

DECLARATION OF IRINA HINRICHS

I, Irina Hinrichs, pursuant to 28 U.S.C. § 1746, hereby declare as follows:

1. I am a Translator at TransPerfect, Inc. I hold a Master's Degree in Anglistics and Germanistics, obtained at the Faculty of Philosophy, University of Niš, English Department (in 2005). I've been translating from German to English in the Technical/Industrial sector since 2008 and in Legal/Business/Financial since 2007. I've been collaborating with TransPerfect since 2011.
2. I submit this declaration to certify the accuracy of the English translation of 2006-05-22 invention disclosure (547) Translation.
3. My statements are based on personal knowledge and my review of 2006-05-22 invention disclosure (547) Translation and its German to English translation. If called as a witness about the facts contained in these statements, I could testify competently based on such personal knowledge and the investigation I have conducted.
4. I certify that the attached document translated from German to the English language is a true, correct, and complete translation of the corresponding source text from 2006-05-22 invention disclosure (547).
5. All statements made herein of my own knowledge are true, and all statements made on information and belief are believed to be true. Further, I am aware that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. § 1001. I declare under penalty of perjury that the foregoing is true and correct.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. Executed on August 21, 2024, at Niš, Serbia.



Irina Hinrichs

Confidential! To OSRAM-OS	INVENTION DISCLOSURE Please forward sealed!	Reference number:
I/We (first and last name(s) of the inventor(s) - further details and signature(s) on the last string! Markus Klein, Norwin von Malm, Benjamin Krummacher		Date of issue: May 15, 2006
hereby disclose the invention described in full on the following pages with the designation: Conversion on OLED with White Off-State Appearance		
I. To the inventor's superior(s) Mr./Ms. <u>Bernhard Stapp</u> OS T (OrgUnit) with the request to answer the following questions: a) When did you receive the invention disclosure?  b) Is the invention the result of publicly funded work? ☐ no ☐ yes, project (project): c) Is there an associated internal R&D project? Name: d) For decision or recommendation on utilization (please check all that apply!): ☒ The invention should be used without restriction. ☐ The invention is eligible for treatment as a trade secret. ☐ The invention may be considered for foreign applications. ☐ Countries: _____ ☐ The invention is not expected to be used. However, a right of use would be desirable upon release. ☐ The invention can be unconditionally released to the inventor(s). ☐ The invention does not concern our field of interest. The following offices are still to be consulted: _____ [hw:] 05/22/2006 [signature] (Date) (Signature of superior)		Received on: [hw:] 05/22/2006 The legal deadline runs from receipt!
Please forward immediately to Osram OS T IP due to legal deadline!		
II. To OSRAM OS T IP, Dr. Nirschl, Rbg W, Fax (0941) 850 444 2327 for further action Copy to OSRAM GC IP, Munich Original to Epping law firm [stamp:] RECEIVED Epping • Hermann • Fischer Patentanwaltskanzlei mbH May 31, 2006 Deadline: _____		Received on: [stamp:] May 29, 2006 E. Nirschl Seq. No. [hw:] 1606 Contact person: [hw:] 05 20 [signature]

1. What technical problem does your invention aim to solve?

See external document

2. How has this problem been solved so far?

Worldwide prior art with specific reference to the source or copy of the documents (literature, patent specifications, brochures, data sheets)

See external document

3. How does your invention solve the stated technical problem? (indicate advantages)

See external document

4. What is the inventive step?

See external document

- 5 Exemplary embodiment(s) of the invention.

See external document

6. Attached for further explanation:

Sheet illustrating one or more embodiments of the invention;

Sheet of additional descriptions (e.g. laboratory reports, test protocols);

Sheet of other documents:

