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Sir:

Transmitted herewith for filing is the patent application of
INVENTORS: Hyung Hwa PARK

FOR: LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME

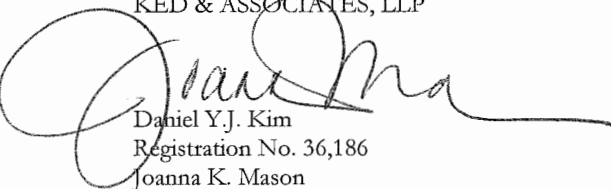
Enclosed are:

- | | |
|---|--|
| 1. ☒ 27 pages of specification, claims, abstract | 7. ☐ Assignment papers for <u>LG Innotek Co., Ltd.</u> cover sheet, assignment and assignment fee) (To Follow) |
| 2. ☒ 6 sheets of FORMAL drawings | 8. ☐ Certified copy of Priority Application No. _____ (To Follow) |
| 3. ☒ 2 pages of newly executed Declaration & Power of Attorney (copy or original) | 9. ☐ Two (2) return postcards
☐ Stamp & Return with Courier
☐ Prepaid postcard-stamped filing date & returned with unofficial Serial Number |
| 4. ☒ Priority claimed to Appln. No. <u>10-2009-0013161</u> filed on <u>February 17, 2009</u> in <u>Korea</u> , whose entire disclosure is incorporated herein by reference. | 10. ☒ Authorization under 37 C.F.R. §1.136(a)(3) |
| 5. ☐ Applicant claims Small Entity Status | 11. ☐ Request and Certification under 35 U.S.C. §122(b)(2)(B)(i) |
| 6. ☐ Information Disclosure Statement, Form PTO-1449 and _____ references | 12. ☐ Other: _____ |

CLAIMS AS FILED					
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UTILITY SEARCH FEE					\$540.00
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Respectfully submitted,
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LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This claims priority under 35 U.S.C. 126 and 35 U.S.C. 365 to Korean Patent Application No. 10-2009-0013161 (filed in Korea on February 17, 2009), the entirety of which is incorporated herein by reference.

BACKGROUND

1. Field

[0002] This relates to a light source and a display device having the same.

2. Background

[0003] Display devices may include a cathode ray tube (CRT), a liquid crystal display device (LCD), a plasma display panel (PDP), and an electroluminescent display (ELD). LCDs may display an image by controlling an amount of light incident from the outside. Thus, a backlight assembly may be used to irradiate light onto a liquid crystal panel and display an image.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The embodiments will be described in detail with reference to the following drawings in which like reference numerals refer to like elements wherein:

[0005] FIG. 1 is a perspective view of a display device in accordance with an embodiment as broadly described herein.

[0006] FIG. 2 illustrates shifts of color coordinate distribution using a color coordinate conversion sheet.

[0007] FIG. 3 is a perspective view of a display device in accordance with another embodiment as broadly described herein.

[0008] FIG. 4 is a perspective view of a display device in accordance with another embodiment as broadly described herein.

[0009] FIG. 5 is a perspective view of a display device in accordance with another embodiment as broadly described herein.

[0010] FIG. 6 is a perspective view of a display device in accordance with another embodiment as broadly described herein.

[0011] FIG. 7 is a perspective view of a display device in accordance with another embodiment as broadly described herein.

[0012] FIG. 8 is a perspective view of a display device in accordance with another embodiment as broadly described herein.

[0013] FIG. 9 is a perspective view of a display device in accordance with another embodiment as broadly described herein.

[0014] FIG. 10 is a perspective view of a display device in accordance with another embodiment as broadly described herein.

[0015] FIG. 11 is a schematic view of a process of fabricating a color coordinate conversion sheet as embodied and broadly described herein.

DETAILED DESCRIPTION

[0016] Reference will now be made in detail to various embodiments, examples of which are illustrated in the accompanying drawings. In description of embodiments, it will be understood that in a case where a layer (or sheet), a region, a pattern, or components is referred to as being 'on' or 'under' another substrate, layer (or film), region or patterns, the 'on' and 'under' include all the meanings of 'directly' and 'indirectly'. Further, references to 'on' and 'under' each layer will be made based on the exemplary illustration in drawings. Also, the thickness of each layer in the drawings is exemplary, and is not limited thereto.

[0017] Referring to FIG. 1, a display device 100 as embodied and broadly described herein may include a cover 105 which encloses or houses various components, a light emitting module 110, a reflective plate 120, a light guide plate (or light guide panel, LGP) 130, an optical sheet 140, a color coordinate conversion sheet 145, and a display panel 150. The cover 105, the light emitting module 110, the reflective plate 120, the light guide plate 130, the optical sheet 140, and the color coordinate conversion sheet 145 may together function as a light source.

[0018] In the embodiment shown in FIG. 1, the cover 105 includes a recess, with inclined side walls disposed along edges of the cover 105. However, the present disclosure is not limited thereto, and other arrangements may also be appropriate.

[0019] The light emitting module 110 may include a board 115 and a plurality of light emitting diodes 112. The light emitting module 110 may be positioned in the recess formed by the cover 105. The board 115 may be, for example, a rigid board, a flexible board, a metal core PCB, a ceramic board, or other type of board as appropriate. The light emitting module 110 may be installed on a cover such as, for example, a mold frame, a chassis, or other cover as appropriate.

[0020] The light emitting diodes 112 may be disposed on a surface of the board 115, such as, for example, on the upper surface of the board 115, and may face a corresponding side surface of the light guide plate 130. Alternatively, the light emitting diodes 112 may be disposed on the lower surface of the board 115 when the board is positioned horizontally as shown in FIG. 1, or, when the board 115 is positioned vertically, the light emitting diodes 112 may be disposed on the front surface of the board 115. That is, the light emitting diodes 112 may be disposed on the board 115 in a side view manner or a top view manner.

[0021] The light emitting diodes 112 may be spaced apart by a constant interval or at different intervals from each other. Each light emitting diode 112 may be provided in a package in which at least one LED chip is molded in a resin layer. Each of the light emitting diodes 112 may be one of a blue LED chip, a yellow LED chip, a green LED chip, a red LED chip, a UV (Ultraviolet) LED chip, an amber LED chip, a blue-green LED chip, a combination of a fluorescent material and at least one of the LED chips, and other combinations as appropriate.

[0022] All of light emitting diodes 112 may emit light having a spectrum of substantially the same color, or a group of the light emitting diodes 112 may emit a spectrum having different colors. For example, a blue LED chip or a three color (red, green, and blue) LED chip may be used for the light emitting diodes 112. The light emitting diodes 112 of the light emitting module 110 may have multi ranks.

