
	2	✓	✓	-						
	3	✓	✓	✓						
	4	✓	✓	✓						
	5	O	O	✓						
	6	O	-	-						
	7	✓	✓	✓						
	8	✓	✓	✓						
	9	✓	✓	✓						
	10	✓	✓	✓						
	11	O	✓	O						
	12	✓	✓	✓						
	13	✓	✓	✓						
	14	✓	O	-						
	15	✓	O	-						
	16	✓	✓	-						
	17	✓	✓	✓						
	18	✓	✓	✓						
	19		=	=						

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S166	32	(US-20100157585-$ or US-20160238234-$ or US-20100076527-$ or US-20080138624-$ or US-20020003403-$ or US-20110133628-$ or US-20090173957-$ or US-20090091258-$ or US-20080188156-$ or US-20080138539-$ or US-20070114520-$ or US-20060128042-$ or US-20090039272-$ or US-20010043046-$ or US-20050156520-$ or US-20050242709-$ or US-20040080938-$ or US-20090167981-$ or US-20070230211-$ or US-20070176195-$ or US-20070153543-$).did. or (US-6926572-$ or US-6884465-$ or US-7922358-$ or US-7733008-$ or US-6331063-$ or US-6575584-$ or US-8987711-$ or US-7560727-$ or US-7358663-$ or US-7205714-$ or US-8123391-$).did.	US-PGPUB; USPAT	OR	ON	2019/03/15 12:38
S168	40	kastner-jung-ulrich$.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/03/15 13:59
S169	963	klein-markus$.in. maes-stan$.in. sigl-romana$.in. lintner-stephan$.in. herget-julian$.in. matjan-gregor$.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/03/15 14:01
S170	167	S169 and (organic$2diode organic near4 (diode LED.u/c. layer))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/03/15 14:02
S172	124	S170 and radiat$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/03/15 14:03
S173	28	("20010052752" | "20020125822" | "20020167270" | "20030064540" | "20030071804" | "20030121767" | "20030175553" | "20030222577" | "20030231495" | "20040113542" |	US-PGPUB; USPAT; USOCR	OR	ON	2019/03/15 14:16

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		"20050099824" | "20060049381" | "20070278937" | "20080219013" | "20080248191" | "20090039272" | "20100157585" | "20120258294" | "5734225" | "6236622" | "7280439" | "7317120" | "7317210" | "7733008" | "7922358").PN. OR ("9797567").URPN.				
S175	47	S173 S174	US-PGPUB; USPAT; USOCR	OR	ON	2019/03/15 14:17
S174	19	("20020080598" | "20030147119" | "20040036990" | "20040141302" | "20040188690" | "20040237065" | "20050122035" | "20060056166" | "20060132919" | "20060290651" | "20070063140" | "20070153543" | "20070176195" | "20070217702" | "20070230211" | "20090015142" | "20090261371" | "6091547" | "6906452").PN. OR ("8653548").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/03/15 14:17
S176	20	("20010040717" | "20050036327" | "20050079324" | "20060232992" | "20070085476" | "20070145889" | "20070230211" | "6006404" | "6511198" | "6650045" | "6965197" | "7358663").PN. OR ("7922358").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/03/15 14:58
S177	38	("20030230980" | "20040174116" | "20070230211" | "20100201256" | "20100258821" | "20120138980" | "20120292652" | "20130244079" | "20140001448" | "20140021450" | "4769292" | "5247190" | "5284792" | "5609284" | "5703436" | "5707745" | "5834893" | "5844363" | "6013982" | "6087196" | "6091195" | "6097147" | "6294398" | "6303238" | "6337102" | "6468819" | "6984934" | "7279704" | "7368756" | "7431968" | "7560727" | "7922358" | "7968146" | "8125138" | "8563343" | "8584490" | "8716749" | "8987711").PN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/03/15 15:36
S178	1	("20050231101").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/03/15 18:43
S179	1	("7205714").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/03/15 18:49
S180	1	("20070114520").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/03/15 18:51
S181	1	("20070114520").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/03/15 19:30

3/15/2019 8:53:30 PM
C:\Users\jcho\Documents\EAST\Workspaces\15651508.wsp

Attorney Docket # 5367-694P/CON/409926 Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	
Kastner-Jung, Ulrich et al.	
Serial No.:	15/651,508
Filed:	July 17, 2017
For:	Organic-Light-Emitting Diode

Examiner: CHO, JAMES H.

Group Art: 2844

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

S I R:

In compliance with the duty of disclosure under 37 C.F.R. §1.56 and in accordance with the practice under 37 C.F.R. §§1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a.

Enclosed is a copy of an Office Action (and an English translation) dated November 29, 2018 which issued in the corresponding Korean Patent Application No. 10-2017-7026128.

This information is being submitted subsequent to the later of three months after the filing date of the present application or the mailing of the first Office Action on the merits, but before the mailing of a final Action or the Notice of Allowance.

STATEMENT

Each item of information contained in the Information Disclosure Statement was first cited in any communication received from a foreign Patent Office in a counterpart foreign application not more than three months prior to the filing of the Information Disclosure Statement.

In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /JC/

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listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicant(s) reserve(s) the right to prove that the date of publication is in fact different.

It is believed that no additional fees or charges are required at this time in connection with the present application. However, if any fees or charges are required at this time, they may be charged to our Patent and Trademark Office Deposit Account No. 503111.

It is respectfully requested that the above information be considered by the Examiner and that a copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

Respectfully submitted,
COZEN O'CONNOR

By: /Ian R. Blum/
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Dated: January 4, 2019

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /JC/

SDC EX. 1016 - 553/959

Attorney Docket # 5367-694P/CON/409926

PTO/SB/08A (04-03)
Approved for use through 04/30/2003. OMB 0651-0031
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Substitute for Form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	15/651,508
Filing Date	July 17, 2017
First Named Inventor	Kastner-Jung, Ulrich
Art Unit	2844
Examiner Name	CHO, JAMES H.
Attorney Docket	5367-694P/CON/409926

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind-Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-2005/0231101	10-20-2005	Chen	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] Number[4] Kind-Code[5] (if known	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
		Office Action dated November 29, 2018 which issued in the corresponding Korean Patent Application No. 10-2017-7026128.	✓

Examiner Signature	/JAMES H CHO/	Date Considered	01/05/2019

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, Washington, DC 20231.** *If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2..*

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /JC/

Electronic Acknowledgement Receipt

EFS ID:	35668049
Application Number:	15651508
International Application Number:	
Confirmation Number:	2349
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Customer Number:	27799
Filer:	Thomas Langer/Jennifer Colwell
Filer Authorized By:	Thomas Langer
Attorney Docket Number:	5367-694P/CON\409926
Receipt Date:	09-APR-2019
Filing Date:	17-JUL-2017
Time Stamp:	11:49:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Response After Final Action	5367-694PCON_Amendment.pdf	574847 68ea5464b945e83530767e2d73fd2d5ef86e4648	no	13

Warnings:

Information:	
Total Files Size (in bytes):	574847

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of Kastner-Jung, Ulrich et al. Serial No.: 15/651,508 Filed: July 17, 2017 For: Organic-Light-Emitting Diode	Examiner: CHO, James H. Group Art Unit: 2844 Conf. No.: 2349

Mail Stop **AF**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT AFTER FINAL OFFICE ACTION

SIR:

RESPONSE

In response to the final Office Action dated March 21, 2019, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper;

Remarks/Arguments begin on page 6 of this paper.

Listing of Claims:

1. (Previously Presented) An organic light-emitting diode comprising an organic layer sequence, a carrier and an encapsulation,

wherein the organic layer sequence comprises at least one radiation-emitting region which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation,

wherein the carrier forms a radiation exit area,

wherein the radiation exit area is structured, so that the electromagnetic radiation has a directional emission profile,

wherein the encapsulation forms a seal of the organic layer sequence against environmental influences,

wherein the carrier comprises a multiplicity of parallel prisms having first areas and second areas which are arranged in a tilted manner with respect to one another,

wherein functional layers of the organic layer sequence are applied to the first and/or the second areas at the top side of the carrier, and

wherein the functional layers, which are arranged on different areas, are driven separately from one another.

2. (Cancelled).

3. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the prisms comprises a length and width which are arranged parallel to the main plane of the organic layer sequence,

wherein the length is at least 1 cm, and

wherein the width is bigger than the wavelength of the electromagnetic radiation which is induced by the organic light-emitting diode.

4. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the emission profile is a symmetrical cardioid in one direction or asymmetrical in at

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least one of the directions.

5. (Currently amended) The organic light-emitting diode according to claim 1,

wherein the first areas are transparent, and the second areas are reflective, so that the directional emission profile has a tilt angle which depends on [[the]] an angle α.

6. (Cancelled).

7. (Currently Amended) The organic light-emitting diode according to claim 1,

wherein the structured radiation exit area comprises a multiplicity of the parallel prisms,

wherein the parallel prisms comprise a length and width which are arranged parallel to the main plane of the organic layer sequence,

wherein the parallel prisms form in side view an isosceles triangle,

wherein the directional emission profile is symmetrical and has two main radiation directions, wherein the two main radiation directions are inclined from the z-axis by [[the]] an angle $\alpha = \beta$ in positive and negative x-directions, and

wherein the main plane forms an x-y-plane.

8. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the first areas and/or the second areas are nonplanar.

9. (Previously Presented) The organic light-emitting diode according to claim 1,

wherein the first areas and/or the second areas are formed in the manner of cylinder sections.

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10. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the directional emission profile has a maximum in the direction perpendicular to the first areas.

11. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the second areas are reflective, which is induced by metallization with metal particles.

12. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the structured radiation exit area is embodied as a separate structured foil, which is arranged on a carrier.

13. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the organic light-emitting diode comprises a carrier which is structured,
wherein the radiation exit area is arranged on the carrier, and
wherein the structuring of the radiation exit area is induced by the structuring of the carrier.

14. (Cancelled).

15. (Cancelled).

16. (Cancelled).

17. (Previously Presented) The organic light-emitting diode according to claim 1, wherein the organic light-emitting diode is an organic light-emitting diode emitting on both sides, which comprises two radiation exit areas,
wherein the two radiation exit areas are arranged on opposite sides of the organic light-emitting diode, and
wherein the radiation exit areas are structured.

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18. (Previously Presented) A luminaire having at least one light-emitting diode according to claim 1 as a light source,

wherein the luminaire is one of the following devices or is at least part of one of the following devices: alarm clock, shower cubicle, shower head, solar protection, rain protection, lamp, bag, signaling light, changing cubicle, vision protection, housing, emergency lighting, mirror, tile, ceiling light, radiator cladding, louver, noise protection, umbrella, warning light.

19. (Previously Presented) An organic light-emitting diode comprising an organic layer sequence, a radiation exit area and an encapsulation,

wherein the organic layer sequence comprises at least one radiation-emitting region which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation,

wherein the radiation exit area is structured, so that the electromagnetic radiation has a directional emission profile,

wherein the encapsulation forms a seal of the organic layer sequence against environmental influences,

wherein the structured radiation exit area comprises a multiplicity of first areas and second areas, wherein the first areas are tilted at an angle α to a plane which is arranged parallel to the main plane of the organic layer sequence,

wherein the second areas are tilted at an angle β to said plane, and

wherein the first areas are transparent and the second areas are reflective, so that the directional emission profile has a tilt angle which depends on the angle α.

REMARKS/ARGUMENTS

Status of claims

Claims 1, 3-5, 7-13, and 17-19 have been examined. Claims 1 and 19 are the only independent claims.

Claim 19 has been allowed. Claim 11 has been indicated by the Examiner as being allowable if suitably rewritten in independent form.

Claims 5 and 7 are being modified for better format. The amendments do not introduce new matter or require new consideration or search. Entry of the amendments is respectfully requested.

Summary of Office Action

The drawings are objected to under 37 C.F.R. § 1.83(a). Specifically, the Examiner states that "the structured radiation exit area comprises a multiplicity of prisms" recited in dependent claim 7 is not shown in the drawings.

Claims 5 and 7 have been rejected under 35 U.S.C. § 112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph, as being indefinite.

Claims 1, 3, 4, 8-10, 12, 13 and 16-18 have been rejected under pre-AIA 35 USC 103(a) as being unpatentable over Garditz (US 2007/0114520 A1) in view of Chen (U.S. Patent No. 7,205,714).

Claim 7 has been rejected under pre-AIA 35 U.S.C. § 103(a) as being unpatentable over Garditz in view of Chen and Ishikawa (U.S. Patent No. 7,560,727).

Reconsideration and withdrawal of these rejections are respectfully requested in view of the claim modifications made herein and in light of the following remarks.

Remarks

Objection to the drawings

The Examiner refers to claim 7 and states the feature "the structured radiation exit area comprises a multiplicity of prisms" is not shown in the drawings. As shown above, claim 7 has been amended to replace "a multiplicity of prisms" with "a multiplicity of the *parallel* prisms," which is shown in Figure 24 of the present application. Therefore, the objection to the drawings is moot.

Rejection under 35 U.S.C. § 112

Claims 5 and 7 have been rejected under 35 U.S.C. §112(b) or 35 U.S.C. § 112 (pre-AIA), second paragraph, as being indefinite. This rejection is moot in view of the above-presented amendments.

Specifically, regarding claim 5, the Examiner states that that there is insufficient antecedent basis for the limitation "the angle." In response, "'the angle " in claim 5 is now replaced with "an angle."

Regarding claim 7, the Examiner states that there is insufficient antecedent basis for the limitation "the angle" in claim 7. In response, "the angle" in claim 7 has now been replaced with "an angle."

The Examiner also refers to the recitation in claim 7 "the structured radiation exit area comprises a multiplicity of prisms," and the recitation in claim 1 "the carrier comprises a multiplicity of parallel prisms." The Examiner states that it is unclear whether the structured radiation exit area in claim 7 includes additional multiplicity of prisms in addition to the

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multiplicity of parallel prisms recited in claim 1. In response, the expression "prisms" in claim 7 has been replaced with "the parallel prisms." Accordingly, it is clear now that the parallel prisms recited in claim 7 refer to the parallel prisms recited in claim 1.

Based on the foregoing, withdrawal of the rejection of claims under 35 U.S.C. §112 is respectfully requested.

Rejection under 35 U.S.C. § 103

Claims 1, 3, 4, 8-10, 12, 13 and 16-18 have been rejected under pre-AIA 35 U.S.C. §103(a) as being unpatentable over Garditz (US 2007/0114520 A1) in view of Chen (U.S. Patent No. 7,205,714).

Claim 7 has been rejected under pre-AIA 35 U.S.C. § 103(a) as being unpatentable over Garditz in view of Chen and Ishikawa (U.S. Patent No. 7,560,727).

Reconsideration and withdrawal of this rejection are respectfully requested.

Independent claim 1 of the present application recites:

> 1. An organic light-emitting diode comprising an organic layer sequence, a carrier and an encapsulation,
>
> wherein the organic layer sequence comprises at least one radiation-emitting region which generates electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation,
>
> wherein the carrier forms a radiation exit area,
>
> wherein the radiation exit area is structured, so that the electromagnetic radiation has a directional emission profile,
>
> wherein the encapsulation forms a seal of the organic layer sequence against environmental influences,

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> wherein the carrier comprises a multiplicity of parallel prisms having first areas and second areas which are arranged in a tilted manner with respect to one another,
>
> wherein functional layers of the organic layer sequence are applied to the first and/or the second areas at the top side of the carrier, and
>
> wherein the functional layers, which are arranged on different areas, are driven separately from one another.

(Emphasis added.)

As shown above, claim 1 describes that the functional layers are arranged at the **top side** of the carrier, which comprises a multiplicity of parallel prisms having the first areas and the second areas. Thus, the functional layers face the first areas and the second areas. S*ee*, for example, Figs. 23 and 24 of the present application.

FIG 23

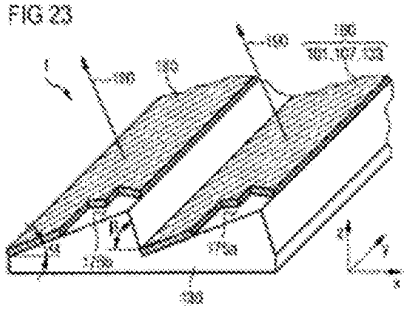
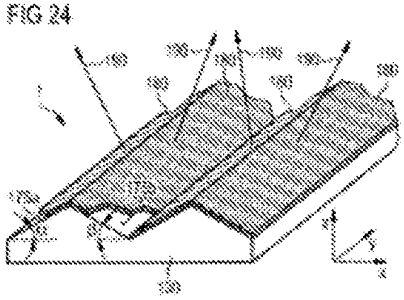


FIG 24



Turning now to the primary reference Garditz, as shown in Figures 1 C and 2D, it describes an organic radiation-emitting component. The radiation-emitting device comprises an organic functional layer (15) between two electrodes (10A) and (10B), which is applied to a substrate (5). Furthermore, a microarray (20F) can be arranged on the substrate (5). The functional layer (15) may be encapsulated by a transparent encapsulation (30). The functional

layer comprises at least one or more organic functional layers sandwiched between the two electrodes (10A) and (10B) (*see* paragraph [0018]).

FIG 1C

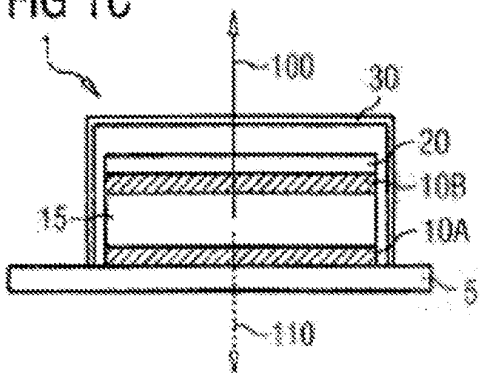
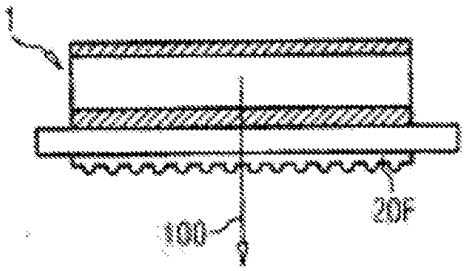


FIG 2D



The Examiner contends that electrodes (10A) and (10B) of Garditz can be identified as the functional layers of the present application. *See* page 4, last paragraph of the Office Action. The Examiner also argues that one half of microarray (20F) of Garditz can be identified as a first area according to claim 1 of the present application, and the other half of microarray (20F) can be identified as a second area according to claim 1 of the present application. According to the Examiner, the electrodes (10A) and (10B) are applied on top of the microarray(20F). Finally, the Examiner argues that the identified functional layers can be driven independently from one another. *See* page 5 of the Office Action.

The Examiner concedes that Garditz does not teach the carrier comprising a multiplicity of parallel prisms having first areas and second areas which are arranged in a tilted manner with respect to one another, as recited in claim 1 of the present application.

Therefore, the Examiner further cites Chen. In connection with the exemplary embodiment of Figure 3c-1, the secondary reference Chen describes an organic light-emitting diode having a substrate (300) comprising a plurality of protrusions (310). The Examiner argues that the protrusions may be a trapezoid having first areas being one sides of 310 in Fig. 3c-1, and

second areas being other sides of 310 in Fig. 3c-1) which are arranged in a tilted manner with respect to one another. *See* the paragraph bridging pages 5 and 6 of the Office Action.

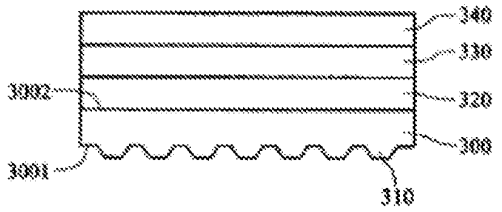


FIG. 3c-1

Therefore, the Examiner argues that "[I]t would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the parallel array of microlenses of Garditz with the trapezoidal or rectangular prism of Chen in order to provide various output radiation for the purpose of controlling scattering phenomenon." Applicants respectfully disagree with the Examiner's argument.

As discussed above, Garditz only discloses that the electrodes (10A) and (10B) are applied to the substrate on a side **facing away** from the microarrays. The cited art does not teach, disclose, or suggest forming the functional layers **on a top side** of the carrier. Moreover, the electrodes according to Garditz are solely applied above every area. In other words, as is evident from a plan view, the electrodes overlap completely with every area in lateral directions. Therefore, these electrodes can only be turned on or off for all areas. Contrary to the Examiner's argument, Garditz fails to teach, disclose, or suggest "the functional layers, which are arranged on different areas, are driven separately from one another" as recited in claim 1 of the present application.

The Examiner argues that the electrodes are driven separately from one another, because it "is inherently required to activate the light emitting." *See* page 5 of the Office Action. However, in order to activate light emission, both electrodes must be energized. Thus, there is a significant dependency between the two electrodes. Both electrodes must be energized such that a voltage drops above the organic functional layer, in order to emit light. **Therefore, Garditz does not teach separately drivable functional layers. In other words, it makes no sense to drive the two electrodes of Garditz separately from one another as this would not result in a functional device which emits light**. Accordingly, a separate drivability for different areas is not disclosed in Garditz as argued by the Examiner.

The secondary reference Chen is merely cited in connection with "carrier comprising a multiplicity of parallel prisms having first areas and second areas which are arranged in a tilted manner with respect to one another." It cannot remedy Garditz's deficiencies as discussed above in connection with claim 1. Modifying Garditz's product based on Chen as proposed by the Examiner would not arrive at the invention as described in claim 1 of the present application.

Based on the foregoing, claim 1 is patentable under pre-AIA 35 U.S.C. § 103(a) over Garditz in view of Chen. For at least the same reasons, dependent claims 3, 4, 8-10, 12, 13 and 16-18 are also patentable under pre-AIA 35 U.S.C. § 103(a) over Garditz in view of Chen. Withdrawal of the rejection of claims 1, 3, 4, 8-10, 12, 13 and 16-18 under pre-AIA 35 U.S.C. § 103(a) over Garditz in view of Chen is respectfully requested.

Dependent claim 7 has been rejected under pre-AIA 35 U.S.C. § 103(a) as being unpatentable over Garditz in view of Chen and Ishikawa (U.S. Patent No. 7,560,727). Ishikawa is merely cited in connection with the additional limitations recited in dependent claim 7 and

cannot remedy Garditz and Chen's deficiencies discussed above in connection with claim 1, from which claim 7 depends. For at least this reason, claim 7 is patentable under pre-AIA 35 U.S.C. § 103(a) over Garditz in view of Chen and Ishikawa. Withdrawal of the rejection of claim 7 under pre-AIA 35 U.S.C. § 103(a) over Garditz in view of Chen and Ishikawa is respectfully requested.

Conclusion

Based on all of the above, the present application is now in proper condition for allowance. Prompt and favorable action to this effect and early passing of this application to issue are respectfully solicited.

It is believed that no additional fees or charges are required at this time in connection with the present application. However, if any additional fees or charges are required at this time, they may be charged to our U.S. Patent and Trademark Office Deposit Account No. 50-3111.

Respectfully submitted,
COZEN O'CONNOR

By /Thomas Langer/
Thomas Langer
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Dated: April 9, 2019

SDC EX. 1016 - 569/959

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/651,508	Filing Date 07/17/2017	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $80 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $420 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

AMENDMENT	04/09/2019	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 14	Minus	** 20	= 0		x $100 =	0
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0		x $460 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	SLIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/ROSALIND A BALL/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	Examiner: CHO, JAMES H.
Kastner-Jung, Ulrich et al.	Group Art: 2844
Serial No.: 15/651,508	
Filed: July 17, 2017	
For: Organic-Light-Emitting Diode	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

S I R:

In compliance with the duty of disclosure under 37 C.F.R. §1.56 and in accordance with the practice under 37 C.F.R. §§1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a. Copies of the listed non-US documents are also enclosed.

Enclosed is a copy of an Office Action (and an English translation) dated March 29, 2019 issued in Korean Patent Application 10-2017-7026128. The reference from the Korean Office Action that is not listed on the attached Form PTO/SB/08a was submitted to the USPTO in a previously filed IDS.

This information is being submitted after issuance of a Final Office.

STATEMENT

Each item of information contained in the Information Disclosure Statement was first cited in any communication received from a foreign Patent Office in a counterpart foreign application not more than three months prior to the filing of the Information Disclosure Statement.

In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document

SDC EX. 1016 - 571/959

listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicant(s) reserve(s) the right to prove that the date of publication is in fact different.

Submitted herewith is the required fee of $240 under 37 C.F.R. § 1.17(p). It is believed that no additional fees or charges are required at this time in connection with the present application. However, if any fees or charges are required at this time, they may be charged to our Patent and Trademark Office Deposit Account No. 503111.

It is respectfully requested that the above information be considered by the Examiner and that a copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

Respectfully submitted,
COZEN O'CONNOR

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Dated: April 12, 2019

SDC EX. 1016 - 572/959

Attorney Docket # 5367-694P/CON/409926

PTO/SB/08A (04-03)
Approved for use through 04/30/2003. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Substitute for Form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	15/651,508
Filing Date	July 17, 2017
First Named Inventor	Kastner-Jung, Ulrich
Art Unit	2844
Examiner Name	CHO, JAMES H.
Attorney Docket	5367-694P/CON/409926

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind-Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]- Number[4]- Kind-Code [5] (if known	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		KR 2008-0042275	05-15-2008	Oh et al.		✓

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
		Office Action dated March 29, 2019 issued in Korean Patent Application 10-2017-7026128.	✓

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, Washington, DC 20231.** *If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2..*

SDC EX. 1016 - 573/959

Electronic Patent Application Fee Transmittal

Application Number:	15651508
Filing Date:	17-Jul-2017
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Filer:	Edward M. Weisz/Sheri Michals
Attorney Docket Number:	5367-694P/CON\409926

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
		Total in USD ($)		**240**

Electronic Acknowledgement Receipt

EFS ID:	35714015
Application Number:	15651508
International Application Number:	
Confirmation Number:	2349
Title of Invention:	Organic-Light-Emitting Diode
First Named Inventor/Applicant Name:	Ulrich KASTNER-JUNG
Customer Number:	27799
Filer:	Edward M. Weisz/Sheri Michals
Filer Authorized By:	Edward M. Weisz
Attorney Docket Number:	5367-694P/CON\409926
Receipt Date:	12-APR-2019
Filing Date:	17-JUL-2017
Time Stamp:	15:28:15
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$240
RAM confirmation Number	041519INTEFSW15285300
Deposit Account	503111
Authorized User	Sheri Michals
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	5367-694PCON-IDS.pdf	80746 333cbcacd534745c017210b6c991ce34c5a0a8d1	no	3
Warnings:					
Information:					
This is not an USPTO supplied IDS fillable form					
2	Non Patent Literature	KROA-Original.pdf	1671607 080bde1edbcaadd513edbcf593fdb33e5c1569d4	no	5
Warnings:					
Information:					
3	Non Patent Literature	KROA-Translation.pdf	173064 5ec4603eeba8cb54729b484073b32e85597a499e	no	6
Warnings:					
Information:					
4	Foreign Reference	KR20080042275A-original.pdf	387928 9dd1d334c225fa6391d2836e587782562df8b0c4	no	9
Warnings:					
Information:					
5	Foreign Reference	KR20080042275-Translation.pdf	188279 be172aa73678c22bee07c1698f95a66da5e627d6	no	8
Warnings:					
Information:					
6	Fee Worksheet (SB06)	fee-info.pdf	30825 3f66f44ef7bd22cd14755f1d6f68fb9329fb88aa	no	2
Warnings:					

Information:	
Total Files Size (in bytes):	2532449

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

(19) 대한민국특허청(KR)
(12) 공개특허공보(A)

(11) 공개번호 10-2008-0042275
(43) 공개일자 2008년05월15일

(51) Int. Cl.
H05B 33/02 (2006.01)
(21) 출원번호 10-2006-0110471
(22) 출원일자 2006년11월09일
심사청구일자 2006년11월09일

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경기도 군포시 오금동 율곡아파트 336동 303호
(74) 대리인
특허법인무한

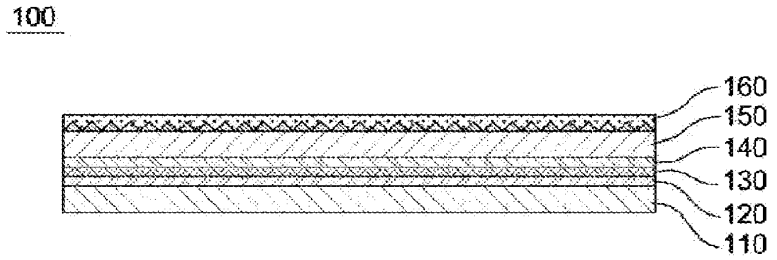
전체 청구항 수 : 총 13 항

(54) 요철 층을 포함하는 유기 발광 소자 및 이를 구비한조명장치

(57) 요 약

본 발명에 따른 유기 발광 소자는 제 1 기판, 상기 제 1 기판 상에 형성된 제 1 전극 패턴 층, 상기 제 1 전극 패턴 층 상에 형성되고, 외부로부터 전압이 인가되면 광을 발생하는 유기 발광 패턴 층, 상기 유기 발광 패턴 층 상에 형성된 제 2 전극 패턴 층, 및 상기 제 2 전극 패턴 층 상에 형성된 제 2 기판을 포함한다. 상기 제 1 기판 및 상기 제 2 기판 중 적어도 일 기판 상에는 요철 층이 형성되어 있다. 상기 유기 발광 소자는 액정표시장치의 백 라이트, 조명 기기, 유기 발광 표시 장치 등에 채용되어 상기 백 라이트, 조명 기기, 유기 발광 표시 장치 등의 수명 및 표시 품질을 향상시킬 수 있다.

대표도 - 도1



SDC EX. 1016 - 579/959

특허청구의 범위

청구항 1

제 1 기판;

상기 제 1 기판 상에 형성된 제 1 전극 패턴 층;

상기 제 1 전극 패턴 층 상에 형성되고, 외부로부터 전압이 인가되면 광을 발생하는 유기 발광 패턴 층;

상기 유기 발광 패턴 층 상에 형성된 제 2 전극 패턴 층; 및

상기 제 2 전극 패턴 층 상에 형성된 제 2 기판을 포함하고,

상기 제 1 기판 및 상기 제 2 기판 중 적어도 일 기판 상에는 요철 층이 형성되어 있는 것을 특징으로 하는 유기 발광 소자.

청구항 2

제 1 항에 있어서,

상기 요철 층은 요철부 및 상기 요철부를 덮어 상기 요철 층을 평탄하게 하는 평탄부를 포함하는 것을 특징으로 하는 유기 발광 소자.

청구항 3

제 2 항에 있어서,

상기 요철부는 상기 기판 표면을 가공하여 형성되고, 상기 기판 표면으로부터 돌출된 복수의 돌출부로 이루어진 것을 특징으로 하는 유기 발광 소자.

청구항 4

제 2 항에 있어서,

상기 요철부는 표면에 요철이 형성된 제 1 투명 고분자 필름으로 이루어진 것을 특징으로 하는 유기 발광 소자.

청구항 5

제 2 항에 있어서,

상기 평탄부는 상기 요철부를 덮도록 형성된 제 2 투명 고분자 필름인 것을 특징으로 하는 유기 발광 소자.

청구항 6

제 2 항에 있어서,

상기 요철부 및 평탄부는 서로 다른 재질로 이루어진 것을 특징으로 하는 유기 발광 소자.

청구항 7

제 1 항에 있어서,

상기 제 1 전극 패턴 및 제 2 전극 패턴은 투명 전극 패턴이고, 상기 제 1 기판 및 제 2 기판 상에는 각각 제 1 요철 층 및 제 2 요철 층이 형성되어 있는 것을 특징으로 하는 유기 발광 소자.

청구항 8

제 2 항에 있어서,

상기 요철부는 톱니 형상의 단면을 갖는 것을 특징으로 하는 유기 발광 소자.

청구항 9

제 1 항에 있어서,

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상기 유기 발광 패턴 층은 유기 물질이 결정화되어 형성된 적어도 하나의 유기 결정질 층을 포함하는 것을 특징으로 하는 유기 발광 소자.

청구항 10

제 9 항에 있어서,

상기 유기 결정질 층은 상기 제 1 전극 패턴 층과 접촉하는 층인 것을 특징으로 하는 유기 발광 소자.

청구항 11

제 1 항에 있어서, 상기 유기 발광 패턴 층은 상기 제 1 전극 패턴 층 상에 각각 순차적으로 적층되어 형성된 정공 수송 층, 유기 발광 층 및 전자 수송 층을 포함하는 것을 특징으로 하는 유기 발광 소자.

청구항 12

제 10 항에 있어서,

상기 정공 수송 층은 정공 수송용 유기 물질이 결정화 되어 형성된 결정질 층으로 이루어진 것을 특징으로 하는 유기 발광 소자.

청구항 13

제 1 기판;

상기 제 1 기판 상에 형성된 제 1 전극 패턴 층;

상기 제 1 전극 패턴 층 상에 형성되고, 외부로부터 전압이 인가되면 광을 발생하는 유기 발광 패턴 층;

상기 유기 발광 패턴 층 상에 형성된 제 2 전극 패턴 층; 및

상기 제 2 전극 패턴 층 상에 형성된 제 2 기판을 포함하고,

상기 제 1 기판 및 제 2 기판 중 적어도 일 기판 상에는 요철 층이 형성되어 있는 것을 특징으로 하는 적어도 하나의 유기 발광 소자를 구비하는 조명 장치.

명 세 서

발명의 상세한 설명

발명의 목적

발명이 속하는 기술 및 그 분야의 종래기술

<6> 본 발명은 유기 발광 소자에 관한 것으로서, 각종 기기들에 채용되어 상기 기기들의 수명 및 표시품질을 향상시킬 수 있는 유기 발광 소자 및 이를 구비한 조명장치에 관한 것이다.

<7> 일반적으로, 액정 표시 장치의 백 라이트 등의 광원으로서, 냉음극 형광 램프(cold cathode fluorescent lamp; CCFL), 발광 다이오드(light emitting diode; LED), 형광 면광원 램프, 유기 발광 다이오드(organic light-emitting diode; OLED) 등이 사용되고 있다. 차세대 주요 광원으로 기대되는 OLED 광원을 이용할 경우, 그 자체를 박막으로 제조 가능하여 광원의 두께를 획기적으로 줄일 수 있고, 온도 상승 경향이 적을 뿐 아니라 저전력 구동이 가능하다. 나아가 광원 장치의 대형화가 가능하다. 최근, 백색 OLED를 이용한 면발광의 수명, 휘도 향상 등을 위한 다양한 연구가 진행되고 있다.

<8> 특히, OLED를 기존 조명 장치를 대체할 수 있는 차세대 조명장치로서 사용하기 위한 연구가 활발히 진행되고 있다.

<9> 이처럼, 상기 OLED는 액정표시장치의 백 라이트, 각종 조명 기기, 표시 장치 등에 효과적으로 적용될 수 있다.

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그러나 현재 개발된 OLED는 아직 수명, 신뢰성, 휘도 면에서 만족할만한 성능을 나타내지 못하고 있다.

발명이 이루고자 하는 기술적 과제

<10> 본 발명은 상기한 바와 같은 종래 기술의 문제점을 감안한 것으로서, 신뢰성이 우수하고 표시 품질, 특히 고휘도 성능을 갖는 유기 발광 소자를 제공한다.

발명의 구성 및 작용

<11> 본 발명의 일 특징에 따른 유기 발광 소자는 제 1 기판, 상기 제 1 기판 상에 형성된 제 1 전극 패턴 층, 상기 제 1 전극 패턴 층 상에 형성되고, 외부로부터 전압이 인가되면 광을 발생하는 유기 발광 패턴 층, 상기 유기 발광 패턴 층 상에 형성된 제 2 전극 패턴 층, 및 상기 제 2 전극 패턴 층 상에 형성된 제 2 기판을 포함한다. 상기 제 1 기판 및 상기 제 2 기판 중 적어도 일 기판 상에는 요철 층이 형성되어 있어 상기 유기 발광 소자의 휘도 성능을 향상 시킬 수 있다.

<12> 상기 요철 층은 요철부 및 상기 요철부를 덮어 상기 요철 층을 평탄하게 하는 평탄부를 포함한다.

<13> 상기 요철부는 상기 기판을 가공하여 일부를 돌출시켜 형성될 수도 있고 기판 상에 다른 재질로 이루어진 부가층을 형성한 후 상기 부가 층에 식각 등의 가공 공정을 수행하여 형성될 수도 있다. 상기 평탄부는 상기 요철부를 덮어 상기 요철 층을 전체적으로 평탄하게 유지할 수 있도록 한다. 상기 평탄부로서는, 투명성 고분자 수지 등이 사용될 수 있다.

<14> 상기 요철의 형태는 특별히 제한되지 않으며, 예를 들어 톱니 형상의 단면을 갖는 요철일 수 있다.

<15> 한편, 상기 유기 발광 패턴 층은 유기 물질이 결정화되어 형성된 적어도 하나의 유기 결정질 층을 포함할 수 있다.

<16> 본 발명의 일 특징에 따른 면 조명 장치는 적어도 하나의 유기 발광 소자를 구비한다. 상기 유기 발광 소자는 제 1 기판, 상기 제 1 기판 상에 형성된 제 1 전극 패턴 층, 상기 제 1 전극 패턴 층 상에 형성되고, 외부로부터 전압이 인가되면 광을 발생하는 유기 발광 패턴 층, 상기 유기 발광 패턴 층 상에 형성된 제 2 전극 패턴 층, 및 상기 제 2 전극 패턴 층 상에 형성된 제 2 기판을 포함한다. 상기 제 1 기판 및 상기 제 2 기판 중 적어도 일 기판상에는 요철 층이 형성되어 있어 상기 유기 발광 소자의 휘도 성능을 향상시켜, 나아가면 조명 장치의 표시 품질을 개선할 수 있다.

<17> 이하, 첨부된 도면들을 참조하여 본 발명의 실시예들을 자세하게 설명하도록 한다.

<18> 도 1은 본 발명의 일 실시예에 따른 유기 발광 소자를 도시한 단면도이다.

<19> 도 1을 참조하면, 유기 발광 소자(100)는 제 1 기판(110), 제 1 전극 패턴 층(120), 유기 발광 패턴 층(130), 제 2 전극 패턴 층(140) 및 제 2 기판(150)을 포함한다. 또한, 상기 제 2 기판(150) 상에는 휘도 향상을 위한 요철 층이 형성되어 있다.

<20> 상기 제 1 기판(110)은 투명한 기판 또는 불투명한 기판일 수 있다. 상기 유기 발광 소자(100)를 양면 발광 장치 등에 사용하기 위해서는 상기 제1 기판(110) 및 제 2 기판(150)은 모두 투명한 기판이어야 한다. 한편, 상기 제 1 기판(110)은 유연성을 갖는 플랙서블(flexible)한 재질로 이루어질 수도 있다. 일 예로, 제 1 기판(110)은 투명한 유리 기판으로 이루어진다. 본 실시예에서, 상기 제 1 기판(110)은 소다라임 유리로 이루어진다. 상기 소다라임 유리는 나트륨 용출에 의한 황변 현상을 방지하기 위하여 보호막이 형성된 것을 사용하는 것이 바람직하다. 이와 다르게, 보로 실리케이트 유리를 사용하여도 된다. 본 실시예에서, 상기 제 1 기판은 0.5 내지 1.1 ㎜의 두께를 갖는다.

<21> 상기 제 1 전극 패턴 층(120)은 양전극용 금속 재료를 증착 또는 도포하여 형성된다. 본 실시예에서, 제1 전극 패턴 층(120)은 불투명한 금속 물질로 형성된다. 예를 들어, 제 1 전극 패턴 층(120)은 칼슘(Ca), 바륨(Ba), 마그네슘(Mg), 은(Ag), 구리(Cu), 알루미늄(Al) 또는 이들의 합금 등으로 형성된다.