7. Technology keywords:

☒ Front End	
☐ Epitaxy	☐ MOVPE ☐ <i>Vision 2005</i> ☐ LPE ☐ Epistruktur ☐ <i>Quanten-Dots in Si</i> ☐ <i>III/V on silicon</i>
☐ Material	☐ InGaAlP ☐ <i>substrate</i> ☐ InGaN ☐ <i>substrate</i> ☐ <i>epimaterial</i> ☐ AlGaAs ☐ <i>disk laser</i> ☐ <u>MISTRAL</u> <i>(frequency conversion)</i> ☐ InP ☐ <i>photonic crystals</i> ☐ <i>Nanopowder</i> ☐ <i>Meta-materials</i>
☒ Chip	
	☐ LED-Chip ☐ IRED ☒ OLED ☐ Chip with substrate ☐ Chip without substrate, Thinfilm ☐ <i>ultrathin wafer</i> ☐ Laserchip ☐ Laser Chip VCSEL ☐ Laser Chip edge emitter ☐ Disk-Laser ☐ Passive Component ☐ <i>MQW</i>
☐ Process	☐ Metallization ☐ Deposition ☐ Structuring ☐ <i>transparent contact</i> ☐ Mechanical process ☐ Testing ☐ <i>Waferbonden</i>
☐ Thinfil Technology	
	☐ <i>Nucleation substrate</i> ☐ <i>Mirror contact and mirror</i> ☐ <i>Carrier substrate</i> ☐ <i>Waferbonden</i> ☐ <i>Removing substrate</i> ☐ <i>via laser</i> ☐ <i>thermal</i> ☐ <i>wet chemistry</i> ☐ <i>Contact at light extraction side</i> ☐ <i>Patterning of epilayer</i> ☐ <i>Special package designs</i>

☒ Back End	
☒ Package Design	
☐ Premolded ☐ Lens ☐ ChipLED ☐ SmartLED ☐ Micro-Modul ☐ ELP ☐ Radial ☐ <i>Submount-Technology</i> ☐ <i>Thermal management</i> ☐ <i>heat sinks</i> ☐ <i>passive cooling technology</i> ☐ <i>Optic integration</i> ☐ <i>on chip</i> ☐ <i>close to the chip</i> ☐ <i>CPC</i> ☐ <i>diffractive optic</i> ☐ _____ ☐ _____ ☐ _____	
☐ Process	
☐ Bonden ☐ Casting ☐ Molding ☐ Testing ☐ Galvanic	
☐ Device Design	
☐ Back-end process	
☐ Die/Wire bonden ☐ <i>Interconnect</i> ☐ <i>D/B</i> ☐ <i>W/B</i> ☐ Packaging ☐ Casting ☐ Molding ☐ Testing	
☒ Product	
☐ LED ☐ IRED ☒ <i>OLED</i> ☒ <i>Lighting</i> ☐ <i>Hybrid-Component</i> ☐ <i>Nanocrystals/Polymer</i> ☐ <i>BE-Structures</i> ☒ <i>Encapsulation</i> ☒ <i>Light extraction</i> ☐ UV ☐ Detector ☐ HPL ☐ Module ☐ Array ☐ Display ☐ Inorganic ☐ Organic ☐ Monochrome ☐ Full color ☐ Flexible ☐ Parts ☐ Optics ☐ Drivers ☐ Circuits ☐ Materials ☐ Converter ☐ <i>Nanocrystals</i> ☐ <i>New material</i> ☐ _____ ☐ _____ ☐ _____ ☐ <i>New Process</i> ☐ _____ ☐ _____ ☐ _____	

☐ Application	
☐ Visible	☐ Automotive ☐ <i>Frontlighting</i>☐ <i>Sensoric + Light</i> ☐ Customer☐ Industrial☐ General lighting ☐ <i>adaptive lighting/ color physiology</i>☐ <i>Power Array</i> ☐ Traffic☐ <i>Projection</i> ☐ <i>LCD backlighting</i> ☐ <i>sequential color</i>☐ <i>polarized light</i>

8. Has the invention already been tested (tests carried out, samples made)?

☒ no ☐ yes, result: _____

9. For which products is the invention applicable? OLED Lighting

10. Is the application of the invention intended?

☐ no ☒ yes, for: OS T OLED (Lighting)

11. Has a product based on the invention been supplied or is a supply intended?

☒ no ☐ yes, (expected) on _____ ; description of the product: _____

12. Is publication of the invention intended or has it already taken place?

☒ no ☐ yes, (expected) on _____ in book, magazine: _____

13. Is a disclosure of the invention to external parties intended or has it already taken place?

☒ no ☐ yes, (expected) on _____ to _____

14. Please estimate the following criteria as far as possible:

a) Difficulty for competitors to circumvent:

Equivalent alternatives

☒ practically not feasible

☐ require effort

☐ can be realized without any problems

b) Attractiveness of use for competitors

Competitor interest

☒ outstanding

☐ average

☐ minimal

c) Proof of competitive use

Proof of use

☒ possible without problems

☐ complicated

☐ practically impossible

d) In-house use

☒ yes (expected)

☐ open

☐ unlikely

15. Personal details of the inventor(s) (enter inventors 1 - 4 here. Please attach an additional sheet for further inventors):

Name	Klein	von Malm	Krummacher	
First name	Markus	Norwin	Benjamin	
Acad. degree	Dr.	Dr.	Graduate engineer	
Office address With location	Leibnizstr. 4 93055 Regensburg	Leibnizstr. 4 93055 Regensburg	Leibnizstr. 4 93055 Regensburg	
Department name	OSTOLED	OS T OLED	OS T OLED	
Personnel number *	██████	██████	██████	
Activity/position in the company (e.g. laboratory manager, etc.)	Office Manager	Development Engineer	Doctoral candidate	
Home phone/fax	██████████	██████████	██████████	
Nationality	German	German	German	
Zip code, Place of residence	██████	██████	██████	
Street, house no.	██████████	██████████	██████████	
Date of birth	██████	██████	██████	
Is the invention based on - your field of work? - another field of work of your employer?	yes ☒ no ☐ yes ☐ no ☒	yes ☒ no ☐ yes ☐ no ☒	yes ☒ no ☐ yes ☐ no ☒	yes ☐ no ☐ yes ☐ no ☐
What part did you play in the invention?	33 %	33 %	33 %	%
Was or is the invention also reported as 3i?	yes ☐ no ☒	yes ☐ no ☒	yes ☐ no ☒	yes ☐ no ☐
If you consider the invention to be a free invention, please give reasons:				
To my/our knowledge, no other persons are involved in the invention.	[signature]	[signature]	[signature]	
	Signature	Signature	Signature	Signature

* Please refer to the payslip

ABSTRACT

In this disclosure a new type of structure for OLED-lighting devices is proposed. The combination of partial down-conversion areas together with areas reflecting and/or absorbing light of a particular color offers the opportunity to designing the off-state of lighting devices. The needed structures proposed here can be processed with low cost.

BACKGROUND OF INVENTION

White OLED-lighting devices can be generated by applying a continuous down-conversion layer on the light emitting side of a blue OLED (Appl. Phys. Letters, 80, 19, A. Duggal et al., 2002; Journal of Appl. Phys., 82, 9, A. Niko et al, 1997). The down-conversion layer comprises of a color changing material, for example phosphor particles or organic dyes. For lighting applications cerium doped garnets, nitride phosphors, ionic phosphors like $\text{SrGa}_2\text{S}_4:\text{Eu}^{2+}$ or $\text{SrS}:\text{Eu}^{2+}$, fluorescent dyes, quantum dots or conjugated polymers are often used as luminescence converting materials. In most applications these materials are dissolved or embedded in a transparent matrix, for example polycarbonate, silicone, epoxy or PMMA. The matrix containing the phosphor is often directly coated on the light source or used as material of the device housing.

The phosphor layer can be laterally structured. This structure gives more flexibility in designing output spectra of down-conversion light sources and makes the emission spectrum less sensitive to phosphor layer uniformities. Especially, this flexibility can help, to find a better compromise between efficiency and color rendering (Siemens P# 2005P07780US, P20050306).

The disadvantage of conventional phosphor coatings (partial or uniform) is that in the off-state of the lighting device the incident light of short wavelengths also is being converted by the phosphor layer leading to a shortage of blue in the emitted spectrum, i.e. the device typically looks annoyingly yellowish in the off-state.

The proposed novel structure allows to shape the off-state appearance of conversion OLED to a more pleasant, especially to a white appearance while not influencing the emission spectrum in the on-state. The proposed device structure can be processed with low costs.