[0023] More specifically, the light emitting diodes 112 may include LED chips having an substantially the same rank or different ranks, respectively. For example, at least two of the light emitting diodes 112 may include LED chips having different ranks. The light emitting diodes 112 may emit light having a color coordinate distribution that falls outside of a target color coordinate distribution. That is, light emitted by the light emitting diodes may have a color that does not correspond to a target color, or a desired or optimal color, for a particular display device.

[0024] The light emitting diodes 112 may have multi color ranks (hereinafter, referred to as multi ranks). The ranks may be obtained by classifying optical characteristics into regions according to a color coordinate, a main wavelength or a peak wavelength. A single rank may be a case in which, for example, the light emitting diodes 112 include blue LED chips, e.g., a rank having the same wavelength. For example, when blue LED chips having wavelengths ranging from 451 to 455 nm are sorted by 1 nm, five ranks, respectively 451 nm, 452 nm, 453 nm, 454 nm, and 455 nm, are generated. When LED chips having only one of the five ranks (i.e., identical wavelengths) are used in LEDs, the LED chips are

referred to as light emitting diodes having a single rank. In this case, LED chips having the other ranks cannot be used, and thus are discarded or set aside, yielding waste and/or additional fabrication time and expense.

[0025] That is, for example, when a blue LED chip uses a rank having a wavelength of 453 nm, only blue LED chips having a wavelength of 453 nm can be used, and thus chips having ranks other than 453 nm would be discarded. However, in a display 100 as embodied and broadly described herein, ranks having wavelengths near 453 nm may also be used and still achieve the same effect. That is, chips of differing ranks may be used to achieve a desired or target color of light, such as, for example, white light, to achieve the desired display characteristics.

[0026] The light guide plate 130 is disposed on a side of the light emitting module 110. The light guide plate 130 may be formed of, for example, a poly carbonate (PC) material, a poly methy methacrylate (PMMA) material, or other material as appropriate. A reflective pattern may be formed on a lower portion of the light guide plate 130.

[0027] The first light emitted from the light emitting diodes 112 is incident on the light guide plate 130. The light guide plate 130 guides the first light emitted from the light emitting diodes 112 to the entire region so as to emit the first light as a surface light source.

[0028] The reflective plate 120 is positioned on the lower side of the light guide plate 130, and the optical sheet 140 and the color coordinate conversion sheet 145 are positioned on the upper side thereof.

[0029] The reflective plate 120 reflects light leaking from the light guide plate 130 to the display panel 150. The optical sheet 140 transmits light emitted by the light guide plate 130 to the display panel 150 in a uniform brightness distribution.

[0030] The optical sheet 140 may be, for example, a diffusion sheet, a horizontal and vertical prism sheet, a brightness improving sheet, or other type of sheet as appropriate. The diffusion sheet spreads incident light, the horizontal and vertical prism sheet collects incident light into a display region, and the brightness improving sheet collects lost light to improve brightness. The optical sheet 140 is configured to refract, reflect, and diffuse incident light, and may include the color coordinate conversion sheet 145 (hereinafter “conversion sheet 145”).

[0031] The conversion sheet 145 may be formed by coating a transparent sheet such as, for example, a plastic or acrylic sheet, with fluorescent material, or by mixing a fluorescent material into the material of a transparent sheet. The fluorescent material may include at least one of yellow, red, blue, and green materials.

[0032] The conversion sheet 145 may be positioned on at least one of the upper and lower sides of the optical sheet 140. In certain embodiments, the conversion sheet 145 may be provided in plurality.

[0033] The conversion sheet 145 may convert a portion of the incident first light to a second light. The first light and the second light may be mixed and converted to the target color. In this embodiment, when the color of light emitted by a combination of one of an

LED chip and/or a light emitting diode falls outside of the target color, the resulting color may be shifted back into the target color.

[0034] Referring to FIGS. 1 and 2, when characteristics (brightness and color) of the first light emitted by the light emitting diodes 112 are measured, the characteristics may be scattered in a region A1 including points B1, C1, and D1 on CIE_x/CIE_y coordinates. When LED chips having one or more colors are configured in a multi rank manner, the characteristics of the light emitting diode 112 having multi ranks may be distributed in the region A1, and outside of a target region A2 on CIE color coordinates. The region A1 may be a standard region, and the region A2 may be a target region of the standard region A1.

[0035] For example, when the conversion sheet 145 includes a yellow based fluorescent material, the point C1 of the first light may be shifted to a point C2 that falls within the target region A2 due to the yellow based fluorescent material in the conversion sheet 145. Similarly, when the conversion sheet 145 is a red based fluorescent sheet, the point D1 of the first light may be shifted to a point D2 within the target region A2 by the red based fluorescent sheet. Likewise, when the conversion sheet 145 is a green based fluorescent sheet, the point B1 of the first light may be shifted to a point B2 within the target region A2 by the green based fluorescent sheet.

[0036] The conversion sheet 145 shifts the color of the first light from the standard region A1 to the target region A2. More specifically, the conversion sheet 145 may shift the color coordinate of one or more of the points B1, C1, and D1 disposed within the standard

region A1 of FIG. 2 to a position close to a center coordinate of the target region A2 having, for example, $CIE_x=0.313$ and $CIE_y=0.329$, which may be representative of the desired color of light, or target color, such as, for example, white light. The conversion sheet 145 may include at least one type of fluorescent material to convert a color rank of light emitted by the light emitting diode 112 to a target color rank.

[0037] Referring to FIG. 1, the display panel 150 may be disposed on the conversion sheet 145 or the optical sheet 140. For example, the display panel 150 may be an LCD panel that includes first and second transparent substrates facing each other, and a liquid crystal layer positioned between the first and second substrates. A polarizer plate may be attached to at least one surface of the display panel 150 in a suitable manner. The display panel 150 displays information using light that passes through the optical sheet 140 and the conversion sheet 145. The display device 100 may be, for example, portable terminals, monitors of notebook computers and laptop computers, televisions, and other such devices.

[0038] FIG. 3 is a perspective view of a display device according to another embodiment as broadly described herein. In describing this embodiment, wherever possible, like reference numerals will be used to denote like elements, and further detailed description thereof will be omitted.

[0039] The display device 100A shown in FIG. 3 may include a cover 105, a light emitting module 110, a reflective plate 120, a light guide plate 130, and a display panel 150 similar to the embodiment shown in FIG. 1. The display device 100A may also include a

diffusion sheet 141 including a color conversion material, and a prism sheet 142. The diffusion sheet 141 and the prism sheet 142 may be considered optical sheets.

[0040] An upper surface 141A of the diffusion sheet 141 may be coated with a color coordinate material. The color conversion material may be, for example, a fluorescent material that may include at least one of yellow, red, blue, and green fluorescent materials. In this case, an incident first light and a second light emitted by the color conversion material may have a complementary color relationship with respect to target color coordinates.