<22> 상기 제 1 전극 패턴 층(120)은 상기 유기 발광 소자(100)의 용도에 따라 다양한 형태로 패터닝될 수 있다. 예를 들어 일반 조명기구나 액정표시장치의 백 라이트로 사용하는 경우에는 단일패턴으로 형성될 수 있다. 이와 다르게 유기 발광 표시장치로 사용되는 경우에는 복수의 화소에 대응하도록 매트릭스 형상으로 패터닝 된다. 이 경우 각 화소에 대응하는 유기 발광 패턴 층(130)을 이루는 유기 발광 물질들은 달라질 수 있다. 상기 제 1 전극 패턴 층(120)은 인듐 틴 옥사이드(Indium tin oxide; ITO)나 인듐 징크 옥사이드(Indium zinc oxide; IZO)

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등의 투명성 도전체로 이루어질 수도 있다. 예를 들어, 양면 발광을 필요로 할 때는 제 1 전극 패턴 층(120) 및 제 2 전극 패턴 층(140)은 모두 투명성 전극이어야 한다.

<23> 상기 제 2 기판(150) 상에는 요철 층(160)이 형성된다. 요철 층(160)은 유기 발광 패턴 층으로부터 발생된 광의 확산을 도모하여, 상기 유기 발광 소자(100)의 휘도 특성을 향상시키는 역할을 한다.

<24> 도 2는 본 발명의 일 실시예에 따른 요철 층이 기판 상에 형성된 모습을 보여 주는 단면도이다.

<25> 도 2를 참조하면, 요철 층(260)은 요철부(262) 및 요철부(262)를 덮어 상기 요철 층(260)을 전체적으로 평탄하게 해주는 평탄부(264)를 포함한다.

<26> 본 실시예에서, 상기 요철부(262)는 제 2 기판(250)의 표면을 가공하여 형성되고, 상기 제 2 기판(250)으로부터 돌출된 돌출부에 해당한다.

<27> 상기 평탄부(264)는 상기 요철부(262) 상에 투명한 고분자 수지를 도포 및 경화시켜 형성된다. 즉, 상기 평탄부(264)는 투명성 고분자 수지로 이루어진다. 예를 들면, 폴리에틸렌 테레프탈레이트(PET) 수지 등이 사용될 수 있다.

<28> 상기 평탄부(264)에 의하여 상기 요철 층(260)은 전체적으로 평탄한 하나의 필름을 형성하지만, 여전히 요철 층(260) 내부에는 요철부(262)의 형상이 유지되고 있어, 상기 요철부(262)에 의한 광학적 기능은 유효하게 발휘될 수 있다.

<29> 도 3은 본 발명의 다른 실시예에 따른 요철 층이 기판 상에 형성된 모습을 보여 주는 단면도이다.

<30> 도 3을 참조하면, 본 실시예에 따른 요철 층(360)은 요철부(362) 및 평탄부(364)를 포함한다.

<31> 상기 요철부(362)는 도 2의 요철부(262)와 달리, 제 2 기판(350)으로부터 돌출된 돌출부가 아니라, 별도의 부가 층을 상기 제 2 기판(350)에 형성 시킨 후 상기 부가 층을 가공함으로써, 형성된다. 상기 부가 층은 투명한 재질이면 특별히 제한되지 않으나, 본 실시예에서는, 상기 부가 층으로서, 투명성 고분자 수지가 사용된다.

<32> 상기 요철부(362)는 상기 부가 층을 재료의 특성에 맞게 가공하여 소정의 형상을 갖도록 형성된다.

<33> 상기 평탄부(364)는 전술한 바와 같으므로, 중복된 설명은 생략하기로 한다. 다만, 상기 부가 층이 고분자 수지를 이용하여 형성될 경우, 상기 부가 층을 이루는 고분자 수지와 상기 평탄부(362)를 이루는 고분자 수지의 종류는 서로 달라야 한다. 왜냐하면, 이렇게 해야만이 굴절률 차이를 이용한 광학적 특성 향상이 극대화 될 수 있기 때문이다.

<34> 이상에서는, 소정의 층을 가공하여 요철을 형성하는 것만을 설명하였으나, 이와 다르게 다양한 방법에 의한 요철 형성이 가능할 것이고, 당업자라면 이상의 설명과 다른 다양한 요철 형성 방법을 용이하게 본 발명에 적용할 수 있을 것이다.

<35> 도 4는 본 발명의 일 실시예에 따른 유기 발광 패턴 층을 도시한 단면도이다.

<36> 도 4를 참조하면, 본 실시예에서, 상기 유기 발광 패턴 층(430)의 적어도 하나의 층은 결정화되어 형성된 유기 결정 층을 포함한다. 상기 유기 결정 층은 아몰퍼스 구조를 갖는 유기 물질 층을 열처리하거나 특정 범위의 에너지를 갖는 광을 조사함으로써 결정화될 수 있다.

<37> 특히, 결정화되는 유기 물질 층은 상기 제 1 전극 패턴 층(이하, 도 1의 120)과 접촉하는 층인 것이 바람직하다. 상기 제 1 전극 패턴 층은 무기 물질 층으로서 상기 유기 물질 층이 결정질을 이루게 되면 계면 특성이 향상되어 발광 특성이 향상될 수 있다. 또한, 결정화 과정에서 두께가 감소하여 상기 유기 발광 소자를 보다 슬림화할 수 있다.

<38> 상기 유기 발광 패턴 층(430)은 정공 수송 층(432), 유기 발광 층(434) 및 전자 수송 층(436)을 포함한다.

<39> 상기 정공 수송 층(432), 유기 발광 층(434) 및 전자 수송 층(436)은 상기 제 1 전극 패턴 층 상에 순차적으로 라미네이트 되어 형성된다. 상기 각 유기 층들(432, 434, 436)은 유기 증착 방식, 스핀 코팅 방식, 스프레이 분사 방식 등에 의하여 상기 제 1 전극 패턴 층 상에 순차적으로 형성된다.

<40> 상기 정공 수송 층(432)은 무기 층인 제 1 전극 패턴 층과 접촉하는 층으로서 상기 제 1 전극 패턴 층 및 정공 수송 층 사이의 계면 특성은 유기 발광 소자의 발광 효율에 직접적으로 영향을 미친다.

<41> 이 경우, 상기 정공 수송 층(432)은 정공 수송용 유기 물질이 결정화되어 형성된 결정질 층으로 이루어진다. 또

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한, 상기 정공 수송 층(432)을 형성하기 위하여 상기 정공 수송용 유기 물질을 결정화하는 단계에서는 미세한 회전 공정을 가미하여 상기 정공 수송용 유기 물질이 균일하게 도포될 수 있도록 함으로써, 상기 정공 수송 층(432)이 상기 제 1 전극 패턴 층 상에 균일하게 형성될 수 있도록 한다. 따라서 상기 유기 발광 소자는 상기 정공 수송 층(432) 및 제 1 전극 패턴 층 사이에 형성된 계면의 평탄도가 우수하다. 또한, 상기 정공 수송 층(432)은 결정질로 이루어져 있어 무기물인 상기 제 1 전극 패턴 층 사이의 접착 성능이 우수하여 접촉 저항을 감소시킬 뿐만 아니라 정공 유동성(hole mobility)이 향상됨으로써 유기 발광 소자의 발광 효율 및 수명을 증가시킬 수 있다.

<42> 상기 유기 발광 패턴 층(430)은 상기 정공 수송 층(434), 유기 발광 층(434), 전자 수송 층(436) 이외에도 필요에 따라 정공 저지 층, 전자 주입 층 등의 다양한 부가 층 들을 포함할 수 있다. 또한 상기 층들(432, 434, 436)은 다양한 인광물질을 포함함으로써, 상기 유기 발광 패턴 층(430)의 수명 및 신뢰성이 향상될 수 있다.

<43> 이상에서는, 주로 정공 수송 층(432)만이 결정질 층을 포함하는 것으로 설명하였으나, 정공 수송 층뿐만 아니라 무기 물질 층과 접촉하는 유기 물질 층이라면 어느 층이든 결정화 될 수 있다. 나아가, 필요에 따라서는 층 간의 접촉관계를 불문하고 결정질 층을 형성할 수도 있다.

<44> 상기 유기 발광 패턴 층(430)은 동일한 유기 발광 물질들로 이루어진 단일 패턴을 형성할 수 도 있으며, 서로 다른 이종의 색상을 발현하는 복수의 패턴들로 이루어질 수 도 있다. 색상이 다르면 유기 발광 패턴 층을 이루는 유기 물질들은 서로 다르다.

<45> 도 1을 다시 참조하면, 유기 발광 패턴 층(130) 상에는 제 2 전극 패턴 층(140)이 형성된다. 상기 제 2 전극 패턴 층(140)은 인듐 틴 옥사이드(Indium tin oxide; ITO)나 인듐 징크 옥사이드(Indium zinc oxide; IZO)등의 투명성 도전체로 이루어질 수 있다. 상기 제 2 전극 패턴 층(140)은 다양한 패턴을 가질 수도 있으나, 본 실시예에서는 공통전극으로서 일체의 단일 패턴을 갖는다.

<46> 상기 제 1 전극 패턴 층(120) 및 제 2 전극 패턴 층(140)은 전원이 공급되면 상기 제 1 전극 패턴 층(120) 및 제 2 전극 패턴 층(140) 사이의 유기 발광 패턴 층(130)에 전계를 형성시킨다. 상기 유기 발광 패턴 층(130)은 전계가 인가되면 광을 발생시킨다.

<47> 상기 유기 발광 소자는 단일 패턴으로 이루어져 있어, 백색 광원으로 기능할 수 있다. 따라서 일반 조명기구나 액정표시장치의 면 광원장치로서 기능할 수 있다. 또한, 상기 유기 발광 패턴 층(130)은 결정화 과정 중에 두께가 감소됨으로써 보다 슬림한 디자인을 갖는 유기 발광 소자의 제작이 가능하다.

<48> 따라서 본 실시예에 따른 유기 발광 소자는 가공성이 우수하여 다양한 형상을 갖는 조명기구에 적용될 수 있다.

<49> 도시하지는 않았으나, 상기 유기 발광 소자는 평면 상에서 보았을 때, 삼각형, 오각형, 별 모양 등의 다각형의 형상을 가질 수 있다. 또한, 평면 상에서 보았을 때, 적어도 일 면이 곡선인 형태 등도 가질 수 있다.

<50> 상기 유기 발광 소자는, 일반 조명 기구뿐만 아니라 형태 가공의 용이성 때문에 야간 광고판 등에 효율적으로 적용될 수 있을 것이다.

<51> 도 5는 본 발명의 다른 실시예에 따른 유기 발광 소자를 도시한 단면도이다.

<52> 본 실시예에 따른 유기 발광 소자는 제 1 기판 상에 요철 층을 더 포함하는 것을 제외하고는 도 1의 유기 발광 소자와 동일하므로, 도 1과 중복된 설명은 생략하도록 한다.

<53> 도 5을 참조하면, 본 실시예에 따른 유기 발광 소자는 제 1 기판(510), 제 1 요철 층(520) 제 1 전극 패턴 층(530), 유기 발광 패턴 층(540), 제 2 전극 패턴 층(550), 제 2 기판(560) 및 제 2 요철 층(570)을 포함한다.

<54> 본 실시예에 따른 유기 발광 소자는 양면 발광형 소자로서, 상기 제 1 전극 패턴 층(530) 및 제 2 전극 패턴 층(550)은 모두 투명 전극으로 이루어져 있다. 또한, 상기 제 1 기판(510) 및 제 2 기판(560) 역시 모두 투명 재질의 기판으로 구성된다.

<55> 본 실시예에서, 상기 제 1 요철 층(520) 및 제 2 요철 층(570)은 모두 동일 한 방향성을 요철층을 포함하고 있다.

<56> 그러나, 이와 다르게, 상기 제 1 요철 층(520) 및 제 2 요철 층(570)은 유기 발광 패턴 층(550)을 기준으로 서로 대칭형을 이룰 수 있다.

<57> 즉, 상기 제 1 요철 층(520)은 상기 제 2 요철 층(570)과 대칭을 이루도록, 상기 제 1 기판(510) 및 제 1 전극

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패턴 층(530)의 사이에 삽입되지 않고, 상기 제 1 기판(510)의 외부면에 형성될 수 있다.

<58> 이처럼, 상기 제 1 요철 층(520) 및 제 2 요철 층(570)은 요구되는 특성이나, 적용 장치의 기능을 고려하여 다양하게 배치될 수 있다.

<59> 본 발명은 또한 상기 유기 발광 소자를 포함하는 조명 장치를 제공한다. 상기 유기 발광 소자는 조명 장치에 적어도 하나 포함되도록 적용됨으로써, 조명 장치의 수명, 신뢰성 및 표시 품질을 향상시킬 수 있다.

<60> 상기 유기 발광 소자는 다양한 형상을 갖는 조명장치에 적용될 수 있으나, 특히 면 조명 장치에 적용됨으로써, 그 성능을 극대화할 수 있다.

발명의 효과

<61> 본 발명에 따른 유기 발광 소자는 유기 발광 패턴 층으로부터 발생된 광이 휘도를 증가시킬 수 있도록 요철 층을 구비하고 있어, 유기 발광 소자의 표시 품질을 개선할 수 있다.

<62> 또한, 상기 유기 발광 소자는 유기 발광 패턴 층 내에 결정질 층을 포함하고 있어 상기 유기 발광 소자의 두께를 감소 시킬 수 있다.

<63> 특히, 전극 층과 접촉하는 유기 층을 결정질 층으로 구성함으로써, 상기 전극 층과의 접착력을 향상시킬 수 있고 이로 인하여, 상기 전극 층과의 사이에서 발생되는 접촉저항을 감소시킬 수 있어 유기 발광 소자의 수명 및 신뢰성을 향상 시킬 수 있다.

<64> 또한, 유기 발광 패턴 층, 정공 수송 층을 결정질 층으로 구성할 경우, 정공 유동성(hole mobility)가 증가하여 유기 전계 발광 소자의 발광 효율을 증대시킬 수 있다.

<65> 또한, 유기 발광 패턴 층을 이루는 각 층들간의 계면 평탄도가 우수하여 외부로부터 이물질 등의 유입을 방지하고 광학적 특성을 보다 향상시킬 수 있다.

<66> 또한, 상기 유기 발광 소자는 상기에서 언급한 바와 같이 두께가 감소됨으로써, 박막 특성 및 가공성이 우수하여 조명기기나 광고판 등을 다양한 형상으로 제작할 수 있게 한다.

<67> 상기 실시예를 참조하여 설명하였지만, 해당 기술 분야의 숙련된 당업자는 하기의 특허 청구의 범위에 기재된 본 발명의 사상 및 영역으로부터 벗어나지 않는 범위 내에서 본 발명을 다양하게 수정 및 변경시킬 수 있음을 이해할 수 있을 것이다.

도면의 간단한 설명

<1> 도1은 본 발명의 일 실시예에 따른 유기 발광 소자를 도시한 단면도이다.

<2> 도 2는 본 발명의 일 실시예에 따른 요철 층이 기판 상에 형성된 모습을 보여 주는 단면도이다.

<3> 도 3은 본 발명의 다른 실시예에 따른 요철 층이 기판 상에 형성된 모습을 보여 주는 단면도이다.

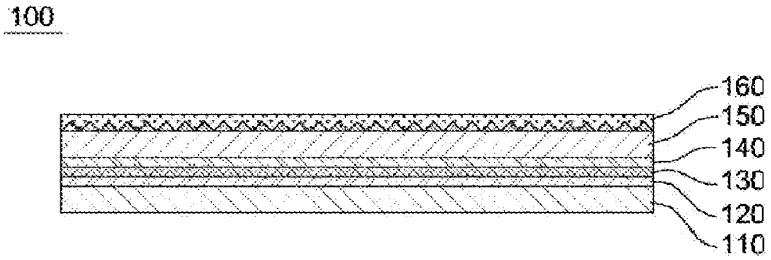
<4> 도 4는 본 발명의 일 실시예에 따른 유기 발광 패턴 층을 도시한 단면도이다.

<5> 도 5는 본 발명의 다른 실시예에 따른 유기 발광 소자를 도시한 단면도이다.

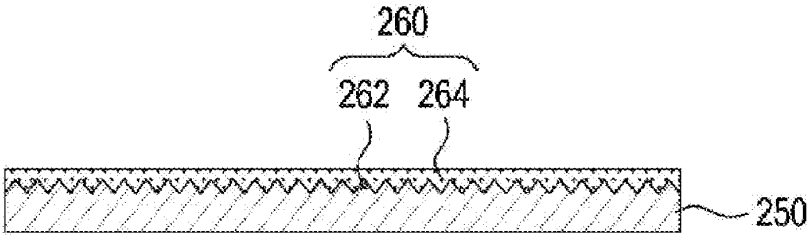
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도면

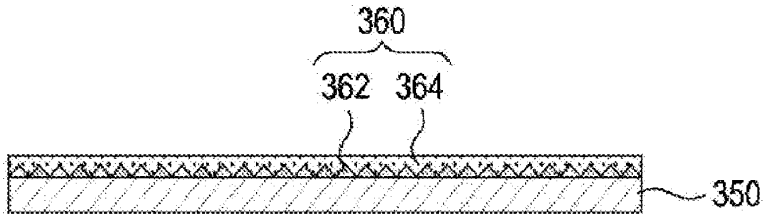
도면1



도면2

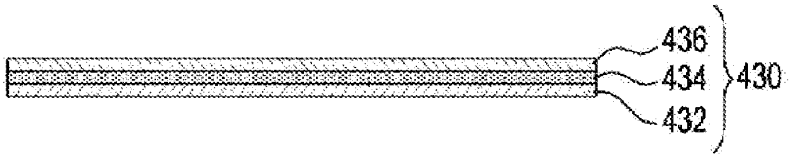


도면3

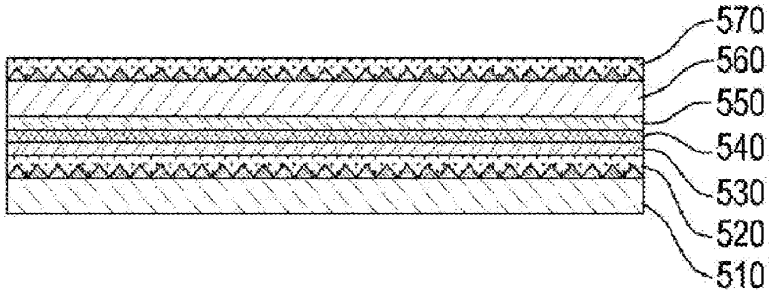


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도면4



도면5



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Examined Patent Publication(B1)

Bibliographic Data

Int.Cl.	H05B 33/02
Published Date	20080519
Registration No.	1008294970000
Registration Date	20080507
Application No.	1020060110471
Application Date	20061109
Unexamined Publication No.	1020080042275
Unexamined Publication Date	20080515
Requested Date of Examination	20061109
Agent.	MUHANN PATENT & LAW FIRM
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Rightholder	LS Cable Ltd.

Title of Invention

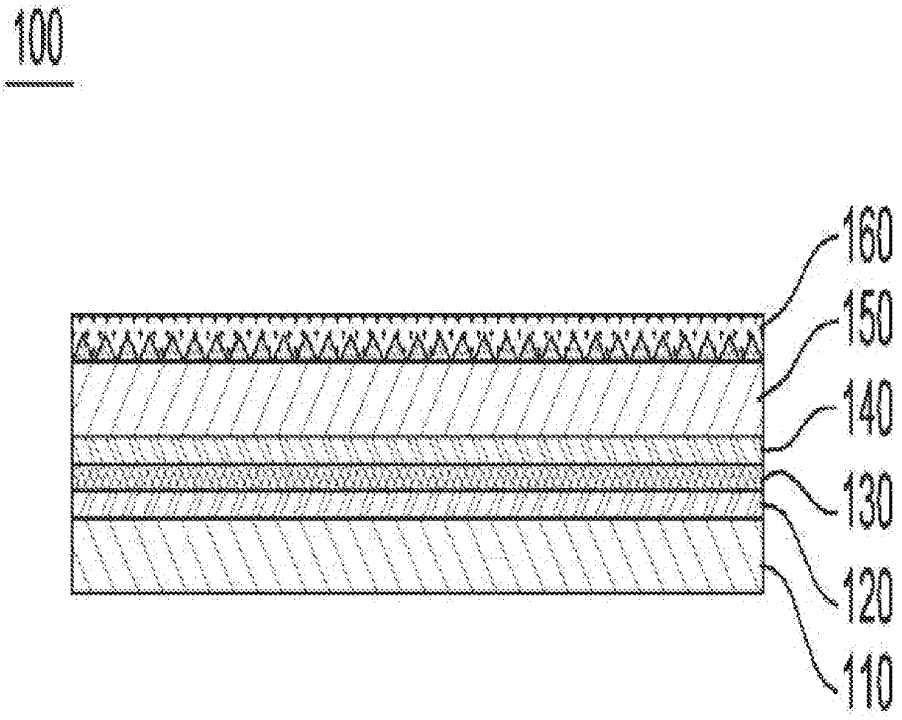
Organic light-emitting device including uneven layer and lightning apparatus having the same

Abstract

The organic light-emitting device according to the present invention comprises the organic electrolum inescent pattern layer which is generated light the voltage is applied from the outside it is formed on the first electrode pattern layer formed on the first substrate, and the first substrate, and the first ele ctrode pattern layer, and the second electrode pattern layer formed on the organic electroluminescen t pattern layer and the second substrate formed on the second electrode pattern layer. The rough lay er is formed on at least task substrate among the first substrate and the second substrate. The orga nic light-emitting device is employed in the backlight of the liquid crystal display, the lighting apparat us, the organic light emitting display device etc. and the lifetime and display quality including the bac klight, the lighting apparatus, the organic light emitting display device etc. can be improved.

대표도면(Representative drawing)

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Scope of Claims

Claim 1:

The organic light-emitting device including the first substrate; the first electrode pattern layer which i s formed on the first substrate and is made of the positive electrode material; the organic electrolumi nescent pattern layer which is formed on the first electrode pattern layer ; and is generated light if th e voltage is applied from the outside; the second substrate formed on the second electrode pattern l ayer: second electrode pattern layer formed on the organic electroluminescent pattern layer; and the rough layer consisting of the uneven part formed in the surface facing the outside of the second subs trate and the plateau which the polymer resin is coated on the uneven part and is formed in order to planarize the uneven part.

Claim 2:

Deletion.

Claim 2:

Deletion.

Claim 3:

As for claim 1, the organic light-emitting device which processes the substrate surface and the uneve n part is formed ; and is made of multiple protrusion parts protruded from the substrate surface.

Claim 4:

As for claim 1, the organic light-emitting device in which the uneven part is made of the first transpa rent high-molecular film in which the concavo-convex is formed in the surface.

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Claim 5:

Deletion.

Claim 5:

Deletion.

Claim 6:

As for claim 1, the organic light-emitting device in which the uneven part and plateau are made of th e different material.

Claim 7:

Deletion.

Claim 7:

Deletion.

Claim 8:

As for claim 1, the organic light-emitting device in which the uneven part has the cross section of the sawtooth shape.

Claim 9:

The organic light-emitting device of claim 1, wherein the organic electroluminescent pattern layer co mprises at least one organic crystalline layer in which the organic material is crystallized and which is formed.

Claim 10:

As for claim 9, the organic light-emitting device which is the layer in which the organic crystalline lay er contacts with the first electrode pattern layer.

Claim 11:

As for claim 1, the organic light-emitting device wherein the organic electroluminescent pattern layer comprises the hole-transport layer respectively successively laminated, and the organic light-emittin g layer and electron-transport layer on the first electrode pattern layer.

Claim 12:

As for claim 10, the organic light-emitting device consisting of the crystalline layer in which the organ ic material for the hole transport the hole-transport layer is crystallized and which is formed.

Claim 13:

The lighting device equipped with the organic light-emitting device including the first substrate; the fi rst electrode pattern layer which is formed on the first substrate and is made of the positive electrod e material; the organic electroluminescent pattern layer which is formed on the first electrode patter n layer ; and is generated the light if the voltage is applied from the outside; the second substrate fo rmed on the second electrode pattern layer: second electrode pattern layer formed on the organic el ectroluminescent pattern layer; and the rough layer consisting of the uneven part formed in the surfa ce facing the outside of the second substrate and the plateau which the polymer resin is coated on th e uneven part and is formed in order to planarize the uneven part.

Background Art

The invention relates to the organic light-emitting device, and to the organic light-emitting device wh ich can improve the life span and display quality of instruments it is employed in various apparatuses and the lighting device including the same.

Generally, as the light source of the back light lamp of the liquid crystal display, the cold cathode fluo rescent lamp (cold cathode fluorescent lamp: CCFL), the light emitting diode (light emitting diode: LE D), fluorescent screen light source lamp, the organic light emitting diode (organic light-emitting diod

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e: OLED) etc is used. When the expected OLED light source is used as the next generation major ligh t source it is able to manufacture and itself the thickness of the light source can be conspicuously red uced to by the thin film and in addition the temperature rise tendency is less the activating in low po wer consumption state is possible. Furthermore, the large-size of the light source device is possible. Recently, the various research including the lifetime of the surface emitting, using the white OLED th e improve brightness etc. proceeds.

Especially, the research for using the existing lighting device as the next generation lighting device c an replace is actively OLED progressed.

Like this, OLED can be effectively applied to the backlight of the liquid crystal display, all kinds of the lighting apparatuses, the display device etc. But the performance which the current developed OLED is yet satisfied in the lifetime, the reliability, and the brightness is not shown.

Summary of Invention

Effects of the Invention

The rough layer is included in order to increase the brightness of the light in which the organic light-emitting device according to the present invention is generated from the organic electroluminescent pattern layer and the display quality of the organic light-emitting device can be improved.

The organic light-emitting device reduces the thickness of the organic light-emitting device the crystalline layer is included within the organic electroluminescent pattern layer.

Especially, the organic layer contacting the electrode layer is organized on the crystalline layer. In that way the constant resistance raising the adhesive force with the electrode layer and due to this, is generated in the interval with the electrode layer can be decreased and the lifetime and reliability of the organic light-emitting device can be improved.

Moreover, among the organic electroluminescent pattern, when the hole-transport layer is organized on the crystalline layer the hole mobility increases and the luminous efficiency of the organic electroluminescent device can be increased.

Moreover, the interface planarity between each layers comprised the organic electroluminescent pattern layer are excellent and the inflow including the foreign substance etc. can be prevented from the outside and the optical characteristic can be more improved.

Moreover, the thickness drops in the above case, as the organic light-emitting device mentioned. In that way the film property and workability are excellent and the lighting apparatus or the advertising board etc. are made with the various shape.

It illustrated with reference to the embodiment. However it will be able to understand it is various changing the invention in the range that it does not deviate from thought and domain of the present invention in which the unskilled person skilled in the art of the target technology part is written in the following scope of claims with the correction.

Technical Task

The present invention is to provide the organic light-emitting device which considers the problem of t he prior art as described above and in which the reliability is excellent and having the display quality, especially, the high luminance performance.

Structure & Operation of the Invention

The organic light-emitting device according to one characteristic of the present invention comprises t he first substrate, the organic electroluminescent pattern layer which is generated light the voltage is applied from the outside it is formed on the first electrode pattern layer formed on the first substrat e, and the first electrode pattern layer, and the second electrode pattern layer formed on the organic electroluminescent pattern layer and the second substrate formed on the second electrode pattern la yer. The rough layer is formed on at least task substrate among the first substrate and the second su bstrate and the brightness performance of the organic light-emitting device can be improved.

The rough layer includes the uneven part and the plateau covering the uneven part and makes the ro ugh layer even.

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The substrate is manufactured and the part is out jutted and the uneven part can be formed and the part of the part consisting of the dissimilar material performs the machining including the etching et c. the layer on the substrate after doing the formation in the layer and the part can be formed. The p lateau covers the uneven part and on the whole, it is even the rough layer is maintained. As the plat eau, the transparency polymer resin etc. can be used.

The form of the concavo-convex is not limited specially and it can be the concavo-convex having for example, the cross section of the sawtooth shape.

In the meantime, the organic electroluminescent pattern layer is the organic material may include at least one organic crystalline layer which crystallized is formed.

The surface lighting device according to one characteristic of the invention includes at least one orga nic light-emitting device. The organic light-emitting device comprises the first substrate, the organic electroluminescent pattern layer which is generated light the voltage is applied from the outside it is formed on the first electrode pattern layer formed on the first substrate, and the first electrode patte rn layer, and the second electrode pattern layer formed on the organic electroluminescent pattern lay er, and the second substrate formed on the second electrode pattern layer. The rough layer is forme d on at least task substrate among the first substrate and the second substrate and the brightness p erformance of the organic light-emitting device is improved and the display quality of the lighting dev ice can be improved if it moves.

Specifically the embodiments of the invention is illustrated with reference to the drawings attached b elow.

Figure 1 is a cross-sectional view showing the organic light-emitting device according to a preferred e mbodiment of the present invention.

Referring to Figure 1, the organic light-emitting device (100) comprises the first substrate (110), the first electrode pattern layer (120), the organic electroluminescent pattern layer (130), and the secon d electrode pattern layer (140), and the second substrate (150). Moreover, the rough layer for the i mprove brightness is formed on the second substrate (150).

It can be the substrate in which the first substrate (110) is transparent or the uncertain substrate. It has to be the first substrate (110) and the substrate in which the second substrate (150) is altogethe r transparent the organic light-emitting device (100) is used in both sides light emitting apparatus et c. In the meantime, the first substrate (110) comprises the flexible one material having flexibility. Fo r example, the first substrate (110) comprises the transparent glass substrate. In the present preferr ed embodiment, the first substrate (110) comprises the soda lime glass. It is the be desirable to use that the protective film is formed so that the soda lime glass prevent the yellowing by the exudation of sodium. It becomes differently with this to steps using the silicate glass. In the present preferred e mbodiment, the first substrate has the thickness of 0.5 through 1.1 mm.

The first electrode pattern layer (120) deposits the metal material for the positive electrode or it coat s and it is formed. In the present preferred embodiment, it is formed with the metal material in whic h the first electrode pattern layer (120) is opaque. For example, the first electrode pattern layer (12 0) is formed with the calcium (Ca), barium (Ba), magnesium (Mg), silver (Ag), copper (Cu), aluminu m (Al) or their alloy etc.

According to the first electrode pattern layer (120) is the use of the organic light-emitting device (10 0), it can be patterned to the various types. For example, the backlight can be formed into the single ton pattern in case of using as the backlight of the general lighting apparatus or the liquid crystal dis play. It is patterned to the matrix shape in order to correspond to multiple pixels in case of it is differ ent from this being used as the organic light emitting display device. In this case, organic luminescen t materials comprised the organic electroluminescent pattern layer (130) corresponding to each pixel can be changed. The first electrode pattern layer (120) comprises the transparency conductor includi ng the Indium-Tin-Oxide (Indium tin oxide: ITO) or the indium zinc oxide (Indium zinc oxide: IZO) et c. For example, the altogether the first electrode pattern layer (120) and the second electrode patter n layer (140) have to be the transparent electrode when requiring both sides light emitting.

The rough layer (160) is formed on the second substrate (150). The diffusion of the light in which the rough layer (160) is generated from the organic electroluminescent pattern layer is planned and the l uminance characteristic of the organic light-emitting device (100) is improved.

Figure 2 is a cross-sectional view in which the rough layer shows the formed appearance on the subs trate according to a preferred embodiment of the present invention.

Referring to Figure 2, the rough layer (260) includes the uneven part (262) and the plateau (264) co vering the uneven part (262) and on the whole, makes the rough layer (260) even.

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In the present preferred embodiment, the surface of the second substrate (250) is processed and the uneven part (262) is formed and it is applicable to the protrusion part protruded from the second sub strate (250).

The transparent polymer resin is solidified with the coating and the plateau (264) is formed on the u neven part (262). That is, the plateau (264) comprises the transparency polymer resin. For example, the polyethylene terephthalate (PET) resin etc. can be used.

One film in which on the whole, the rough layer (260) is even with the plateau (264) is formed. How ever the shape of the uneven part (262) is still maintained inside the rough layer (260) and the optic al function by the uneven part (262) can be tellingly displayed.

Figure 3 is a cross-sectional view in which the rough layer shows the formed appearance on the subs trate according to the other embodiment of the invention.

Referring to Figure 3, the rough layer (360) according to this embodiment includes the uneven part (362) and the plateau (364).

It is not protrusion part in which the uneven part (362) is protruded to the uneven part (262) of fig. 2 from the second substrate (350). The part processes the layer after the separate part forms the lay er in the second substrate (350). In that way protrusion part is formed. The part is not limited specia lly if the layer is the transparent material. But in the present preferred embodiment, the part is the la yer and the transparency polymer resin mades use of.

The uneven part (362) is formed so that the layer is processed according to the property of the mate rial and the part has the predetermined shape.

It is the same like. Therefore the plateau (364) describes in the above the overlapped description dec ides to omit. But when the layer of the part is formed using the polymer resin if the kind of the poly mer resin and the polymer resin comprised the layer is different from each other then comprised the plateau (362) the part does. Because, the optical characteristic improvement which uses the differen ce of refractive index only when making like this become maximized.

In the above, the predetermined layer was processed and the concavo-convex was formed it illustrat ed. But it is different from this the ruggedness formation by the various method will be possible and t he person skilled in the art the various ruggedness formation method different from the description w ill be able to be easily applied to the invention.

Figure 4 is a cross-sectional view showing the organic electroluminescent pattern layer according to a preferred embodiment of the present invention.

Referring to Figure 4, in the present preferred embodiment, the organic crystalline layer in which at l east one layer of the organic electroluminescent pattern layer (430) is crystallized and which is forme d is included. By the organic crystalline layer heat-treating the organic layer having the amorphous s tructure or irradiating the light having the energy of the specific range it can be crystallized.

Especially, it is the be desirable the layer in which the crystallized organic layer contacts with the first electrode pattern layer (hereinafter, 120 of fig. 1). If the first electrode pattern layer the organic laye r is comprised the crystalline as the inorganic material layer the interfacial property is improved and t he light emittance can be improved. Moreover, in the crystallization, the thickness reduces and the o rganic light-emitting device more can be slimmed.

The organic electroluminescent pattern layer (430) comprises the hole-transport layer (432), the org anic light-emitting layer (434), and the electron-transport layer (436).

Is successively raminated on the first electrode pattern layer and the hole-transport layer (432) , and the organic light-emitting layer (434) and electron-transport layer (436) are formed. Each organic la yer (432, 434, 436) is successively formed by the organic vapor deposition method, the spin coating method, the spray-jet method etc. on the first electrode pattern layer.

The interfacial property between the hole-transport layer and the first electrode pattern layer directly affect the luminous efficiency of the organic light-emitting device as the layer contacting with the firs t electrode pattern layer in which the hole-transport layer (432) is the inorganic layer.

In this case, the hole-transport layer (432) comprises the crystalline layer in which the organic mater ial for the hole transport is crystallized and which is formed. Moreover, the rotation scheme of being minute is seasoned with and the organic material for the hole transport is coated with the uniformly i n the step of crystallizing the organic material for the hole transport in order to form the hole-transp ort layer (432). In that way the hole-transport layer (432) is formed on the first electrode pattern lay er. Therefore, the organic light-emitting device the planarity of the interface formed between the first electrode pattern layer and hole-transport layer (432) is excellent. Moreover, in addition the hole-tra

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nsport layer (432) is made of the crystalline and the bonding capacity between the first electrode pat tern layer which is the inorganic material is excellent and the constant resistance is decreased the ho le mobility is improved the luminous efficiency and lifetime of the organic light-emitting device can b e increased.

The organic electroluminescent pattern layer (430) is the hole-transport layer (434), the organic light -emitting layer (434), and the electron-transport layer (436), as necessary, the various part includin g the hole blocking layer, the electron injection layer etc may include the layer field. Moreover, the p hosphor in which layers (432, 434, 436) are various is included. In that way the lifetime and reliabilit y of the organic electroluminescent pattern layer (430) can be improved.

In the above, it illustrated that the crystalline layer the mainly was included only the hole-transport l ayer (432). But if it is not only the hole-transport layer but also the organic layer contacting the inor ganic material layer it can be crystallized as a layer. Furthermore, the contact relation between the la yer can be disregarded and the crystalline layer can be formed according to the need.

It has the number forming the singleton pattern consisting of organic luminescent materials in which the organic electroluminescent pattern layer (430) is identical and the number has the number made of multiple patterns expressing the color of the different different kind. The organic material s which are comprised the organic electroluminescent pattern layer if color is different are different from each other.

If fig. 1 is again referred to the second electrode pattern layer (140) is formed on the organic electrol uminescent pattern layer (130). The second electrode pattern layer (140) comprises the transparenc y conductor including the Indium-Tin-Oxide (Indium tin oxide: ITO) or the indium zinc oxide (Indium zinc oxide: IZO) etc. It can have the pattern in which the second electrode pattern layer (140) is vari ous. But in the present preferred embodiment, it has the singleton pattern of integration as the com mon electrode.

The first electrode pattern layer (120) and the second electrode pattern layer (140) form the electric field in the organic electroluminescent pattern layer (130) between the second electrode pattern laye r (140) and the first electrode pattern layer (120) if the power source is supplied. The organic electro luminescent pattern layer (130) generates light if the electric field is applied.

The organic light-emitting device is made of the singleton pattern and it can function to the white lig ht source. Therefore, it can function as the surface light source device of the general lighting apparat us or the liquid crystal display. Moreover, the manufacture of the organic light-emitting device which has more slim design since the thickness the organic electroluminescent pattern layer (130) drops a mong the crystallization is possible.

Therefore, it can be applied to the lighting apparatus in which the workability is excellent and the org anic light-emitting device according to the operation looked has the various shape.

Although not illustrated, when the organic light-emitting device looked on plane it can have the polyg onal shape including the triangle, the pentagon, the star-shaped etc. Moreover, when it looked on pla ne the form etc. can have. At least one side is the curve.

The organic light-emitting device the simplicity of not only the general lighting apparatus but also the form processing will be able to be therefore efficiently applied in the night advertisement board etc.

Figure 5 is a cross-sectional view showing the organic light-emitting device according to another pref erred embodiment of the present invention.

The organic light-emitting device according to this embodiment excludes on the first substrate furthe r including the rough layer and it is identical with the organic light-emitting device of fig. 1. Therefore the description overlapped with fig. 1 omits.

Referring to Figure 5, the organic light-emitting device according to this embodiment comprises the fi rst substrate (510), the first rough layer (520) first electrode pattern layer (530), the organic electrol uminescent pattern layer (540), the second electrode pattern layer (550), the second substrate (56 0), and the second rough layer (570).

The organic light-emitting device according to this embodiment is both sides emission type element a nd comprises the first electrode pattern layer (530) and the second electrode pattern layer (550), alt ogether, the transparent electrode. Moreover, also it is altogether composed of the substrate of the t ransparent material with the first substrate (510) and the second substrate (560).

In the present preferred embodiment, the one-way in which the first rough layer (520) and the secon d rough layer (570) altogether bind the rough layer is included.

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But the first rough layer (520) and the second rough layer (570) can be differently comprised the sy mmetric with this based on the organic electroluminescent pattern layer (550).

That is, in order that the first rough layer (520) is comprised the second rough layer (570) and sym metry it is not inserted between the first substrate (510) and the first electrode pattern layer (530) a nd symmetry can be formed in the external side of the first substrate (510).

Like this, the variously can be arranged in consideration of the function of the property, that the first rough layer (520) and the second rough layer (570) are required or the application apparatus.

The invention further provides the lighting device comprising the organic light-emitting device. The lif etime of the lighting device, and the reliability and display quality can be improved as the application so that the organic light-emitting device is included in the lighting device with at least one.

It can be applied to the lighting device having the shape in which the organic light-emitting device is various. But the performance can be maximized in especially, the surface lighting device as the appli cation.