Fig. 1 shows a typical setup of a conversion OLED where the emission spectrum of the device is tuned by laterally structuring the lighting tile into areas in which OLED light simply is passing towards the spectator (a) and areas where it is being converted by a color conversion (e.g. phosphor) layer (b). The spectrum now can be tuned by the conversion material but also by the ratio of area (a) and (b). Preferably, in areas where a conversion layer is applied, the original OLED emission is completely converted by the phosphor making the device less sensitive to uniformity variations in the conversion layer.

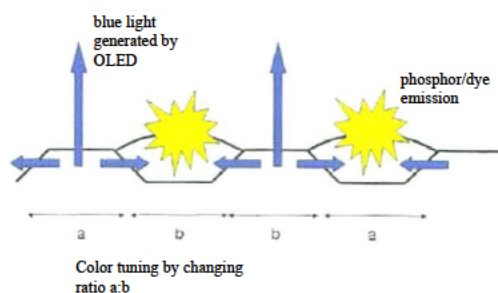


FIG. 1

The proposed structure of the conversion layer can be for example stripes, crossed stripes, circles or squares (Fig. 2 - dark areas could e.g. be conversion areas, white areas exhibit the original OLED spectrum). The structured coating could be applied on the light source by the means of screen printing, ink jet printing or other film application techniques. Another approach is, to structure a uniform coating by scratching, photo lithography, laser ablation, molding or other processes. The lateral structures in the conversion layer are preferably made using dimension not resolved by the human eye making the device looking uniform in a color consisting out of a mixture of OLED and conversion layer emission spectrum.

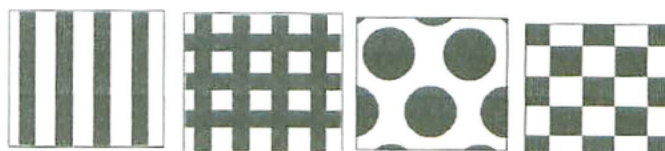


Fig. 2

In the off-state of the device the conversion layer typically absorbs the blue fraction from the ambient light and converts it into red-shifted light. In laterally structured conversion layers, this is true for the coated areas as well. In the non-coated areas typically the incident light is being reflected by the electrode with hardly any red-shift (typically low PL with visible excitation for blue OLED material). Superimposing those two effects in laterally structured OLED (reddish and white light reflection) one still gets a yellowish appearance of the device although maybe less pronounced than in uniformly coated devices (see Fig. 3).

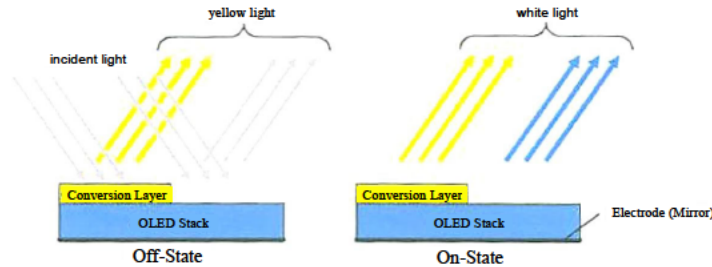


Fig. 3

INVENTION DETAILS

The novel structure proposed here offers flexibility in designing the off-state appearance of down-con version OLED devices. It tunes the light in the non-conversion coated areas in a way as to compensate the red-shift in the coated area without influencing the on-state itself by e.g. an additional layer (see Fig. 4).