[0041] The color coordinate distribution of the first light incident on the diffusion sheet 141 may be converted to a target color coordinate distribution by the fluorescent material. That is, the fluorescent material may excite a portion of the incident first light to generate the second light, the second light having a different wavelength. At this point, the incident first light and the second light may be mixed and converted to the target color.

[0042] Although the diffusion sheet 141 shown in FIG. 3 is coated with a color conversion material on an upper surface thereof in this embodiment, in alternative embodiments, a color conversion material may be added into the diffusion sheet 141. In a similar manner, instead of the diffusion sheet 141, the prism sheet 142 may be coated with a color conversion material, or a color conversion material may be added into the prism sheet 142.

[0043] In this embodiment, the light emitting module 110 may include at least one

type of LED chips that have multi ranks, or the light emitting diodes 112 that have multi ranks, so as to increase the use yield of LED chips and light emitting diodes.

[0044] FIG. 4 is a perspective view of a display device according to another embodiment as broadly described herein. In describing this embodiment, wherever possible, like reference numerals will be used to denote like elements, and further detailed description thereof will be omitted.

[0045] A display device 100B as shown in FIG. 4 may include a plurality of light emitting modules 110 and 110A provided at two opposite ends of the light guide plate 130. The first light emitting module 110 includes the board 115 and the light emitting diodes 112, and is positioned at a first end of the light guide plate 130. The second light emitting module 110A includes a board 115A and light emitting diodes 112A, and is positioned at a second end of the light guide plate 130.

[0046] The conversion sheet 145 may be positioned between the diffusion sheet 141 and the prism sheet 142 to excite portions of light emitted by the light emitting modules 110 and 110A to emit light having different wavelengths. The conversion sheet 145 converts the color of light emitted by the first light emitting module 110 and the second light emitting module 110A to a target color. For example, the conversion sheet 145 may shift the color coordinates of the points B1, C1, and D1 distributed in the region A1 of FIG. 2 to a position close to a target coordinate, e.g., the coordinate having $CIE_x=0.313$ and $CIE_y=0.329$ representative of a desired/target color of light, such as, for example, white

light.

[0047] FIG. 5 is a perspective view of a display device according to another embodiment as broadly described herein. In this embodiment, wherever possible, like reference numerals will be used to denote like elements, and further detailed description thereof will be omitted.

[0048] A display device 100C as shown in FIG. 5 may include a plurality of light emitting modules 110 and 110B provided at adjacent/neighboring sides of the light guide plate 130. The conversion sheet 145 may be positioned between the diffusion sheet 141 and the prism sheet 142. The first light emitting module 110 may extend in a longitudinal direction of the light guide plate 130. The second light emitting module 110B may include light emitting diodes 112B and a board 115B, and may extend in a lateral direction of the light guide plate 130. When the lateral length of the light guide plate 130 is different from the longitudinal length thereof, the light emitting modules 110 and 110B may be positioned along the longitudinal and lateral directions of the light guide plate 130, respectively.

[0049] In this embodiment, when the color of light emitted by a combination of one of the light emitting modules 110 and 110B, one of LED chips, and one of the light emitting diodes 112B is outside of a target color distribution, a resulting abnormal color distribution may be shifted into the target color distribution.

[0050] FIG. 6 is a perspective view of a display device according to another embodiment as broadly described herein. In this embodiment, wherever possible, like

reference numerals will be used to denote like elements, and further detailed description thereof will be omitted.

[0051] The display device 200 shown in FIG. 6 may include a cover 210, a light emitting module 220, an optical sheet 240, a conversion sheet 245, and a display panel 250. The cover 210, the light emitting module 220, the optical sheet 240, and the conversion sheet 245 may function together as a light source. The cover 210 may define a recess 211, with an inclined side wall that extends along an outer peripheral edge of the bottom cover 210. Other arrangements may also be appropriate.

[0052] The light emitting module 220 may be arranged in at least one row and at least one column in the cover 210, or in other arrangements as appropriate. The light emitting module 220 may include light emitting diodes 222 arranged in at least one column on a board 225. Alternatively, the light emitting diodes 222 may be installed on the cover 210, without the board 225. The light emitting diodes 222 may be installed on the board 225 in a chip on board manner, a package on board manner, or other manner as appropriate.

[0053] The color of a first light emitted by the light emitting module 220 may be shifted to a target color by the conversion sheet 245. In this embodiment, when the color coordinate distribution of light emitted by a combination of one of the light emitting module 220, one of LED chips, and one of the light emitting diodes 222 is outside of the target color coordinate distribution, the resulting abnormal color coordinate distribution may be shifted to the target color coordinate distribution.

[0054] FIG. 7 is a perspective view of a display device according to another embodiment as broadly described herein. In this embodiment, wherever possible, like reference numerals will be used to denote like elements, and further detailed description thereof will be omitted.

[0055] A display device 200A as shown in FIG. 7 may include the cover 210, the light emitting module 220, and the display panel 250. The display device 200A may also include a diffusion sheet 241, a prism sheet 242, and a conversion sheet 245A. The light emitting module 220 may be arranged in at least one row and at least one column in the cover 210, or in another arrangement as appropriate. The light emitting module 220 may include the light emitting diodes 222 arranged on the board 225. Reflective materials or reflective sheets 227 may be disposed around the light emitting diodes 222. The conversion sheet 245A may be a light transmitting sheet including a fluorescent material. Alternatively, through a coating process, the conversion sheet 245A may be formed on the upper surface of the diffusion sheet 241 or on the lower surface of the prism sheet 242.

[0056] FIG. 8 is a perspective view of a display device according to another embodiment as broadly described herein. In this embodiment, wherever possible, like reference numerals will be used to denote like elements, and further detailed description thereof will be omitted.

[0057] A display device 200B as shown in FIG. 8 may include the cover 210, the light emitting module 220, the optical sheet 240, the conversion sheet 245, and the display

panel 250. The display device 200B may also include a light guide plate 230. The light guide plate 230 emits light emitted by the light emitting module 220 as a surface light source. The optical sheet 240 may be configured as a prism sheet.

[0058] The conversion sheet 245 shifts the color coordinate distribution of light emitted by the light guide plate 230 to a target color coordinate distribution. That is, when more than one light emitting module 220 is provided, the conversion sheet 245 excites portions of a first light emitted by the light emitting modules 220 so as to convert the first light to a second light, and emits the first light and the second light such that the first light and the second light are mixed to the color coordinate distribution of a target light. Accordingly, the color of light incident on the display panel 250 is the target color, which has been shifted from the color of light originally emitted by the light emitting modules 220.