Brief explanation of the drawing

Figure 1 is a cross-sectional view showing the organic light-emitting device according to a preferred e mbodiment of the present invention.
Figure 2 is a cross-sectional view in which the rough layer shows the formed appearance on the subs trate according to a preferred embodiment of the present invention.
Figure 3 is a cross-sectional view in which the rough layer shows the formed appearance on the subs trate according to the other embodiment of the invention.
Figure 4 is a cross-sectional view showing the organic electroluminescent pattern layer according to a preferred embodiment of the present invention.
Figure 5 is a cross-sectional view showing the organic light-emitting device according to another pref erred embodiment of the present invention.

Disclaimer

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/651,508	07/17/2017	Ulrich KASTNER-JUNG	5367-694P/CON\409926	2349

27799 7590 05/31/2019

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EXAMINER
CHO, JAMES HYONCHOL

ART UNIT	PAPER NUMBER
2844	

NOTIFICATION DATE	DELIVERY MODE
05/31/2019	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patentdocket@cozen.com
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Office Action Summary	Application No. 15/651,508	Applicant(s) KASTNER-JUNG et al.	
	Examiner James H Cho	Art Unit 2844	AIA (FITF) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 4/9/2019.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1,3-5,7-13 and 17-19 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1,3-5,7-13 and 17-19 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 7/17/2017 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☑ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☑ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☑ Certified copies of the priority documents have been received in Application No. 13/139514.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Drawings

The drawings were received on 7/17/2017. These drawings are approved.

Claim Objections

Claims 4, 13 are objected to because of the following informalities:

In claim 4, "the emission profile" on line 2 should to be -- the directional emission profile --;

In claim 13, “a carrier” on line 2 should be -- the carrier--

Appropriate correction is required.

Claim Rejections - 35 USC § 103

In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 1, 3-5, 7-13, and 17-19 are rejected under 35 U.S.C. 103 as being unpatentable over Cina et al. (US 20019/0072711 A1) in view of Garditz et al. (US 2007/0114520 A1).

Regarding claims 1 and 19, Cina et al. teaches an organic light-emitting diode (see Fig. 1) comprising an organic layer sequence (4 having sublayers, see paragraph [0077]), a carrier (5),

wherein the organic layer sequence comprises at least one radiation-emitting region which generates electromagnetic radiation (OLED radiation, see paragraph [0100]),

wherein the carrier forms a radiation exit area (5 having a prismatic structure having areas denoted by 6 and 7 where 6 being a transparent providing exit area while 7 being opaque reflective, see paragraph [0077]),

wherein the radiation exit area is structured, so that the electromagnetic radiation has a directional emission profile (prism providing direction profile as shown in Fig. 5A and 5B),

wherein the carrier comprises a multiplicity of parallel prisms (prismatic structure being mutually parallel, see paragraph [0077]) having first areas (6) and second areas (7) which are arranged in a tilted manner with respect to one another (6 and 7 having a tilted angle),

wherein functional layers (two electrodes 3 and 6 being anode or cathode, see paragraph [0077]) of the organic layer sequence are applied to the first and/or the second areas at the top side of the carrier (6 being on a top of the carrier 5), and

wherein the functional layers, which are arranged on different areas, are driven separately from one another (3 on a bottom of 4 while 6 on the top of 5),

but does not teach an encapsulation wherein the encapsulation forms a seal of the organic layer sequence against environmental influences and the OLDE generating electromagnetic radiation in the spectral range from infrared radiation to UV radiation during operation (.

However, Garditz et al. teaches an encapsulation wherein the encapsulation with glass or ceramic which provides protection from environment influences, e.g. water and moisture as well as the OLDE providing light in a visible range and in the spectral range from infrared radiation to UV radiation during operation (see paragraph [0018]).

Therefore; it would have been obvious to one ordinary skill in the art at the time of invention was made to utilize the encapsulation of Garditz et al. in order to provide protections for reliable operation as well as the teaching of Garditz et al. where a typical OLED would emit light in the spectral range from infrared to UV radiation.

Regarding claim 3, Cina et al. in view of Garditz et al. teaches the organic light-emitting diode according to claim 1, wherein the prisms comprises a length and width (the prismatic structures having plurality of prism each having a length = 300 micrometer and width= 100 micrometers, see paragraph [0098]) which are arranged parallel to the main plane of the organic layer sequence (where each prism being parallel to the main plane 2) wherein the width is bigger than the wavelength (e.g. 400 nanometer) of the electromagnetic radiation which is induced by the organic light-emitting diode,

but does not teach the length is at least 1 cm,

However, it would have been obvious to one having ordinary skill in the art at the time the invention was made to specify the length of the OLED being at least 1 cm, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art.

Regarding claim 4, Cina et al. in view of Garditz et al. teaches the organic light-emitting diode according to claim 1, wherein the emission profile is a symmetrical cardioid in one direction or asymmetrical in at least one of the directions (see Fig. 5A and 5B show various asymmetrical directions).

Regarding claim 5, Cina et al. in view of Garditz et al. teaches the organic light-emitting diode according to claim 1, wherein the first areas are transparent (6 being transparent), and the second areas are reflective (7 being opaque and reflective, see paragraph [0077]), so that the directional emission profile has a tilt angle which depends on an angle α (see Fig. 5A and 5B).

Regarding claim 7, Cina et al. in view of Garditz et al. teaches the organic light-emitting diode according to claim 1, wherein the structured radiation exit area comprises a multiplicity of the parallel prisms (parallel prisms, see paragraph [0085]),

wherein the parallel prisms comprise a length and width which are arranged parallel to the main plane of the organic layer sequence (length= 300 micrometer, width = 100 micrometer, see paragraph [0098]),

wherein the parallel prisms form in side view an isosceles triangle (symmetrical triangular two sides 6 and 7 having the equal surface, see paragraph [0085]), wherein the directional emission profile is symmetrical (see an exemplary directional emission shown in Fig. 5A and 5B using a right triangle, where an isosceles right triangle would provide similar directional emission) has two main radiation directions (see various directions shown in Fig. 5B) , wherein the two main radiation directions are inclined from the z-axis by an angle a = P in positive and negative x-directions, and wherein the main plane forms an x-y-plane (the main plane defined by the width, x-axis and length y-axis, where the emission angle being inclined from z-axis).

Regarding claim 8, Cina et al. in view of Garditz et al. teaches the organic light-emitting diode according to claim 1, wherein the first areas (areas 6 being nonplanar) and/or the second areas (areas 7 nonplanar) are nonplanar.

Regarding claim 9, Cina et al. in view of Garditz et al. teaches the organic light-emitting diode according to claim 1, wherein the first areas and/or the second areas are formed in a manner of cylinder sections (areas defined by 6 and/or areas defined by 7 having a width and a height along its length are in the manner of cylinder sections).

Regarding claim 10, Cina et al. in view of Garditz et al. teaches the organic light-emitting diode according to claim 1, wherein the directional emission profile has a maximum in the direction perpendicular to the first areas (see Fig. 5B).

Regarding claim 11, Cina et al. in view of Garditz et al. teaches the organic light-emitting diode according to claim 1, wherein the second areas (7 being reflective conductive strip, see paragraph [0121]) are reflective, which is induced by metallization with metal particles.

Regarding claim 12, Cina et al. in view of Garditz et al. teaches the organic light-emitting diode according to claim 1, wherein the structured radiation exit area is embodied as a separate structured foil (6 is being deposited on the embossed layer 5 uniformly, i.e. providing thin foil or film over the embossed layer 5, see paragraph [0120]), which is arranged on a carrier.

Regarding claim 13, Cina et al. in view of Garditz et al. teaches the organic light-emitting diode according to claim 1, wherein the organic light-emitting diode comprises the carrier (5 being prismatic structure) which is structured, wherein the radiation exit area (6 is on the top of 5) is arranged on the carrier, and wherein the structuring of the radiation exit area is induced by the structuring of the carrier (structure of prismatic provides the radiation exit area).

Regarding claim 17, Cina et al. in view of Garditz et al. teaches the organic light-emitting diode according to claim 1, wherein the organic light-emitting diode is an organic light-emitting diode emitting on both sides (see Fig. 7 of Cina et al.), which comprises two radiation exit areas (6),

wherein the two radiation exit areas are arranged on opposite sides of the organic light-emitting diode (two exit areas are facing each other, see paragraph [0101]), and

wherein the radiation exit areas are structured.

Regarding claim 18, Cina et al. in view of Garditz et al. teaches a luminaire having at least one light-emitting diode according to claim 1 as a light source,

wherein the luminaire is one of the following devices or is at least part of one of the following devices: alarm clock, shower cubicle, shower head, solar protection, rain protection, lamp, bag, signaling light (OLED for producing signaling lights and display devices, see paragraph [0001]), changing cubicle, vision protection, housing, emergency lighting, mirror, tile, ceiling light, radiator cladding, louver, noise protection, umbrella, warning light.

Response to Amendment

Applicant's request for reconsideration of the finality of the rejection of the last Office action is persuasive and, therefore, the finality of that action is withdrawn.

Response to Arguments

Applicant's arguments filed 4/9/2019, with respect to the rejection(s) of claim(s) 1, 3-5, 7-10, 12-13 and 17-18 under 35 USC 103 have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground(s) of rejection is made in view of Cina et al. and Garditz et al. as stated above.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to James H Cho whose telephone number is (571)272-1802. The examiner can normally be reached on M-F 8-5.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Douglas Owens can be reached on 571-272-16621662. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JAMES H CHO/
Examiner, Art Unit 2844

/MINH D A/
Primary Examiner, Art Unit 2844

Notice of References Cited	Application/Control No. 15/651,508	Applicant(s)/Patent Under Reexamination KASTNER-JUNG et al.	
	Examiner James H Cho	Art Unit 2844	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20090072711-A1	03-2009	Cina; Salvatore	H01L51/5209	313/504
	B					
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/651,508	KASTNER-JUNG et al.
	Examiner	**Art Unit**
	James H Cho	2844

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	02/01/2018	08/03/2018	03/15/2019	05/13/2019					
	1	✓	✓	✓	✓					
	2	✓	✓	-	-					
	3	✓	✓	✓	✓					
	4	✓	✓	✓	✓					
	5	O	O	✓	✓					
	6	O	-	-	-					
	7	✓	✓	✓	✓					
	8	✓	✓	✓	✓					
	9	✓	✓	✓	✓					
	10	✓	✓	✓	✓					
	11	O	✓	O	✓					
	12	✓	✓	✓	✓					
	13	✓	✓	✓	✓					
	14	✓	O	-	-					
	15	✓	O	-	-					
	16	✓	✓	-	-					
	17	✓	✓	✓	✓					
	18	✓	✓	✓	✓					
	19		=	=	✓					

SDC EX. 1016 - 606/959

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/651,508	KASTNER-JUNG et al.
	Examiner	Art Unit
	James H Cho	2844

CPC - Searched*		
Symbol	Date	Examiner
B60Q3/30,745 B05B1/18,268 B60Q7/00 F21S10/02 F21V23/0442,0016,004,0052,006 F21Y2113/20,10 F21Y2115/15 F21Y2105/00 (text search, see the search history printout)	2/1/2018	JC
F21S8/033,04,061 F21S9/03 G04C19/02 G04G11/00 G04G13/023 H05B33/0896,22 H05B37/00,0281 H01L2251/5361 Y02B20/36,42 (text search, see the search history printout)	2/1/201	JC

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
BRS text search, see the search history printout	2/1/2018	JC
updated search	03/15/2019	JC
updated search	05/13/2019	JC

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

SDC EX. 1016 - 607/959

Attorney Docket # 5367-694P/CON/409926 Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	Examiner: CHO, JAMES H.
Kastner-Jung, Ulrich et al.	Group Art: 2844
Serial No.: 15/651,508	
Filed: July 17, 2017	
For: Organic-Light-Emitting Diode	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

S I R:

In compliance with the duty of disclosure under 37 C.F.R. §1.56 and in accordance with the practice under 37 C.F.R. §§1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a. Copies of the listed non-US documents are also enclosed.

Enclosed is a copy of an Office Action (and an English translation) dated March 29, 2019 issued in Korean Patent Application 10-2017-7026128. The reference from the Korean Office Action that is not listed on the attached Form PTO/SB/08a was submitted to the USPTO in a previously filed IDS.

This information is being submitted after issuance of a Final Office.

STATEMENT

Each item of information contained in the Information Disclosure Statement was first cited in any communication received from a foreign Patent Office in a counterpart foreign application not more than three months prior to the filing of the Information Disclosure Statement.

In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /JC/

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listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicant(s) reserve(s) the right to prove that the date of publication is in fact different.

Submitted herewith is the required fee of $240 under 37 C.F.R. § 1.17(p). It is believed that no additional fees or charges are required at this time in connection with the present application. However, if any fees or charges are required at this time, they may be charged to our Patent and Trademark Office Deposit Account No. 503111.

It is respectfully requested that the above information be considered by the Examiner and that a copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

Respectfully submitted,
COZEN O'CONNOR

By: /Ian R. Blum/
Ian R. Blum
Reg. No. 42,336
277 Park Avenue
New York, New York 10172
(212) 883-4900

Dated: April 12, 2019

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /JC/

SDC EX. 1016 - 609/959

Attorney Docket # 5367-694P/CON/409926

PTO/SB/08A (04-03)
Approved for use through 04/30/2003. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	15/651,508
Filing Date	July 17, 2017
First Named Inventor	Kastner-Jung, Ulrich
Art Unit	2844
Examiner Name	CHO, JAMES H.
Attorney Docket	5367-694P/CON/409926

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind-Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]- Number[4]- Kind-Code[5] (if known	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		KR 2008-0042275	05-15-2008	Oh et al.		✓

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[6]
		Office Action dated March 29, 2019 issued in Korean Patent Application 10-2017-7026128.	✓

Examiner Signature	/JAMES H CHO/	Date Considered	05/09/2019

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, Washington, DC 20231.** *If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.*.

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S182	33	(US-20160238234-$ or US-20100076527-$ or US-20080138624-$ or US-20020003403-$ or US-20110133628-$ or US-20090173957-$ or US-20090091258-$ or US-20080188156-$ or US-20080138539-$ or US-20070114520-$ or US-20060128042-$ or US-20090039272-$ or US-20010043046-$ or US-20050156520-$ or US-20050242709-$ or US-20040080938-$ or US-20090167981-$ or US-20070230211-$ or US-20070176195-$ or US-20070153543-$).did. or (US-6926572-$ or US-6884465-$ or US-7922358-$ or US-7733008-$ or US-6331063-$ or US-6575584-$ or US-8987711-$ or US-7560727-$ or US-7358663-$ or US-7205714-$ or US-8123391-$ or US-8653548-$ or US-9797567-$).did.	US-PGPUB; USPAT	OR	ON	2019/05/09 14:05
S183	19	("20020080598" | "20030147119" | "20040036990" | "20040141302" | "20040188690" | "20040237065" | "20050122035" | "20060056166" | "20060132919" | "20060290651" | "20070063140" | "20070153543" | "20070176195" | "20070217702" | "20070230211" | "20090015142" | "20090261371" | "6091547" | "6906452").PN. OR ("8653548").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2019/05/09 14:06
S185	1	("20180003354").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/05/09 16:40
S186	1	("20050231101").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/05/09 17:03
S190	65	S189 and (encapsulat$4 seal$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/05/09 17:20
S189	101	S188 and layer	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/05/09 17:20
S188	103	S187 and organic near4 (LED.u/c. diode)	US-PGPUB; USPAT;	OR	ON	2019/05/09 17:20

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			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S187	1002	kastner$2jung-ulrich$.in. klein-markus$.in. maes-stan$.in. signl-romana$.in. haid-annette$.in. lintner-stephan$.in. herget-julian$.in. matjan-gregor$.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/05/09 17:20
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S204	25	((infrared UV.u/c.) with (radiat$4 and (OLED.u/c. LED.u/c))).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/05/13 15:05
S205	626	((infrared UV.u/c.) with (radiat$4 and (OLED.u/c. LED.u/c)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/05/13 15:13
S206	271	S205 and encapsulat$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/05/13 15:14
S208	94	S206 and @ad<"20081211"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/05/13 15:16
S209	47	S208 and infrared	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/05/13 15:18
S211	2	S210 and radiat$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/05/13 17:29
S210	2	(("20070114520") or ("20090072711")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2019/05/13 17:29

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	Examiner: CHO, JAMES H.
Kastner-Jung, Ulrich et al.	Group Art: 2844
Serial No.: 15/651,508	
Filed: July 17, 2017	
For: Organic-Light-Emitting Diode	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

S I R:

In compliance with the duty of disclosure under 37 C.F.R. §1.56 and in accordance with the practice under 37 C.F.R. §§1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO/SB/08a. Copies of the listed non-US documents are also enclosed.

Enclosed is a copy of a Notice of Allowance (and a partial English translation) dated July 9, 2019 issued in Korean Patent Application No. 10-2017-7026128 which corresponds to the present application. The references from the Korean Notice of Allowance that are not listed on the attached Form PTO/SB/08a were submitted to the USPTO in a previously filed IDS.

This information is being submitted subsequent to the later of three months after the filing date of the present application or the mailing of the first Office Action on the merits, but before the mailing of a final Office Action or the Notice of Allowance.

STATEMENT

Each item of information contained in the Information Disclosure Statement was first cited in any communication received from a foreign Patent Office in a counterpart foreign application not more than three months prior to the filing of the Information Disclosure Statement.

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In accordance with 37 C.F.R §§1.97(g) and (h), the filing of this Information Disclosure Statement should not be construed as a representation that a search has been made or that information cited is, or is considered to be, material to patentability as defined in §1.56(b), or that any cited document listed or attached is (or constitutes) prior art. Unless otherwise indicated, the date of publication indicated for an item is taken from the face of the item and Applicant(s) reserve(s) the right to prove that the date of publication is in fact different.

It is believed that no additional fees or charges are required at this time in connection with the present application. However, if any fees or charges are required at this time, they may be charged to our Patent and Trademark Office Deposit Account No. 503111.

It is respectfully requested that the above information be considered by the Examiner and that a copy of the enclosed Form PTO/SB/08a be returned indicating that such information has been considered.

Respectfully submitted,
COZEN O'CONNOR

By /Thomas Langer/
Thomas Langer
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277 Park Avenue
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(212) 883-4900

Dated: July 25, 2019

SDC EX. 1016 - 615/959

Attorney Docket # 5367-694P/CON/409926

PTO/SB/08A (04-03)
Approved for use through 04/30/2003. OMB 0651-0031
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known	
Application Number	15/651,508
Filing Date	July 17, 2017
First Named Inventor	Kastner-Jung, Ulrich
Art Unit	2844
Examiner Name	CHO, JAMES H.
Attorney Docket	5367-694P/CON/409926

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Document Number Number-Kind-Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. [1]	Foreign Patent Document Country Code[3]- Number[4]- Kind-Code [5] (if known	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		JP 2007-200887	08-09-2007	Dong-Soo et al.		Abs.
		JP 2004-296423	10-21-2004	Toshitaka et al.		Abs.
		JP 2008-538155	10-09-2008	Cok et al.		Abs.
		JP 4182467B2	11-19-2008	Takashi		Abs.
		JP 4228248B2	02-25-2009	Hideo et al.		Abs.
		JP 4637390B2	02-23-2011	Shunpei et al.		Abs.
		JP 4713010B2	06-29-2011	Kenji		Abs.
		JP 4742880B2	08-10-2011	Osamu et al.		Abs.
		JP 4828881B2	11-30-2011	Satoshi		Abs.
		JP 2003-195775	07-09-2003	Takashi		Abs.
		JP 2004-047179	02-12-2004	Tamotsu et al.		Abs.

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation designation number (optional). 2 See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, Washington, DC 20231.** *If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.*.

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Espacenet

Bibliographic data: JP2007200887 (A) — 2007-08-09

ORGANIC ELECTROLUMINESCENT DISPLAY AND MANUFACTURING METHOD THEREFOR

Inventor(s): CHOI DONG-SOO; PARK JIN-WOO ± (CHOI DONG-SOO, ; PARK JIN-WOO)

Applicant(s): SAMSUNG SDI CO LTD ± (SAMSUNG SDI CO LTD)

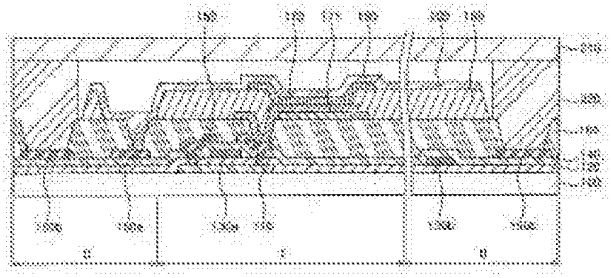
Classification: - international: ***G09F9/00; G09F9/30; H01L27/32; H01L51/50; H05B33/04; H05B33/10***
- cooperative: **H01L27/3276; H01L27/3288; H01L51/5246**

Application number: JP20070011996 20070122 Global Dossier

Priority number(s): KR20060007962 20060125 ; KR20060027321 20060327

Also published as: US2007170859 (A1) US8164257 (B2)

Abstract of JP2007200887 (A)



PROBLEM TO BE SOLVED: To provide an organic electroluminescent display with a structure capable of preventing deterioration of adhesion, when sealing substrates with glass frits, and to provide its manufacturing method. ;SOLUTION: The organic electroluminescent display is provided with a first substrate 300 having a pixel region I and a non-pixel region II, a second substrate 420 for sealing the first substrate. The pixel region is provided with a thin-film transistor that includes a semiconductor layer 320, a gate electrode 340a, a source electrode 360a, and a drain electrode 360b, an organic planarizing film 370 located on the thin-film transistor, a first electrode 380 located on the organic planarizing film, a pixel defining layer 390 located on the first electrode, an organic film layer 400 which is located on the first electrode and the pixel defining layer 390 and at least includes a light-emitting layer 400, and a second electrode 410 located on the organic film layer. The non-pixel layer is provided with a metal wiring 360d and glass frit which is located on the metal wiring, without contacting the organic flattening film, and seals the first substrate and the second substrate. ;COPYRIGHT: (C)2007,JPO&INPIT

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(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2007-200887
(P2007-200887A)
(43)公開日　平成19年8月9日(2007.8.9)

(51)Int.Cl.		F I			テーマコード（参考）
H05B 33/04	(2006.01)	H05B	33/04		3K107
H05B 33/10	(2006.01)	H05B	33/10		5C094
H01L 51/50	(2006.01)	H05B	33/14	A	5G435
G09F 9/30	(2006.01)	G09F	9/30	309	
G09F 9/00	(2006.01)	G09F	9/00	338	

審査請求 有　請求項の数 11　OL　（全 25 頁）　最終頁に続く

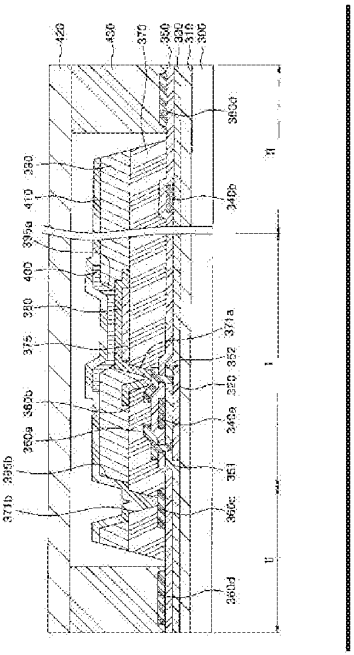
(21)出願番号　特願2007-11996(P2007-11996)
(22)出願日　平成19年1月22日(2007.1.22)
(31)優先権主張番号　10-2006-0007962
(32)優先日　平成18年1月25日(2006.1.25)
(33)優先権主張国　韓国(KR)
(31)優先権主張番号　10-2006-0027321
(32)優先日　平成18年3月27日(2006.3.27)
(33)優先権主張国　韓国(KR)

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(54)【発明の名称】有機電界発光表示装置及びその製造方法

(57)【要約】
【課題】基板をガラスフリットで封止する際、接着力の低下を防止できる構造の有機電界発光表示装置及びその製造方法を提供する。
【解決手段】本発明に係る有機電界発光表示装置は、画素領域I及び非画素領域IIを備えた第１基板３００と、前記第１基板を封止する第２基板４２０とを有し、前記画素領域には、半導体層３２０、ゲート電極３４０ａ、ソース電極３６０ａ及びドレイン電極３６０ｂを含む薄膜トランジスタと、前記薄膜トランジスタ上に位置する有機平坦化膜３７０と、前記有機平坦化膜上に位置する第１電極３８０と、前記第１電極上に位置する画素定義膜３９０と、前記第１電極及び前記画素定義膜上に位置し、少なくとも発光層を含む有機膜層４００と、前記有機膜層上に位置する第２電極４１０と、が設けられ、前記非画素領域には、メタル配線３６０ｄと、前記メタル配線上に前記有機平坦化膜に接することなく位置し、前記第１基板と前記第２基板を封止するガラスフリットと、が設けられる。
【選択図】　図５



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【特許請求の範囲】
【請求項1】
画素領域及び該画素領域以外の領域である非画素領域を備えた第１基板と、
前記第１基板を封止する第２基板とを有し、
前記画素領域には、
半導体層、ゲート電極、ソース電極及びドレイン電極を含む薄膜トランジスタと、
前記薄膜トランジスタ上に位置する有機平坦化膜と、
前記有機平坦化膜上に位置する第１電極と、
前記第１電極上に位置する画素定義膜と、
前記第１電極及び前記画素定義膜上に位置し、少なくとも発光層を含む有機膜層と、
前記有機膜層上に位置する第２電極と、が設けられ、
前記非画素領域には、
メタル配線と、
前記メタル配線上に前記有機平坦化膜に接することなく位置し、前記第１基板と前記第２基板間を封止するガラスフリットと、が設けられている、ことを特徴とする有機電界発光表示装置。
【請求項2】
前記ガラスフリットは、酸化マグネシウム（ＭｇＯ）、酸化カルシウム（ＣａＯ）、酸化バリウム（ＢａＯ）、酸化リチウム（Li_2O）、酸化ナトリウム（Na_2O）、酸化カリウム（K_2O）、酸化ホウ素（B_2O_3）、酸化バナジウム（V_2O_5）、酸化亜鉛（ＺｎＯ）、酸化テルル（TeO_2）、酸化アルミニウム（Al_2O_3）、二酸化シリコン（SiO_2）、酸化鉛（ＰｂＯ）、酸化スズ（ＳｎＯ）、酸化リン（P_2O_5）、酸化ルテニウム（Ru_2O）、酸化ロジウム（Rh_2O）、酸化フェライト（Fe_2O_3）、酸化銅（ＣｕＯ）、酸化チタニウム（TiO_2）、酸化タングステン（WO_3）、酸化ビスマス（Bi_2O_3）、酸化アンチモン（Sb_2O_3）、ホウ酸鉛ガラス、リン酸スズガラス、バナジン酸ガラス、及びホウケイ酸ガラスよりなる群から選ばれた少なくとも１種の物質よりなる、ことを特徴とする請求項１に記載の有機電界発光表示装置。
【請求項3】
前記ガラスフリットは、前記第１基板の面内外側部に位置する、ことを特徴とする請求項１または２に記載の有機電界発光表示装置。
【請求項4】
前記メタル配線は、前記ゲート電極、前記ソース電極、前記ドレイン電極または前記第１電極のうちいずれか１つに接続されたラインである、ことを特徴とする請求項１ないし３のいずれかに記載の有機電界発光表示装置。
【請求項5】
前記メタル配線は、共通電源供給ラインである、ことを特徴とする請求項１ないし３のいずれかに記載の有機電界発光表示装置。
【請求項6】
前記非画素領域には、前記第２電極への電源供給ライン及びスキャンドライバを有する、ことを特徴とする請求項１ないし５のいずれかに記載の有機電界発光表示装置。
【請求項7】
画素領域及び非画素領域を備えた第１基板を用意する段階と、
前記画素領域の第１基板上に、半導体層、ゲート電極、ソース電極及びドレイン電極を含む薄膜トランジスタを形成し、且つ前記非画素領域の第１基板上にメタル配線を形成する段階と、
前記基板全面に有機平坦化膜を形成する段階と、
前記第１基板の面内外側部におけるメタル配線上の有機平坦化膜をエッチングして除去する段階と、
前記有機平坦化膜上に第１電極を形成する段階と、

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前記第１電極上に画素定義膜を形成する段階と、
前記非画素領域のメタル配線上の画素定義膜をエッチングして除去する段階と、
前記画素領域の第１電極及び画素定義膜上に、少なくとも発光層を含む有機膜層を形成する段階と、
前記基板全面に第２電極を形成する段階と、
前記非画素領域のメタル配線上の前記第２電極をエッチングして除去する段階と、
封止用の第２基板を用意する段階と、
前記第２基板の面内外側部にガラスフリットを塗布し、前記基板間を封止する段階と、を含む、ことを特徴とする有機電界発光表示装置の製造方法。
【請求項8】
前記メタル配線は、前記ゲート電極、前記ソース電極、前記ドレイン電極及び前記第１電極のうちいずれか１つを形成するのと同時に形成する、ことを特徴とする請求項７に記載の有機電界発光表示装置の製造方法。
【請求項9】
前記基板間を封止する段階では、前記ガラスフリットが前記メタル配線及び前記層間絶縁膜上に接着される、ことを特徴とする請求項７または８に記載の有機電界発光表示装置の製造方法。
【請求項10】
前記基板間を封止する段階以後に、前記ガラスフリットにレーザーを照射する段階をさらに含む、ことを特徴とする請求項７ないし９のいずれかに記載の有機電界発光表示装置の製造方法。
【請求項11】
前記ガラスフリットは、ディスペンシング法またはスクリーン印刷法で形成する、ことを特徴とする請求項７ないし１０のいずれかに記載の有機電界発光表示装置の製造方法。
【発明の詳細な説明】
【技術分野】
【0001】
本発明は、有機電界発光表示装置及びその製造方法に関し、より詳細には、基板をガラスフリットで封止する際、接着力の低下を防止できる有機電界発光表示装置及びその製造方法に関する。
【背景技術】
【0002】
最近、陰極線管（ｃａｔｈｏｄｅ　ｒａｙ　ｔｕｂｅ）のような従来の表示素子の短所を解決する液晶表示装置（ｌｉｑｕｉｄ　ｃｒｙｓｔａｌ　ｄｉｓｐｌａｙ　ｄｅｖｉｃｅ）、有機電界発光装置（ｏｒｇａｎｉｃ　ｅｌｅｃｔｒｏｌｕｍｉｎｅｓｃｅｎｃｅ　ｄｅｖｉｃｅ）またはＰＤＰ（ｐｌａｓｍａ　ｄｉｓｐｌａｙ　ｐａｎｅｌ）などのような平板型表示装置（ｆｌａｔ　ｐａｎｅｌ　ｄｉｓｐｌａｙ　ｄｅｖｉｃｅ）が注目されている。
【0003】
前記液晶表示装置は、自発光型ではなく、受光型のデバイスであるから、明るさ、コントラスト、視野角及び大面積化などに限界がある。また、ＰＤＰは、自発光型ではあるが、他の平板型表示装置に比べて重さが重くて、消費電力が高いだけでなく、製造方法が複雑であるという問題点がある。
【0004】
これに対し、有機電界発光表示装置は、自発光型のデバイスであるから、視野角、コントラストなどに優れていて、バックライトが不要なので、軽量及び薄形化が可能であり、消費電力の観点から有利である。また、直流低電圧駆動が可能であり、応答速度が速くて、全て固体からなるため、外部衝撃に強くて、使用温度範囲も広いだけでなく、製造方法が単純で、且つ安価であるという長所を有する。
【0005】
図１は、従来の有機電界発光表示装置を示す断面図である。
【0006】

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図１において、基板１００上には、その中央の画素領域Iに、半導体層１１０、ゲート絶縁膜１２０、ゲート電極１３０ａ、スキャンドライバ１３０ｂ、層間絶縁膜１４０、ソース・ドレイン電極１５０が設けられ、また両側の非画素領域IIには、ソース及びドレイン配線からなる共通電源供給ライン１５０ｂ及び第２電極電源供給ライン１５０ａが設けられる。

【0007】

次いで、前記基板１００の全面に平坦化膜１６０が設けられる。前記平坦化膜１６０は、有機物として、アクリル系樹脂またはポリイミド系樹脂からなる。

【0008】

次いで、前記平坦化膜１６０には、前記共通電源供給ライン１５０ｂ、第２電極電源供給ライン１５０ａ及びソース及びドレイン電極１５０を露出させるビアホールが設けられる。前記共通電源供給ライン１５０ｂを露出させる理由は、以後に基板をガラスフリットで封止する時、接着力を向上させるためである。

【0009】

次いで、前記基板１００上に、反射膜１７０を含む第１電極１７１が設けられ、前記基板１００全面に画素定義膜１８０が設けられる。

【0010】

次いで、前記第１電極１７１上に、少なくとも発光層を含む有機膜層１９０が設けられ、その上部に第２電極２００が設けられる。そして、前記基板１００に対向する封止基板２１０を用意し、前記基板１００と封止基板２１０とをガラスフリット２２０で封止することによって、従来の技術に係る有機電界発光表示装置が構成される。

【0011】

しかしながら、従来の有機電界発光表示装置は、基板を封止するガラスフリットの下部に有機平坦化膜が位置するので、ガラスフリットにレーザーを照射する際、レーザーの高熱により有機物からなる有機平坦化膜が損傷される。

【0012】

これにより、前記ガラスフリットが有機平坦化膜と接着する界面において接着力が低下するという短所がある。なお、封止構造に関連したものとして下記特許文献１～４がある。

【特許文献1】大韓民国公開第２００３－００８９４４７号明細書
【特許文献2】特開１９９８－０７４５８３号公報
【特許文献3】特開２００５－２１６７４６号公報
【特許文献4】特開２００５－３０２７３８号公報

【発明の開示】

【発明が解決しようとする課題】

【0013】

従って、本発明は、前述のような従来技術の諸問題点を解決するためになされたもので、本発明の目的は、基板をガラスフリットで封止する際、接着力の低下を防止できる構造の有機電界発光表示装置及びその製造方法を提供することにある。

【課題を解決するための手段】

【0014】

前記目的を達成するために、本発明の一態様に係る有機電界発光表示装置は、画素領域及び該画素領域以外の領域である非画素領域とを備えた第１基板と、前記基板を封止する封止基板と有し、前記画素領域には、半導体層、ゲート電極、ソース電極及びドレイン電極を含む薄膜トランジスタと、前記薄膜トランジスタ上に位置する有機平坦化膜と、前記有機平坦化膜上に位置する第１電極と、前記第１電極上に位置する画素定義膜と、前記第１電極及び前記画素定義膜上に位置し、少なくとも発光層を含む有機膜層と、前記有機膜層上に位置する第２電極と、が設けられ、前記非画素領域には、メタル配線と、前記メタル配線上に前記有機平坦化膜に接することなく位置し、前記第１基板と前記第２基板を封止するガラスフリットと、が設けられていることを特徴とする。

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【0015】
本発明の他の態様に係る有機電界発光表示装置の製造方法は、画素領域及び非画素領域を備えた第１基板を用意する段階と、前記画素領域の第１基板上に、半導体層、ゲート電極、ソース電極及びドレイン電極を含む薄膜トランジスタを形成し、且つ前記非画素領域の第１基板上にメタル配線を形成する段階と、前記基板全面に有機平坦化膜を形成する段階と、前記第１基板の面内外側部におけるメタル配線上の有機平坦化膜をエッチングして除去する段階と、前記有機平坦化膜上に第１電極を形成する段階と、前記第１電極上に画素定義膜を形成する段階と、前記非画素領域のメタル配線上の画素定義膜をエッチングして除去する段階と、前記画素領域の第１電極及び画素定義膜上に、少なくとも発光層を含む有機膜層を形成する段階と、前記基板全面に第２電極を形成する段階と、前記非画素領域のメタル配線上の第２電極をエッチングして除去する段階と、封止用の第２基板を用意する段階と、前記第２基板の面内外側部にガラスフリットを塗布し、前記基板間を封止する段階と、を含むことを特徴とする有機電界発光表示装置の製造方法。
【発明の効果】
【0016】
本発明の有機電界発光表示装置及びその製造方法は、基板をガラスフリットで封止する際、接着力の低下を防止することができ、有機電界発光素子の信頼性を高めることができるという効果がある。
【発明を実施するための最良の形態】
【0017】
以下、添付の図面を参照して、本発明の好適な実施形態を詳細に説明する。本発明の前記目的と技術的構成及びそれによる作用効果に関する詳細な事項は、本発明の好ましい実施形態を示している図面と下記の詳細な説明から明らかになるであろう。また、図面において、層及び領域の長さや厚さなどは、便宜上、誇張して表現している。明細書の全般において、同一の参照番号は、同一の構成要素を示す。
【0018】
図７Ａ乃至図７Ｅは、本発明の実施形態に係る有機電界発光表示装置を示す断面図である。
【0019】
一般的に、有機電界発光表示装置（Ｏｒｇａｎｉｃ　Ｌｉｇｈｔ　ＥｍｉｔｔＩｎｇ　ＤｅｖＩｃｅ：ＯＬＥＤ）は、電流が提供される配列により２つの基本的なタイプにグループ分けすることができる。図７Ａは、パッシブマトリクス式の有機電界発光表示装置（Ｐａｓｓｉｖｅ　ＭａｔｒＩｘ　ＯｒｇａｎＩｃ　ＬＩｇｈｔ　ＥｍｉｔｔＩｎｇ　Ｄｅｖｉｃｅ：ＰＭＯＬＥＤ）１０００の簡単な構造を概略的に示す斜視図である。また、図７Ｂは、アクティブマトリクス式の有機電界発光表示装置（ＡｃｔＩｖｅ　ＭａｔｒＩｘ　ＯｒｇａｎＩｃ　ＬＩｇｈｔ　ＥｍＩｔｔＩｎｇ　ＤｅｖＩｃｅ：ＡＭＯＬＥＤ）１００１の簡単な構造を概略的に示す斜視図である。有機電界発光表示装置１０００、１００１の構成は、基板１００２上に形成された有機電界発光画素を含み、有機電界発光画素は、アノード１００４と、カソード１００６と、有機膜層１０１０とを含む。ここで、適切な電流がアノード１００４に印加される時、電流は、画素を流れて貫通するようになり、可視光線が有機膜層から放出される。
【0020】
まず、図７Ａを参照するに、パッシブマトリクス式有機電界発光表示装置（ＰＭＯＬＥＤ）は、一般的にストリップ形態のカソード１００６と、これに直交するように配列されたストリップ形態のアノード１００４と、両者の間に介在された有機膜層１０１０を含む。この際、カソード１００６とアノード１００４の交差により個々のＯＬＥＤ画素（ピクセル）が定義され、対応するアノード１００４とカソード１００６を適切に付勢することにより光が生成される。このパッシブマトリクス式有機電界発光表示装置は、簡単に製作ができるという利点を有する。
【0021】

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次に、図７Ｂを参照するに、アクティブマトリクス式有機電界発光表示装置（ＡＭＯＬＥＤ）は、基板１００２とＯＬＥＤ画素アレイとの間に駆動回路１０１２を含む。ＡＭＯＬＥＤの個々の画素は、共通のカソード１００６及び電気的に遮断された各々のアノード１００４により定義される。各駆動回路１０１２は、ＯＬＥＤ画素のアノード１００４と結合され、またデータライン１０１６及びスキャンライン１０１８とも連結される。例えば、スキャンライン１０１８は、駆動回路の列を選択する選択信号であるスキャン信号を供給し、データライン１０１６は、特定の駆動回路用のデータ信号を供給する。このデータ信号及びスキャン信号を受けて作動する駆動回路１０１２によりアノード１００４が付勢され、対応する画素から光が放出される。