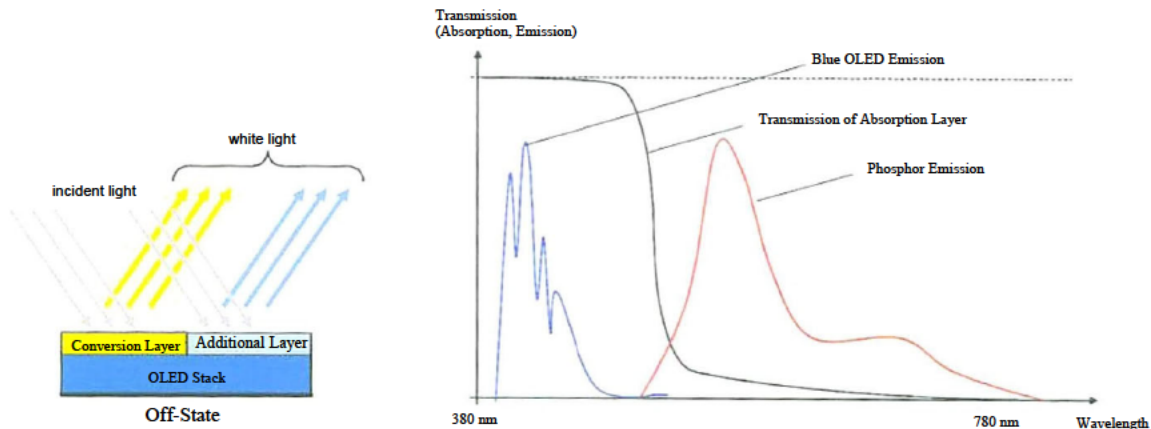
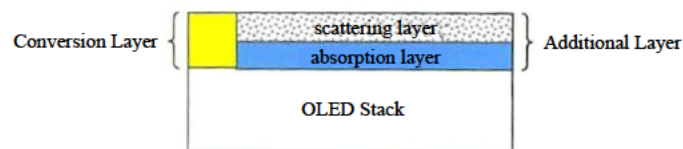


Fig. 4

The additional layer absorbs incident long wavelength light whereas it is transparent in the blue. In the on-state, the layer therefore does not absorb the emitted light, whereas in the off-state it makes the reflected incident white light look blue-ish. The superposition of the reddish reflected light from the conversion areas together with the blue-ish reflected light forms again white light. The color coordinates of the appearance of the device can now be tuned to match the criteria of the customer (white or color) by adapting the absorption spectrum of the additional layer.

Additionally, scattering can be included in the additional layer to more isotropically emit the reflected light. This can be done by additional scattering layers underneath or above the absorption layer, it could be a combination of absorption and scattering, or even a surface modification (roughening).



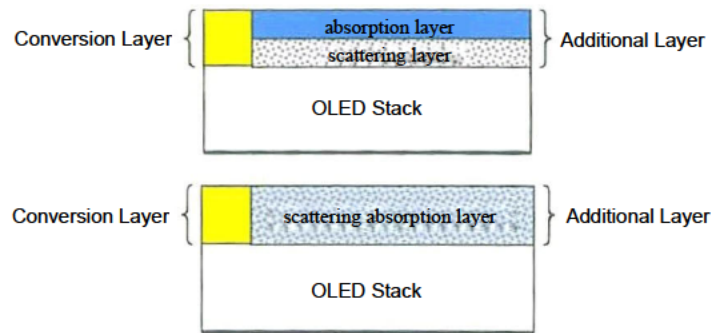


Fig. 5

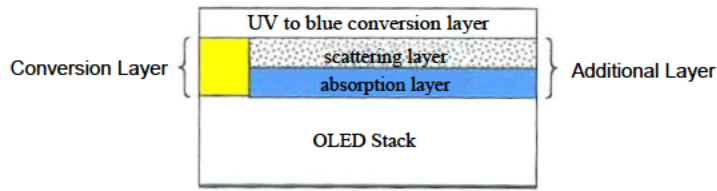


Fig. 6

Fig. 6 shows a setup in which the above proposed measure is combined with a layer that transfers UV light (present e.g. outdoor) into the visible blue range. This measure can also be used solely, i.e. without the additional absorption and scattering layer. In this case, the benefit will hardly be visible in indoor illumination scenarios, where hardly any UV is present.

The here proposed structures can be applied to both, bottom and top emitting OLEDs, n- or p-up structures, etc. as long as the conversion layer is being laterally structured. The novel structure is applied on the passivation layer or encapsulation of the organic EL-device. In the case of top emitter structures, the proposed concept can also be combined with any kind of thin film encapsulation of the OLED device. The encapsulation layer or layers can be applied between OLED device and laterally structured conversion/absorption layer or on the outside surface of OLED-conversion/absorption layer device. (Norwin von Malm-REPORT OF INVENTION dated 01/19/06).