[0059] The cover 210 may accommodate the light emitting module 220, the light guide plate 230, the optical sheet 240, and the conversion sheet 245. The outer peripheral surface of the cover 210 that extends from the bottom surface of the cover 210 may be inclined, vertical, or bent several times to accommodate these components. For example, as shown in FIG. 9, a lower portion of the outer peripheral surface of the cover 210 may extend upward at an incline from the bottom surface, and the upper portion thereof may be bent and then extend vertically upward therefrom.

[0060] FIG. 10 is a perspective view of a display device according to another embodiment as broadly described herein. In this embodiment, wherever possible, like

reference numerals will be used to denote like elements, and further detailed description thereof will be omitted.

[0061] A display device 200C as shown in FIG. 10 may include the cover 210, the light emitting module 220, the prism sheet 242, and the display panel 250. The display device 200C may also include a diffusion sheet 241A including a color conversion material. The upper or lower surface of the diffusion sheet 241A may be coated with a layer of color conversion material, or a color conversion material may be included in the material from which diffusion sheet 241A is formed.

[0062] In this embodiment, when the color of light emitted by a light source falls outside of a target color distribution, the color distribution may be shifted into the target color distribution by the diffusion sheet 241A or by a layer including a color conversion material. Accordingly, the light emitting diodes 222 of the light emitting module 220 may use LEDs having ranks adjacent to and out of the target color distribution, that is, LEDs having multi ranks or LEDs having failure ranks, thus improving yield use.

[0063] FIG. 11 illustrates fabrication of a conversion sheet as embodied and broadly described herein.

[0064] As shown in FIG. 11, a sheet of raw material 161 formed of transparent resin may be coated with a solvent 162 mixed with a specific fluorescent dye by a coating apparatus 163. The coated material may be conveyed by a roller 165, and then dried by a drying apparatus 164 so as to form a conversion sheet 161A. A surface of the conversion

sheet 161A is coated with the solvent 162 by, for example, a laminating method, or other process as appropriate.

[0065] Fluorescent dye may be obtained by mixing powders including various colors such as, for example, yellow, red, blue, and green, a resin (e.g., transparent acryl) having an appropriate viscosity, and alcohol in a predetermined ratio. A coloring matter and a distribution amount of the fluorescent dye may be determined based on a difference between the color of incident light and the color of target light.

[0066] Alternatively, the solvent 162 may be mixed with the raw sheet material. Such a fluorescent material may be added in this manner when the diffusion sheet or the prism sheet is fabricated.

[0067] In a display device as embodied and broadly described herein, to obtain the target color coordinate, light emitting diodes having multi ranks, that is, light emitting diodes including LED chips out of a target color range may be used instead of light emitting diodes having a single rank. In addition, a color coordinate distribution that falls outside of the target color range may be shifted into the target color coordinate distribution by the sheet including a color coordinate conversion material. Accordingly, the use yield of LED chips and light emitting diodes may be increased and fabrication cost may be decreased.

[0068] In a display device as embodied and broadly described herein, the use yield of light emitting diodes may be increased, fabrication cost may be decreased and a color coordinate distribution may be adjusted on the light unit. In addition, the rank tolerance of

an LED chip of a light emitting diode may be increased.

[0069] Embodiments provide a light unit including a color coordinate conversion sheet that converts a color coordinate distribution of light emitted from a plurality of light emitting diodes to a predetermined color coordinate distribution, and a display device having the light unit.

[0070] Embodiments provide a light unit including a layer or sheet that shifts the color coordinate distribution of a first light emitted from a plurality of light emitting diodes to a target color coordinate distribution so as to emit a second light, and a display device having the light unit.

[0071] A light unit as embodied and broadly described herein may include a light guide plate; a light emitting module comprising a plurality of light emitting diodes emitting a light to a side of the light guide plate; and a color coordinate conversion sheet disposed on the light guide plate and converting a color coordinate distribution of the light emitted from the light emitting module to another color coordinate distribution.

[0072] A light unit as embodied and broadly described herein may include a bottom cover; a light emitting module comprising a plurality of light emitting diodes disposed on the bottom cover; an optical sheet on the light emitting module; and a color coordinate conversion layer disposed on the light emitting module and emitting a light for converting a color coordinate distribution of light emitted from the light emitting module to another color coordinate distribution.

[0073] A display device as embodied and broadly described herein may include a bottom cover; a light emitting module comprising a plurality of light emitting diodes disposed on a side of the bottom cover; a light guide plate on a side of the light emitting module; an optical sheet on the light guide plate; a display panel on the optical sheet; and a color coordinate conversion layer disposed on the light guide plate and converting a color coordinate distribution of light emitted from the light guide plate to another color coordinate distribution.

[0074] Any reference in this specification to “one embodiment,” “an embodiment,” “example embodiment,” etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to effect such feature, structure, or characteristic in connection with other ones of the embodiments.

[0075] Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, numerous variations and modifications are possible in the component parts and/or arrangements of

the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

WHAT IS CLAIMED IS:

1. A light source, comprising:

a light guide plate;

at least one light emitting module positioned so as to emit light incident on the light guide plate, wherein the at least one light emitting module comprises a plurality of light emitting diodes; and

a conversion sheet provided on the light guide plate, wherein the conversion sheet converts a color of the light emitted by the at least one light emitting module to a target color.
2. The light source of claim 1, wherein the conversion sheet includes a fluorescent material having at least one color.
3. The light source of claim 1, wherein the conversion sheet includes at least one of red, green, blue, or yellow fluorescent materials.
4. The light source of claim 1, wherein the conversion sheet comprises a diffusion sheet including a color conversion material.
5. The light source of claim 4, wherein the conversion sheet further comprises a

prism sheet aligned with the diffusion sheet.

6. The light source of claim 1, further comprising an optical sheet aligned with either an upper or a lower side of the conversion sheet, wherein the optical sheet comprises at least one of a diffusion sheet or a prism sheet.

7. The light source of claim 1, further comprising a reflective plate positioned under the light guide plate.

8. The light source of claim 1, wherein the at least one light emitting module comprises a first light emitting module positioned at a first side edge of the light guide plate, and a second light emitting module positioned at a second side edge of the light guide plate.

9. The light source of claim 8, wherein the first and second side edges of the light guide plate are opposite each other.

10. The light source of claim 8, wherein the first and second side edges of the light guide plate are adjacent to each other.

11. The light source of claim 1, wherein at least two of the plurality of light

emitting diodes have different color coordinate distributions within a same color spectrum.

12. The light source of claim 1, wherein at least two of the light emitting diodes comprise light emitting diode chips having multi ranks.

13. The light source of claim 12, wherein each of the light emitting diode chips comprises at least one of a blue light emitting diode chip, a green light emitting diode chip, a yellow light emitting diode chip, an amber light emitting diode chip, or a blue-green light emitting diode chip.

14. The light source of claim 1, wherein the conversion sheet is configured to excite a portion of a first light emitted by the plurality of light emitting diodes so as to convert the portion of the first light to a second light, and to mix the first light and the second light so as to provide a third light having the target color.