【0022】

前述したＡＭＯＬＥＤにおいては、駆動回路１０１２、データライン１０１６及びスキャンライン１０１８は、画素アレイと基板１００２との間に介在された平坦化膜１０１４に覆われる。前記平坦化膜１０１４は、ＯＬＥＤ画素アレイ上に平坦な表面を提供する。前記平坦化膜１０１４は、有機物または無機物で形成されることができ、単一層または二重層で形成されることができる。前記駆動回路１０１２は、薄膜トランジスタと一緒に形成され、ＯＬＥＤ画素アレイの下部に格子で配列される。前記駆動回路１０１２は、部分的に有機物質で形成された有機薄膜トランジスタを含む。このようなＡＭＯＬＥＤは、速い応答速度を有するだけでなく、ＰＭＯＬＥＤより消費電力が低いという利点がある。

【0023】

前記ＰＭＯＬＥＤとＡＭＯＬＥＤの共通的な特徴を考察するに、基板１００２は、ＯＬＥＤ画素及び回路を構造的に支持する。前記基板１００２は、プラスチック、ガラスまたは不透明物質を含むことができる。前記ＯＬＥＤ画素またはダイオードは、アノード１００４と、カソード１００６と、前記アノード１００４とカソード１００６との間に介在される有機膜層１０１０とから構成される。ここで、適切な電流がアノード１００４に印加された場合、カソード１００４は電子を放出し、アノード１００４は正孔を放出する。これとは異なって、基板１００２上にカソードが形成され、アノードが反対側に配列されるインバーテッド構造もあり得る。

【0024】

前記カソード１００６とアノード１００４との間に少なくとも１つ以上の有機膜層が介在される。より詳細には、カソード１００６とアノード１００４との間に少なくとも１つ以上の発光層が介在される。発光層は、１つ以上の有機化合物を含むことができる。通常、発光層は、青色、緑色、赤色または白色のような単一色の可視光線を発光する。この際、前記有機膜層１０１０は、カソード１００６とアノード１００４との間に形成され、光を放出する役目をする。また、前記カソード１００６とアノード１００４との間に正孔輸送層、正孔注入層、電子輸送層及び電子注入層をさらに含むことができる。

【0025】

前記正孔輸送層または正孔注入層は、発光層としての有機膜層１０１０とアノード１００４との間に位置することができる。また、電子輸送層または電子注入層は、カソード１００６と有機膜層１０１０との間に位置することができる。前記電子注入層は、カソード１００６から電子を注入するための仕事関数を低減し、有機膜層１０１０への電子注入を円滑にする。同様に、正孔注入層は、アノード１００４から発光層に正孔注入を円滑にする。前記正孔と電子注入層は、各々電極から発光層にキャリアの移動を円滑にする。

【0026】

一実施形態として、１つの層をもって電子注入及び輸送の役割または正孔注入及び輸送の役目を共に行うことができる。また、他の実施形態として、これらの１つまたはそれ以上は、欠如されてもよい。また、少なくとも１つ以上の有機膜層は、キャリアの注入または輸送を助ける１つ以上の物質がドープされてもよい。ここで、１つの有機膜層がカソードとアノードとの間に形成される場合には、有機膜層は、有機発光化合物だけでなく、キャリアの注入または輸送を助ける機能性物質を含むことができる。この際、前記発光層を含んでこの層内に使用され得るように開発された数多くの有機物質を含めることができる

。また、前記発光層内に使用できる多くの有機物質が開発されている。一実施形態として、このような有機物質は、オリゴマー重合体を含む高分子物質であってもよい。また、発光層の有機物質は、微細な小さい分子であってもよい。

【0027】

電気回路が、カソード１００６とアノード１００４との間に適切な電位を与える。この結果、間に介在する有機膜を介してアノード１００４からカソード１００６に電流が流れる。この際、前記カソード１００６は、隣接する有機膜層１０１０に電子を提供し、アノード１００４は、有機膜層１０１０に正孔を注入する。ここで、正孔と電子とは、有機膜層１０１０で再結合し、“励起子”を生成する。励起子は、有機膜層１０１０内の有機発光物質にエネルギーを提供し、そのエネルギーは、有機発光物質から光を発光するのに使われる。前記ＯＬＥＤ１０００、１００１により生成され放出される光の特性は、有機膜層内の有機分子の性格及び構成によって変わることができる。

【0028】

前記ＯＬＥＤは、光の発光方向によって分けられる。前面発光ＯＬＥＤと呼ばれるタイプは、カソードまたは上部電極１００６を介してイメージを表示する。この際、カソード１００６は、可視光線を透過させる程度に透明な物質で形成される。また、アノードまたは下部電極１００４を介して光の損失を防ぐために、アノードは、光を反射できる物質で形成される。他のタイプのＯＬＥＤは、アノードまたは下部電極１００４を介して光を放出する背面発光タイプである。前記背面発光ＯＬＥＤにおいて、アノード１００４は、光を透過できる程度に透明な物質で形成される。また、カソード１００６は、光を反射できる物質で形成される。さらに他のタイプのＯＬＥＤは、アノード１００４とカソード１００６の両方の方向に光を放出するものであって、基板が透明な物質で形成される。

【0029】

次に、具体的な多くの形態では、図７Ｃに示すように、多数のＯＬＥＤ画素を含むＯＬＥＤ画素アレイ１０２１が、基板１００２上に形成される。前記アレイ１０２１の画素は、駆動回路によってオン・オフ制御され、画素の大部分は、アレイ１０２１上の全体ディスプレイ情報またはイメージとなる。また、ＯＬＥＤ画素アレイ１０２１は、発光領域及び非発光領域の境界を画するものであり、これらの領域には他の構成要素も配列される。すなわち、発光領域は、ＯＬＥＤ画素アレイ１０２１が形成された基板１００２上の領域であり、非発光領域は、発光領域以外の領域である。前記非発光領域には、ロジックまたは電力供給回路を含むことができる。また、ＡＭＯＬＥＤにおいて、駆動回路と、前記駆動回路と結合されるデータ及びスキャンラインは、ＡＭＯＬＥＤの各画素を駆動及び制御するために発光領域に拡張することができる。

【0030】

前記ＯＬＥＤは、有機物質層が水分、酸素または他の有害なガスにより損傷または低下することを考慮に入れて製作される。したがって、ＯＬＥＤは、水分、酸素または他の有害なガスが侵入することを防止できるように、封止する。

【0031】

ここで、図７Ｄは、図７ＣのＤ－Ｄ線に沿った断面図である。同図に示すごとく、ＯＬＥＤ画素アレイ１０２１を密閉させるために、上部基板１０６１と下部基板１００２とを、シール材１０７１を用いて封止する。この実施形態においては、上部基板１０６１または下部基板１００２に１つ以上の層を形成し、上部または下部基板１０６１、１００２をシール材１０７１で封止する。この際、シール材１０７１は、ＯＬＥＤ画素アレイ１０２１の周辺に沿って下部または上部基板１００２、１０６１に位置する。

【0032】

この際、前記シール材１０７１は、後述するフリット物質で形成される。上部または下部基板１０６１、１００２は、酸素または水分による露出からＯＬＥＤ画素アレイ１０２１を保護するために、プラスチック、ガラス、金属箔などのような物質を含む。例えば、上部基板１０６１と下部基板１００２のうち少なくとも一方は、全体的に透明な物質で形成される。

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【0033】
したがって、ＯＬＥＤの寿命を長くするために、上部基板１０６１、下部基板１００２及びシール材１０７１は、酸素と水蒸気を遮断する空間領域１０８１を形成する。一適用例として、上部と下部基板１０６１，１００２を結合するフリット物質からなるシール材１０７１は、10^{-3}ｃｃ／m^2 ｄａｙの酸素遮断能力と10^{-6}ｇ／m^2 ｄａｙの水分遮断能力を示す。この際、一部の酸素と湿気は、遮断領域１０８１内に侵入することができるので、遮断領域１０８１内に酸素と水分を吸入できる物質を形成する。
【0034】
次に、図７Ｄに示されたように、シール材１０７１は、上部または下部基板１０６１、１００２の表面に平行する方向に見た厚さである幅Ｗを有する。この際、前記幅Ｗは、３００乃至３０００μｍの幅を有することができる。好ましくは、５００乃至１５００μｍの幅を有することができる。また、前記幅Ｗは、シール材１０７１の他の位置で多様化される。例えば、シール材１０７１の幅は、下部基板と上部基板１００２、１０６１のうちいずれか一方に当接する領域のシール材１０７１が最も大きいことができる。
【0035】
また、図７Ｄに示すように、前記シール材１０７１は、上部または下部基板１０６１、１００２の表面に垂直な方向に見た幅である高さＨを有する。この際、前記高さＨは、２乃至３０μｍの高さを有することができる。好ましくは、１０乃至１５μｍである。また、前記シール材１０７１の位置による高さは多様化されることができる。
【0036】
図示の実施形態の場合、前記シール材１０７１は、一般的な断面を有する。しかし、このシール材１０７１は、必要に応じて方形、台形または円形の多様な断面形態を有することができる。この際、密封力を高めるために、一般的に下部基板または上部基板１００２、１０６１に直接接触するシール材１０７１の領域を増加させることができる。一実施形態として、シール材の形態は、界面積が増加し得るように形成することができる。
【0037】
前記シール材１０７１は、ＯＬＥＤアレイ１０２１に直ぐに隣接するように位置させることもできるし、ＯＬＥＤアレイ１０２１から離隔された空間に位置させることもできる。一例として、前記シール材１０７１は、ＯＬＥＤアレイ１０２１の周囲を包囲するために一般的に線形に形成される。また、前記シール材１０７１は、ＯＬＥＤアレイ１０２１の境界に平行するように設けることができる。他の例として、前記シール材１０７１は、ＯＬＥＤアレイ１０２１の境界に平行でないように位置させることができる。この際、前記シール材１０７１の少なくとも一部は、上部基板１０６１と下部基板１００２との間に位置させる。
【0038】
前述したように、前記シール材１０７１は、微細ガラス粒子を含むフリット物質（本明細書においては単に“フリット”または“ガラスフリット”とも称する）で形成される。このフリット物質は、酸化マグネシウム（ＭｇＯ）、酸化カルシウム（ＣａＯ）、酸化バリウム（ＢａＯ）、酸化リチウム（Li_2O）、酸化ナトリウム（Na_2O）、酸化カリウム（K_2O）、酸化ホウ素（B_2O_3）、酸化バナジウム（V_2O_5）、酸化亜鉛（ＺｎＯ）、酸化テルル（TeO_2）、酸化アルミニウム（Al_2O_3）、二酸化シリコン（SiO_2）、酸化鉛（ＰｂＯ）、酸化スズ（ＳｎＯ）、酸化リン（P_2O_5）、酸化ルテニウム（Ru_2O）、酸化ロジウム（Rh_2O）、酸化フェライト（Fe_2O_3）、酸化銅（ＣｕＯ）、酸化チタニウム（TiO_2）、酸化タングステン（WO_3）、酸化ビスマス（Bi_2O_3）、酸化アンチモン（Sb_2O_3）、ホウ酸鉛ガラス、リン酸スズガラス、バナジン酸ガラス、及びホウケイ酸ガラスよりなる群から選ばれた一種又はそれ以上の物質からなることができる。また、粒子サイズは、２乃至３０μｍであることができ、好ましくは、５乃至１０μｍであることができる。前記フリット物質は、前記フリットシール材１０７１に接触する上部基板及び下部基板１０６１、１００２間の間隔分のまとまった大きさにすることができる。

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【0039】
前記シール材１０７１を形成するためのフリット物質は、１つ以上の充填物または添加物を含むことができる。前記充填物または添加物は、シール材の熱膨張特性を調整し、選択された周波数による吸収特性を調整するためである。また、充填物または添加物は、フリットの熱膨張系を調整するために添加された充填物をさらに含むことができる。例えば、充填物または添加物は、遷移金属、クロム（Ｃｒ）、鉄（Ｆｅ）、マンガン（Ｍｎ）、コバルト（Ｃｏ）、銅（Ｃｕ）及びバナジウムを含むことができる。また、付加的に充填物または添加物は、$ZnSIO_4$、$PbTIO_3$、ZrO_2及びユークリプタイト（ｅｕｃｒｙｐｔＩｔｅ）をさらに含むことができる。
【0040】
前記フリット物質は、２０乃至９０ｗｔ％のガラス粒子を含み、残りとして充填物または添加物を含む。また、フリットペーストは、１０乃至３０ｗｔ％の有機物質及び７０乃至９０％の無機物質を含む。また、前記フリットペーストは、２０ｗｔ％の有機物質及び８０ｗｔ％の無機物質を含むことができる。また、有機物質は、０乃至３０ｗｔ％のバインダー及び７０乃至１００ｗｔ％のソルベントを含むことができる。また、有機物質は、１０ｗｔ％のバインダー及び９０ｗｔ％ソルベントを含むことができる。また、無機物質は、０乃至１０ｗｔ％添加物と、２０乃至４０ｗｔ％の充填物、及び５０乃至８０ｗｔ％のガラスパウダーを含むことができる。また、無機物質は、０乃至５ｗｔ％の添加物と、２５乃至３０ｗｔ％の充填物及び６５乃至７５ｗｔ％のガラスパウダーを含むことができる。
【0041】
前記フリットシール材を形成するには、乾燥フリット物質に液体物質を追加してフリットペーストを形成する。添加物を含むか、含まない有機または無機ソルベントを、液体物質として利用することができる。一実施形態として、ソルベントは、１つ以上の有機化合物を含む。例えば、適用可能な有機化合物として、エチルセルロース（ｅｔｈｙｌｃｅｌｌｕｌｏｓｅ）、ニトロセルロース（ｎＩｔｒｏ　ｃｅｌｌｕｌｏｓｅ）、ヒドロキシルプロピルセルロース（ｈｙｄｒｏｘｙｌ　ｐｒｏｐｙｌ　ｃｅｌｌｕｌｏｓｅ）、ブチルカルビトールアセテート（ｂｕｔｙｌ　ｃａｒｂＩｔｏｌ　ａｃｅｔａｔｅ）、テルピネオール（ｔｅｒｐＩｎｅｏｌ）、ブチルセルロース（ｂｕｔｙｌ　ｃｅｌｌｕｓｏｌｖｅ）、アクリレート（ａｃｒｙｌａｔｅ）化合物が挙げられる。また、前記シール材１０７１は、このように形成したフリットペーストを上部または下部基板１０６１、１００２に適用することができる。
【0042】
一実施形態として、前記シール材１０７１を、まず、フリットペーストから形成し、上部基板１０６１と下部基板１００２との間に設ける。次に、このシール材１０７１を、上部基板及び下部基板１０６１、１００２の一方に前処理（プレキュア）または前焼成する。この際、上部基板１０６１と下部基板１００２との間に介在する前記シール材１０７１は、部分的に加熱され溶融される。次に、前記ＯＬＥＤ画素アレイ１０２１が露出して酸素または水分に晒されることを防止するために、前記シール材１０７１が固体化され、上部基板１０６１と下部基板１００２とを結合する。
【0043】
この際、前記フリットシール材に選択的に熱を加えることは、レーザーまたは赤外線ランプのように光を照射する方法を利用する。上記のように、前記シール材１０７１を形成するためのフリット物質は、前記シール材１０７１を形成するためのフリット物質に熱を加えて溶ける特性を改良するために選択された１つ以上の添加剤または充填剤を含むことができる。
【0044】
次に、図７Ｅは量産形態を示したもので、多数の分離されたＯＬＥＤ画素１０２１が、共通の下部基板１１０１上に形成される。図示の実施形態の場合、各ＯＬＥＤアレイ１０２１は、前記熱により付形されたシール材１０７１によって周囲を取り囲まれている。ま

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た、共通の上部基板（図示せず）が、ＯＬＥＤ画素１０２１が形成された共通の下部基板１１０１を覆い、フリットペーストは、この共通の下部基板１１０１と共通の上部基板との間に介在される。したがって、ＯＬＥＤアレイ１０２１は、上述の単一のＯＬＥＤ表示装置で説明したような工程を経て、封止され完成される。

【0045】

図２乃至図５は、本発明の第１実施形態に係る有機電界発光表示装置の製造方法を示す断面図である。

【0046】

図２を参照して、まず第１基板として画素領域I及び非画素領域IIを備えた基板３００を用意する。前記基板３００は、絶縁ガラス、プラスチックまたは導電性基板を使用することができる。

【0047】

次に、前記基板３００全面にバッファ層３１０を形成する。前記バッファ層３１０は、シリコン酸化膜、シリコン窒化膜またはこれらの多重層であってもよい。前記バッファ層３１０は、下部の基板から不純物が上部に上がらないように防止する保護膜の役割をする。

【0048】

次に、前記画素領域Iの前記バッファ層３１０上に半導体層３２０を形成する。前記半導体層３２０は、非晶質シリコン膜、またはこれを結晶化した多結晶シリコン膜であってもよい。次いで、前記基板３００全面にゲート絶縁膜３３０を形成する。前記ゲート絶縁膜３３０は、シリコン酸化膜、シリコン窒化膜またはこれらの多重層であってもよい。

【0049】

その後、前記ゲート絶縁膜３３０上に、前記半導体層３２０の一部領域と対応するようにゲート電極３４０ａを形成する。前記ゲート電極３４０ａは、Ａｌ、ＣｕまたはＣｒを使用することができる。

【0050】

次に、前記基板３００全面に層間絶縁膜３５０を形成する。前記層間絶縁膜３５０は、シリコン酸化膜、シリコン窒化膜またはこれらの多重層であってもよい。前記画素領域I上の前記層間絶縁膜３５０及びゲート絶縁膜３３０をエッチングして、前記半導体層３２０を露出させるコンタクトホール３５１、３５２を形成する。

【0051】

次に、前記画素領域I上の層間絶縁膜３５０上にソース電極及びドレイン電極３６０ａ、３６０ｂを形成する。前記ソース電極及びドレイン電極３６０ａ、３６０ｂは、Ｍｏ、Ｃｒ、Ａｌ、Ｔｉ、Ａｕ、ＰｄまたはＡｇよりなる群から選ばれた１つを使用することができる。また、前記ソース電極及びドレイン電極３６０ａ、３６０ｂは、前記コンタクトホール３５１、３５２を介して前記半導体層１２０に連結される。

【0052】

一方、前記非画素領域II上には、前記ソース電極及びドレイン電極３６０ａ、３６０ｂを形成するのと同時に、共通電源供給ラインとして作用するメタル配線３６０ｄが形成される。また、第２電極電源供給ライン３６０ｃも形成される。

【0053】

また、前記非画素領域II上には、前記ゲート電極３４０ａを形成する時、スキャンドライバ３４０ｂが同時に形成される。

【0054】

本実施形態では、トップゲート構造の薄膜トランジスタを形成したが、これとは異なって、ゲート電極が半導体層の下部に位置するボトムゲート構造の薄膜トランジスタを形成することもできる。

【0055】

また、本実施形態では、ソース電極及びドレイン電極を形成するのと同時にメタル配線を形成したが、これとは異なって、ゲート電極または第１電極を形成するのと同時にメタ

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ル配線を形成することもできる。

【0056】

その後、図３に示すように、前記基板３００の全面に有機平坦化膜３７０を形成する。前記有機平坦化膜３７０は、アクリル系樹脂、ポリイミド系樹脂またはＢＣＢ（ｂｅｎｚｏｃｙｃｌｏｂｕｔｅｎｅ）を使用することができる。

【0057】

この際、有機平坦化膜３７０をエッチングして、前記画素領域Ｉの前記ソース電極及びドレイン電極３６０ａ、３６０ｂのうちいずれか一方と前記非画素領域ＩＩの第２電極電源供給ライン３６０ｃを露出させるビアホール３７１ａ、３７１ｂを形成する。

【0058】

また、前記非画素領域ＩＩにおいて、以後にガラスフリットが形成されるべき領域の前記有機平坦化膜３７０をエッチングして除去する。これは、以後にガラスフリットで封止する時、前記ガラスフリットにレーザーを照射して接着するようになるが、この際、前記ガラスフリットの下部に、有機物からなる平坦化膜が存在すると、前記レーザーの高熱により損傷される。これにより、前記ガラスフリットが平坦化膜と接着する界面において剥離し、接着力が低下するという短所がある。

【0059】

そこで、以後に前記ガラスフリットが接着される前記基板３００の外側（基板面内の外側部）のメタル配線上の平坦化膜を除去して、前述のような短所が発生することを防止する。

【0060】

次に、図４に示すように、前記画素領域Ｉの有機平坦化膜３７０上に反射膜３７５を含む第１電極３８０を形成する。前記第１電極３８０は、前記ビアホール３７１の底部に位置し、前記露出したソース電極及びドレイン電極３６０ａ、３６０ｂのいずれか一方に当接し、前記有機平坦化膜３７０上に延びる。前記第１電極３８０は、ＩＴＯ（Ｉｎｄｉｕｍ　ＴＩｎ　Ｏｘｉｄｅ）またはＩＺＯ（Ｉｎｄｉｕｍ　ＺＩｎｃ　Ｏｘｉｄｅ）を使用することができる。

【0061】

次に、前記第１電極３８０を含む基板３００全面に画素定義膜３９０を形成するが、前記第１電極３８０が位置したビアホール３７１ａを十分に満たすことができる程度の厚さに形成する。前記画素定義膜３９０は、有機膜または無機膜で形成できるが、好ましくは、有機膜で形成する。より好ましくは、前記画素定義膜３９０は、ＢＣＢ（ｂｅｎｚｏｃｙｃｌｏｂｕｔｅｎｅ）、アクリル系高分子及びポリイミドよりなる群から選ばれた１つから形成する。前記画素定義膜は、流動性（ｆｌｏｗａｂｉｌｉｔｙ）に優れているので、前記基板全体に平坦に形成できる。

【0062】

この際、画素定義膜３９０をエッチングして、前記画素領域Ｉの前記第１電極３８０を露出させる開口部３９５ａを形成し、前記非画素領域ＩＩの画素定義膜３９０をエッチングして、第２電極電源供給ライン３６０ｃの一部領域を露出させる。また、前記非画素領域ＩＩのメタル配線３６０ｄ領域に前記画素定義膜３９０が存在しないように、前記画素定義膜３９０をエッチングする。

【0063】

次に、前記開口部３９５ａを介して露出した第１電極３８０上に有機膜層４００を形成する。前記有機膜層４００は、少なくとも発光層を含み、正孔注入層、正孔輸送層、電子輸送層または電子注入層のうちいずれか１つ以上の層を追加に含むことができる。

【0064】

次に、前記基板３００の全面に第２電極４１０を形成する。前記第２電極４１０は、透過電極であり、透明で且つ仕事関数が低いＭｇ、Ａｇ、Ａｌ、Ｃａ及びこれらの合金のうちいずれか１つ以上を使用して形成する。

【0065】

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この際、前記非画素領域IIの前記メタル配線３６０ｄ上における第２電極４１０をエッチングにより除去し、前記メタル配線３６０ｄを露出させる。

【0066】

次に、図５に示すように、前記基板３００に対向させる第２基板として封止基板４２０を用意する。前記封止基板４２０には、エッチングされた絶縁ガラスまたはエッチングしない絶縁ガラスを使用する。

【0067】

次に、前記封止基板４２０の外側、正確には基板の面内外側部にガラスフリット４３０を形成する。すなわち、前記基板３００に対向させる封止基板４２０の面内外側部にガラスフリット４３０を塗布する。

【0068】

前記ガラスフリット４３０は、酸化マグネシウム（ＭｇＯ）、酸化カルシウム（ＣａＯ）、酸化バリウム（ＢａＯ）、酸化リチウム（Li_2O）、酸化ナトリウム（Na_2O）、酸化カリウム（K_2O）、酸化ホウ素（B_2O_3）、酸化バナジウム（V_2O_5）、酸化亜鉛（ＺｎＯ）、酸化テルル（TeO_2）、酸化アルミニウム（Al_2O_3）、二酸化シリコン（SiO_2）、酸化鉛（ＰｂＯ）、酸化スズ（ＳｎＯ）、酸化リン（P_2O_5）、酸化ルテニウム（Ru_2O）、酸化ロジウム（Rh_2O）、酸化フェライト（Fe_2O_3）、酸化銅（ＣｕＯ）、酸化チタニウム（TiO_2）、酸化タングステン（WO_3）、酸化ビスマス（BI_2O_3）、酸化アンチモン（Sb_2O_3）、ホウ酸鉛ガラス、リン酸スズガラス、バナジン酸ガラス、及びホウケイ酸ガラスよりなる群から選ばれた１種の物質またはこれらの組合よりなるものを使用することができ、ディスペンシング法またはスクリーン印刷法を用いて塗布することができる。

【0069】

前記ガラスフリット４３０の幅は、前記メタル配線３６０ｄの幅より広く形成する。これは、前記ガラスフリット４３０が接着される面積が広いほど接着力を向上させることができ、外部の水分や酸素の侵入から有機電界発光素子を保護することができるからである。

【0070】

本実施形態では、前記封止基板４２０上にガラスフリット４３０を形成したが、前記基板３００上に形成してもよい。

【0071】

次に、前記基板３００と封止基板４２０を整列させた後、接合する。この際、前記ガラスフリット４３０は、有機平坦化膜３７０、画素定義膜３９０及び第２電極４１０の存在しない領域に在るので、有機平坦化膜３７０と非接触状態で、基板３００の前記非画素領域II上のメタル配線３６０ｄ及び層間絶縁膜３５０と接触するようになる。

【0072】

次に、前記ガラスフリット４３０にレーザーを照射して、前記ガラスフリット４３０を溶融し、固状化し、前記基板及び封止基板に接着することによって、本発明の有機電界発光表示装置を完成する。このレーザー照射に際し、前記ガラスフリット４３０は、前記メタル配線３６０ｄ上に、前記有機平坦化膜３７０に接することなく位置しているので、レーザーの高熱により有機平坦化膜が損傷されることが防止される。

【0073】

以上のように、従来、基板を封止するガラスフリットの下部に有機平坦化膜が位置し、ガラスフリットにレーザーを照射する時、レーザーの高熱により有機物からなる有機平坦化膜が損傷され、ガラスフリットが有機平坦化膜と接着する界面において剥離し、接着力が低下するという短所があったが、前記ガラスフリットの下部に位置する有機平坦化膜を除去することによって、前記ガラスフリットの接着力が低下するという短所を防止することができる。

【0074】

図６は、本発明の第２実施形態に係る有機電界発光表示装置を示す断面図である。なお

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、図中、符号５００、５１０、５２０、５３０、５４０ａ、５４０ｂ、５５０、５５１、５５２、５６０ａ、５６０ｂ、５６０ｃ、５６０ｄ、５７０、５７１ａ、５７１ｂ、５７５、５８０、５９０、５９５ａ、５９５ｂ、６００、６１０、６２０は、それぞれ図２～図５中の符号３００、３１０、３２０、３３０、３４０ａ、３４０ｂ、３５０、３５１、３５２、３６０ａ、３６０ｂ、３６０ｃ、３６０ｄ、３７０、３７１ａ、３７１ｂ、３７５、３８０、３９０、３９５ａ、３９５ｂ、４００、４１０、４２０と対応する同一の構成要素を示す。

【0075】

図６の有機電界発光表示装置においても、図２～図５の前記第１実施形態と同様に、有機電界発光素子を形成し、封止基板６２０上に前記ガラスフリット４３０に対応するガラスフリット６３０を塗布し、基板５００と封止基板６２０を接合する。次に、前記ガラスフリット６３０にレーザーを照射して、前記ガラスフリット６３０を溶融し、固状化することによって、本発明の第２実施形態に係る有機電界発光表示装置を完成する。

【0076】

この第２実施形態では、前記第１実施形態の前記ガラスフリット４３０とは異なって、前記ガラスフリット６３０の幅は、前記メタル配線５６０ｄの幅と同一であるか、又は狭く形成される。これは、前記ガラスフリット６３０による基板５００と封止基板６２０との接着力を考慮したもので、ガラスフリット６３０が前記メタル配線５６０ｄ上に接着された構造とすることで、接着力を向上させることができるからである。

【0077】

また、前記ガラスフリット６３０の下部に有機平坦化膜５７０が存在しないので、前記ガラスフリット６３０の接着力が低下することを防止することができる。

【0078】

以上のように、従来、基板を封止するガラスフリットの下部に有機平坦化膜が位置し、ガラスフリットにレーザーを照射する時、レーザーの高熱により有機物からなる有機平坦化膜が損傷され、ガラスフリットが有機平坦化膜と接着する界面から剥離して接着力が低下する短所を、前記ガラスフリットの下部に位置する有機平坦化膜を除去することによって防止することができるという利点がある。

【0079】

したがって、外部の水分や酸素の侵入を防止することができ、有機電界発光素子の信頼性を向上させることができるという利点がある。

【0080】

本発明の第１及び第２実施形態では、基板の左右側に位置し、且つガラスフリットの下部に位置するメタル配線を例に挙げたが、基板の上下側に位置し、且つガラスフリットの下部に位置するメタル配線にも同様に適用することができる。

【0081】

以上において説明した本発明は、本発明が属する技術の分野における通常の知識を有する者であれば、本発明の技術的思想を逸脱しない範囲内で、様々な置換、変形及び変更が可能であるので、上述した実施形態及び添付された図面に限定されるものではない。

【図面の簡単な説明】

【0082】

【図1】従来の有機電界発光表示装置を示す断面図である。

【図2】本発明の第１実施形態に係る有機電界発光表示装置の製造途中における構造の断面図である。

【図3】本発明の第１実施形態に係る有機電界発光表示装置の製造途中における構造の断面図である。

【図4】本発明の第１実施形態に係る有機電界発光表示装置の製造途中における構造の断面図である。

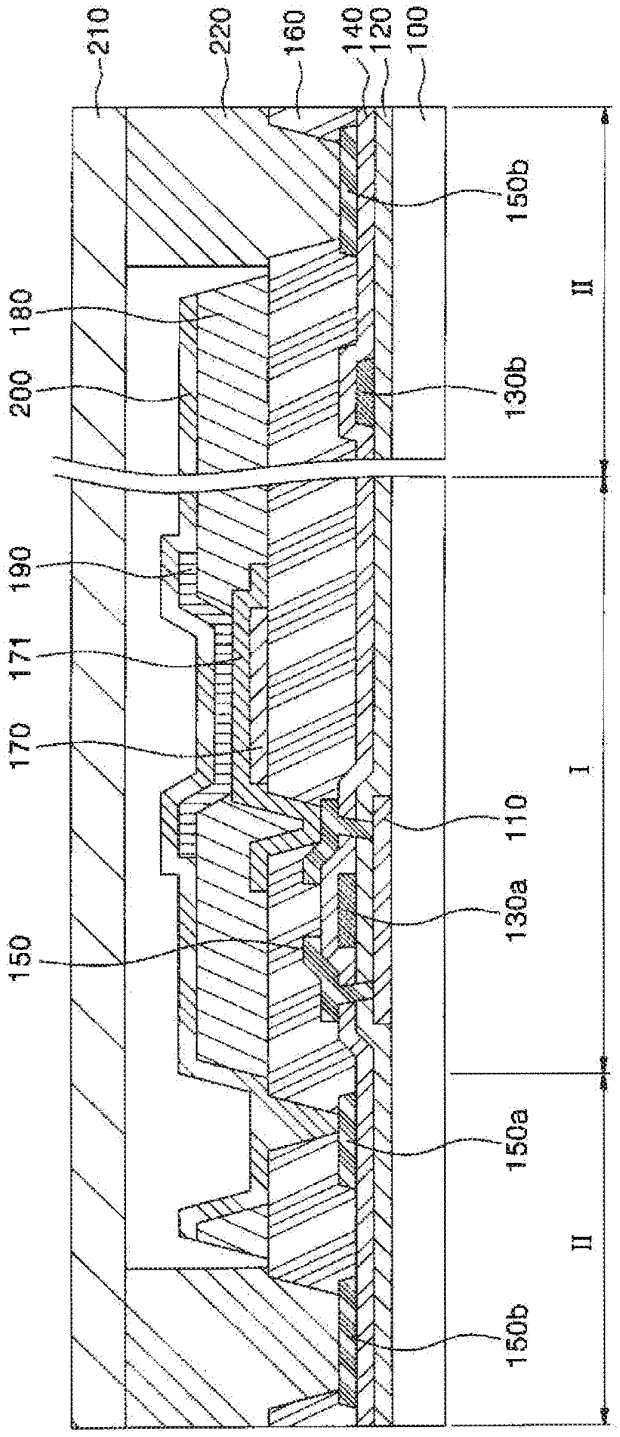
【図5】本発明の第１実施形態に係る有機電界発光表示装置の製造が終了した段階における構造の断面図である。

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【図6】本発明の第２実施形態に係る有機電界発光表示装置の構造を示す断面図である。
【図7A】本発明の実施形態に係るパッシブマトリックス式有機電界発光表示装置の要部を示す分解斜視図である。
【図7B】本発明の実施形態に係るアクティブマトリックス式有機電界発光表示装置の要部を示す分解斜視図である。
【図7C】本発明の実施形態に係る有機電界発光表示装置を示す上面図である。
【図7D】図７ＣのＤ－Ｄ線に沿った有機電界発光表示装置の断面図である。
【図7E】本発明の有機電界発光表示装置の量産形態を示す斜視図である。
【符号の説明】
【0083】
３００　基板、
３１０　バッファ層、
３２０　半導体層、
３３０　ゲート絶縁膜、
３４０ａ　ゲート電極、
３４０ｂ　スキャンドライバ、
３５０　層間絶縁膜、
３５１、３５２　コンタクトホール、
３６０ａ　ソース電極、
３６０ｂ　ドレイン電極、
３６０ｃ　第２電極電源供給ライン、
３６０ｄ　メタル配線、
３７０　有機平坦化膜、
３７１ａ、３７１ｂ、３７１ｃ　ビアホール、
３７５　反射膜、
３８０　第１電極、
３９０　画素定義膜、
３９５ａ　開口部、
４００　有機膜層、
４１０　第２電極、
４２０　封止基板、
４３０　ガラスフリット、
１０００、１００１　有機電界発光表示装置、
１００２　基板、
１００４　アノード、
１００６　カソード、
１０１０　有機膜層、
１０１２　駆動回路、
１０１４　平坦化膜、
１０１６　データライン、
１０１８　スキャンライン、
１０２１　ＯＬＥＤ画素アレイ、
１０７１　シール材。

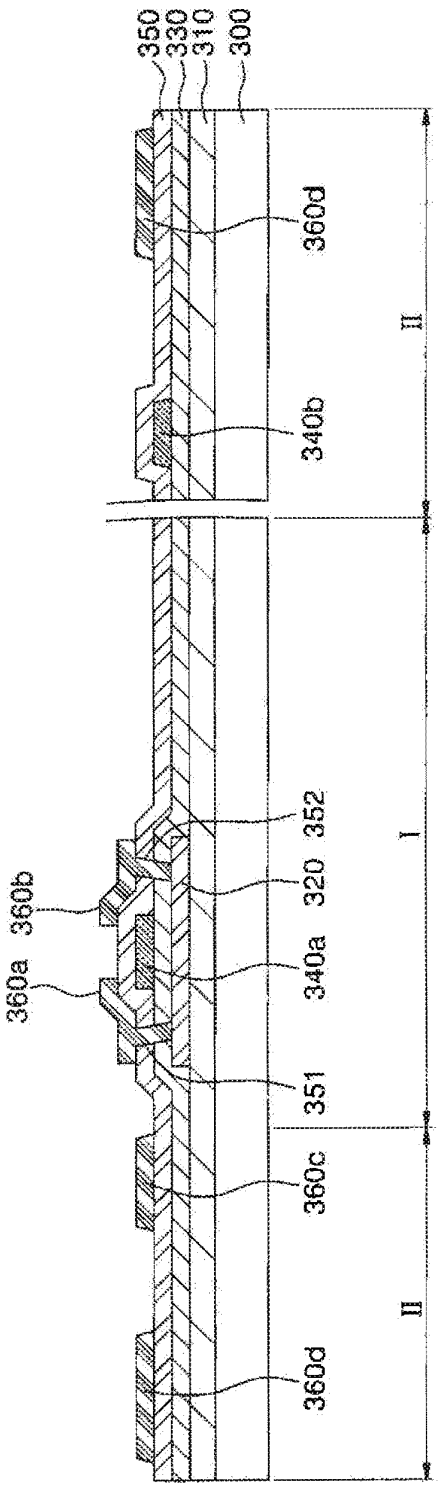
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【図1】



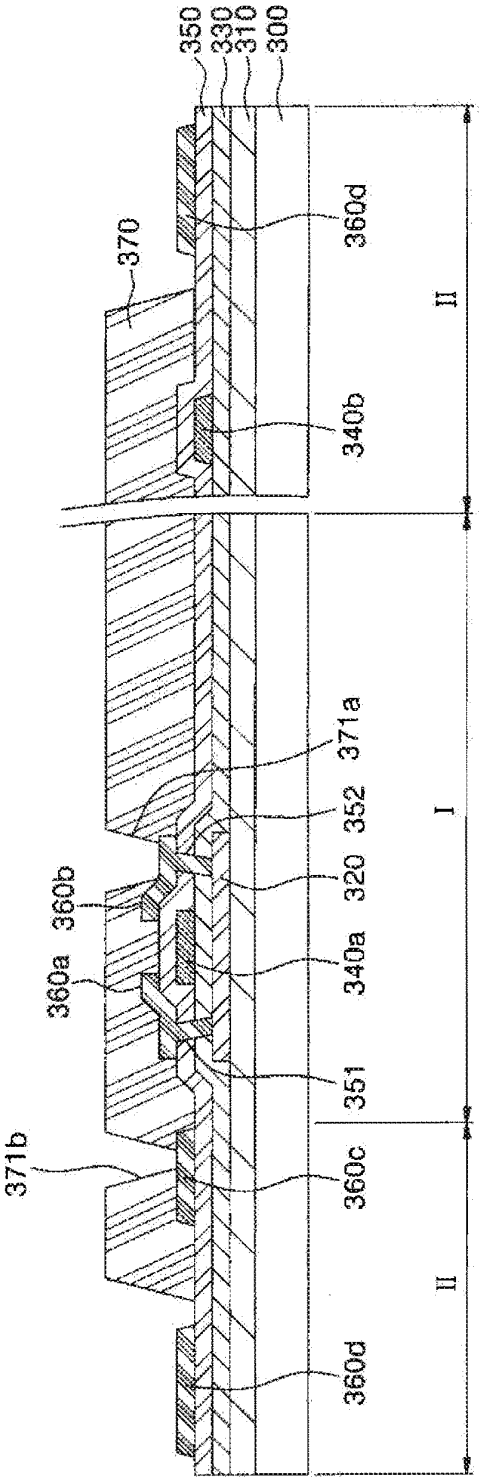
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【図2】