15. The light source of claim 14, wherein the target color falls within a range in which x of CIE x is between approximately 0.293 and 0.333, and y of CIE y is between approximately 0.309 and 0.349.

16. The light source of claim 15, wherein light emitted by the light guide plate has

a color coordinate distribution that is outside of that of the target color.

17. The light source of claim 1, wherein a size of the conversion sheet is substantially equal to a size of the light guide plate.

18. The light source of claim 1, wherein the light guide plate, the at least one light emitting module and the conversion sheet are configured to be coupled to a cover having a receiving surface and side walls extending along an outer peripheral edge of the receiving surface, the side walls defining an open face of the cover so as to form a receiving space therein.

19. The light source of claim 18, wherein the at least one light emitting module is positioned adjacent to the light guide plate within the receiving space on the receiving surface of the cover, and the color coordinate conversion assembly is positioned on a distal edge of the cover defined by an exposed surface of the side walls of the cover.

20. The light source of claim 18, wherein the at least one light emitting module is positioned adjacent to the light guide plate within the receiving space on the receiving surface of the cover, and the color coordinate conversion assembly is positioned within the

receiving space of the cover, spaced apart from the light guide plate and at least one light emitting module.

21. The light source of claim 18, wherein the side walls of the cover extend at an incline from a first end thereof that is adjacent to the receiving surface of the cover to a second end thereof that defines the open face of the cover.

22. The light source of claim 18, wherein the side walls of the cover extend at an incline from a first end thereof that is adjacent to the receiving surface of the cover to an intermediate point of the side walls, and wherein the side walls are bent at the intermediate point so as to extend in a direction that is perpendicular to the receiving surface of the cover from the intermediate point to a second end thereof that defines the open face of the cover.

23. A display device, comprising:

- a cover;
- a light emitting module provided on the cover, the light emitting module comprising a plurality of light emitting diodes ;
- a light guide plate provided at a side of the light emitting module;
- an optical sheet provided on the light guide plate;
- a display panel provided on the optical sheet; and

a conversion layer provided on the light guide plate, wherein the conversion layer converts a first color of light emitted by the light guide plate to a target color.

24. The display device of claim 23, wherein the conversion layer shifts a color coordinate distribution of the light emitted by the light guide plate to a color coordinate having $CIE_x=0.313$ and $CIE_y=0.329$.

25. The display device of claim 24, wherein the conversion layer comprises a light transmitting sheet positioned at either an upper or a lower side of the optical sheet.

26. The display device of claim 24, wherein the optical sheet and the conversion layer comprise one of a diffusion sheet or a prism sheet.

27. The display device of claim 23, wherein the color coordinate conversion layer comprises a coating of color coordinate conversion material provided on a surface of the diffusion sheet.

ABSTRACT

A display device including a light unit is provided. The light unit may include a light guide plate, a light emitting module, and a color coordinate conversion sheet. The light emitting module may include a plurality of light emitting diodes configured to emit light to a side of the light guide plate. The color coordinate conversion sheet may be positioned on the light guide plate to convert a color coordinate distribution of the light emitted by the light emitting module to a color coordinate distribution that falls within a target distribution range.

FIG.1

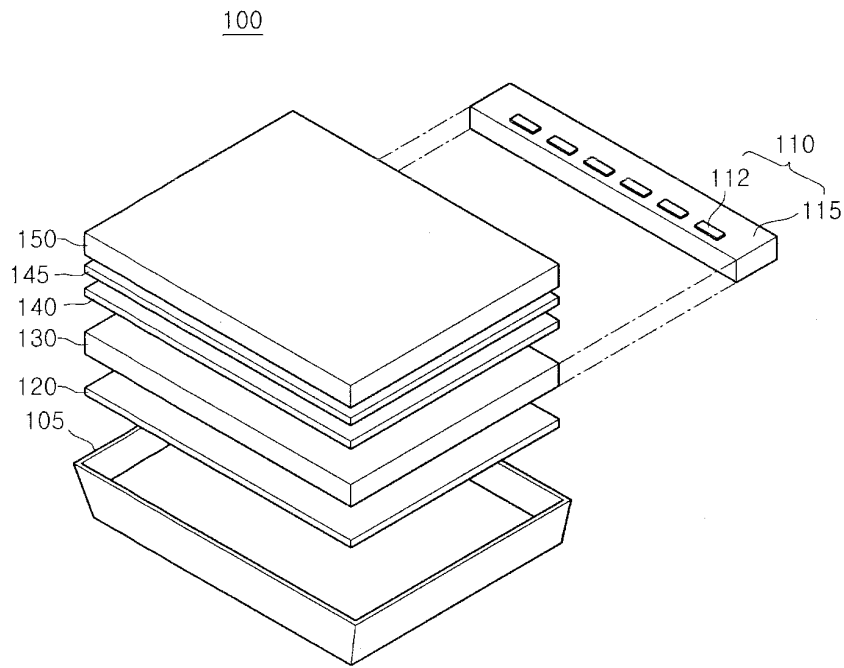


FIG.2

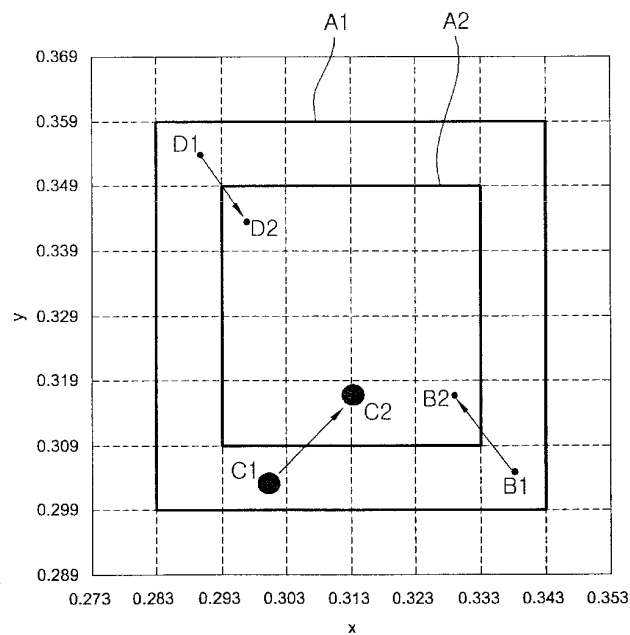


FIG.3

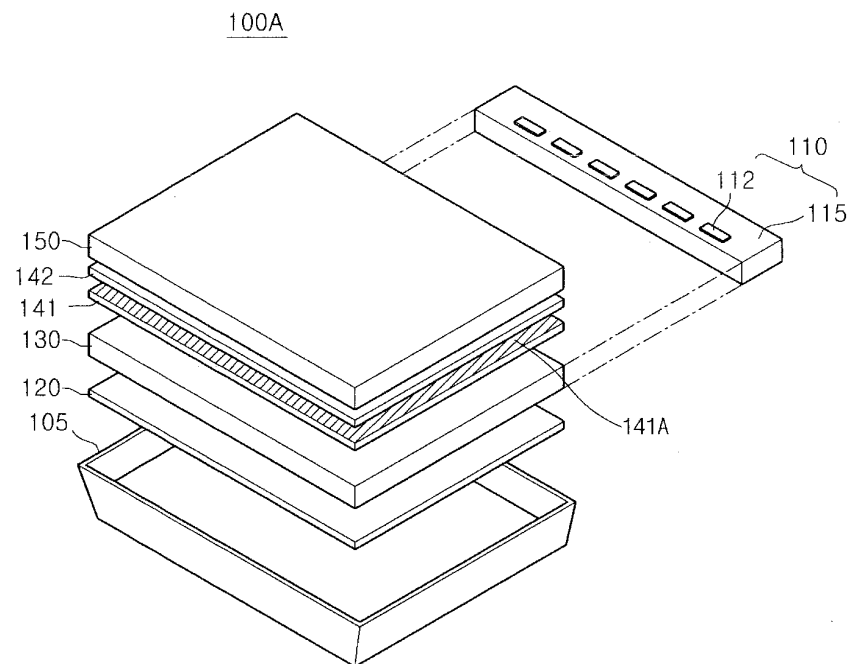


FIG.4

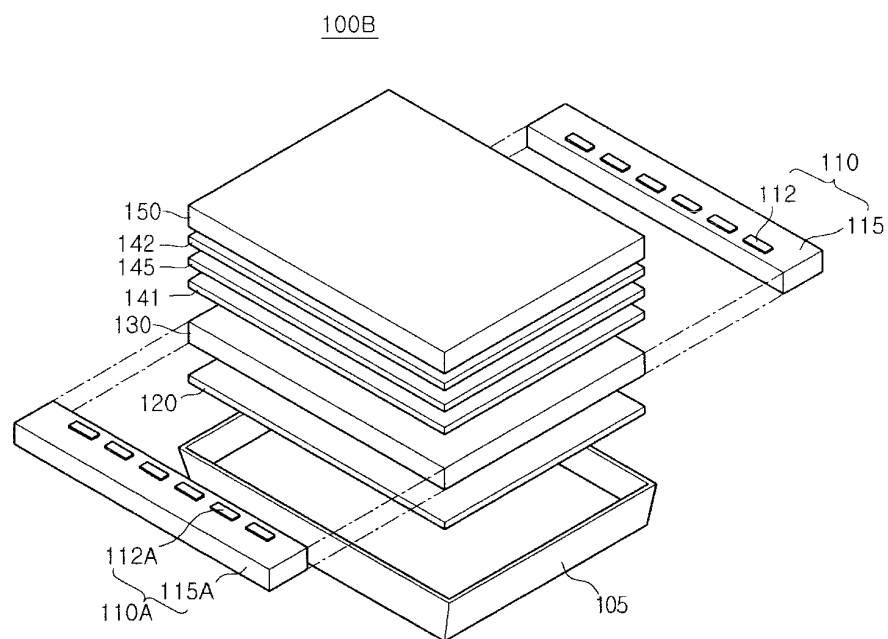


FIG.5

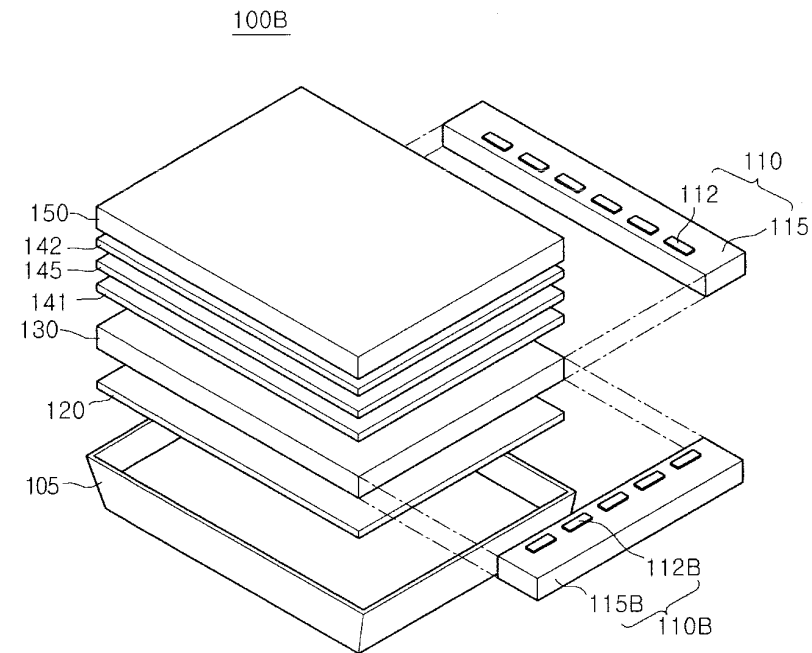


FIG.6

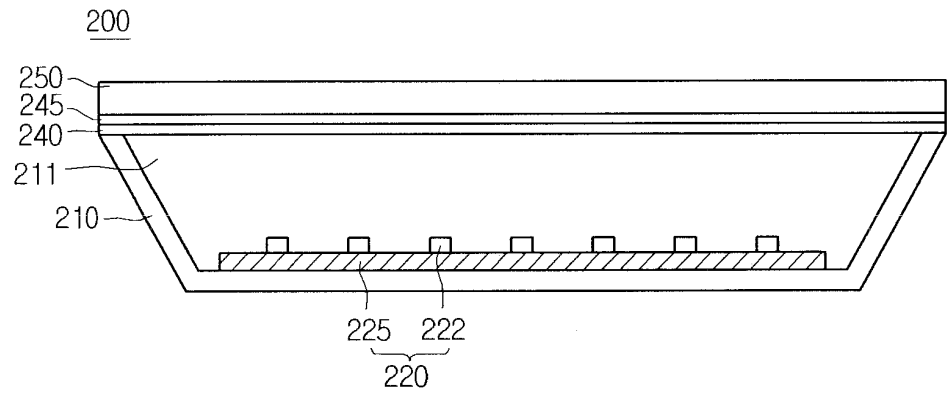


FIG. 7

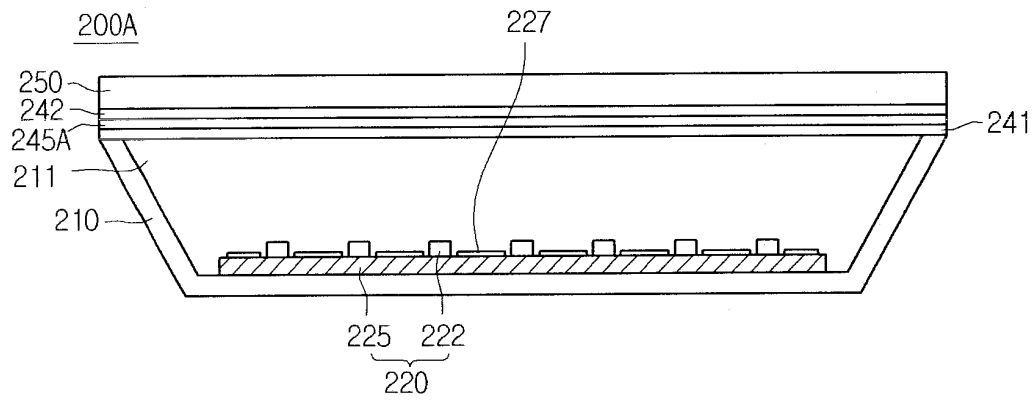


FIG. 8

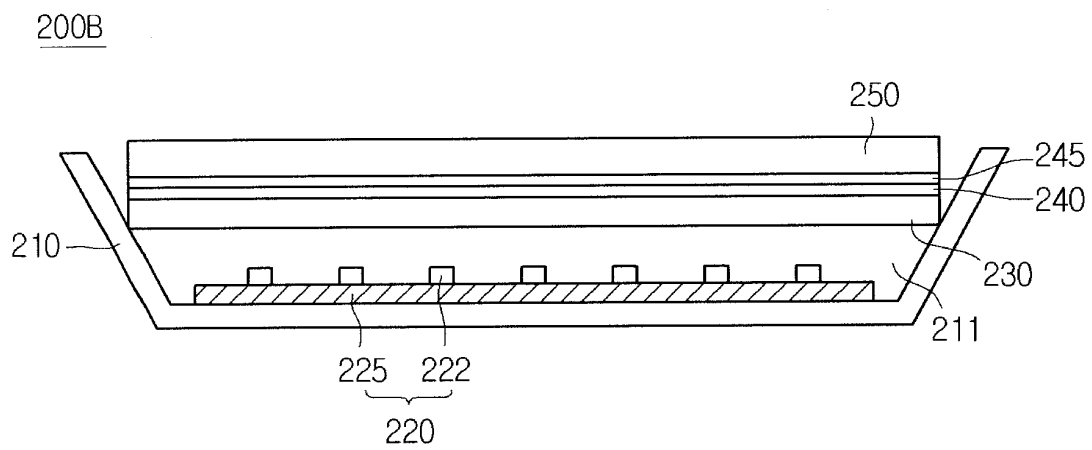


FIG. 9

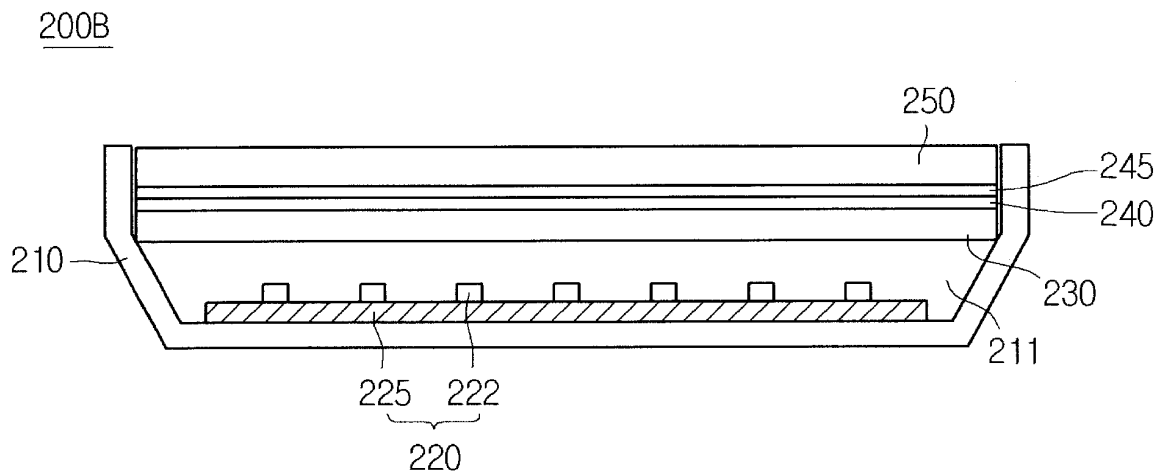


FIG. 10

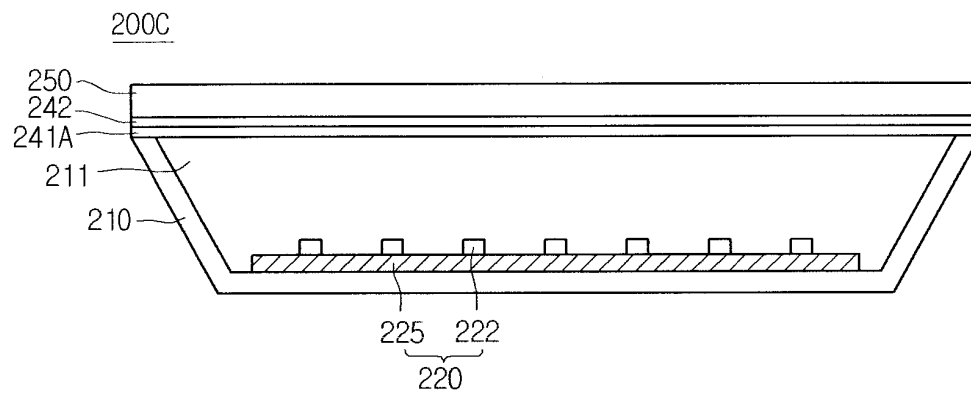
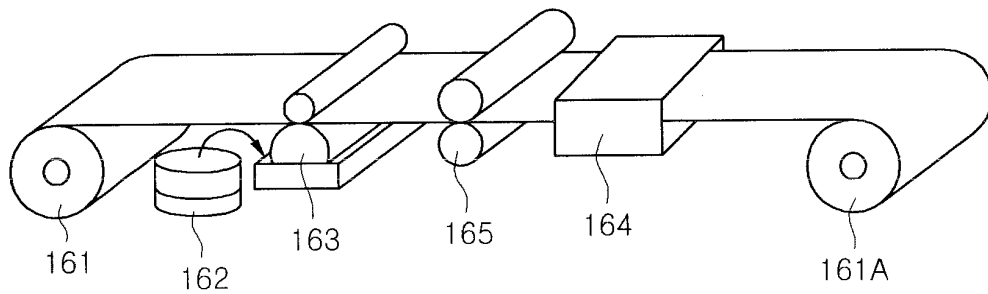


FIG. 11



Docket No.: HI-0434

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office 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 claimed and for which a patent is sought on the invention entitled LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME, the specification of which

☒ is attached hereto ☐ was filed on _____ as Application Serial No. and was amended 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 referred to above.