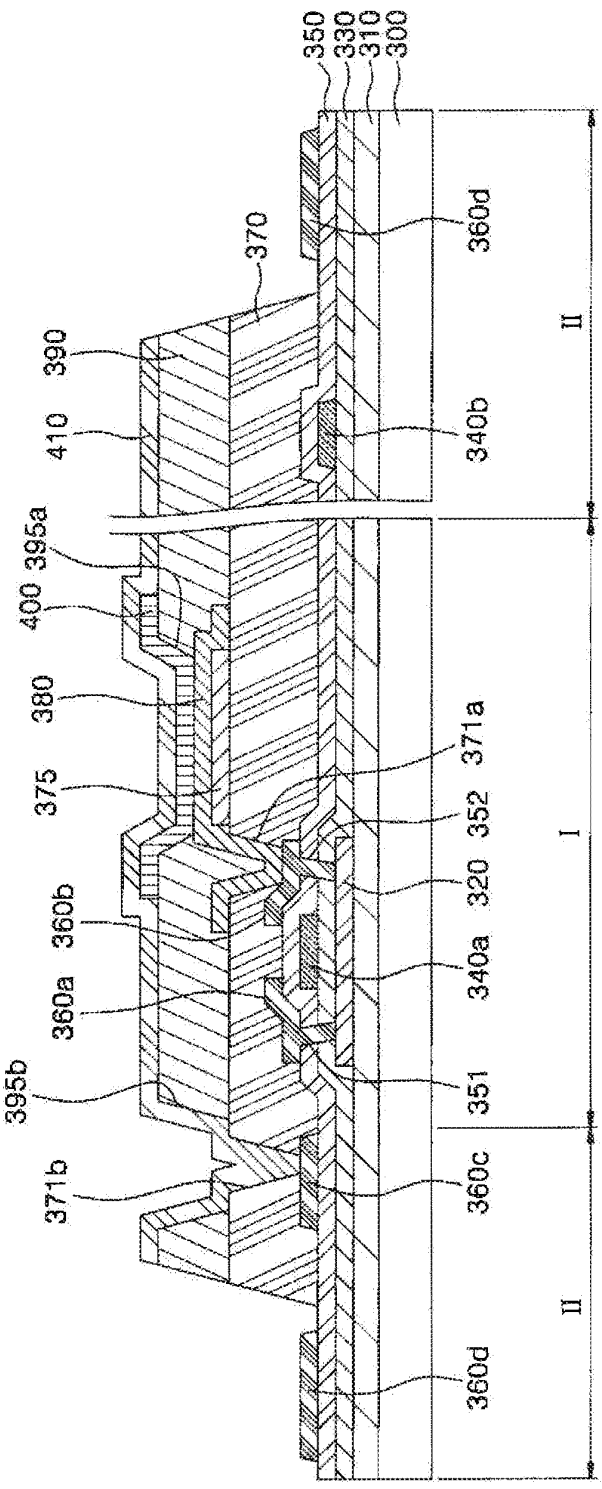
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【図3】



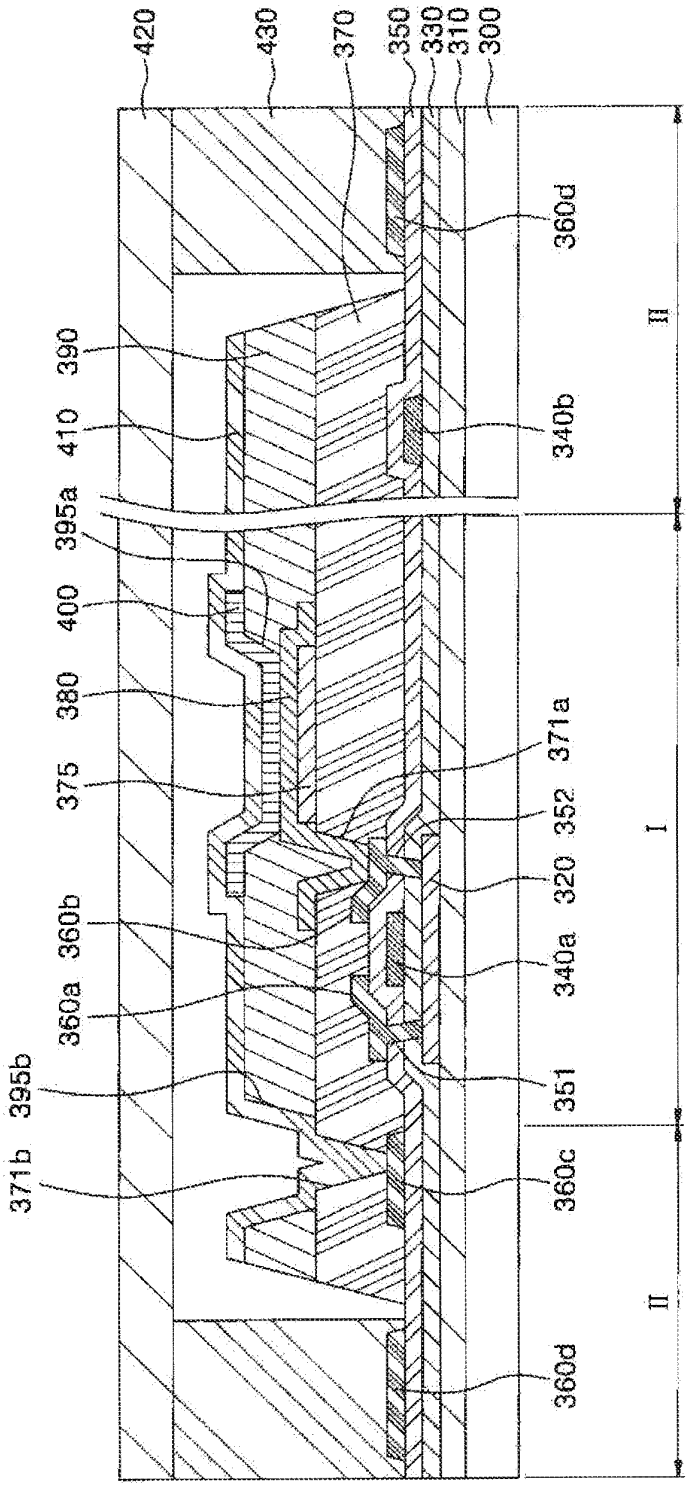
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【図4】



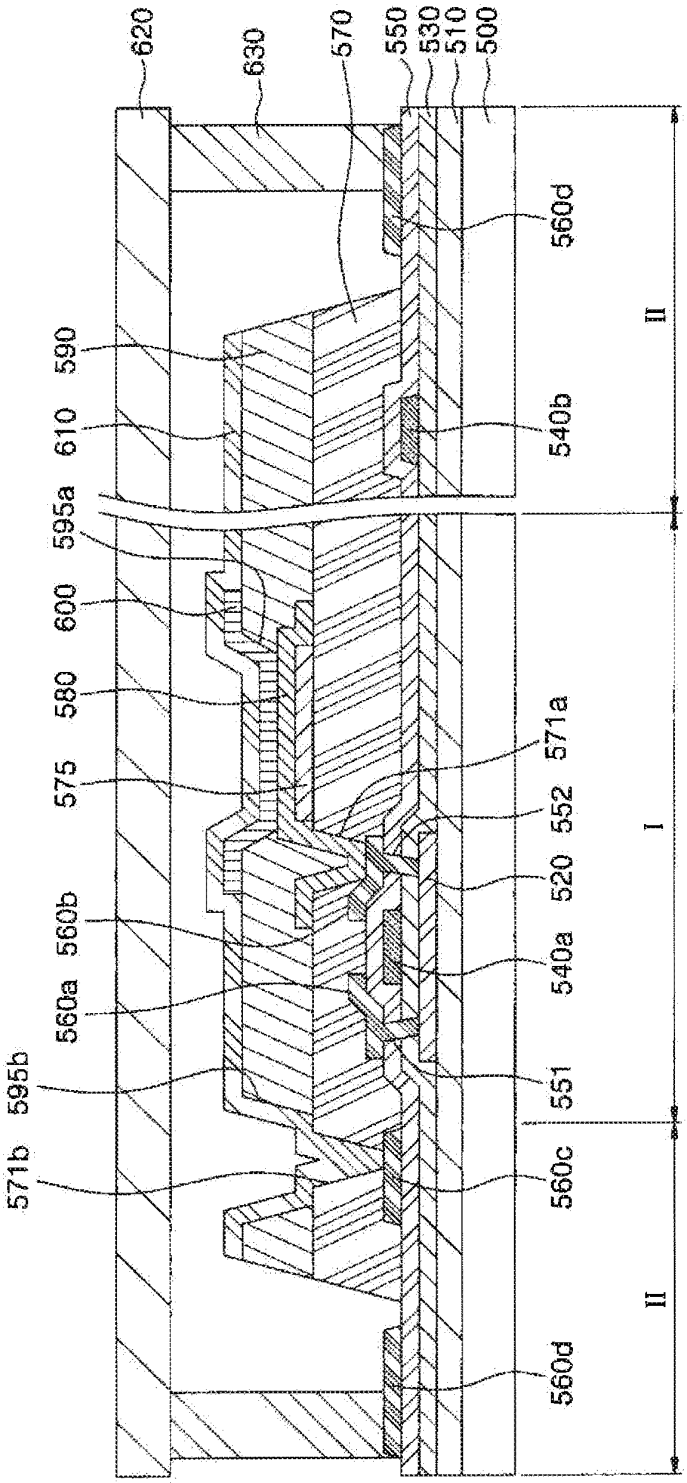
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【図5】



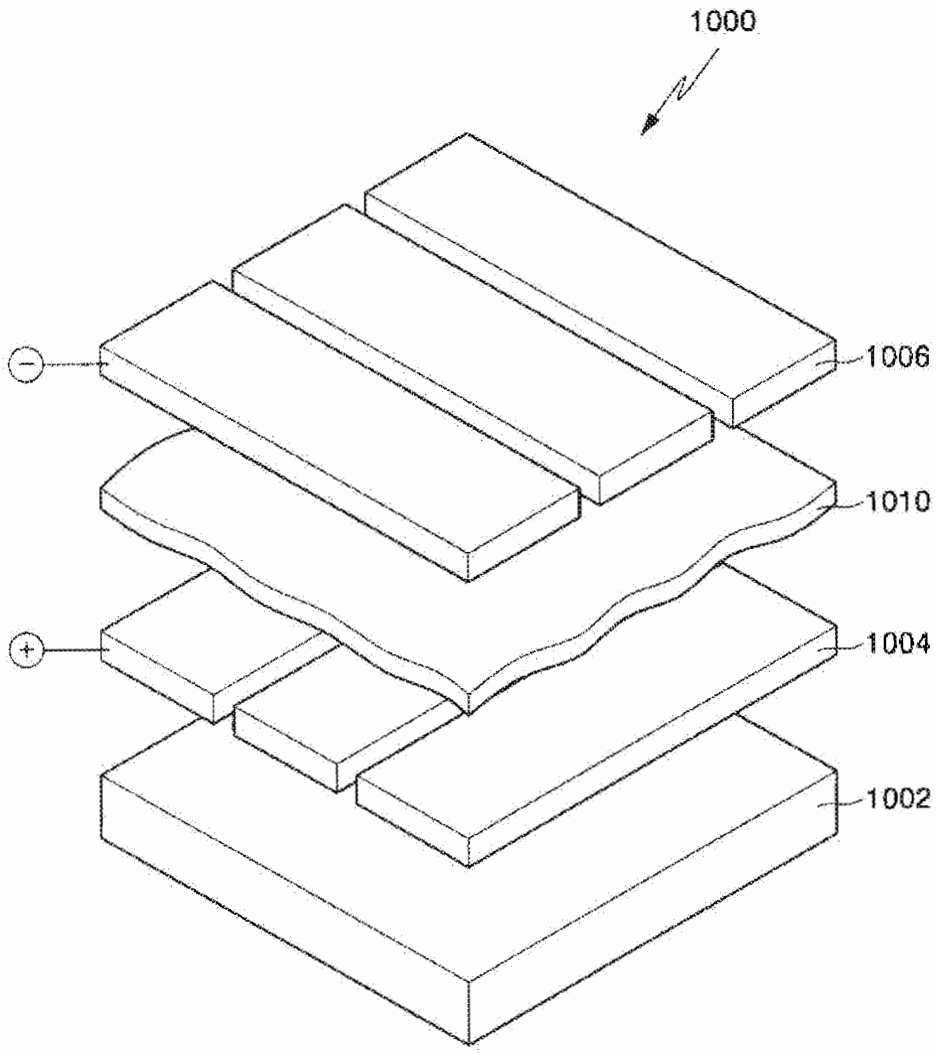
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【図6】

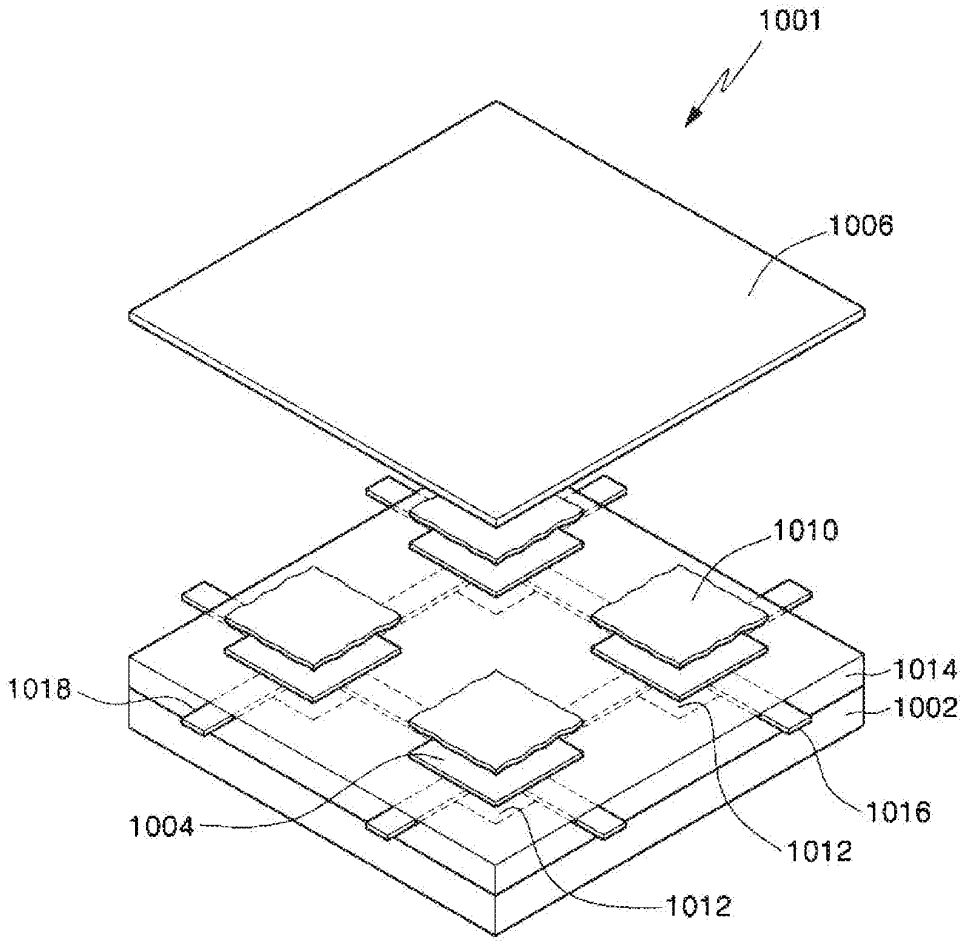


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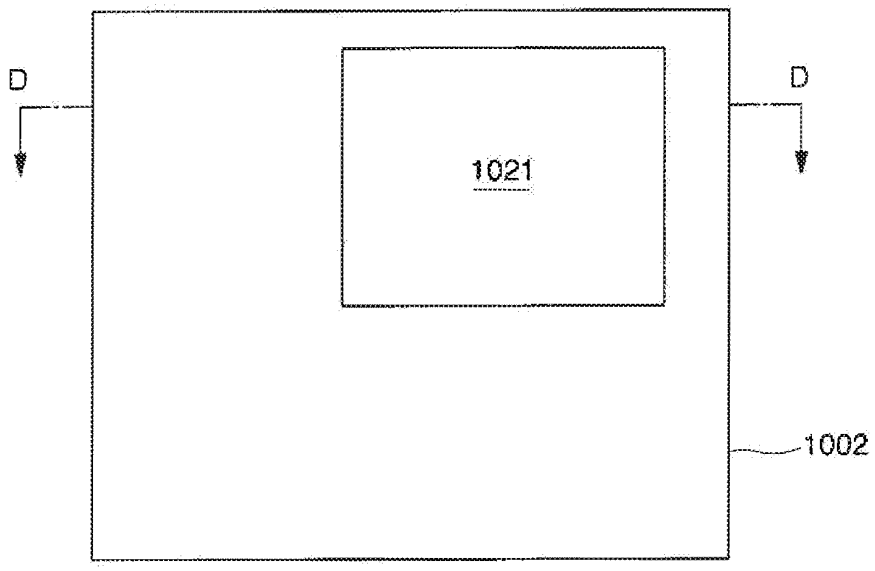
【図7A】



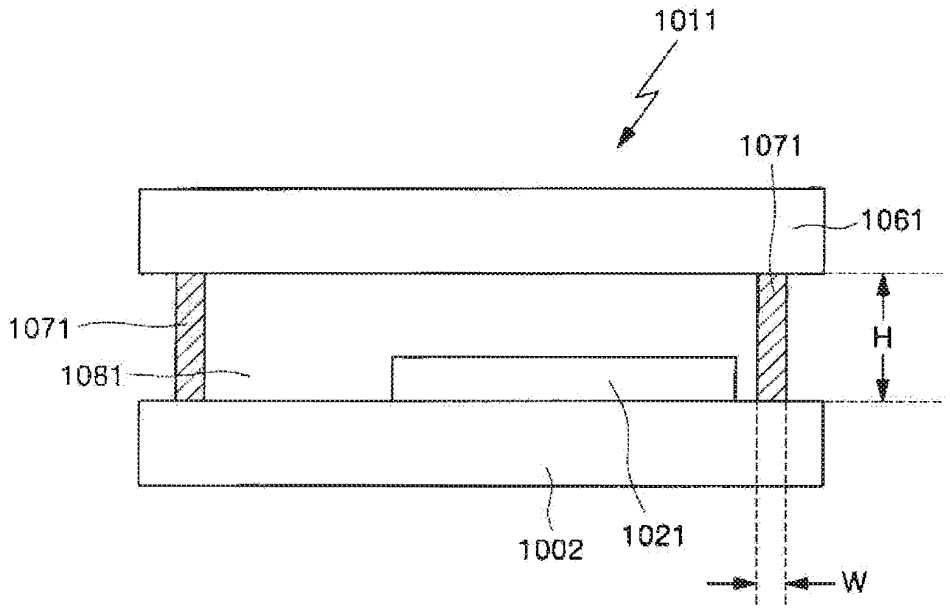
【図7B】



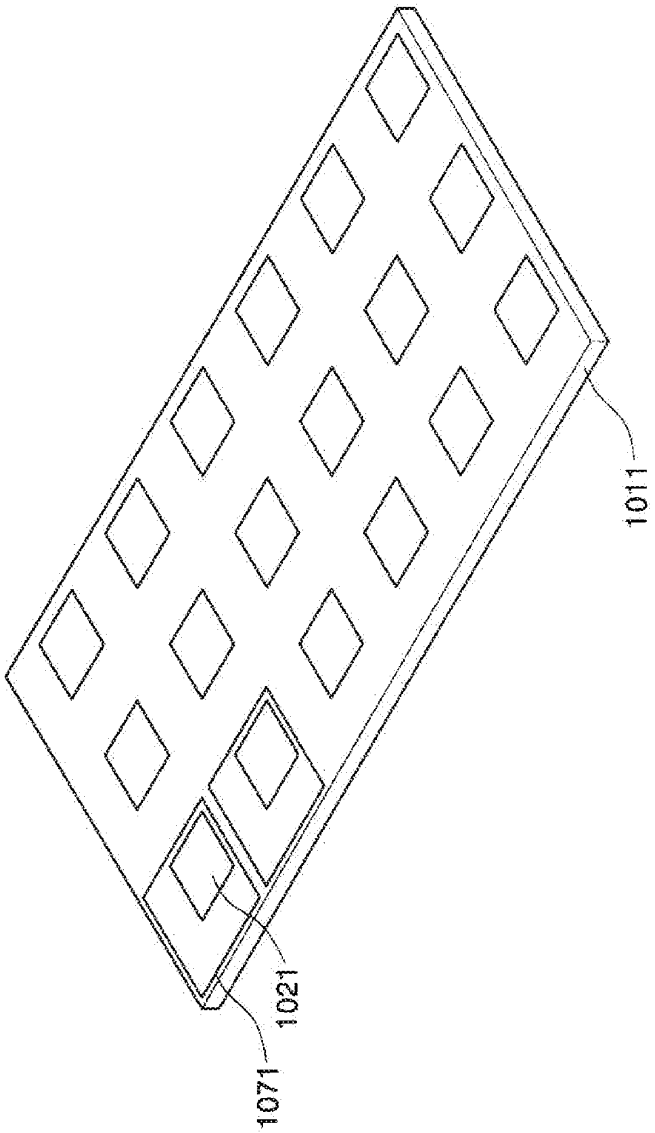
【図7C】



【図7D】



【図7E】



(51)Int.Cl.　　F I　　テーマコード（参考）
　Ｈ０１Ｌ　27/32　　(2006.01)　　Ｇ０９Ｆ　9/30　　３６５Ｚ

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Ｆターム(参考)　3K107 AA01　BB01　CC24　CC25　DD39　EE03　EE55　GG07　GG12　GG14
　　GG37
　　5C094 AA37　AA38　AA43　BA03　BA27　DA07　FB02　GB10
　　5G435 AA13　AA14　AA17　BB05　CC09　KK05　KK10

SDC EX. 1016 - 643/959

Espacenet

Bibliographic data: JP2004296423 (A) — 2004-10-21

ORGANIC ELECTROLUMINESCENT ELEMENT, SURFACE LIGHT SOURCE, AND DISPLAY

Inventor(s): NAKAMURA TOSHITAKA; MIYATAKE MINORU; NAKANO SHUSAKU ± (NAKAMURA TOSHITAKA, ; MIYATAKE MINORU, ; NAKANO SHUSAKU)

Applicant(s): NITTO DENKO CORP ± (NITTO DENKO CORP)

Classification: - international: ***G02B5/02; G02F1/13357; H01L51/50; H01L51/52; H05B33/02; H05B33/22;*** *H01L51/00; H01L51/30;* (IPC1-7): G02B5/02; G02F1/13357; H05B33/02; H05B33/14

- cooperative: **H01L51/5262;** H01L2251/558; H01L51/0037; H01L51/0041; H01L51/0042; H01L51/005; H01L51/0052; H01L51/0059; H01L51/0062; H01L51/007; H01L51/0078; H01L51/0081

Application number: JP20030280576 20030728 Global Dossier

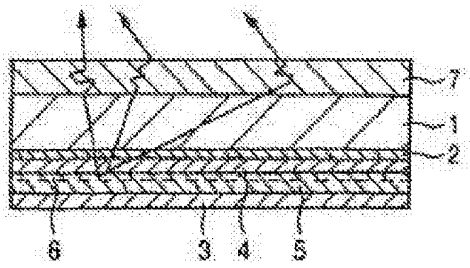
Priority number(s): JP20030280576 20030728 ; JP20020341821 20021126 ; JP20030000080 20030106 ; JP20030062554 20030307

Also published as: AT546845 (T) CN1503606 (A) CN1503606 (B) EP1424739 (A2) EP1424739 (A3) EP1424739 (B1) JP4350996 (B2) KR100704082 (B1) KR20040047670 (A) US2004195962 (A1) US7109651 (B2) less

Abstract of JP2004296423 (A)

PROBLEM TO BE SOLVED: To provide an organic electroluminescent element having excellent efficiency of externally extracting light, capable of efficiently extracting loss light confined in the element as waveguide light. ;SOLUTION: In this organic electroluminescent element wherein a pair of electrodes composed of at least one layer of organic layers 4, 5, and a reflective electrode 3 and a transparent electrode 2 to sandwich the layer are formed so that a front luminance value of emission light emitted to the observer side

FIG. 1



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from a light extracting surface and a luminance value of light making an angle of 50-70 degrees satisfy the formula (1): the front luminance value < the luminance value of light making the angle of 50-70 degrees, a region 7 causing disturbance in reflection/refraction angles of light before the emission light is emitted to the observer side from the luminescent layer 5 through the transparent electrode 2 is provided.
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SDC EX. 1016 - 645/959

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2004-296423
(P2004-296423A)
(43)公開日　平成16年10月21日(2004.10.21)

(51)Int.Cl.[7]	FI		テーマコード（参考）
H05B 33/02	H05B 33/02		2H042
G02B 5/02	G02B 5/02	B	2H091
G02F 1/13357	G02F 1/13357		3K007
H05B 33/14	H05B 33/14	A	

審査請求 未請求　請求項の数 16　OL　（全 43 頁）

(21)出願番号　特願2003-280576(P2003-280576)
(22)出願日　平成15年7月28日(2003.7.28)
(31)優先権主張番号　特願2002-341821(P2002-341821)
(32)優先日　平成14年11月26日(2002.11.26)
(33)優先権主張国　日本国(JP)
(31)優先権主張番号　特願2003-80(P2003-80)
(32)優先日　平成15年1月6日(2003.1.6)
(33)優先権主張国　日本国(JP)
(31)優先権主張番号　特願2003-62554(P2003-62554)
(32)優先日　平成15年3月7日(2003.3.7)
(33)優先権主張国　日本国(JP)

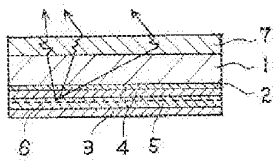
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Fターム(参考)　2H042 BA02　BA13　BA20

最終頁に続く

(54)【発明の名称】有機エレクトロルミネッセンス素子、面光源および表示装置

(57)【要約】
【課題】　素子内部に導波光として閉じ込められていた損失光を効率良く取り出し、外部取り出し効率にすぐれた有機エレクトロルミネッセンス素子を提供する。
【解決手段】　発光層（５）を含む少なくとも１層の有機層（４，５）とこれを挟持する反射性電極（３）と透明電極（２）とからなる一対の電極が、光取り出し面から観測者側に放射される発光光の正面輝度値と５０度～７０度方向の輝度値が、式（１）；正面輝度値＜５０度～７０度方向の輝度値、の関係を満たすように形成されてなる有機エレクトロルミネッセンス素子において、発光光が発光層（５）から透明電極（２）を介して観測者側に出射するまでの間に光の反射・屈折角に乱れを生じさせる領域７を設けたことを特徴とする有機エレクトロルミネッセンス素子。
【選択図】　図１



1：支持基板（ガラス基板）　2：透明電極（陽極）
3：反射性電極（陰極）　4：正孔輸送層
5：電子輸送性発光層　6：発光領域
7：反射・屈折角に乱れを生じさせる領域

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【特許請求の範囲】
【請求項1】
発光層を含む少なくとも１層の有機層とこれを挟持する少なくとも一方が透明電極である陽極電極と陰極電極とからなる一対の電極が、光取り出し面から観測者側に放射される発光光の正面輝度値と５０度～７０度方向の輝度値が、式（１）：正面輝度値＜５０度～７０度方向の輝度値、の関係を満たすように形成されてなる有機エレクトロルミネッセンス素子において、発光光が発光層から透明電極を介して観測者側に出射するまでの間に、光の反射・屈折角に乱れを生じさせる領域が、実質的に空気層を介することなく設けられていることを特徴とする有機エレクトロルミネッセンス素子。
【請求項2】
陽極電極と陰極電極とのうちの一方が透明電極で、他方が反射性電極であり、正孔と電子の再結合発光領域の略中心部と反射性電極との距離をｄ（ｎｍ）、発光層に用いている材料の蛍光発光スペクトルのピーク波長をλ（ｎｍ）、発光層と反射性電極との間の有機層の屈折率をｎとすると、式（２）：（０．３／ｎ）λ＜ｄ＜（０．５／ｎ）λ、の関係を満たす請求項１に記載の有機エレクトロルミネッセンス素子。
【請求項3】
光の反射・屈折角に乱れを生じさせる領域は、透明材料中にこれとは屈折率の異なる透明材料または不透明材料を分散分布させた光拡散性部位からなる請求項１または２に記載の有機エレクトロルミネッセンス素子。
【請求項4】
光の反射・屈折角に乱れを生じさせる領域は、レンズ構造からなる請求項１または２に記載の有機エレクトロルミネッセンス素子。
【請求項5】
光の反射・屈折角に乱れを生じさせる領域は、凹凸面からなる請求項１または２に記載の有機エレクトロルミネッセンス素子。
【請求項6】
光の反射・屈折角に乱れを生じさせる領域より観測者側に反射型偏光子を有する請求項３～５のいずれかに記載の有機エレクトロルミネッセンス素子。
【請求項7】
反射型偏光子は、コレステリック液晶層からなる反射型円偏光子である請求項６に記載の有機エレクトロルミネッセンス素子。
【請求項8】
反射型偏光子は、屈折率の異なる少なくとも２種の材料を多層積層してなる反射型直線偏光子である請求項６に記載の有機エレクトロルミネッセンス素子。
【請求項9】
面内には屈折率異方性を持たず、その面内屈折率よりも厚さ方向の屈折率が大きい光学補償層が設けられている請求項６～８のいずれかに記載の有機エレクトロルミネッセンス素子。
【請求項10】
光の反射・屈折角に乱れを生じさせる領域は、透光性樹脂中に複屈折特性の相違する微小領域を分散分布させた偏光散乱性部位からなる請求項１または２に記載の有機エレクトロルミネッセンス素子。
【請求項11】
偏光散乱性部位における微小領域は、液晶性材料、液晶相を過冷却固定したガラス状態材料または重合性液晶の液晶相をエネルギー線により架橋固定した材料のいずれかから構成されている請求項１０に記載の有機エレクトロルミネッセンス素子。
【請求項12】
偏光散乱性部位は、透光性樹脂中にこの樹脂のガラス転移温度よりも低温でネマチック液晶相を呈するガラス転移温度が５０℃以上の液晶ポリマーからなる微小領域を分散含有させてなる請求項１０に記載の有機エレクトロルミネッセンス素子。

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【請求項13】
偏光散乱性部位は、微小領域とそれ以外の部分との間で、微小領域の各光軸方向における屈折率差Δn_1、Δn_2、Δn_3が最大値を示す軸方向（Δn_1方向）において０．０３～０．５（Δn_1）であり、この軸方向と直交する２軸方向（Δn_2方向、Δn_3方向）において０．０３以下である請求項１０～１２のいずれかに記載の有機エレクトロルミネッセンス素子。
【請求項14】
請求項１～５のいずれかに記載の有機エレクトロルミネッセンス素子を具備することを特徴とする面光源。
【請求項15】
請求項６～１３のいずれかに記載の有機エレクトロルミネッセンス素子を具備することを特徴とする偏光面光源。
【請求項16】
請求項１４に記載の面光源または請求項１５に記載の偏光面光源を具備することを特徴とする表示装置。

【発明の詳細な説明】
【技術分野】
【0001】
本発明は、発光効率、とくに発光光の外部取り出し効率にすぐれた有機エレクトロルミネッセンス素子と、この有機エレクトロルミネッセンス素子を使用した高効率な（偏光）面光源と、これを具備する（液晶）表示装置とに関する。
【背景技術】
【0002】
電極間に発光層を設け、電気的に発光を得るエレクトロルミネッセンス素子や発光ダイオードは、ディスプレイ表示装置としての利用はもちろん、平面型照明、光ファイバー用光源、液晶ディスプレイ用バックライト、液晶プロジェクタ用バックライトなどの各種光源としても、盛んに研究開発が進んでいる。
とくに、有機エレクトロルミネッセンス素子は、発光効率、低電圧駆動、軽量、低コストという点ですぐれており、近年、注目を浴びている。これらの光源用途で最大の関心事は発光効率の向上であり、蛍光灯に匹敵する発光効率を目標として、素子構成、材料、駆動方法、製造方法などの改良が検討されている。
【0003】
しかし、有機エレクトロルミネッセンス素子のように、発光層自体から発光を取り出す固体内発光素子では、発光層の屈折率と出射媒質との屈折率により決まる臨界角以上の発光光は全反射し内部に閉じ込められ、導波光として失われる。
古典論的な屈折の法則（スネルの法則）による計算では、発光層の屈折率をｎとしたとき、発生した光が外部に取り出される光取り出し効率ηは、$\eta = 1/(2n^2)$で近似される。仮に発光層の屈折率が１．７であると、$\eta \fallingdotseq$１７％程度となり、８０％以上の光は導波光として素子側面方向の損失光として失われる。
【0004】
また、有機エレクトロルミネッセンス素子は、電極から注入された電子・正孔の再結合により生成する励起子のうち、発光に寄与するのは１重項励起子のみであり、その生成確率は１／４である。これだけを考慮しても、効率は５％以下と極めて低い。
近年、発光層自体の発光効率を上げる方法として、３重項励起子からの燐光からも発光が得られる発光材料の開発（特開２００１－３１３１７８号公報）も進んでおり、量子効率を飛躍的に向上できる可能性も見い出されている。
しかし、仮に量子効率を向上できても、取り出し効率としてはそれに乗ずる形で発光効率を低下させてしまう。言い換えると、取り出し効率を改善できれば、相乗効果として飛躍的に発光効率を向上できる余地が残されている。
【0005】

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このように、導波光を外部に取り出すには、発光層と出射面との間に反射・屈折角を乱れさせる領域を形成し、スネルの法則を崩して、本来導波光として全反射される光の伝送角を変化させてやるか、発光自体に集光性を持たせる必要がある。しかし、導波光をすべて外部に出射させる領域を形成するのは容易でなく、このため、できるだけ多くの導波光を取り出す提案がなされている。

【0006】

たとえば、取り出し効率を改善する方法として、基板自体に集光性を持たせることで取り出し効率を向上させる方法（特開昭６３－３１４７９５号公報）や、発光層をディスコチック液晶で形成し、発光光自体の正面指向性を向上させる方法（特開平１０－３２１３７１号公報）、素子自体に立体構造や傾斜面、回折格子などを形成する方法（特開平１１－２１４１６２号、特開平１１－２１４１６３号、特開平１１－２８３７５１号公報）が提案されている。しかしながら、これらの提案では複雑な構成になってしまったり、発光層自体の発光効率が低くなるなどの問題がある。

【0007】

また、比較的簡単な方法として、光拡散層を形成し、光の屈折角を変化させて全反射条件にある光を減らす方法も提案されている。

たとえば、内部と表面で屈折率の異なる屈折率分布構造を有する粒子を透明基材中に分散させた拡散板を用いる方法（特開平６－３４７６１７号公報）、透光性基体上に単粒子層を並べた拡散部材を用いる方法（特開２００１－３５６２０７号公報）、発光層と同じ材質中に散乱粒子を分散させる方法（特開平６－１５１０６１号公報）などが、数多く提案されている。これらの提案は、散乱粒子の特性、分散マトリックスとの屈折率差、粒子の分散形態、散乱層の形成場所などに特徴を見い出したものである。

【0008】

ところで、有機エレクトロルミネッセンス素子は、電界を印加することで、陽極より注入された正孔と陰極より注入された電子とが再結合して励起子となり、蛍光物質（または燐光物質）が発光する原理を利用したものである。よって、量子効率を上げるためには、この再結合が効率良く行われる必要がある。その方法として一般的に行われるのが、素子を積層構造とする方法であり、その例として、正孔輸送層／電子輸送性発光層の２層型、正孔輸送層／発光層／電子輸送層の３層型などがある。また、効率を上げるために、ダブルヘテロ構造とするような積層型素子も多数提案されている。

【0009】

このような積層構造の場合、再結合はある領域で、ほぼ集中して起こる。たとえば、２層型の有機エレクトロルミネッセンス素子では、図１２に示すように、支持基板１上で反射性電極３と透明電極２とからなる一対の電極間に挟持された正孔輸送層４と電子輸送性発光層５の界面層から、約１０ｎｍ程度電子輸送性発光層側の領域６で集中的に発生する（Ｔａｋｕｙａ，Ｏｇａｗａ　ｅｔ　ａｌ，「ＩＥＩＣＥ　ＴＲＡＮＳ　ＥＬＥＣＴＲＯＮ」Ｖｏｌ．Ｅ８５－Ｃ，Ｎｏ．６，ｐ．１２３９、２００２の報告）。

また、発光領域６で発生する光は全方向に放射される。その結果、図１３に示すように透明電極２側の光取り出し面方向に放射した光と、反射性電極３側に放射し反射されて光取り出し面方向に放射される光に光路差が生じる。

【0010】

図１３において、通常、有機エレクトロルミネッセンス素子の電子輸送性発光層の厚さは数十～百数十ｎｍであり、可視光波長のオーダーである。したがって、最終的に外部に出射する光は干渉を起こし、発光領域と反射電極との距離ｄにより強め合ったり弱め合ったりする。また、図１３では正面方向の放射光のみを記述しているが、実際には斜め方向の光も存在し、距離ｄと発光波長λによっては、放射光の角度により干渉条件が異なる。その結果、正面方向の光は強め合い、広角度方向の光は弱め合う場合や、その反対の場合が起こりうる。すなわち、発光輝度が視角度により変化する。

もちろん、距離ｄが大きくなると、角度により顕著に光の強度が変化することになる。よって、通常は正面方向の光が互いに強め合うように、距離ｄが発光波長のおよそ１／４

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波長の長さとなるように膜厚が設定される。

【0011】

また、距離ｄが、たとえば５０ｎｍ程度より薄いと、通常金属が用いられる反射性電極では、光の吸収が顕著になり、発光強度の低下と強度分布にも影響が現れる。すなわち、有機エレクトロルミネッセンス素子では、発光領域と反射性電極との間の距離ｄにより、放射光分布が顕著に変化し、導波光成分もそれに伴い大きく変化する。さらに、この種の素子の発光スペクトルは、比較的広い波長にわたりブロードな特性をもっている。したがって、距離ｄにより強め合う波長域が変化する結果、発光ピーク波長が変化する。また、距離ｄによっては、発光スペクトルも視角度により変化する。

【0012】

これらの問題を解決するために、視角により発光色が異なる現象を抑制するように、膜厚を選定する提案がなされている（特許文献１参照）。しかしながら、この提案には、導波光に関する記述はなく、この提案で発光色の視角依存性が抑制できる膜厚は、後述する本発明の範囲とは明らかに異なるものである。

【0013】

以上の理由より、発光光のうち約８０％は導波光として素子内部に閉じ込められているという古典論的な計算では、積層型の有機エレクトロルミネッセンス素子の外部取り出し効率は正しく見積もれないことになる。すなわち、導波光成分も、素子構成により顕著に変化しているのである。たとえば、Ｍ．Ｈ．Ｌｕらの報告（Ｊ．Ａｐｐｌ．Ｐｈｙｓ．，Ｖｏｌ．９１，Ｎｏ．２，ｐ．５９５，２００２）によれば、マイクロキャビティー効果を考慮した量子論的計算手法により、素子構成による導波光成分の変化について詳細な研究がなされている。

したがって、全反射条件を崩すべく、光拡散層などを形成しても、古典論から期待されるほど大きな効果が得られない場合も起こりうる。

【0014】

また、これらの有機エレクトロルミネッセンス素子を液晶表示装置用のバックライト光源として用いる場合、素子から放射される発光光は自然光であるため、液晶表示に際しては、それらを偏光板を介して直線偏光に変換する必要がある。その結果、偏光板による吸収ロスを生じることになり、光の利用効率を５０％を超える値とすることができないという問題があった。したがって、上記の方法により、効率良く導光光を取り出しても、その半分以上は偏光板にて吸収されてしまう。

【0015】

このような問題を改善する方法として、配向膜上に有機エレクトロルミネッセンス素子層を形成し、発光光自体を直線偏光発光として取り出す提案がなされている（特許文献２参照）。しかしながら、この提案により偏光板での吸収ロスは最大で１／２に低減できるものの、有機薄膜を配向させるための配向膜などの挿入により、素子の発光効率が低下するおそれがある。また、全反射による導波光に関しては、従来の素子と同様に、なんら改良されていない。

【0016】

また、本件出願人は、偏光散乱フィルムを介して有機エレクトロルミネッセンス素子による発光を出射させる方法を提案している（特許文献３参照）。この提案は、光散乱により導波光として失われている光が取り出され、かつ出射光は直線偏光リッチな偏光として取り出されるため、偏光板での吸収ロスを低減でき、液晶表示装置用の光源として高効率な偏光面光源を提供することができる。

しかしながら、この提案では、たとえば前記した発光領域と反射性電極との距離による干渉の影響と導波光の関係については言及されておらず、液晶表示装置用の光源として、その効果を最大限に引き出せるものとはいえない。

【0017】

また、液晶表示装置において、バックライト光の偏光板での吸収ロスを低減する方法として、反射型偏光子からなる偏光分離層を使用する方法が知られており（特許文献４，５

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参照）、これを有機エレクトロルミネッセンス素子に適用する提案もなされている（特許文献６，７参照）。

しかしながら、有機エレクトロルミネッセンス素子において、発光領域と反射性電極との距離による干渉の影響と導波光の関係について、詳しく研究し、そのうえで反射型円偏光子と組み合わせるなどして、発光効率を最大限に引き出せるような提案はまだなされていない。したがって、偏光を利用した液晶表示装置用に最適な高効率な偏光面光源の提供が切望されているのが現状である。

【0018】

【特許文献1】特開平５－３０８１号公報（第２～４頁）
【特許文献2】特開平１１－３１６３７６号公報（第２～５頁）
【特許文献3】特開２００１－２０３０７４号公報（第２～６頁）
【特許文献4】特開平４－２６８５０５号公報（第２～６頁）
【特許文献5】特開平８－２７１８９２号公報（第２～５頁）
【特許文献6】特開２００１－２４４０８０号公報（第２～４頁）
【特許文献7】特開２００１－３１１８２６号公報（第２～３頁）

【発明の開示】

【発明が解決しようとする課題】

【0019】

本発明は、上記のような事情に照らし、有機エレクトロルミネッセンス素子において、従来、素子内部に導波光として閉じ込められていた損失光を、効率良く取り出し、外部取り出し効率にすぐれた有機エレクトロルミネッセンス素子を提供すること、また液晶表示装置のバックライト光源などとして用いる場合、上記損失光を偏光光として効率良く取り出すことができ、偏光板での吸収を最小限に抑えることができる高効率な有機エレクトロルミネッセンス素子を提供することを目的とする。さらに、本発明は、これらの有機エレクトロルミネッセンス素子を用いた高効率な面光源ないし偏光面光源と、これを具備する液晶表示装置などの表示装置を提供することを目的とする。

【課題を解決するための手段】

【0020】

本発明者らは、上記の課題を解決するために、鋭意検討を重ねた結果、以下のような知見を得た。この知見について、図９を用いて説明する。同図は、図１２に示した２層型の有機エレクトロルミネッセンス素子に関して、その発光領域６からの発光光が外部に出射される場合の模式図を、上半球面のみについて、示したものである。実際には、反射性電極３方向の発光光も存在するが、ここでは省略している。

【0021】

図９において、支持基板（ガラス基板）１の屈折率と空気層の屈折率差により決まる臨界角は約４０度である。つまり、４０度より大きな角度の光は、ガラス／空気界面で全反射し、導波光として素子内部に閉じ込められる。紙面上では４０度／９０度、すなわち、４５％近くの光は、外部に出射するように見えるが、実際の発光は全方位に放射される。このため、立体角の関係から、より広角度の成分になるほどその光量は大きくなる。古典論的計算で発光効率が２０％以下と算出されるのはそのためである。

また、実際の有機エレクトロルミネッセンス素子では光の干渉効果が起こる。これに対し外部に出射できる正面方向の光が強め合うように素子構成を決定するのが普通である。この場合、導波光は逆に弱め合うように干渉するため、この素子構成に反射・屈折角に乱れを生ずる領域を形成しても、大きな輝度向上効果は望めない。

【0022】

しかるに、本発明者らは、わざと正面方向の光は弱めあい、通常は導波光として素子内部に閉じ込められる広角度成分の光を強め合うように素子構成を決定し、大部分の光量が分布する導波光を増幅した上で反射・屈折角に乱れを生ずる領域を形成してみたところ、上記従来の方法に比べ、発光効率が顕著に高められることがわかった。つまり、反射・屈折角に乱れを生ずる領域を設けない場合、発光効率がかえって低下する素子構成を形成し

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た上で、上記領域を設けると、従来の素子構成に上記領域を設ける場合よりも、高効率な有機エレクトロルミネッセンス素子が得られることがわかった。

また、このような構成とした有機エレクトロルミネッセンス素子を、液晶表示装置のバックライト光源用などとして利用する際には、偏光板により吸収される光を反射型偏光子を用いて低減する構成とすることにより、偏光板での吸収が最小限に抑えられた高効率な偏光面光源および液晶表示装置が得られることもわかった。

【0023】

さらに、本発明者らは、上記の反射・屈折角に乱れを生ずる領域を設ける場合に、この領域として、とくに透光性樹脂中に複屈折特性の相違する微小領域を分散分布させた偏光散乱性部位を設けるようにすると、上記した反射型偏光子を用いることなく、素子内部に閉じ込められる導波光を偏光光として効率良く取り出せることもわかった。すなわち、図９に示す有機エレクトロルミネッセンス素子において、支持基板（ガラス基板）１上の光取り出し面側、つまり透明電極２とは反対面側に、透光性樹脂中に複屈折特性の相違する微小領域を分散分布させた偏光散乱性部位を実質的に空気層を介することなく形成して、このときの発光領域６からの発光光の外部への出射の様子を調べてみた。

【0024】

発光光のうち、紙面上半球の光は透明電極、ガラス基板を通過し、偏光散乱性部位に入射する。また、下半球の光は陰極により反射されたのち、同様に偏光散乱性部位に入射する。この過程で屈折率の低い空気層（屈折率＝１）が介在しないため、発光光は全反射を受けることなく偏光散乱性部位に入射できる（ただし、透明電極やガラス基板の屈折率によっては、一部の光が全反射される場合がある）。図９に示すように、通常の素子では、ガラス基板の屈折率と空気層の屈折率差により決まる臨界角以上の角度の光は全反射して導波光として失われ、通常の２０％程度しか外部に出射されない。

【0025】

全反射することなく偏光散乱部位に入射した発光光の大部分は、偏光散乱性部位と空気界面との屈折率差により全反射され、偏光散乱部位内を伝送する。この伝送光は、偏光散乱部位内で微小領域との最大屈折率差（Δn_1）を示す軸方向（Δn_1 方向）に平行な振動面を有する直線偏光成分が選択的に強く散乱され、その一部が全反射角よりも小さい角度となり、外部（空気）へ出射する。ちなみに、微小領域が存在せず選択的な偏光散乱が起きない場合、発光光は、立体角の関係上、約８０％が閉じ込められ、全反射を繰り返している状態である。閉じ込められた光は、微小領域と透光性樹脂との界面での散乱にて全反射条件が壊されたときのみ外部に出射するため、微小領域のサイズや存在の程度により出射の効率を任意に制御可能である。

【0026】

一方、前記のΔn_1 方向の散乱で大きい角度で散乱された光と、Δn_1 方向条件を満足したが散乱を受けなかった光と、さらにΔn_1 方向以外の振動方向を有する光は、偏光散乱性部位内に閉じ込められて全反射を繰り返しつつ伝送され、複屈折位相差などにより偏光状態も解消されて前記のΔn_1 方向条件を満足して出射する機会を待つ。この繰り返しにより、偏光散乱性部位より所定振動面の直線偏光が効率よく出射される。すなわち、最終的に本来導波光として閉じ込められている光を直線偏光成分として取り出すことが可能になる。よって、この方法によると、マイクロレンズや反射ドットなどの特別な光出射手段を形成することなく、発光光を直線偏光成分がリッチな偏光光として、効率よく外部へ出射させることができる。また、偏光散乱性部位の設置角度により直線偏光の振動方向を任意に変えることができる。したがって、液晶表示装置用のバックライトに用いる場合、消費電力を低減することが可能となる。

【0027】

このようにわざと正面方向の光は弱めあい、通常は導波光として素子内部に閉じ込められる広角度成分の光を強め合うように素子構成を決定し、立体角の関係上、大部分の光量が分布する広角度の光を増幅した上で、上記した偏光散乱性部位を空気層を介することなく一体形成すると、従来の方法に比べ、発光効率を高められることがわかった。つまり、

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通常の素子ではかえって発光効率が低下するが、偏光散乱性部位と組み合わせると、発光光を効率良くしかも直線偏光リッチな偏光光として外部に取り出せ、最終的に液晶表示装置用のバックライトなどに用いる場合、飛躍的に発光効率を向上できる。

【0028】

また、有機エレクトロルミネッセンス素子の最大の欠点として、微量の湿気、酸素により素子が劣化し、発光効率の低下はもちろん、微小な欠陥を起点にダークスポットが発生するという問題がある。ダークスポットについては、Ｊ．ＭｃＥｌｖａｉｎｓらによる報告（Ｊ．Ａｐｐｌ．Ｐｈｙｓ．Ｖｏｌ，８０，Ｎｏ．１０，ｐ．６００２，１９９６）などに詳細に記載されている。この問題を防ぐため、通常は素子を完全に封止しているが、それでもダークスポットの発生を完全に防止することは容易でない。このダークスポットは面光源や表示装置としての外観、視認性を著しく低下させる。

しかしながら、上記のように偏光散乱性部位を形成すると、多少のダークスポットが発生しても、最終的に観測者側に出射する光は、偏光散乱性部位内にて幾度も散乱されて、外部に出射するため、ダークスポットの発生による視認性の低下がほとんど気にならなくなるという、非常にすぐれた効果が奏される。

【0029】

本発明は、以上の知見にもとづいて、完成されたものである。

すなわち、本発明は、発光層を含む少なくとも１層の有機層とこれを挟持する少なくとも一方が透明電極である陽極電極と陰極電極とからなる一対の電極が、光取り出し面から観測者側に放射される発光光の正面輝度値と５０度～７０度方向の輝度値が、式（１）；正面輝度値＜５０度～７０度方向の輝度値、の関係を満たすように形成されてなる有機エレクトロルミネッセンス素子において、発光光が発光層から透明電極を介して観測者側に出射するまでの間に、光の反射・屈折角に乱れを生じさせる領域が、実質的に空気層を介することなく設けられていることを特徴とする有機エレクトロルミネッセンス素子（以下、単に有機ＥＬ素子という）に係るものである。

また、本発明は、上記構成の有機ＥＬ素子のとくに好ましい態様として、陽極電極と陰極電極とのうちの一方が透明電極で、他方が反射性電極であり、正孔と電子の再結合発光領域の略中心部と反射性電極との距離をｄ（ｎｍ）、発光層に用いている材料の蛍光発光スペクトルのピーク波長をλ（ｎｍ）、発光層と反射性電極との間の有機層の屈折率をｎとしたときに、式（２）；（０．３／ｎ）λ＜ｄ＜（０．５／ｎ）λ、の関係を満たす有機ＥＬ素子に係るものである。

【0030】

さらに、本発明は、光の反射・屈折角に乱れを生じさせる領域が、透明材料中にこれとは屈折率の異なる透明材料または不透明材料を分散分布させた光拡散性部位からなる上記構成の有機ＥＬ素子と、光の反射・屈折角に乱れを生じさせる領域が、レンズ構造からなる上記構成の有機ＥＬ素子と、光の反射・屈折角に乱れを生じさせる領域が、凹凸面からなる上記構成の有機ＥＬ素子に係るものである。

また、本発明は、上記各構成の有機ＥＬ素子を具備することを特徴とする面光源とこの面光源を具備することを特徴とする表示装置に係るものである。

【0031】

また、本発明は、光の反射・屈折角に乱れを生じさせる領域より観測者側に反射型偏光子を有する上記構成の有機ＥＬ素子に係るものである。とくに、上記の反射型偏光子が、コレステリック液晶層からなる反射型円偏光子である上記構成の有機ＥＬ素子と、上記の反射型偏光子が、屈折率の異なる少なくとも２種の材料を多層積層してなる反射型直線偏光子である上記構成の有機ＥＬ素子に係るものである。さらに、本発明は、面内には屈折率異方性を持たず、その面内屈折率よりも厚さ方向の屈折率が大きい光学補償層が設けられている上記各構成の有機ＥＬ素子に係るものである。

また、本発明は、上記各構成の有機ＥＬ素子を具備することを特徴とする偏光面光源に係るものである。さらに、本発明は、上記の偏光面光源を具備することを特徴とする液晶表示装置などの表示装置に係るものである。

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【0032】

また、本発明は、光の反射・屈折角に乱れを生じさせる領域が、透光性樹脂中に複屈折特性の相違する微小領域を分散分布させた偏光散乱性部位からなる前記構成の有機ＥＬ素子に係るものである。とくに、上記の偏光散乱性部位における微小領域が、液晶性材料、液晶相を過冷却固定したガラス状態材料または重合性液晶の液晶相をエネルギー線により架橋固定した材料のいずれかから構成されている上記構成の有機ＥＬ素子と、上記の偏光散乱性部位が、透光性樹脂中にこの樹脂のガラス転移温度よりも低温でネマチック液晶相を呈するガラス転移温度が５０℃以上の液晶ポリマーからなる微小領域を分散含有させてなる上記構成の有機ＥＬ素子に係るものである。さらに、本発明は、上記の偏光散乱性部位が、微小領域とそれ以外の部分との間で、微小領域の各光軸方向における屈折率差Δn_1、Δn_2、Δn_3が最大値を示す軸方向（Δn_1方向）において０．０３～０．５（Δn_1）であり、この軸方向と直交する２軸方向（Δn_2方向、Δn_3方向）において０．０３以下である上記各構成の有機ＥＬ素子に係るものである。

また、本発明は、上記各構成の有機ＥＬ素子を具備することを特徴とする偏光面光源に係るものである。さらに、本発明は、上記の偏光面光源を具備することを特徴とする液晶表示装置などの表示装置に係るものである。

【発明の効果】

【0033】

本発明では、反射・屈折角に乱れを生じさせる領域を形成する前は発光効率が低いが、本来素子内部に閉じ込められる導波光成分を増幅し、これに反射・屈折角に乱れを生じさせる領域を形成して、導波光成分を外部に取り出す構成としたことにより、最終的に出射光量を増加でき、高効率な有機ＥＬ素子を提供できる。

また、上記反射・屈折角に乱れを生じさせる領域として、偏光散乱性部位を形成することにより、出射光量を増加させうるうえに、その光を直線偏光リッチな偏光光として取り出すことができるので、液晶表示装置に用いられる偏光面光源として応用するにあたり、極めて高効率な有機ＥＬ素子を提供できる。

また、上記反射・屈折角に乱れを生じさせる領域として、光拡散層やレンズ構造などを形成したうえで、さらに反射型偏光子を設置することにより、導波光成分の半分以上を偏光光として出射可能であり、液晶表示装置に用いられる偏光面光源に応用するにあたり、高効率な有機ＥＬ素子を提供できる。

このため、本発明により消費電力を大幅に低下でき、素子に流す電流を少なくできるので、素子の長寿命化をはかれる。また、有機ＥＬ素子の外部取り出し効率を向上できるので、有機ＥＬ材料や電極材料などが進歩して内部量子効率が向上すれば、それに乗じた形で発光効率が増加し、本発明の効果がより一層得られるようになる。

【発明を実施するための最良の形態】

【0034】

以下、本発明の実施の形態について、図面を参考にして、説明する。

図１は、本発明の２層型の有機ＥＬ素子の一例を示したものである。この素子は、基本構成として、支持基板１上に透明電極２、正孔輸送層４、電子輸送性発光層５および反射性電極３が順次積層された構成を有している。

つまり、上記の正孔輸送層４および電子輸送性発光層５からなる有機層が透明電極２と反射性電極３とからなる一対の電極間に挟持された構成を有しており、動作時には正孔輸送層４と電子輸送性発光層５の界面層から約１０ｎｍ程度電子輸送性発光層側の領域で再結合が生じ、図示される発光領域６で集中して発光が生じる。

なお、この２層型とは異なる、たとえば、正孔輸送層／発光層／電子輸送層の３層型の有機ＥＬ素子では、電極間に電圧を印加すると、陽極からは正孔が、陰極からは電子が注入され、これらがそれぞれのキャリア輸送層を移動し発光層にて再結合して励起子が発生し、上記と同様にＥＬ発光が生じる。

【0035】

また、本発明では、上記の基本構成として、とくに、正面方向の発光光は弱め合うが、

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素子内部に閉じ込められる導波光は強め合うような構成とされている。このことを、図２の特性図を用いて、説明する。

図２は、上記の基本構成のみからなる（すなわち、後述する反射・屈折角に乱れを生ずる領域を設ける前の）有機ＥＬ素子の輝度の角度分布を、正面０度から８０度まで、１０度おきに測定した特性図を示したものである。図中、曲線－ａは本発明のもの、曲線－ｂは従来のものである。

ただし、基本構成中、透明電極２の厚さは１００ｎｍ、正孔輸送層４の厚さは５０ｎｍであり、電子輸送性発光層５の厚さは、１４０ｎｍ（本発明のもの）および６０ｎｍ（従来のもの）となっている。また、素子に流す電流は上記本発明のものと従来のものとで同じとなるように、電圧を印加して測定してある。

【0036】

この図２から明らかなように、従来のものは、正面輝度値、つまり正面０度方向の輝度値が高く、しかも比較的広い角度範囲にわたって輝度値がおよそ一定であり、完全拡散型の好ましい輝度分布を示している。これに対して、本発明のものは、正面輝度値が低く、かつ広角度になるほど輝度が高くなる特性を示している。つまり、本発明のものは、輝度の角度依存性において、式（１）：正面輝度値＜５０度～７０度方向の輝度値、の関係を満たすように構成されている。

なお、この関係は、上記の例では、電子輸送性発光層５の厚さの違いにより、達成しているが、発光層５を含む有機層と一対の電極との材料や厚さなどを適宜選択することにより、任意に達成できるものである。

【0037】

また、本発明のより好ましい態様として、正孔と電子の再結合発光領域６の略中心部と反射性電極３との距離をｄ、発光層（この場合は電子輸送性発光層５）に用いている材料の蛍光発光スペクトルのピーク波長をλ、発光層と反射性電極３の間の有機層（この場合は電子輸送性発光層５）の屈折率をｎとしたときに、式（２）：（０．３／ｎ）λ＜ｄ＜（０．５／ｎ）λ、の関係を満たすように、構成されているのがよい。

たとえば、上記の例で、電子輸送性発光層５の蛍光発光のピーク波長が５４０ｎｍの緑色光であり、その屈折率が１．６５であれば、上記距離ｄは９８．２～１６３．６ｎｍの範囲となるようにされているのが、望ましい。

【0038】

本発明においては、このように式（１）を満たし、また好ましくは式（２）を満たす基本構成としたうえで、さらに発光層と観測者側の出射媒質との間に光の反射・屈折角に乱れを生じさせる領域７を設けたことを特徴とする。

すなわち、本来、導波光として閉じ込められる光は上記領域７に入射すると、その伝送角が変化し、この伝送角が全反射角よりも小さい角度に変化した光は素子外部に出射し、そうでない光も素子内を繰り返し反射し散乱する間に素子外部に出射する。これにより、目的とする高い発光効率が得られるものである。

【0039】

なお、式（１）または式（２）を満足させるために、通常有機層に用いられる厚みより幾分厚い有機層を形成する必要がある場合がある。その際、膜厚が厚くなるため、欠陥や電極の微小な凹凸などに起因した電気的な短絡が軽減され、歩留りが向上する利点がある反面、膜厚の増加に伴い素子抵抗が増加し、動作電圧が増加する問題がある。つまり、単位電流あたりの効率（ｃｄ／Ａ）は向上しても、単位電力あたりの全光束量（Ｌｍ／Ｗ）は従来技術と同等か、場合により却って低下する場合が起こりうる。

これを回避するには、たとえば、特開２０００－１８２７７４号公報やこれに引用されている文献に開示されているように、アルカリ金属イオン、アルカリ土類金属イオン、希土類金属イオンなどを含有する金属有機錯体化合物と有機ＥＬ材料とを混合させるなどして、有機層の電気抵抗を低減させ、動作電圧の上昇を抑えて膜厚を厚くする方法を適用すればよい。その混合層に加える金属錯体を代表とするドーパント材料やその混合法についてはとくに限定はなく、適宜の方法を採用することができる。このような方法により、動

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作電圧を上昇させることなく、本発明の効果を得ることができるため、電流効率と同様、電力効率も向上させることが可能である。

【0040】

また、上記の式（２）は、有機ＥＬ素子の発光色が１色の場合であるが、赤色、緑色、青色など複数の発光材料からＥＬ発光を利用した白色素子であっても、本発明の効果は存分に発揮される。もちろん、青色と黄色の混色による白色発光光などの組み合わせでもよいし、混色による白色以外の任意の発光色についても適用可能である。たとえば、赤色、緑色、青色の３色の混色である場合、すべての発光色で本発明の式（２）を満足させることは不可能である。したがって、たとえば、３色のうち、最も発光効率の悪い色の波長λに式（２）の波長λを適用することで、全体的な発光効率を向上させることができるし、それぞれの発光スペクトルなどから、適宜最適の構成を選択し、式（１）を満たすように有機ＥＬ素子を作製すればよい。用いる白色素子の構成は、たとえば、発光層のホスト材料に赤色、緑色、青色の色素をドーピングしたり、発光層をそれぞれ赤色、緑色、青色の３層に分離させたりするなど、従来の技術にて行うことができる。なお、３層に分離させる場合は、すべての発光色に対して式（２）を満足させることも可能である。

【0041】

さらに、本発明では、反射・屈折角に乱れを生じさせる領域を形成する前に、外部から測定した輝度値が式（１）のような角度分布を持っていることが肝要なのであり、反射・屈折角に乱れを生じさせる領域を形成したのちの輝度値がどのような角度分布を持っていてもなんら問題はない。たとえば、広範囲を照らす照明に用いる場合は均一な角度分布を持つのが好ましいし、携帯電話やモバイル機器に用いられる液晶表示装置用バックライトに用いる場合は、広角度の輝度より正面方向の輝度分布が大きい方が好ましい。この場合は、適宜プリズムシートなどを設置すればよい。

なお、拡散層などがあらかじめ一体化された基板や基板自体に拡散性のある基板上に、有機ＥＬ層を形成する場合、拡散層形成前の輝度分布を知ることはできないが、それと同じ条件で通常の拡散性のない基板上に有機ＥＬ層を形成すれば、本発明に適した素子かどうかを容易に調べることができるし、透過型電子顕微鏡で断面観察するなどして、その積層構成や各層の膜厚などがわかれば、ある程度輝度の角度分布を予想できる。

【0042】

本発明において、光の反射・屈折角に乱れを生じさせる領域７は、基本的に、全反射角以上の角度にある光の伝送角を効率良く全反射角以下の伝送角に乱すことができ、素子内部に閉じ込められている導波光をより多く外部に出射できるように形成されているほど、前記効果が得られるので、望ましい。なお、この領域７は、発光層との間に空気層を介することなく、形成されていることが必要である。何故なら、発光層から領域７までの間に空気が存在すると、発光光が領域７に入射する前にその界面で全反射による光の閉じ込めが起こり、本発明の効果が発現できなくなるためである。

【0043】

このような光の反射・屈折角に乱れを生じさせる領域７の形成方法には、とくに限定はなく、従来より提案されているものをそのまま応用できる。

たとえば、透明材料中にこれとは屈折率の異なる透明材料または不透明材料を分散分布させた光拡散性部位を形成すればよい。具体的には、ガラスやポリマー中にシリカ粒子、チタニア粒子、ジルコニア粒子、プラスチック粒子、液晶粒子、気泡などを分散分布させたものなどが挙げられる。これらの屈折率および屈折率差や粒子の粒径などには、とくに限定はないが、光散乱を生じさせるという点より、粒径としては０．１～１０μｍ、屈折率差としては０．０５以上であるのが好ましい。

【0044】

また、レンズ構造も好適に用いることができる。レンズ構造とは同心円状、互いに平行な複数本の線状、格子状などに配列ないし形成された複数のレンズ、プリズム、Ｖ字溝などによって、直進する光の方向を変化させる薄型板状透明物質を意味する。具体的には、レンティキュラーレンズシート、フレネルレンズシート、コーナーキューブレンズシート

、ハエの目レンズシート、猫の目レンズシート、二重ハエの目レンズシート、二重レンティキュラーレンズシート、放射状レンティキュラーレンズシート、プリズムレンズフィルム、マイクロプリズムレンズフィルムなどや、これらレンズシートの凸面を凹面に変えてなるレンズシート、透明球または半透明球を面状に並べたものなどが挙げられる。また、Ｖ字溝などの溝を彫ることによって光の方向を変化させたものでもよい。レンズシートの材質はガラスであってもよいし、樹脂であってもよい。

【0045】

さらに、支持基板表面や各界面に物理的な凹凸面を形成してもよい。この凹凸面はどんな凹凸構造であってもよく、たとえば１mmオーダーの構造から１００ｎｍオーダーの構造まで、すべてが含まれる。具体的には、支持基板表面を艶消し処理したり、有機層（ポリマー層）表面に周期的な凹凸構造を熱転写するなどして形成したり、半導体製造プロセスを応用し、リアクティブイオンエッチング法などにより数百ｎｍオーダーの凹凸構造、すなわちフォトニック結晶構造なども、好適に適用できる。また、凹凸構造の形状も任意であり、規則正しく配列した周期構造であっても、ランダムな構造であってもよい。そのピッチやアスペクト比も、とくに限定はなく、素子内部に閉じ込められる導波光を効率良く外部に取り出しうる構造であれば、適宜採用できる。

【0046】

また、このような光の反射・屈折角に乱れを生じさせる領域７の形成位置についても、とくに限定はなく、任意の位置に形成できる。たとえば、支持基板１の表面に粘着剤や接着剤を介して拡散フィルムを貼り合わせたり、支持基板１自体に光拡散性を持たせてもよく、また透明電極２と支持基板１の間に形成してもよい。発光面積が比較的大きい照明用途に用いる場合は、基板表面に形成すればよいが、表示装置のように発光面積が小さくなる場合は、発光層と反射・屈折角に乱れを生じさせる領域との伝送距離による視差を低減するため、できるだけ発光層近傍に形成するのが好ましい。

【0047】

つぎに、本発明においては、上記の光の反射・屈折角に乱れを生じさせる領域として、図３に示すように、透光性樹脂中に複屈折特性の相違する微小領域を分散分布させた偏光散乱性部位７０を形成することができる。すなわち、図１に示す有機ＥＬ素子と同様に、式（１）を満たし、また好ましくは式（２）を満たす基本構成としたうえで、発光光が電子輸送性発光層５から透明電極２を介して観測者側に出射するまでの間、ここでは、支持基板１の光取り出し面側に、光の反射・屈折角に乱れを生じさせる領域として、上記した透光性樹脂中に複屈折特性の相違する微小領域を分散分布させた偏光散乱性部位７０を、実質的に空気層を介することなく、形成する。

【0048】

この構成により、本来、導波光として閉じ込められる光は、偏光散乱性部位７０に入射するとその伝送角が変化し、この伝送角が全反射角よりも小さい角度に変化した光は素子外部に出射し、そうでない光も素子内を繰り返し反射し散乱する間に素子外部に出射して、目的とする高い発光効率が得られる。この偏光散乱性部位７０によると、発光光を直線偏光成分がリッチな偏光光として出射でき、また偏光散乱性部位７０の設置角度によって直線偏光の振動方向を任意に変えることができるので、液晶表示装置用のバックライトに用いる場合に、消費電力を著しく低減できるなど、すぐれた効果が奏される。

【0049】

図３において、偏光散乱性部位７０は、直接、支持基板１に形成されているが、透明な粘着剤や接着剤を介して、貼り合わせてもよい。その際、有機ＥＬ素子の発光光を極力全反射により失わないように、各層の屈折率を考慮して、これらの粘着剤や接着剤の屈折率を調整することが好ましい。たとえば、粘着剤の屈折率は、支持基板１の屈折率より高くかつ偏光散乱性部位７０の透光性樹脂の屈折率より小さくしておくのが好ましい。そうすることで、支持基板／粘着剤の界面および粘着剤／偏光散乱性部位の界面で全反射は起こらず、効率よく偏光散乱性部位に発光光を入射できる。

ただし、上記した粘着剤や接着剤の屈折率は、必ずしも上記関係を満足していなくても

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よい。その屈折率差が０．１程度かそれ以下であれば、本発明の前記の効果を著しく低下させる心配はないものである。

なお、上記の偏光散乱性部位７０は、図３とは異なり、支持基板１と透明電極２との間に形成するようにしてもよい。偏光散乱性部位７０上に支持基板１（ガラス基板）があっても、本発明の前記効果は同様に奏されるものである。

【0050】

偏光散乱性部位７０の形状は、少なくとも２面の対向するフラットな面を有していればとくに制限はないが、偏光面光源としての利用や全反射の効率から、フィルム状やシート状、プレート状の形状であるのがよく、中でも、取り扱い性の容易性などより、フィルム形状であるのが望ましい。厚さとしては１０㎜以下が好ましく、０．１～５㎜であるのがより好ましく、０．４～２㎜であるのが最も好ましい。

対向する２面の平滑性は、全反射による発光光の閉じこめ効率の点より、鏡面に近いほどよい。対向する２面が平滑性に乏しい場合、別途、平滑性にすぐれた透光性のフィルムやシートを透明な接着剤や粘着剤で貼り合わせ、全反射界面を貼り合わせた透光性のフィルムやシートの平滑な表面とすることでも同様の効果が得られる。

【0051】

偏光散乱性部位７０の形成は、たとえば、ポリマー類や液晶類などの透明性にすぐれる適宜の材料の１種または２種以上を、延伸処理などによる適宜な配向処理で複屈折性が相違する領域を形成する組み合せで用いて配向フィルムを得る方式などの適宜の方式にて行うことができる。ちなみに、上記組み合せの例としては、ポリマー類と液晶類の組み合わせ、等方性ポリマーと異方性ポリマーの組み合わせ、異方性ポリマー同士の組み合わせなどが挙げられる。微小領域の分散分布性などの点より、相分離する組み合せが好ましく、組み合わせる材料の相溶性により、分散分布性を制御することができる。相分離は、たとえば、非相溶性の材料を溶媒にて溶液化する方式や、非相溶性の材料を加熱溶融下に混合する方式などの適宜の方式で行うことができる。

【0052】

上記組み合わせで延伸方式により配向処理する場合、ポリマー類と液晶類の組み合わせおよび等方性ポリマーと異方性ポリマーの組み合わせでは任意の延伸温度や延伸倍率にて、異方性ポリマー同士の組み合わせでは延伸条件を適宜に制御することにて、目的とする偏光散乱性部位を形成することができる。

なお、異方性ポリマーでは、延伸方向の屈折率変化の特性に基づいて正負に分類されるが、本発明では正負いずれの異方性ポリマーも用いることができ、正同士や負同士、または正負の組み合わせのいずれにても用いうる。

【0053】

上記のポリマー類の例としては、たとえば、ポリエチレンテレフタレート、ポリエチレンナフタレートなどのエステル系ポリマー、ポリスチレン、アクリロニトリル・スチレン共重合体などのスチレン系ポリマー、ポリエチレン、ポリプロピレン、シクロ系ないしノルボルネン構造を有するポリオレフィン、エチレン・プロピレン共重合体などのオレフィン系ポリマー、ポリメチルメタクリレートなどのアクリル系ポリマー、二酢酸セルロース、三酢酸セルロースなどのセルロース系ポリマー、ナイロン、芳香族ポリアミドなどのアミド系ポリマーなどが挙げられる。

【0054】

また、カーボネート系ポリマー、塩化ビニル系ポリマー、イミド系ポリマー、スルホン系ポリマー、ポリエーテルスルホン、ポリエーテルエーテルケトン、ポリフェニレンスルフイド、ビニルアルコール系ポリマー、塩化ビニリデン系ポリマー、ビニルブチラール系ポリマー、アリレート系ポリマー、ポリオキシメチレン、シリコーン系ポリマー、ウレタン系ポリマー、エーテル系ポリマー、酢酸ビニル系ポリマー、上記ポリマーのブレンド物、あるいはフェノール系、メラミン系、アクリル系、ウレタン系、ウレタンアクリル系、エポキシ系、シリコーン系などの熱硬化型ないし紫外線硬化型のポリマー類なども、前記したポリマー類の例として挙げられる。

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【0055】
液晶類の例としては、たとえば、シアノビフェニル系、シアノフェニルシクロヘキサン系、シアノフェニルエステル系、安息香酸フェニルエステル系、フェニルピリミジン系、それらの混合物などの室温または高温でネマチック相やスメクチック相を呈する低分子液晶や架橋性液晶モノマー、あるいは室温または高温でネマチック相やスメクチック相を呈する液晶ポリマーなどが挙げられる。
上記の架橋性液晶モノマーは、通常は、配向処理したのち、熱や光などによる適宜の方式で架橋処理されてポリマーとされる。
【0056】
耐熱性や耐久性などにすぐれる偏光散乱性部位７０を得るには、ガラス転移温度が５０℃以上、とくに８０℃以上、中でも１２０℃以上のポリマー類と、架橋性液晶モノマーないし液晶ポリマーとの組み合わせで用いるのが好ましい。
液晶ポリマーとしては、主鎖型や側鎖型などの適宜のものを使用でき、その種類に限定はない。粒径分布の均一性にすぐれる微小領域の形成性や熱的安定性、フィルムへの成形性や配向処理の容易性などの点より、好ましく使用できる液晶ポリマーは、重合度が８以上、とくに１０以上、中でも１５～５，０００のものである。
この液晶ポリマーを用いて偏光散乱性部位を形成するには、ポリマー類の１種または２種以上と微小領域を形成するための液晶ポリマーの１種または２種以上を混合し、液晶ポリマーを微小領域の状態で分散含有するポリマーフィルムを形成して適宜な方式で配向処理し、複屈折性が相違する領域を形成する方法などが用いられる。
【0057】
配向処理による屈折率差Δn_1，Δn_2の制御性などの点からは、ガラス転移温度が５０℃以上で、併用するポリマー類のガラス転移温度よりも低い温度域でネマチック液晶相を呈するものが、好ましく用いられる。
具体的には、つぎの一般式（Ａ）：

$$\begin{array}{c}(-X-)_n \\ | \\ Y-Z\end{array} \quad \cdots(A)$$

で表されるモノマー単位を有する側鎖型の液晶ポリマーが挙げられる。
このような側鎖型の液晶ポリマーは、一般式（Ａ）で表されるモノマー単位を有するホモポリマーやコポリマーなどの適宜の熱可塑性ポリマーであればよく、モノドメイン配向性にすぐれるものが好ましい。
【0058】
一般式（Ａ）において、Ｘは、液晶ポリマーの主鎖を形成する骨格基であり、線状、分岐状、環状などの適宜の連結鎖で構成されたものであってよい。具体的には、ポリアクリレート類、ポリメタクリレート類、ポリ－α－ハロアクリレート類、ポリ－α－シアノアクリレート類、ポリアクリルアミド類、ポリアクリロニトリル類、ポリメタクリロニトリル類、ポリアミド類、ポリエステル類、ポリウレタン類、ポリエーテル類、ポリイミド類、ポリシロキサン類などが挙げられる。
Ｙは、主鎖より分岐するスペーサ基であり、屈折率制御などの偏光散乱性部位の形成性などの点より、エチレン、プロピレン、ブチレン、ペンチレン、ヘキシレン、オクチレン、デシレン、ウンデシレン、ドデシレン、オクタデシレン、エトキシエチレン、メトキシブチレンなどであるのがよい。Ｚは、液晶配向性を付与するメソゲン基である。
【0059】
ネマチック配向性の液晶ポリマーを用いた偏光散乱性部位の形成は、ポリマーフィルムを形成するためのポリマー類と、そのポリマー類のガラス転移温度よりも低い温度域でネマチック液晶相を呈するガラス転移温度が５０℃以上、とくに６０℃以上、中でも７０℃以上の液晶ポリマーを混合して、液晶ポリマーを微小領域の状態で分散含有するポリマーフィルムを形成し、その微小領域を形成する液晶ポリマーを加熱処理してネマチック液晶相に配向させ、その配向状態を冷却固定する方法などにより、行える。

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上記微小領域を分散含有するポリマーフィルム、すなわち、配向処理対象のフィルムの形成は、キャスティング法、押出成形法、射出成形法、ロール成形法、流延成形法などの適宜の方式にて作製できる。モノマー状態で展開しそれを加熱処理や紫外線などの放射線処理などにより重合して、フィルム状に製膜する方式などでも行える。

【0060】

微小領域の均等分布性にすぐれる偏光散乱性部位７０を得る点などよりは、溶媒を介した形成材の混合液をキャスティング法や流延成形法などにて製膜する方式を採用するのが好ましい。この場合、溶媒の種類や混合液の粘度、混合液展開層の乾燥速度などにより、微小領域の大きさや分布性などを適当に制御できる。ちなみに、微小領域の小面積化には混合液の低粘度化や混合液展開層の乾燥速度の急速化などが有利である。

配向処理の対象となるフィルムの厚さは適宜に決定できるが、通常は配向処理性などの点より、１μｍ～３㎜、とくに５μｍ～１㎜、中でも１０～５００μｍとするのがよい。フィルムの形成に際し、たとえば、分散剤、界面活性剤、色調調節剤、難燃剤、離型剤、酸化防止剤などの適宜の添加剤を配合してもよい。

【0061】

配向処理は、１軸や２軸、逐次２軸やＺ軸などによる延伸処理方式や圧延方式、ガラス転移温度または液晶転移温度以上の温度で電場または磁場を印加して急冷し配向を固定化する方式、製膜時に流動配向させる方式、等方性ポリマーの僅かな配向に基づいて液晶を自己配向させる方式などの、配向により屈折率を制御しうる各種方式の中から、その１種または２種以上を用いて行うことができる。したがって、得られる偏光散乱性部位７０は延伸フィルムであってもよいし、非延伸フィルムであってもよい。

なお、延伸フィルムとする場合には、脆性ポリマーも使用できるが、延び性にすぐれるポリマーがとくに好ましく用いうる。

【0062】

微小領域が液晶ポリマーからなる場合、ポリマーフィルム中に微小領域として分散分布する液晶ポリマーがネマチック相などの目的とする液晶相を呈する温度に加熱して溶融させ、それを配向規制力の作用下で配向させて急冷し、配向状態を固定化する方式などでも行える。微小領域の配向状態は、可及的にモノドメイン状態にあることが光学特性のバラツキ防止などの点より、好ましい。

なお、上記配向規制力は、ポリマーフィルムを適宜の倍率で延伸処理する方式による延伸力やフィルム形成時のシェアリング力、電界や磁界などの、液晶ポリマーを配向しうる適宜の規制力を適用でき、その１種または２種以上の規制力を作用させて液晶ポリマーの配向処理を行うことができる。

【0063】

したがって、偏光散乱性部位における微小領域以外の部分は、複屈折性を示すものであってもよいし、等方性のものであってもよい。

偏光散乱性部位の全体が複屈折性を示すものは、フィルム形成用のポリマー類に配向複屈折性のものを用いて上記した製膜過程における分子配向などにより得ることができ、必要に応じて、たとえば延伸処理などの公知の配向手段を加えて複屈折性を付与ないし制御することができる。

微小領域以外の部分が等方性である偏光散乱性部位は、フィルム形成用のポリマー類に等方性のものを用い、そのフィルムを上記ポリマー類のガラス転移温度以下の温度領域で延伸処理する方式などで、得ることができる。

【0064】

本発明において、上記微小領域とそれ以外の部分、つまり透光性樹脂からなる部分との間で、微小領域の各光軸方向における屈折率差Δn_1、Δn_2、Δn_3が最大値を示す軸方向（Δn_1方向）において０．０３～０．５（Δn_1）であり、かつそのΔn_1方向と直交する２軸方向（Δn_2方向、Δn_3方向）において０．０３以下（Δn_2、Δn_3）となるように制御したものであるのが好ましく、Δn_2とΔn_3の等しいものがより好ましい。このような屈折率差とすることにより、Δn_1方向の直線偏光が強く散乱され臨界

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角よりも小さい角度で散乱されて偏光散乱性部位より出射する光量を増やすことができ、それ以外の方向の直線偏光は散乱されにくくて全反射を繰り返し、偏光散乱性部位内に閉じ込めることができる。

なお、微小領域の各光軸方向と微小領域以外の部分との屈折率差は、透光性樹脂が光学的等方性のものである場合は、微小領域の各光軸方向の屈折率と透光性樹脂の平均屈折率との差を意味するものである。また、光学的異方性のものである場合は、透光性樹脂の主光軸方向と微小領域の主光軸方向とが通常は一致しているため、それぞれの軸方向における各屈折率の差を意味するものである。

【0065】

本発明においては、前記した全反射の点より、Δn_1 方向における屈折率差Δn_1 は適度に大きいことが好ましく、とくに０．０３５～０．５、中でも０．０４０～０．４５であるのが好ましい。また、Δn_2 方向とΔn_3 方向における屈折率差Δn_2 、Δn_3 は、小さければ小さいほどよく、可及的にゼロであることが望ましい。このような屈折率差は使用材料の屈折率や上記した配向操作などにより、制御できる。

また、前記のΔn_1 方向としては、偏光散乱性部位より出射される直線偏光の振動面であることより、このΔn_1 方向は偏光散乱性部位の対向する２面に平行であることが好ましい。なお、面内での上記Δn_1 方向は、目的とする液晶セルなどに応じた適宜の方向とすることができる。

【0066】

偏光散乱性部位における微小領域は、散乱効果などの均質性などの点より、可及的に均等に分散分布していることが好ましい。微小領域の大きさ、とくに散乱方向であるΔn_1 方向の長さは、後方散乱（反射）や波長依存性に関係する。光利用効率の向上や波長依存性による着色の防止、微小領域の視覚による視認阻害の防止ないし鮮明な表示の阻害防止、さらに製膜性やフィルム強度などの点より、微小領域の好ましい大きさ、とくにΔn_1 方向の好ましい長さは、０．０５～５００μｍ、とくに０．１～２５０μｍ、中でも１～１００μｍである。なお、微小領域は、通例ドメインの状態で偏光散乱性部位内に存在するが、そのΔn_2 などの長さについてはとくに限定はない。

偏光散乱性部位７０中に占める微小領域の割合としては、Δn_1 方向の散乱性などの点より、適宜に決定することができるが、一般には、フィルム強度なども踏まえて、０．１～７０重量％とするのが望ましく、とくに０．５～５０重量％とするのがより望ましく、中でも１～３０重量％とするのがさらに望ましい。

【0067】

本発明において、偏光散乱性部位７０は、単層により形成することもできるし、２層以上重畳したものとして形成することもできる。重畳化により、厚さ増加以上の相乗的な散乱効果を発揮させることができる。重畳体は、散乱効果の拡大などの点よりは、Δn_1 方向が上下の層で平行関係となるように重畳したものが、好ましい。重畳数は２層以上の適宜の数とすることができる。重畳する偏光散乱性部位は、Δn_1 またはΔn_2 などが同じものであってもよいし、異なるものであってもよい。

なお、Δn_1 方向などにおける上下の層での平行関係は、可及的に平行であることが好ましいが、作業誤差によるズレなどは許容される。また、Δn_1 方向などにバラツキがある場合には、その平均方向に基づくものである。

【0068】

偏光散乱性部位７０は、この部位を光が伝送する過程で適当に偏光状態が解消される必要があるため、面光源の全体または部分的に位相差を有するのが望ましい。基本的には、偏光散乱性部位の遅相軸と、散乱されにくい直線偏光の偏光軸（振動面）とは直交関係にあるため、位相差による偏光変換は起きにくいが、僅かな散乱で見かけの角度が変化し、偏光変換が生じるものと考えられる。

偏光変換の点よりは偏光散乱性部位の厚さにて変化するが、一般には５ｎｍ以上の面内位相差があるのが好ましい。その位相差の付与は、複屈折性の微粒子を含有させる方式、表面に付着させる方式、透光性樹脂を複屈折性とする方式、それらを併用する方式、さら

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に複屈折性フィルムを一体化積層するなどの適宜の方式にて行える。

【0069】

また、本発明においては、上記の偏光散乱性部位７０を形成する代わりに、光の反射・屈折角に乱れを生じさせる領域として、図１に示す有機ＥＬ素子の場合と同様の光拡散層やレンズ構造などを形成し、この領域より観測者側にさらに反射型偏光子を設置することにより、出射光を偏光光として効率良く取り出すことができ、偏光板での吸収を最小限が抑えられた有機ＥＬ素子を作製することができる。

【0070】

図４は、この有機ＥＬ素子の一例を示したものであり、図１に示す有機ＥＬ素子の場合と同様に、支持基板１上に透明電極２、正孔輸送層４、発光領域６を持つ電子輸送性発光層５および反射性電極３が順次積層された構造を有して、式（１）を満たし、また好ましくは式（２）を満たす基本構成を形成したうえで、光の反射・屈折角に乱れを生じさせる領域７として光拡散層やレンズ構造などを形成し、さらにこの領域７より観測者側に反射型偏光子８を設けるようにしたものである。

この反射型偏光子８は、上記領域７を通じて導かれる発光光を入射させて得られる偏光からなる透過光を偏光板に供給して吸収ロスを低減するとともに、反射型偏光子８による反射光を面光源装置における反射層を介して反転させて反射型偏光子に再入射させ、その一部または全部を所定の偏光として吸収型偏光板を透過させ、さらに液晶表示などに利用しうる光量を増大して輝度を向上させるものである。この輝度向上の観点より、偏光の反射率が４０％以上の反射型偏光子が好ましい。

【0071】

このような反射型偏光子８としては、自然光を入射させて反射光と透過光が得られる適宜のものが用いられる。具体的には、コレステリック液晶層からなる反射型円偏光子（円偏光分離シート）や、屈折率の異なる少なくとも２種の材料を多層積層してなる反射型直線偏光子（直線偏光分離シート）（たとえば、特表平９－５０６９８４号公報、特表平９－５０７３０８号公報）などが挙げられる。

反射型円偏光子は、グランジャン配向のコレステリック液晶層からなり、入射光を左右一方の円偏光からなる反射光と透過光に分離する。また、反射型直線偏光子は、入射光を振動面が直交する直線偏光からなる反射光と透過光に分離するものであり、３Ｍ社製の「ＤＢＥＦ」などの市販品もある。

【0072】

反射型円偏光子において、コレステリック液晶層としては、入射光を左右一方の円偏光からなる光を反射し、他の光は透過する特性を示す適宜のものを用いることができる。その種類についてとくに限定はない。

反射型円偏光子は、通常は、透明基材上にコレステリック液晶ポリマーによるフィルムやコレステリック液晶層を密着支持したものとして、得られる。また、広い波長範囲の透過円偏光を得るため、反射波長域が相違するコレステリック液晶層を２層または３層以上重畳した構造としてもよい。

なお、本発明の有機ＥＬ素子を液晶表示装置用のバックライトとして用いる場合、反射型円偏光子から出射する光は円偏光光であるが、１／４波長板を用いることなどにより容易に直線偏光光に変化させることができる。

【0073】

本発明において、反射型偏光子８は、光の反射・屈折角に乱れを生じさせる領域７より観測者側、つまり外側に形成されておればよい。その際、空気層を介して設置してもよいし、領域７に直接密着させたり、接着剤や粘着剤を介して貼り合わせてもよく、とくに限定はない。領域７と反射型偏光子８との間に防湿層などの別の機能を有する層を付加してもよい。図５～図７は、図４以外の例を示したものである。

【0074】

図５は、光の反射・屈折角に乱れを生じさせる領域７を透明電極２に隣接して設け、支持基板１を介して反射型偏光子８を設けたものである。図６は、光の反射・屈折角に乱れ

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を生じさせる領域７として、支持基板１表面にマイクロレンズ構造を形成したものを使用し、これに空気層を介して反射型偏光子８を設けたものである。その他の構成要素は、図４と同じであり，同一番号を付して、その説明を省略する。

図７は、支持基板１上に、反射性電極３、電子輸送性発光層５、正孔輸送層４、透明電極２、光の反射・屈折角に乱れを生じさせる領域７および反射型偏光子８を、この順に設けて、支持基板１の反対面側から発光光を取り出す、いわゆる上面取り出し方式の例を示したものである。この場合、支持基板１は、透明性であることを必要としない。

【0075】

上記構成の有機ＥＬ素子は、出射光が偏光光として得られるため、液晶表示装置用のバックライト用光源として最適であり。携帯電話やモバイル機器のように軽量化、薄型化、電池容量の関係から、低消費電力化が要求される用途に最適である。

図８は、図４に示す有機ＥＬ素子における反射型偏光子８としてコレステリック液晶層からなる反射型円偏光子を用いた場合の適用例である。この場合、有機ＥＬ素子における有機層はせいぜい５００ｎｍ以下という薄い層であり、光の反射・屈折角に乱れを生じさせる領域７も２００μｍかそれ以下（５０μｍ程度までの厚さ）で形成できる。よって、支持基板１であるガラス板を薄くしたり、樹脂フィルムを使用することで、従来の導光板によるバックライトに比べて、薄型軽量化が可能である。

【0076】

図８において、上記構成の有機ＥＬ素子により導波光成分が強められて、本質的に全光量が増幅され、その光は光の反射・屈折角に乱れを生じさせる領域７により、効率良く取り出される。反射型偏光子８に入射した光の半分は円偏光光として透過し、残り半分は逆の円偏光として反射される。この円偏光光は再度領域７に入り、散乱されることで偏光解消され、自然光として領域７で後方散乱されたり、反射性電極３で反射されて再び反射型偏光子８に入射し、そのうちの半分が円偏光光として透過する。

このプロセスを繰り返すことにより、５０％以上の発光光が外部に導かれる。反射型偏光子８を通り抜けた円偏光光は１／４波長板９にて直線偏光に変換され、その振動方向と液晶表示セルの偏光板１０の透過軸を一致させることにより、偏光板１０での吸収ロスを受けず、そのまま液晶セル１１に入射する。

【0077】

円偏光光を直線偏光光に変換するための１／４波長板は、位相差フィルムとして面位相差は１／４であるが、斜め方向の光に関しては光路長の変化から正確に１／４波長として機能しなくなる。このため、斜め方向の光は、完全に円偏光から直線偏光に変換されないため、一部偏光板で吸収が起こる。

これを改善するには、面内方向には異方性がなく、その面内屈折率より厚さ方向の屈折率が大きい光学補償層（板）を挿入することにより、改善できる。また、使用する１／４波長板自体に厚さ方向の屈折率変化を持たせ、光学補償機能を付加してもよい。

これらの光学補償方法は、たとえば、特開平１１－２３１１３２号公報などに開示されている。本発明において、これら光学補償方法にはなんら限定はなく、その使用材料などについてもとくに限定はない。

なおまた、本発明における偏光状態や偏光子は、厳密にいうと完全な直線偏光や円偏光ではなく、実際にはそれらから僅かに楕円偏光した状態にあるが、これらを含めて、直線偏光や円偏光と称しており、必ずしも完全な偏光状態になくても，本発明の効果は十分に発揮されるものである。

【0078】

本発明の有機ＥＬ素子において，前記の基本構成となる有機材料、電極材料、層構成や各層の膜厚などには限定はなく、従来技術をそのまま適用できる。

具体的な構成としては、前記した２層型の有機ＥＬ素子である陽極／正孔輸送層／電子輸送性発光層／陰極のほか、３層型の有機ＥＬ素子である陽極／正孔輸送層／発光層／電子輸送層／陰極、これらの積層型素子とは異なる陽極／発光層／陰極などの種々の構成を選択することができ、とくに限定はない。

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また、陽極界面に正孔注入層や陰極界面に電子注入層を設けたり、再結合効率を高めるための電子ブロック層、正孔ブロック層を挿入した構成としてもよい。基本的には、発光効率がより高くなる構成、材料、形成方法を選択すると、少ない消費電力で強度のＥＬ発光が得られ、本発明の効果をより高められる。

【００７９】

また、本発明の有機ＥＬ素子において、陰極電極と陽極電極とのうちの一方が透明電極で、他方が極力反射率の高い反射性電極であるとき、干渉効果がより顕著に現れるため、好ましいが、他方が必ずしも反射性電極である必要はない。

両極がともに透明電極であったり、また反射性電極が半透過性の比較的反射率の低い電極であってもよく、逆に誘電体ミラーなどで構成された極めて反射率の高い電極であってもよい、要は、式（１）を満足していることが肝要である。

【００８０】

電極材料も、適宜最適なものを選択できる。通常の有機ＥＬ素子において、陽極には酸化インジウム錫（ＩＴＯ）、酸化錫や酸化亜鉛に適宜ドーパントを添加した材料に代表される透明導電膜が用いられ、陰極にはＭｇとＡｇをおよそ１０：１の原子比で共蒸着したものや、Ｃａ電極、Ｌｉを微量ドープしたＡｌ電極などが陰極の低仕事関数化による電子注入効率向上の観点から応用されているが、とくに限定されない。

陽極をＩＴＯなどの透明電極とする以外に、陰極として有機層界面から厚さ数ｎｍ～数十ｎｍの透光性を維持できる薄さの金属電極を形成し、その後、ＩＴＯを形成するなどして、陰極を透明電極としてもよい。また、陽極と陰極とを上記同様にして透明電極とし、発光を陽極と陰極の両方から取り出す両面取り出し構造としてもよく、その片面または両面に反射・屈折角に乱れを生じさせる領域を形成してもよい。

【００８１】

陰極と陽極の両面側の発光分布が式（１）を満たしている場合が最も好ましいが、いずれか一方が式（１）を満たしておれば、本発明の効果は発揮できる。両面に反射・屈折角に乱れを生じさせる領域を形成してもよいし、片面だけに形成してもよく、それぞれ異なる特性のものを貼り合わせてもよい。式（１）を満たさない面に形成してあっても本発明の効果を損なうことはなく、用途に応じて任意に選択できる。

両面取り出し構造とする方法には、アルカリ金属に代表される低仕事関数金属を有機層に混入させＩＴＯ電極から電子注入を可能とさせる方法（松本、「ＯＰＴＲＯＮＩＣＳ」Ｎｏ．２、ｐ．１３６、２００３）、銅フタロシアニンなどの金属錯体材料を電子輸送層とＩＴＯの間に挿入する方法（Ａｓｕｋａ　ｅｔ　ａｌ．，Ａｐｐｌ．Ｐｈｙ．Ｌｅｔｔ．，Ｖｏｌ．７８，ｐ．３３４３，２００１）などが挙げられる。

【００８２】

本発明において、有機層の材料（有機ＥＬ材料）には限定はなく、低分子系と高分子系のいずれも好適に使用できる。つまり、低分子系材料を真空蒸着して形成してもよいし、高分子系材料を塗布法などにより形成してもよく、とくに制限はない。

高分子系の有機ＥＬ素子でも、電子移動度や正孔移動度の大小とその素子構成により、式（１）を満足する有機ＥＬ素子を作製できるし、どちらかのキャリアをトラップするような部位を導入した分子構造とすることで、再結合発光領域を特定の部位に限定させ、式（２）をも満足させることも可能である。

たとえば、透明電極（陽極）／発光層／反射性電極（陰極）の単層型素子であれば、発光層の電子輸送性を正孔輸送性より大きくすることで、再結合を主に反射電極より離れた陽極側で生じさせることができるため、発光層の膜厚を適宜調整することで、式（１）さらには式（２）を満足させることができる。また、キャリアトラップ性を有する材料としては、たとえば、Ｍａｔｓｕｍｕｒａら（Ｍ．Ｍａｔｓｕｍｕｒａ　ｅｔ　ａｌ．，Ａｐｐｌ．Ｐｈｙ．Ｌｅｔｔ．，Ｖｏｌ．７９，ｐ．４４９１，２００１）が報告しているポリフェニレンビニレン誘導体からなるコポリマーなどがある。

【００８３】

本発明の有機ＥＬ素子において、支持基板には、透明性の有無に関わらず、一般的なも

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のが使用できる。ガラス基板を用い、発光を透明電極を介してガラス基板側に取り出す方法のほかに、不透明な金属板を支持基板に用い、支持基板とは逆の方面から光を取り出すよ構成としてもよい。支持基板には、高分子フィルムのような可撓性のある材料を用いてもよいし、支持基板自体に光の反射・屈折角に乱れを生じさせる領域を形成したものであってもよい。また、支持基板と透明電極の間に光の反射・屈折角に乱れを生じさせる領域を形成してもよい。本発明においては、光の反射・屈折角に乱れを生じさせる領域上に支持基板があっても、本発明の効果は同様に奏される。

【0084】

支持基板として高分子フィルムを使用する場合、その具体的な材料としては、ポリエチレンテレフタレート、トリアセチルセルロース、ポリエチレンナフタレート、ポリエーテルスルホン、ポリカーボネート、ポリアクリレート、ポリエーテルエーテルケトン、ノルボルネン系樹脂などが挙げられる。

支持基板が光の反射・屈折角に乱れを生じさせる領域である偏光散乱性部位よりも出射面側に位置する場合、偏光散乱性部位により得られる直線偏光を維持するため、支持基板には複屈折を示す光学異方性のないものを選択する必要がある。

仮に複屈折があると、偏光散乱性部位から出射する直線偏光と、その光軸、位相差の関係によっては直線偏光が楕円偏光に変換され、液晶表示装置などに適用する場合、偏光板で吸収される成分が増加してしまう場合がある。したがって、この場合の支持基板には、ガラス板、エポキシ樹脂基板、三酢酸セルロースフィルム、ノルボルネン系樹脂フィルムやその他市販の光学異方性のない基板を用いる必要がある。

【0085】

本発明の有機ＥＬ素子において、光の反射・屈折角に乱れを生じさせる領域として偏光散乱性部位を形成する場合、光の取り出し面には偏光維持性のレンズシートや光拡散板、波長カットフィルター、位相差フィルムなどを適宜使用できる。

レンズシートは、出射光（直線偏光）をその偏光度を可及的に維持しつつ光路制御して視認に有利な正面方向への指向性を向上させ、散乱性の出射光の強度ピークを正面方向とすることなどを目的とする。

波長カットフィルターは、励起光源からの直接光をたとえば液晶表示素子などに進入することを防止する目的で用いられ、とくに励起光が紫外線である場合、紫外線による液晶や偏光板の劣化を防止する必要がある。また、不必要な波長の可視光線を排除する目的で用いることもできる。また、本発明では、上記の波長カットフィルターを設けずに、偏光散乱性部位やその他の構成部材に対し、必要により、たとえば紫外線吸収剤などを配合して波長カットの機能をもたせることもできる。

【0086】

本発明の有機ＥＬ素子は、以上説明したような特異な構成をとることにより、これを発光素子として具備する発光効率の高い面光源とこの面光源を具備する表示装置を提供できる。またとくに、上記の有機ＥＬ素子における光の反射・屈折角に乱れを生じさせる領域として偏光散乱性部位を形成したものや、光の反射・屈折角に乱れを生じさせる領域として光拡散層やレンズ構造などを形成し、さらに反射型偏光子を設置したものでは、これらを発光素子として具備する発光効率の高い偏光面光源とこの偏光面光源を具備する液晶表示装置などの表示装置を提供できるものである。

【実施例】

【0087】

つぎに、本発明の有機ＥＬ素子において、反射・屈折角に乱れを生じさせる領域として光拡散層（光拡散性粘着剤）またはレンズ構造を設けた「実施例１－１～６」および「比較例１－１～６」を記載して、本発明を具体的に説明する。

【0088】

実施例１－１

＜有機ＥＬ素子の基本構成の作製＞

ガラス基板の片面側に、ＩＴＯセラミックターゲット（In_2O_3：SnO_2＝９０重

量％：１０重量％）から、ＤＣスパッタリング法にて、厚さ１００ｎｍのＩＴＯ膜を形成し、透明電極（陽極）を形成した。

その後、フォトレジストを用いて、ＩＴＯをエッチングすることにより、発光面積が１５㎜×１５㎜となるようにパターンを形成した。超音波洗浄を行ったのち、低圧紫外線ランプを用いてオゾン洗浄した。

【0089】

つぎに、ＩＴＯ面上に、真空蒸着法により．有機層を順次形成した。まず、正孔注入層として、式（３）で表されるＣｕＰｃを、蒸着速度０．３ｎｍ／ｓで、１５ｎｍの厚さに形成した。つぎに．正孔輸送層として、式（４）で表されるα－ＮＰＤを、蒸着速度０．３ｎｍ／ｓで、４０ｎｍの厚さに形成した。最後に、電子輸送性発光層として、式（５）で表されるＡｌｑを、蒸着速度０．３ｎｍ／ｓで、１４０ｎｍの厚さに形成した。

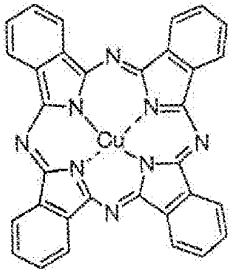
【0090】

その後、Ｍｇを１ｎｍ／ｓ、Ａｇを０．１ｎｍ／ｓの蒸着速度にて共蒸着し、厚さ１００ｎｍのＭｇＡｇを形成後、ＭｇＡｇの酸化防止の観点から、さらに、その上にＡｇを５０ｎｍ形成して、反射性電極（陰極）とした。

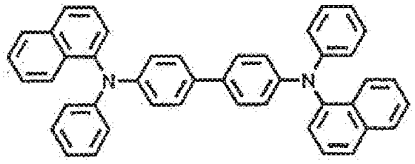
真空蒸着装置から取り出したのち、陰極電極側に紫外線硬化性エポキシ樹脂を滴下し、その上にスライドガラスを被せ、十分にエポキシ樹脂が広がった時点で高圧紫外線ランプを用いてエポキシ樹脂を硬化させ、素子を封止した。

【0091】

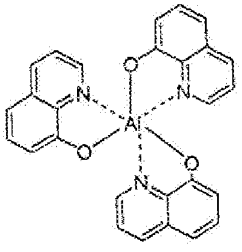
【化1】



・・・（３）



・・・（４）



・・・（５）

【0092】

このように作製した反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子について、１５Ｖの電圧を印加したところ、１０．５ｍＡ／ｃｍ^2 の電流密度で素子に電流が通じ、発光が観測された。

図１０に示すように、市販の輝度計（トプコン社製の品名「ＢＭ９」）を用い、θ方向の素子の輝度を、０度～８０度方向まで、１０度おきに測定したところ、表１－１に示す結果となった。また、φ方向に測定方向を変えて、輝度の角度依存性を測定したところ、ほぼ全方向で輝度値は同じであった。

よって、φ方向に関しては、発光は均一に分布しているものと仮定し、８０度方向までの空間に出射する単位面積当たりの光束量（ｌｍ／ｍ^2 ）を、数値的に積分して算出した。この結果も合わせて、表１－１に示した。

【0093】

表１－１のように、上記の有機ＥＬ素子は、本発明の式（１）の関係を十分に満たすものであった。また、この素子において、正孔と電子の再結合は、ほぼα－ＮＰＤとＡｌｑの界面で起こる。よって、本発明にいう正孔と電子の再結合発光領域の中心部と反射性電極との距離ｄはおよそ１４０ｎｍであった。

また、励起光源に発光波長が３６５ｎｍのブラックライトを用い、ガラス基板上に蒸着したＡｌｑ薄膜に照射した際の蛍光スペクトルのピーク波長λはおよそ５３０ｎｍであった。また、分光エリプソメータを用いて測定したＡｌｑ薄膜の屈折率ｎはおよそ１．６７であった。よって、上記の有機ＥＬ素子は、本発明の式（２）の関係も満足するものであった。

【0094】

＜反射・屈折角に乱れを生じさせる領域の形成＞

トルエン５０ｇに、屈折率１．４３、粒子径４μｍのシリコーン粒子２５ｇを加え、よく撹拌した。また、屈折率が１．４７であるアクリル系粘着剤をトルエンに加えて溶解させた。この溶液を、粘着剤に対するシリコーン濃度が２５重量％になるように、上記のシリコーン粒子を分散させたトルエン溶液に加え、さらに粘着剤のトルエンに対する濃度が２５重量％になるように、濃度調整を行い、よく撹拌した。

アプリケータを用い、セパレーター上に上記調整した溶液を塗布し、乾燥させることにより、厚さ２０μｍの光拡散性粘着剤を作製した。

【0095】

つぎに、前記のように作製した有機ＥＬ素子のガラス基板表面上に、上記の光拡散性粘着剤を１０枚重ねて貼り合わせ、厚さがおよそ２００μｍの光拡散層を形成した。その後、この素子に前記同様にして、１５Ｖの電圧を印加して、１０．５ｍＡ／ｃｍ^2 の電流密度で素子に電流を流した際の輝度を、０度～８０度の範囲で測定した。この結果を、表１－１に合わせて示した。また、単位面積当たりの光束量についても、前記同様に算出して、表１－１に示した。

【0096】

表１－１

角　度	輝度値　（ｃｄ／ｍ^2 ）	
	光拡散層形成前	光拡散層形成後
０°	１２６	３９２
１０°	１３８	３８２
２０°	１５４	３８２
３０°	１８１	４２４
４０°	２２５	４４５
５０°	２７２	４６６
６０°	３０７	５０９

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７０°	３８６	４８７
８０°	３３９	４６６
全光量	７６１（ｌｍ／ｍ^2）	１３７４（ｌｍ／ｍ^2）

【0097】
実施例１－２
電子輸送性発光層として、式（５）で表されるＡｌｑを１２０ｎｍの厚さに形成した以外は、実施例１－１と同様にして、基本構成としての有機ＥＬ素子と、これに光散乱層を形成した有機ＥＬ素子を作製した。
この光拡散層の形成前後の有機ＥＬ素子に１３．１Ｖの電圧を印加し、同様に１０．５ｍＡ／ｃｍ^2 の電流密度で素子に電流を流して発光させ、実施例１－１と同様に評価した。これらの結果を表１－２に示した。なお、光拡散層を形成する前のθ方向の輝度分布は、本発明の式（１）の関係を満足し、またＡｌｑ層１２０ｎｍという値も、本発明の式（２）の関係を満足するものであった。
【0098】
表１－２

角　度	輝度値　（ｃｄ／ｍ^2）	
	光拡散層形成前	光拡散層形成後
０°	１６６	４２６
１０°	１７１	４３１
２０°	１７６	４５０
３０°	２０５	４６０
４０°	２４５	４６５
５０°	２８４	４８４
６０°	３１３	４９９
７０°	３６２	４８４
８０°	３４２	３７７
全光量	７９８（ｌｍ／ｍ^2）	１４３２（ｌｍ／ｍ^2）

【0099】
比較例１－１
電子輸送性発光層として、式（５）で表されるＡｌｑを６０ｎｍの厚さに形成した以外は、実施例１－１と同様にして、基本構成としての有機ＥＬ素子と、これに光散乱層を形成した有機ＥＬ素子を作製した。
この光拡散層の形成前後の有機ＥＬ素子に８．２Ｖの電圧を印加し、同様に１０．５ｍＡ／ｃｍ^2 の電流密度で素子に電流を流して発光させ、実施例１－１と同様に評価した。これらの結果を表１－３に示した。なお、光拡散層を形成する前のθ方向の輝度分布は、本発明の式（１）の関係を満足せず、またＡｌｑ層６０ｎｍという値も、本発明の式（２）の関係を満足しないものであった。
【0100】
表１－３

角　度	輝度値　（ｃｄ／ｍ^2）	
	光拡散層形成前	光拡散層形成後

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0°	323	384
10°	323	384
20°	319	384
30°	315	384
40°	302	360
50°	286	336
60°	269	312
70°	244	265
80°	202	143
全光量	884（lm／m²）	1034（lm／m²）

【0101】

比較例１－２

電子輸送性発光層として、式（５）で表されるＡｌｑを２５ｎｍの厚さに形成した以外は、実施例１－１と同様にして、基本構成としての有機ＥＬ素子と、これに光散乱層を形成した有機ＥＬ素子を作製した。

この光拡散層の形成前後の有機ＥＬ素子に６．１Ｖの電圧を印加し、同様に１０．５ｍＡ／cm² の電流密度で素子に電流を流して発光させ、実施例１－１と同様に評価した。これらの結果を表１－４に示した。なお、光拡散層を形成する前のθ方向の輝度分布は、本発明の式（１）の関係を満足せず、またＡｌｑ層２５ｎｍという値も、本発明の式（２）の関係を満足しないものであった。

【0102】

表１－４

角　度	輝度値　（cd／m²）	
	光拡散層形成前	光拡散層形成後
0°	123	138
10°	123	138
20°	118	138
30°	114	138
40°	107	137
50°	106	135
60°	102	126
70°	95	116
80°	82	95
全光量	328（lm／m²）	402（lm／m²）

【0103】

比較例１－３

電子輸送性発光層として、式（５）で表されるＡｌｑを１８０ｎｍの厚さに形成した以外は、実施例１－１と同様にして、基本構成としての有機ＥＬ素子と、これに光散乱層を形成した有機ＥＬ素子を作製した。

この光拡散層の形成前後の有機ＥＬ素子に１７．３Ｖの電圧を印加し、同様に１０．５ｍＡ／cm² の電流密度で素子に電流を流して発光させ、実施例１と同様に評価した。これらの結果を表１－５に示した。なお、光拡散層を形成する前のθ方向の輝度分布は、本発

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明の式（１）の関係を満足せず、またＡｌｑ層１８０ｎｍという値も、本発明の式（２）の関係を満足しないものであった。

【0104】

表１－５

角　度	輝度値　（ｃｄ／ｍ²）	
	光拡散層形成前	光拡散層形成後
0°	１５４	２４３
１０°	１４８	２４０
２０°	１３４	２３８
３０°	１１６	２５２
４０°	１０１	２６７
５０°	９２	２６７
６０°	９５	２６４
７０°	８９	２４３
８０°	８０	１５７
全光量	３２３（ｌｍ／ｍ²）	７７３（ｌｍ／ｍ²）

【0105】

比較例１－４

電子輸送性発光層として、式（５）で表されるＡｌｑを２２０ｎｍの厚さに形成した以外は、実施例１－１と同様にして、基本構成としての有機ＥＬ素子と、これに光散乱層を形成した有機ＥＬ素子を作製した。

この光拡散層の形成前後の有機ＥＬ素子に２１．２Ｖの電圧を印加し、同様に１０．５ｍＡ／ｃｍ² の電流密度で素子に電流を流して発光させ、実施例１－１と同様に評価した。これらの結果を表１－６に示した。なお、光拡散層を形成する前のθ方向の輝度分布は、本発明の式（１）の関係を満足せず、またＡｌｑ層２２０ｎｍという値も、本発明の式（２）の関係を満足しないものであった。

【0106】

表１－６

角　度	輝度値　（ｃｄ／ｍ²）	
	光拡散層形成前	光拡散層形成後
0°	３６３	３６３
１０°	３５４	３６７
２０°	３５８	３５４
３０°	３４１	３４１
４０°	３１１	３２０
５０°	２７２	３３２
６０°	２２５	３０２
７０°	１７７	２６３
８０°	１６０	２０７
全光量	８６３（ｌｍ／ｍ²）	９７５（ｌｍ／ｍ²）

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【0107】
上記の実施例１－１，２の結果を、表１－７にまとめて示した。

表１－７

	実施例１－１	実施例１－２
Ａｌｑ層の膜厚　（ｎｍ）	１４０	１２０
正面輝度　（ｃｄ／ｍ^2）		
光拡散層形成前	１２６	１６６
光拡散層形成後	３９２	４２６
輝度増加度	３．１１	２．５６
全光束量　（ｌｍ／ｍ^2）		
光拡散層形成前	７６１	７９８
光拡散層形成後	１３７４	１４３２
光量増加度	１．８１	１．７９

【0108】
また、上記の比較例１－１～４の結果を、表１－８にまとめて示した。

表１－８

	比較例 1-1	比較例 1-2	比較例 1-3	比較例 1-4
Ａｌｑ層の膜厚　（ｎｍ）	６０	２５	１８０	２２０
正面輝度　（ｃｄ／ｍ^2）				
光拡散層形成前	３２３	１２３	１５４	３６３
光拡散層形成後	３８４	１３８	２４３	３６３
輝度増加度	１．１９	１．１３	１．５８	１．００
全光束量　（ｌｍ／ｍ^2）				
光拡散層形成前	８８４	３２８	３２３	８６３
光拡散層形成後	１０３４	４０２	７７３	９７５
光量増加度	１．１７	１．２３	２．３９	１．１３

【0109】
上記の結果から明らかなように、本発明の実施例１－１，２の有機ＥＬ素子は、光拡散層を形成する前は、輝度、全光束量とも大きな値は得られていないが、光拡散層を形成したのちは、正面輝度、全光束量ともに大きく輝度が増加しており、同一の素子電流を流して比較すると、比較例１－１～４のどの有機ＥＬ素子よりも、最終的に高効率な有機ＥＬ素子が得られることがわかる。

【0110】
実施例１－３

トルエン１０ｇに、屈折率１．４３、粒子径４μｍのシリコーン粒子１．５ｇを加え、よく撹拌した。また、ポリメチルメタクリレート（ＰＭＭＡ）樹脂を、濃度が２０重量％となるように、トルエンに加えて溶解させた。この溶液を、ＰＭＭＡに対するシリコーン濃度が１５重量％になるように、上記のシリコーン粒子を分散させたトルエン溶液に加え、さらにＰＭＭＡのトルエンに対する濃度が２０重量％になるように、濃度調整を行い、よく撹拌した。

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その後、ガラス基板上に、ＰＭＭＡ層の厚みが約２００μｍとなるように、アプリケータを用いてコーティングして、光拡散層を形成した。

【0111】

上記のガラス基板の光拡散層に、Ｓｉターゲットを用い、アルゴンガスと酸素ガスの混合ガス雰囲気にて反応性スパッタ法を用い、厚さ５０ｎｍのSiO_2を形成した。その後、さらにその面上に、実施例１－１と同様の方法で、厚さが１００ｎｍのＩＴＯ膜を形成して、透明電極（陽極）とした。

その後、フォトレジストを用いて、ＩＴＯをエッチングすることにより、発光面積が１５㎜×１５㎜となるようにパターンを形成した。超音波洗浄を行ったのち、低圧紫外線ランプを用いてオゾン洗浄した。

【0112】

つぎに、ＩＴＯ面上に、真空蒸着法により、有機層を順次形成した。まず、正孔注入層として、前記の式（３）で表されるＣｕＰｃを、蒸着速度０．３ｎｍ／ｓで、１５ｎｍの厚さに形成した。つぎに、正孔輸送層として、前記の式（４）で表されるα－ＮＰＤを、蒸着速度０．３ｎｍ／ｓで、４０ｎｍの厚さに形成した。最後に、電子輸送性発光層として、前記の式（５）で表されるＡｌｑを、蒸着速度０．３ｎｍ／ｓで、１４０ｎｍの厚さに形成した。

【0113】

その後、Ｍｇを１ｎｍ／ｓ、Ａｇを０．１ｎｍ／ｓの蒸着速度にて共蒸着し、厚さ１００ｎｍのＭｇＡｇを形成後、ＭｇＡｇの酸化防止の観点から、さらに、その上にＡｇを５０ｎｍ形成して、反射性電極（陰極）とした。

真空蒸着装置から取り出したのち、陰極電極側に紫外線硬化性エポキシ樹脂を滴下し、その上にスライドガラスを被せ、十分にエポキシ樹脂が広がった時点で高圧紫外線ランプを用いてエポキシ樹脂を硬化させ、素子を封止した。

【0114】

このように作製した有機ＥＬ素子について、１５Ｖの電圧を印加したところ、１０．５ｍＡ／cm^2の電流密度で素子に電流が通じ、発光が観測された．この際の正面輝度は４１８（ｃｄ／m^2）、全光束量は１４９２（ｌｍ／m^2）であった。この結果から、光拡散層を形成する前のθ方向の角度分布が式（１）の関係を満たし、また素子構成自体が式（２）の関係を満たすようにすることにより、これに反射・屈折角に乱れを生じさせる領域を設けることにより、本発明の効果が十分に発揮できるものであることが確認された。

【0115】

実施例１－４

実施例１－１において、反射・屈折角に乱れを生じさせる領域として、光拡散性粘着剤を用いる代わりに、三角錐が多数配置されたコーナーキューブレンズシートを使用し、これを透明粘着剤を介して有機ＥＬ素子のガラス基板表面に貼り合せるようにした以外は、実施例１－１と同様にして、有機ＥＬ素子を作製した。

【0116】

比較例１－５

電子輸送性発光層として、式（５）で表されるＡｌｑを６０ｎｍの厚さに形成した以外は、実施例１－４と同様にして、有機ＥＬ素子を作製した。

【0117】

上記の実施例１－４および比較例１－５の有機ＥＬ素子について、前記と同様にして、全光束量を求めたところ、実施例１－４の有機ＥＬ素子は１７９２（ｌｍ／m^2）、比較例１－５の有機ＥＬ素子は１３０８（ｌｍ／m^2）となり、本発明の有機ＥＬ素子とすることにより、発光効率が高められることが確認された。

【0118】

実施例１－５

実施例１－１と同様に、ガラス基板の片面にＩＴＯ膜を形成し、超音波洗浄、低圧紫外線ランプを用いてオゾン洗浄した。

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つぎに、ＩＴＯ面上に、式（６）で表されるＰＥＤＯＴ／ＰＳＳ溶液（Ｂａｙｅｒ社製の「ＢＡＹＴＲＯＮ　Ｐ　ＡＩ　４０８３」）を、４，０００ｒｐｍの回転数でスピンコートし、正孔注入層として３０ｎｍの厚さに形成した。その後、１２０℃で２時間乾燥させたのち、文献（森他、「応用物理」第６１巻、１０号、ｐ．１０４４、１９９２）を参考にして、つぎのように、有機ＥＬ層を形成した。

【0119】

まず、溶媒としての１，１，２，２－テトラクロロエタン９．８８ｇに、式（７）で表されるＰＶＫを正孔輸送性マトリックスポリマーとして０．１２ｇ、式（８）で表されるＢＮＤを電子輸送性材料として０．０５１４ｇ、式（９）で表されるクマリン６を発光材料として０．０００６ｇ添加し、よく溶解混合することにより、塗工液を調製した。つぎに、この塗工液を、前記の正孔注入層の上に、７５０ｒｐｍの回転数でスピンコートし、厚さが１５０ｎｍの有機ＥＬ層を形成した。

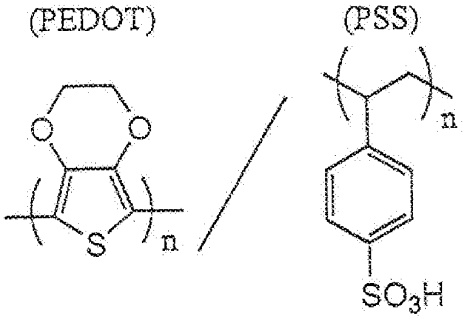
その後、７０℃で１時間乾燥したのち、実施例１－１と同様に、真空蒸着装置にてＭｇＡｇ／Ａｇ電極を形成し、真空蒸着装置から取り出したのち、素子を封止した。電極蒸着時のマスクにより、発光面積は１５㎜×１５㎜となるようにした。

【0120】

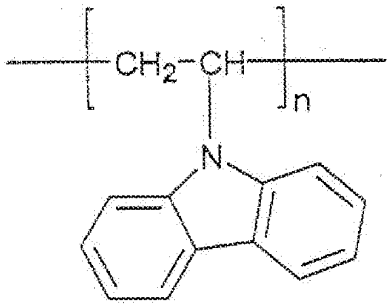
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【化2】

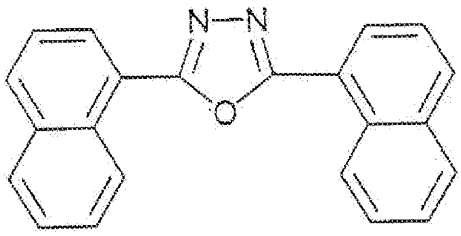
(PEDOT)　　(PSS)



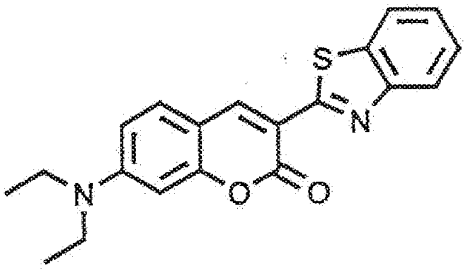
・・・（６）



・・・（７）



・・・（８）



・・・（９）

【0121】

このように作製した反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子について、２１Ｖの電圧を印加したところ、２０ｍＡ／㎠ の電流密度で素子に電流が通じ、クマリン６からの緑色発光が観測された。この際の輝度を、実施例１－１と同様に、０度～８０度方向まで、１０度おきに測定した。また、単位面積あたりの光束量についても、実施例１－１と同様に、算出した。

つぎに、この基本構成としての有機ＥＬ素子のガラス基板表面上に、実施例１と同じ光拡散性粘着剤を、１０枚貼り合わせて、厚さがおよそ２００μｍの光拡散層を形成した。その後、この素子に上記と同様に２１Ｖの電圧を印加して、２０ｍＡ／㎠ の電流密度で

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素子に電流を流した際の輝度を測定した。また、単位面積あたりの光束量を算出した。

これらの結果は、表１－９に示されるとおりであった。

【0122】

表１－９

角　度	輝度値　（ｃｄ／ｍ^2）	
	光拡散層形成前	光拡散層形成後
０°	１８３	３５１
１０°	１８３	３５１
２０°	１８３	３５１
３０°	１８９	３４７
４０°	１９６	３４４
５０°	２１５	３３０
６０°	２２７	３１５
７０°	２３３	２８７
８０°	２０２	２２２
全光量	６２８（ｌｍ／ｍ^2）	１００２（ｌｍ／ｍ^2）

【0123】

比較例１－６

有機ＥＬ層形成時の回転数を２，５００ｐｐｍとし、厚さを７５ｎｍとした以外は、実施例１－５と同様にして、反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子と、これに光拡散層を形成した有機ＥＬ素子を作製した。

この光散乱層の形成前後の有機ＥＬ素子について、１２．７Ｖの電圧を印加し、同様に２０ｍＡ／ｃｍ^2 の電流密度で素子に電流を流して発光させ、実施例１－５と同様に評価した。これらの結果は、表１－１０に示されるとおりであった。

【0124】

表１－１０

角　度	輝度値　（ｃｄ／ｍ^2）	
	光拡散層形成前	光拡散層形成後
０°	２３６	２９１
１０°	２３６	２９１
２０°	２３６	２８９
３０°	２３３	２８８
４０°	２３０	２８６
５０°	２２７	２８４
６０°	２１７	２６３
７０°	２０５	２２９
８０°	１７４	１８０
全光量	６５８（ｌｍ／ｍ^2）	８３３（ｌｍ／ｍ^2）

【0125】

上記の結果から明らかなように、本発明の実施例１－５の有機ＥＬ素子は、光拡散層を

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形成する前の輝度分布は、本発明の式（１）を満足するものであり、その結果、光拡散層を形成することにより、全光量が約１．６倍に増加した。これに対して、比較例１－６の有機ＥＬ素子は、光拡散層を形成する前は正面輝度こそ実施例１－５の素子よりも高くなったが、本発明の式（１）を満足しないものであり、その結果、全光量の増加度は約１．２倍と、拡散層形成による導波光取り出し効果に乏しいものであった。

【実施例】

【0126】

つぎに、本発明の有機ＥＬ素子において、反射・屈折角に乱れを生じさせる領域として偏光散乱性部位を設けた「実施例２－１～３」を記載し、これと「比較例２－１～６」や「参考例２－１，２」と対比して、本発明を具体的に説明する。

【0127】

実施例２－１

実施例１－１と同様にして、電子輸送性発光層〔式（５）で表されるＡｌｑ〕の厚さが１４０ｎｍである、本発明の式（１），式（２）の関係を満足する、反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。

つぎに、この基本構成としての有機ＥＬ素子のガラス基板上に、反射・屈折角に乱れを生じさせる領域として、下記の方法で形成した偏光散乱性部位としてのフィルムを、アクリル系粘着剤を介して、貼り合わせた。

その後、この有機ＥＬ素子に対し、実施例１－１と同様にして、１５Ｖの電圧を印加して、１０．５ｍＡ／cm^2 の電流密度で素子に電流を流した際の正面輝度を測定した。

また、上記の偏光散乱性部位の延伸方向と、偏光板（日東電工社製の「ＮＰＦ－ＳＥＧ１４２５ＤＵ」）の透過軸が平行となるように、偏光板を偏光散乱性部位上に設置したのち、上記と同様にして、正面輝度を測定した。

【0128】

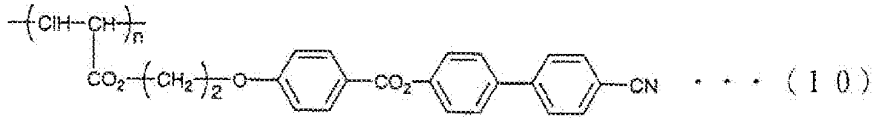
＜偏光散乱性部位の形成＞

ノルボルネン系樹脂（ＪＳＲ社製のアートン、ガラス転移温度１８２℃）９５０重量部と、つぎの式（１０）で表される液晶ポリマー（ガラス転移温度８０℃、ネマチック液晶化温度１００～２９０℃）５０重量部とを溶解させた２０重量％ジクロロメタン溶液を用いて、キャスト法により、厚さが１００μｍのフィルムを形成し、これを１８０℃で３倍に延伸処理したのち、急冷して、偏光散乱性部位としてのフィルムとした。

この偏光散乱性部位としてのフィルムは、ノルボルネン系樹脂からなる透明フィルム中に液晶ポリマーが延伸方向に長軸な状態でほぼ同じ形状のドメイン状に分散したものであり、屈折率差Δn_1 が０．２３で、Δn_2 、Δn_3 が０．０２９であった。また、前記の微小領域の平均径を偏光顕微鏡観察による位相差に基づく着色により測定したところ、Δn_1 方向の長さが約５μｍであった。

【0129】

【化3】



・・・（１０）

【0130】

実施例２－２

実施例１－２と同様にして、電子輸送性発光層〔式（５）で表されるＡｌｑ〕の厚さが１２０ｎｍである、本発明の式（１），式（２）の関係を満足する、反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。

つぎに、この基本構成としての有機ＥＬ素子のガラス基板上に、反射・屈折角に乱れを生じさせる領域として、実施例２－１で形成した偏光散乱性部位としてのフィルムを、アクリル系粘着剤を介して、貼り合わせた。

その後、この有機ＥＬ素子に対し、実施例１－２と同様にして、１３．１Ｖの電圧を印加して、１０．５ｍＡ／㎠ の電流密度で素子に電流を流した際の正面輝度を測定した。また、上記の偏光散乱性部位の延伸方向と、偏光板（日東電工社製の「ＮＰＦ－ＳＥＧ１４２５ＤＵ」）の透過軸が平行となるように、偏光板を偏光散乱性部位上に設置したのち、上記と同様にして、正面輝度を測定した。

【0131】

比較例２－１

電子輸送性発光層として、式（５）で表されるＡｌｑを６５ｎｍの厚さに形成した以外は、実施例１－１と同様にして、反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。この素子に８．８Ｖの電圧を印加し、１０．５ｍＡ／㎠ の電流密度で素子に電流を流して発光させ、実施例１－１と同様に評価した。

結果は、０°：３１４ｃｄ／㎡、１０°：３１５ｃｄ／㎡、２０°：３１２ｃｄ／㎡、３０°：３０９ｃｄ／㎡、４０°：２９８ｃｄ／㎡、５０°：２８５ｃｄ／㎡、６０°：２７４ｃｄ／㎡、７０°：２５７ｃｄ／㎡、８０°：２２９ｃｄ／㎡となった。

これより、θ方向の輝度分布は、本発明の式（１）の関係を満足せず、Ａｌｑ層６５ｎｍという値も、本発明の式（２）の関係を満足しなかった。

【0132】

つぎに、上記のように作製した基本構成としての有機ＥＬ素子のガラス基板上に、実施例２－１で形成した偏光散乱性部位としてのフィルムを、アクリル系粘着剤を介して、貼り合わせた。この有機ＥＬ素子に、前記と同様に、８．８Ｖの電圧を印加して、１０．５ｍＡ／㎠ の電流密度で素子に電流を流した際の正面輝度を測定した。

また、上記の偏光散乱性部位の延伸方向と、偏光板（日東電工社製の「ＮＰＦ－ＳＥＧ１４２５ＤＵ」）の透過軸が平行となるように、偏光板を偏光散乱性部位上に設置したのち、上記と同様にして、正面輝度を測定した。

【0133】

比較例２－２

比較例１－２と同様にして、電子輸送性発光層〔式（５）で表されるＡｌｑ〕の厚さが２５ｎｍである、本発明の式（１），式（２）の関係を満足しない、反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。

つぎに、この基本構成としての有機ＥＬ素子のガラス基板上に、反射・屈折角に乱れを生じさせる領域として、実施例２－１で形成した偏光散乱性部位としてのフィルムを、アクリル系粘着剤を介して、貼り合わせた。

その後、この有機ＥＬ素子に対し、比較例１－２と同様にして、６．１Ｖの電圧を印加して、１０．５ｍＡ／㎠ の電流密度で素子に電流を流した際の正面輝度を測定した。

また、上記の偏光散乱性部位の延伸方向と、偏光板（日東電工社製の「ＮＰＦ－ＳＥＧ１４２５ＤＵ」）の透過軸が平行となるように、偏光板を偏光散乱性部位上に設置したのち、上記と同様にして、正面輝度を測定した。

【0134】

比較例２－３

比較例１－３と同様にして、電子輸送性発光層〔式（５）で表されるＡｌｑ〕の厚さが１８０ｎｍである，本発明の式（１），式（２）の関係を満足しない，反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。

つぎに、この基本構成としての有機ＥＬ素子のガラス基板上に、反射・屈折角に乱れを生じさせる領域として、実施例２－１で形成した偏光散乱性部位としてのフィルムを、アクリル系粘着剤を介して、貼り合わせた。

その後、この有機ＥＬ素子に対し、比較例１－３と同様にして、１７．３Ｖの電圧を印

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加して、１０．５ｍＡ／㎠ の電流密度で素子に電流を流した際の正面輝度を測定した。また、上記の偏光散乱性部位の延伸方向と、偏光板（日東電工社製の「ＮＰＦ－ＳＥＧ１４２５ＤＵ」）の透過軸が平行となるように、偏光板を偏光散乱性部位上に設置したのち、上記と同様にして、正面輝度を測定した。

【0135】

比較例２－４

比較例１－４と同様にして、電子輸送性発光層〔式（５）で表されるＡｌｑ〕の厚さが２２０ｎｍである、本発明の式（１），式（２）の関係を満足しない、反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。

つぎに、この基本構成としての有機ＥＬ素子のガラス基板上に、反射・屈折角に乱れを生じさせる領域として、実施例２－１で形成した偏光散乱性部位としてのフィルムを、アクリル系粘着剤を介して、貼り合わせた。

その後、この有機ＥＬ素子に対し、比較例１－４と同様にして、２１．２Ｖの電圧を印加して、１０．５ｍＡ／㎠ の電流密度で素子に電流を流した際の正面輝度を測定した。また、上記の偏光散乱性部位の延伸方向と、偏光板（日東電工社製の「ＮＰＦ－ＳＥＧ１４２５ＤＵ」）の透過軸が平行となるように、偏光板を偏光散乱性部位上に設置したのち、上記と同様にして、正面輝度を測定した。

【0136】

比較例２－５

実施例２－１で作製した反射・屈折角に乱れを生じさせる領域を形成する前の基本構成としての有機ＥＬ素子のガラス基板上に、実施例２－１で形成した偏光散乱性部位としてのフィルムに代えて、下記の方法で作製した微小領域が複屈折特性を持たない通常の拡散フィルムを、アクリル系粘着剤を介して、貼り合わせた。

この有機ＥＬ素子に、前記と同様に、１５Ｖの電圧を印加して，１０．５ｍＡ／㎠ の電流密度で素子に電流を流した際の正面輝度を測定した。

また、上記の通常の拡散フィルム上に偏光板（日東電工社製の「ＮＰＦ－ＳＥＧ１４２５ＤＵ」）を設置したのち、上記と同様にして、正面輝度を測定した。

【0137】

＜通常の拡散フィルムの作製＞

トルエンを１０ｇとり、これに屈折率１．４３、粒子径４μｍのシリコーン粒子を１．５ｇ加え、よく撹拌した。また、ポリメチルメタクリレート（ＰＭＭＡ）樹脂を、濃度が２０重量％となるようにトルエンに加え溶解させた。その溶液をＰＭＭＡに対するシリコーン濃度が１５重量％になるように、シリコーン粒子を分散させたトルエン溶液に加え、さらにＰＭＭＡのトルエンに対する濃度が２０重量％になるように、濃度調整を行い、よく撹拌した。その後、ガラス基板上にＰＭＭＡ層の厚みが約２００μｍとなるように、アプリケータによりコーティングし、乾燥後、剥がしとって拡散フィルムを得た。

【0138】

参考例２－１

実施例２－１において、作製した基本構成としての有機ＥＬ素子のガラス基板上に、直接偏光板を設置して、正面輝度を測定した。

【0139】

参考例２－２

比較例２－１において、作製した基本構成としての有機ＥＬ素子のガラス基板上に、直接偏光板を設置して、正面輝度を測定した。

【0140】

上記の実施例２－１，２、比較例２－１～５および参考例２－１，２の結果を、表２にまとめて示した。また、表２には、参考例２－２の偏光板を設置したときの正面輝度を基準（１．００）として、各例での輝度増加度を併記した。輝度増加度が１．００より小さい値は、正面輝度が逆に低下していることを意味する。

【0141】

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表２

	Ａｌｑ層の膜厚（ｎｍ）	光拡散層の種類	正面輝度（ｃｄ／ｍ²）			
			光拡散層形成前	光拡散層形成後	偏光板設置後	輝度増加度
参考例２－１	１４０	なし	１２６	－	５８	0.40
参考例２－２	６５	なし	３１４	－	１４５	1.00
実施例２－１	１４０	偏光散乱フィルム	１２６	３５８	２６１	1.80
実施例２－２	１２０	偏光散乱フィルム	１６６	３８８	２７６	1.90
比較例２－１	６５	偏光散乱フィルム	３１４	３４０	１９７	1.36
比較例２－２	２５	偏光散乱フィルム	１２３	１２６	６７	0.46
比較例２－３	１８０	偏光散乱フィルム	１５４	２２２	１３１	0.90
比較例２－４	２２０	偏光散乱フィルム	３６３	３３１	１７９	1.23
比較例２－５	１４０	拡散フィルム	１２６	４２２	１９４	1.34

【0142】

上記の結果から明らかなように、本発明の実施例２－１，２の有機ＥＬ素子は、偏光散乱フィルムを貼り合わせる前は、たとえば参考例２－２の有機ＥＬ素子に比べ、正面輝度が小さくなっているが、偏光散乱フィルムを貼り合わせたのちは、正面輝度が大きく増加しており、さらに偏光板を設置したのちの正面輝度をみると、直線偏光リッチな出射光が得られているため、偏光板での吸収が小さく、最終的な輝度の低下を最小限に抑えられていることがわかる。

【0143】

これに対し、比較例２－５の有機ＥＬ素子は、光拡散層形成後の正面輝度は、実施例２－１の有機ＥＬ素子よりも大きな値が得られているが、出射光は偏光していない自然光であるため、偏光板により半分以上の光が吸収され、最終的には実施例２－１の有機ＥＬ素子よりも正面輝度が低下している。また、比較例２－１～４の有機ＥＬ素子では、光拡散層形成後の輝度向上度が小さく、やはり最終的な輝度は実施例２－１の有機ＥＬ素子に比べて、低いものであった。

【0144】

実施例２－３

実施例１－５において、作製した基本構成としての有機ＥＬ素子のガラス基板表面に、拡散性粘着剤を１０枚貼り合わせて光拡散層を形成する代わりに、実施例２－１で形成した偏光散乱性部位としてのフィルムを、アクリル系粘着剤を介して、貼り合わせることにより、有機ＥＬ素子を作製した。

つぎに、このように作製した有機ＥＬ素子の偏光散乱性部位の延伸方向と偏光板の透過軸が平行となるように、偏光板を上記有機ＥＬ素子の偏光散乱性部位上に設置したのち、２１Ｖの電圧を印加して、２０ｍＡ／ｃｍ² の電流密度で素子を駆動して正面輝度を測定したところ、２２９ｃｄ／ｍ² の輝度が得られた。

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【0145】
比較例２－６
比較例１－６において、作製した基本構成としての有機ＥＬ素子のガラス基板表面に、拡散性粘着剤を１０枚貼り合わせて光拡散層を形成する代わりに、実施例２－１で形成した偏光散乱性部位としてのフィルムを、アクリル系粘着剤を介して、貼り合わせることにより、有機ＥＬ素子を作製した。
つぎに、このように作製した有機ＥＬ素子の偏光散乱性部位の延伸方向と偏光板の透過軸が平行となるように、偏光板を上記有機ＥＬ素子の偏光散乱性部位上に設置したのち、１２．７Ｖの電圧を印加して、２０ｍＡ／cm^2 の電流密度で素子を駆動して正面輝度を測定したところ、１５８ｃｄ／m^2 の輝度が得られた。
【0146】
上記の実施例２－３および比較例２－６を比較すると、同一の素子電流で得られる輝度が約１．４倍向上した。実施例１－５の素子に同様の偏光板を設置すると、偏光板の吸収によりその正面輝度は３５１ｃｄ／m^2 から１６１ｃｄ／m^2 に低下するが、拡散層に本発明の偏光散乱性部位を用いることで、導波光が直線偏光リッチな偏光光として取り出せるため、液晶表示装置用のバックライトとして用いる場合、さらにその効率を１．４倍に高めることができる。すなわち、液晶表示装置用のバックライト光源として用いる場合、本発明の導波光を増強させて取り出す効果と偏光出射させる効果を合わせると、従来技術に比べて、その輝度を約２倍に高められることが確認された。
なお、液晶表示装置用バックライトへの応用に際し、反射型偏光子を設置しても偏光板での吸収を低減させることができ、これにより輝度を高めることができる。このことは、以下の実施例３の結果からも明らかである。
【実施例】
【0147】
つぎに、本発明の有機ＥＬ素子において、反射・屈折角に乱れを生じさせる領域として光拡散性粘着剤を設け、さらに反射型偏光子を設けた「実施例３－１～４」を記載し、これと「比較例３－１～１０」と対比して、本発明を具体的に説明する。
【0148】
実施例３－１
実施例１－１と同様にして、電子輸送性発光層〔式（５）で表されるＡｌｑ〕の厚さが１４０ｎｍである、本発明の式（１），式（２）の関係を満足する、反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。
つぎに、この基本構成としての有機ＥＬ素子のガラス基板上に、反射・屈折角に乱れを生じさせる領域として、下記の方法で形成した光拡散性粘着剤を１０枚重ねて貼り合わせて、厚さがおよそ２００μｍの光拡散層を形成した。さらに、この光拡散層上に、下記の方法で形成した反射型偏光子を貼り合わせ、有機ＥＬ素子を作製した。
【0149】
＜光拡散性粘着剤の形成＞
トルエン１０ｇに、屈折率１．４３、粒子径４μｍのシリコーン粒子１．５ｇを加え、よく撹拌した。また、屈折率が１．４７であるアクリル系粘着剤を、濃度が２０重量％となるように、トルエンに加えて溶解させた。この溶液を、粘着剤に対するシリコーン濃度が１５重量％になるように、上記のシリコーン粒子を分散させたトルエン溶液に加え、さらに粘着剤のトルエンに対する濃度が２０重量％になるように、濃度調整を行い、よく撹拌した。アプリケータを用い、セパレーター上に上記調整した溶液を塗布し、乾燥させることにより、厚さ２０μｍの光拡散性粘着剤を作製した。
【0150】
＜反射型偏光子の形成＞
複屈折を示さない厚さが５０μｍの三酢酸セルロースフィルムの上に、厚さが０．１μｍのポリビニルアルコール層を設けて、レーヨン布でラビング処理して配向膜を形成し、この配向膜上にアクリル系サーモトロピックコレステリック液晶ポリマーの２０重量％テ

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トラヒドロフラン溶液をワイヤーバーにて塗工し、乾燥したのち、１５０±２℃で５分間加熱配向処理し、室温まで放冷して、厚さが１μｍのコレステリック液晶ポリマー層を形成する方式により、円偏光二色性を示す波長域が（Ａ）３５０～４５０ｎｍ、（Ｂ）４５０～５５０ｎｍ、（Ｃ）６００～７００ｎｍ、（ｄ）７５０～８５０ｎｍで、右円偏光を鏡面的反射する４種のコレステリック液晶ポリマー層を得た。

つぎに、上記の（Ａ）と（Ｂ）のコレステリック液晶ポリマー層を、その液晶面同士を密着させて、１５０±２℃で２分間加熱圧着処理したのち、その（Ｂ）側の三酢酸セルロースフィルムを剥離し、その液晶ポリマー層の露出面に、（Ｃ）のコレステリック液晶ポリマー層を、その液晶面同士を密着させて、１５０±２℃で２分間加熱圧着処理した。さらに、上記に準じて、（Ｄ）のコレステリック液晶ポリマー層も加熱圧着処理して、厚さ方向に螺旋ピッチが変化して円偏光二色性を示す波長域が４００～８００ｎｍのコレステリック液晶層からなる反射型偏光子を得た。

【0151】

実施例３－２

実施例１－２と同様にして、電子輸送性発光層〔式（５）で表されるＡｌｑ〕の厚さが１２０ｎｍである、本発明の式（１），式（２）の関係を満足する．反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。

つぎに、この基本構成としての有機ＥＬ素子のガラス基板上に、反射・屈折角に乱れを生じさせる領域として、実施例３－１と同様にして、厚さがおよそ２００μｍの光拡散層を形成した。さらに、この光拡散層上に、実施例３－１と同様にして、反射型偏光子を貼り合わせ、有機ＥＬ素子を作製した。

【0152】

比較例３－１

電子輸送性発光層として、式（５）で表されるＡｌｑを６５ｎｍの厚さに形成した以外は、実施例１－１と同様にして、反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。この素子に８．８Ｖの電圧を印加し、１０．５ｍＡ／cm^2 の電流密度で素子に電流を流して発光させ、実施例１－１と同様に評価した。結果は、０°：３１４ｃｄ／m^2、１０°：３１５ｃｄ／m^2、２０°：３１２ｃｄ／m^2、３０°：３０９ｃｄ／m^2、４０°：２９８ｃｄ／m^2、５０°：２８５ｃｄ／m^2、６０°：２７４ｃｄ／m^2、７０°：２５７ｃｄ／m^2、８０°：２２９ｃｄ／m^2 となった。

【0153】

この結果より、反射・屈折角に乱れを生じさせる領域を形成する前の基本構成としての輝度分布は、本発明の式（１）の関係を満足せず、またＡｌｑ層６５ｎｍという値も、本発明の式（２）の関係を満足しないものであった。

つぎに、この基本構成としての有機ＥＬ素子のガラス基板上に、反射・屈折角に乱れを生じさせる領域として、実施例３－１と同様にして、厚さがおよそ２００μｍの光拡散層を形成した。さらに、この光拡散層上に、実施例３－１と同様にして、反射型偏光子を貼り合わせ、有機ＥＬ素子を作製した。

【0154】

比較例３－２

比較例１－２と同様にして、電子輸送性発光層〔式（５）で表されるＡｌｑ〕の厚さが２５ｎｍである、本発明の式（１），式（２）の関係を満足しない、反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。

つぎに、この基本構成としての有機ＥＬ素子のガラス基板上に、反射・屈折角に乱れを生じさせる領域として、実施例３－１と同様にして、厚さがおよそ２００μｍの光拡散層を形成した。さらに、この光拡散層上に、実施例３－１と同様にして、反射型偏光子を貼り合わせ、有機ＥＬ素子を作製した。

【0155】

比較例３－３

比較例１－３と同様にして、電子輸送性発光層〔式（５）で表されるＡｌｑ〕の厚さが

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１８０ｎｍである、本発明の式（１），式（２）の関係を満足しない、反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。

つぎに、この基本構成としての有機ＥＬ素子のガラス基板上に、反射・屈折角に乱れを生じさせる領域として、実施例３－１と同様にして、厚さがおよそ２００μｍの光拡散層を形成した。さらに、この光拡散層上に、実施例３－１と同様にして、反射型偏光子を貼り合わせ、有機ＥＬ素子を作製した。

【0156】

比較例３－４

比較例１－４と同様にして、電子輸送性発光層〔式（５）で表されるＡｌｑ〕の厚さが２２０ｎｍである、本発明の式（１），式（２）の関係を満足しない、反射・屈折角に乱れを生じさせる領域を形成する前の有機ＥＬ素子を作製した。

つぎに、この基本構成としての有機ＥＬ素子のガラス基板上に、反射・屈折角に乱れを生じさせる領域として、実施例３－１と同様にして、厚さがおよそ２００μｍの光拡散層を形成した。さらに、この光拡散層上に、実施例３－１と同様にして、反射型偏光子を貼り合わせ、有機ＥＬ素子を作製した。

【0157】

上記の実施例３－１，２および比較例３－１～４の各有機ＥＬ素子について、液晶表示装置用のバックライトして用いる場合を想定し、下記の方法により、性能試験を行った。結果は、表３－１に示されるとおりであった。

【0158】

＜有機ＥＬ素子の性能試験＞

吸収型偏光板として日東電工社製の「ＮＰＦ－ＨＥＧ１４２５ＤＵ」を用いた。厚さは１８０μｍであった。１／４波長板（λ／４波長板）として、ノルボルネン系樹脂フィルム（ＪＳＲ社製の「アートン」）を１８０℃で１．５倍延伸（縦１軸延伸）して，波長λ＝５５０ｎｍでΔｎｄ＝１３５ｎｍになるように調整した。厚さは９０μｍであった。

上記の吸収型偏光板の吸収軸と、上記の１／４波長板の延伸軸とを、なす角度が４５°になるようにして、アクリル系粘着剤で貼り合わせた。

このようにして得た１／４波長板付き偏光板を、各有機ＥＬ素子の発光面上に置いて、１０．５ｍＡの電流が通じるように、各素子に所定の電圧を印加して、正面輝度を測定した。また、発光効率（ｃｄ／Ａ）を調べた。

【0159】

表３－１

	Ａｌｑ層の膜厚（ｎｍ）	電流密度（ｍＡ／ｃｍ²）	正面輝度（ｃｄ／ｍ²）	発光効率（ｃｄ／Ａ）
実施例３－１	１４０	１０．５	３２３	３．０８
実施例３－２	１２０	１０．５	３３７	３．２１
比較例３－１	６５	１０．５	２３５	２．２４
比較例３－２	２５	１０．５	７３	０．７０
比較例３－３	１８０	１０．５	１５６	１．４９
比較例３－４	２２０	１０．５	２１６	２．０６

【0160】

上記の表３－１の結果から明らかなように、本発明の実施例３－１，２の有機ＥＬ素子は、いずれも、比較例３－１～４のどの有機ＥＬ素子よりも、正面輝度が高く、発光効率に非常にすぐれているものであることがわかる。

【0161】

比較例３－５

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光拡散層と反射型偏光子をともに形成しなかった以外は、実施例３－１と同様にして、有機ＥＬ素子を作製した。つまり、この有機ＥＬ素子は、実施例３－１における基本構成としての有機ＥＬ素子そのものである。

【0162】

比較例３－６

光拡散層だけを形成し、反射型偏光子を形成しなかった以外は、実施例３－１と同様にして、有機ＥＬ素子を作製した。

【0163】

比較例３－７

光拡散層を形成せず、反射型偏光子だけを形成した以外は、実施例３－１と同様にして、有機ＥＬ素子を作製した。

【0164】

比較例３－８

光拡散層と反射型偏光子をともに形成しなかった以外は、比較例３－１と同様にして、有機ＥＬ素子を作製した。つまり、この有機ＥＬ素子は、比較例３－１における基本構成としての有機ＥＬ素子そのものである。

【0165】

比較例３－９

光拡散層だけを形成し、反射型偏光子を形成しなかった以外は、比較例３－１と同様にして、有機ＥＬ素子を作製した。

【0166】

比較例３－１０

光拡散層を形成せず、反射型偏光子だけを形成した以外は、比較例３－１と同様にして、有機ＥＬ素子を作製した。

【0167】

上記の比較例３－５～７および比較例３－８～１０の各有機ＥＬ素子について、液晶表示装置用のバックライトして用いる場合を想定し、前記と同様に、性能試験を行った。これらの結果を、比較例３－５～７に対応する実施例３－１の結果および比較例３－８～１０に対応する比較例３－１の結果と合わせて、表３－２に示した。

【0168】

表３－２

	Ａｌｑ層の膜厚（ｎｍ）	電流密度（mA／cm²）	光拡散層の有無	反射型偏光子の有無	正面輝度（cd／m²）	発光効率（cd／A）
実施例３－１	１４０	１０．５	有り	有り	３２３	３．０８
比較例３－５	１４０	１０．５	無し	無し	６８	０．６５
比較例３－６	１４０	１０．５	有り	無し	２１５	２．０５
比較例３－７	１４０	１０．５	無し	有り	１１３	１．０８
比較例３－１	６５	１０．５	有り	有り	２３５	２．２４
比較例３－８	６５	１０．５	無し	無し	１４２	１．３６
比較例３－９	６５	１０．５	有り	無し	１６８	１．６０
比較例３－10	６５	１０．５	無し	有り	２３１	２．２０

【0169】

上記の表３－２の結果から、光拡散層と反射型偏光子をともに形成していない比較例３－５，８の通常の有機ＥＬ素子同士では、式（１），式（２）を満足しない比較例３－８の方が発光効率が高くなっているが、これらに光拡散層だけを形成した比較例３－６，９

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の有機ＥＬ素子同士では、上記傾向が逆転し、式（１），式（２）を満足する比較例３－６の方が発光効率が高くなっている。

これは、本発明の効果である通常は取り出されない導波光を強め合うように有機ＥＬ素子の構成を決定したためである。つまり、光拡散層を形成することで、上記導波光が取り出され、結果として発光効率が高くなる。このように発光効率を高めた比較例３－６の有機ＥＬ素子にさらに反射型偏光子を形成した実施例３－１は、上記の比較例３－６に比べて、発光効率がより一段と高くなる。

【0170】

また、反射型偏光子だけを形成した比較例３－７および比較例３－１０の有機ＥＬ素子は、反射型偏光子の作用により、それぞれ、比較例３－５および比較例３－８の有機ＥＬ素子に比べて、およそ１．６倍程度発光効率は高くなっている。しかし、実施例３－１の有機ＥＬ素子に比べると、その値はやはり小さかった。

以上の試験結果から、本発明の有機ＥＬ素子は、液晶表示装置用の偏光面光源としてすぐれたものであることが確認された。

【0171】

実施例３－３

反射型偏光子の面上に、さらに光学補償層を、アクリル系透明粘着剤を介して貼り合わせた有機ＥＬ素子について、前記と同様にして、液晶表示装置用のバックライトしての性能試験を行った。ただし、ここでは、１０．５ｍＡの電流が通じるように電圧を印加して、正面０度～８０度の輝度値を、１０度おきに測定した。この結果を、実施例３－１の有機ＥＬ素子についての同様の試験結果と合わせて、図１１に示した。

図中、曲線－ｃは実施例３－１、曲線－ｄは実施例３－３である。また、用いた光学補償層は、下記の方法により、作製したものである。

【0172】

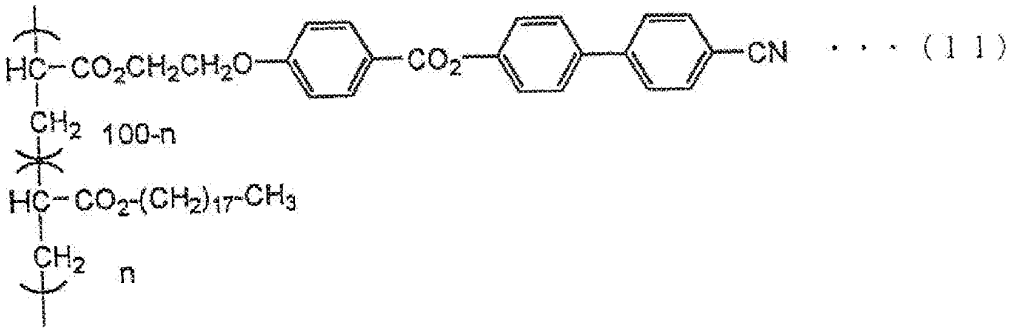
＜光学補償層の作製＞

下記の式（１１）で表される側鎖型液晶ポリマー（式中、ｎ＝３５で、モノマーユニットのモル％を示し、便宜的にブロック体を表示している。重量平均分子量は５，０００）２５重量部を、シクロヘキサノン７５重量部に溶解した溶液を、ノルボルネン系ポリマー（日本ゼオン社製の「ゼオネックス」）をポリマー材料とした厚さが２０μｍのプラスチックフィルムの上に、スピンコーティングにより、塗布した。

ついで、１３０℃で１分間加熱したのち、室温まで一気に冷却し、上記液晶層をホメオトロピック配向させ、かつ配向を維持したままホメオトロピック配向液晶層を固定化し、面内の屈折率が一定であり、厚さ方向の屈折率が大きい光学補償層を作製した。

【0173】

【化4】



・・・（１１）

【0174】

図１１から明らかなように、実施例３－１の有機ＥＬ素子では、広角度になるほど輝度が小さくなる傾向がみられるが、実施例３－３の有機ＥＬ素子では、光学補償層を挿入することで、広い角度範囲で高い輝度が得られていることがわかる。

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なお、実施例３－１，３の角度分布は、式（１）を満足していないが、これは、光の反射・屈折角に乱れを生じさせる領域を形成したのちの測定結果を示しているためである。言うまでもなく、本発明では、光の反射・屈折角に乱れを生じさせる領域を形成する前の状態で式（１）を満足するように有機ＥＬ素子の基本構成を決定するものである。

【0175】

実施例３－４

コレステリック液晶層からなる反射型円偏光子に代えて、反射型直線偏光子として、３Ｍ社製の「ＤＢＥＦ」を使用するようにした以外は、実施例３－１と同様にして、有機ＥＬ素子を作製した。

この有機ＥＬ素子について、液晶表示装置用のバックライトしての性能試験を行った。すなわち、吸収型偏光板として日東電工社製の「ＮＰＦ－ＨＥＧ１４２５ＤＵ」を用い、この偏光板を透過率が最大になるように上記素子のＤＢＥＦ上に設置し、１０．５ｍＡの電流が通じるように電圧を印加して、正面輝度を測定した。

その結果、３０８ｃｄ／ｍ^2 の値が得られ、実施例３－１とほぼ同様の効果が奏されるものであることが確認された。

【図面の簡単な説明】

【0176】

【図1】本発明の有機エレクトロルミネッセンス素子の一つ目の例を示す断面図である。

【図2】本発明および従来の有機エレクトロルミネッセンス素子の基本構成についての（反射・屈折角に乱れを生じさせる領域を形成する前の）特性図である。

【図3】本発明の有機エレクトロルミネッセンス素子の二つ目の例を示す断面図である。

【図4】本発明の有機エレクトロルミネッセンス素子の三つ目の例を示す断面図である。

【図5】本発明の有機エレクトロルミネッセンス素子の四つ目の例を示す断面図である。

【図6】本発明の有機エレクトロルミネッセンス素子の五つ目の例を示す断面図である。

【図7】本発明の有機エレクトロルミネッセンス素子の六つ目の例を示す断面図である。

【図8】本発明の有機エレクトロルミネッセンス素子を液晶表示装置に適用した例を示す断面図である。

【図9】本発明の有機エレクトロルミネッセンス素子の原理説明図である。

【図10】実施例１－１の有機エレクトロルミネッセンス素子の特性の説明図である。

【図11】実施例３－１および実施例３－３の有機エレクトロルミネッセンス素子の輝度に関する特性図である。

【図12】有機エレクトロルミネッセンス素子の発光領域を示す説明図である。

【図13】有機エレクトロルミネッセンス素子の輝度についての説明図である。

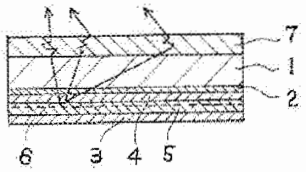
【符号の説明】

【0177】

１　支持基板（ガラス基板）
２　透明電極（陽極）
３　反射性電極（陰極）
４　正孔輸送層
５　電子輸送性発光層
６　発光領域
７　反射・屈折角に乱れを生じさせる領域
７０　偏光散乱性部位
８　反射型偏光子
９　１／４波長板
１０　偏光板
１１　液晶セル

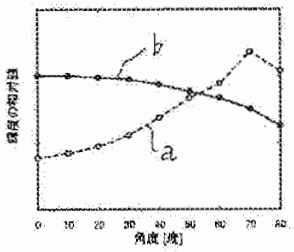
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【図1】

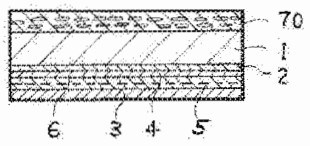


1：支持基板（ガラス基板）　2：透明電極（陽極）
3：反射性電極（陰極）　4：正孔輸送層
5：電子輸送性発光層　6：発光領域
7：反射・屈折角に乱れを生じさせる領域

【図2】

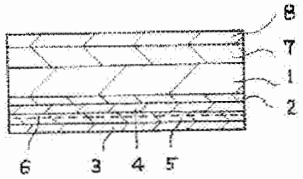


【図3】



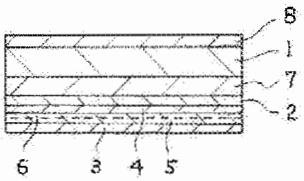
7 0：偏光散乱性部位

【図4】

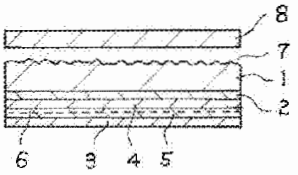


8：反射型偏光子

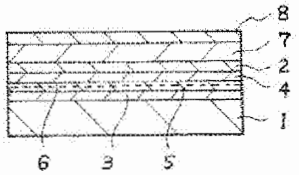
【図5】



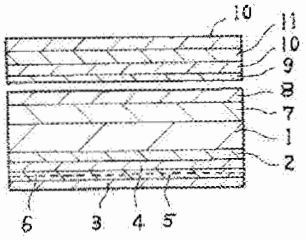
【図6】



【図7】

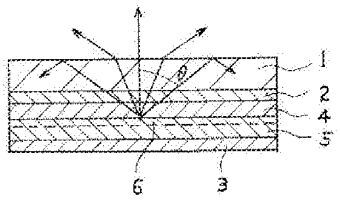


【図8】

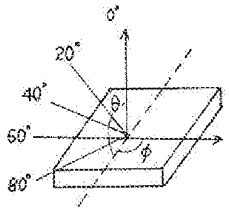


9：1／4波長板　10：偏光板
11：液晶セル

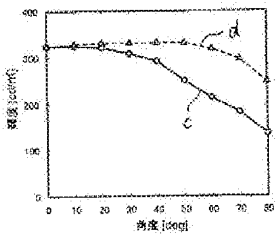
【図9】



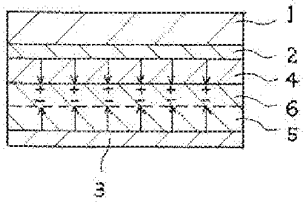
【図10】



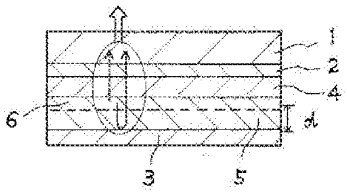
【図11】



【図12】



【図13】



Ｆターム(参考) 2H091 FA44 FB02 LA18
3K007 AB03 BB06 DB03

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