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I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365 (b) of any foreign application(s) for patent or inventor's certificate, 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 or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s):
Number

Country

Foreign Filing Date
Month/Day/Year

10-2009-0013161

Korea

February 17, 2009

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Application Number(s):

Filing Date (Month/Day/Year)

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Direct all correspondence to Customer Number 34610

Full name of sole or first inventor: Hyung Hwa PARK

Inventor's signature: 

Date: 2009.12.24

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Inventor's signature:

Date:

Mailing Address:

Citizenship:

Residence Address

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Application Number:				
Filing Date:				
Title of Invention:		LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME		
First Named Inventor/Applicant Name:		Hyung Hwa PARK		
Filer:		Joanna K. Mason/Lisa Dyer		
Attorney Docket Number:		HI-0434		
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Utility application filing	1011	1	330	330
Utility Search Fee	1111	1	540	540
Utility Examination Fee	1311	1	220	220
Pages:				
Claims:				
Claims in excess of 20	1202	7	52	364
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1454

Electronic Acknowledgement Receipt	
EFS ID:	6931871
Application Number:	12698478
International Application Number:	
Confirmation Number:	4085
Title of Invention:	LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME
First Named Inventor/Applicant Name:	Hyung Hwa PARK
Customer Number:	34610
Filer:	Joanna K. Mason/Lisa Dyer
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Attorney Docket Number:	HI-0434
Receipt Date:	02-FEB-2010
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Time Stamp:	15:25:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

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1	Transmittal of New Application	HI-0434Transmittal.pdf	193223 9564fd21539f1a5f79552d53c7cbbf6c2cc70b44	no	1
Warnings:					
Information:					
2		HI-0434Application.pdf	2060452 39db522651da208a5c90d5da353075ef5687b748	yes	33
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	20	
	Claims		21	26	
	Abstract		27	27	
	Drawings-only black and white line drawings		28	33	
Warnings:					
Information:					
3	Oath or Declaration filed	HI-0434Declaration.pdf	329313 83149769171290e6e2e4bcde822b8506a59f8141	no	2
Warnings:					
Information:					
4	Authorization for Extension of Time all replies	HI-0434Authorization.pdf	90114 3dcfabe5904f4bc98cddd2e610f6042d26197710	no	1
Warnings:					
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5	Fee Worksheet (PTO-875)	fee-info.pdf	36443 38a2a62c8196fee684871f33fe9fa76cb08407a0	no	2
Warnings:					
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UTILITY PATENT APPLICATION TRANSMITTAL UNDER 37 C.F.R. §1.53(b)

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Randolph Building
401 Dulany Street
Alexandria, VA 22314

Docket No.: **HI-0434**

Sir:

Transmitted herewith for filing is the patent application of
INVENTORS: Hyung Hwa PARK

FOR: LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME

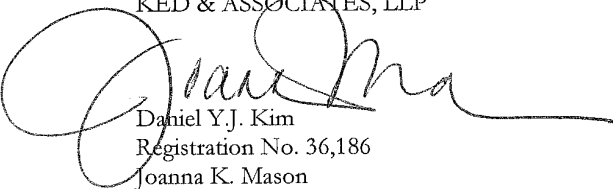
Enclosed are:

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| 1. ☒ 27 pages of specification, claims, abstract | 7. ☐ Assignment papers for LG Innotek Co., Ltd. _____ cover sheet, assignment and assignment fee) (To Follow) |
| 2. ☒ 6 sheets of FORMAL drawings | 8. ☐ Certified copy of Priority Application No. _____ (To Follow) |
| 3. ☒ 2 pages of newly executed Declaration & Power of Attorney (copy or original) | 9. ☐ Two (2) return postcards
☐ Stamp & Return with Courier
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| 4. ☒ Priority claimed to Appln. No. 10-2009-0013161 filed on February 17, 2009 in Korea, whose entire disclosure is incorporated herein by reference. | 10. ☒ Authorization under 37 C.F.R. §1.136(a)(3) |
| 5. ☐ Applicant claims Small Entity Status | 11. ☐ Request and Certification under 35 U.S.C. §122(b)(2)(B)(i) |
| 6. ☐ Information Disclosure Statement, Form PTO-1449 and _____ references | 12. ☐ Other: _____ |

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For	No. Filed		No. Extra	Rate	Fee
Total Claims	27	- 20	7	X \$52.00	\$364.00
Independent Claims	2	- 3	0	X \$220.00	\$0.00
Multiple Dependent Claims (If applicable)				X \$390.00	\$0.00
APPLICATION SIZE FEE (-100 = /52 x 270.00)					\$0.00
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UTILITY SEARCH FEE					\$540.00
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- ☒ Any filing fees under 37 C.F.R. 1.16 for presentation of extra claims.

Respectfully submitted,
KED & ASSOCIATES, LLP


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Date: February 2, 2010

Please direct all correspondence to Customer Number 34610

221936

Date: 02/02/10

Approved for use through 7/31/2006. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875					Application or Docket Number 12/698,478	
APPLICATION AS FILED – PART I						
(Column 1)		(Column 2)		SMALL ENTITY		OR
OTHER THAN SMALL ENTITY						
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)	RATE (\$)	FEE (\$)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A		N/A	330
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A		N/A	540
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A		N/A	220
TOTAL CLAIMS (37 CFR 1.16(j))	27	minus 20 = 7	x\$26		x\$52	364
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2	minus 3 = *	x\$110		x\$220	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$260 (\$130 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR					
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			195		390	
			TOTAL		TOTAL	1454
* If the difference in column 1 is less than zero, enter "0" in column 2.						
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	Application Size Fee (37 CFR 1.16(s))					
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					
(Column 1)		(Column 2)		(Column 3)		
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA			
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	Independent (37 CFR 1.16(h))	*	Minus ***	=		
	Application Size Fee (37 CFR 1.16(s))					
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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
12/698,478	02/02/2010	2811	1454	HI-0434	27	2

CONFIRMATION NO. 4085

34610
KED & ASSOCIATES, LLP
P.O. Box 221200
Chantilly, VA 20153-1200

FILING RECEIPT



Date Mailed: 02/22/2010

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Applicant(s)

Hyung Hwa PARK, Namdong-gu, KOREA, REPUBLIC OF;

Power of Attorney: The patent practitioners associated with Customer Number 34610

Domestic Priority data as claimed by applicant

Foreign Applications

REPUBLIC OF KOREA 10-2009-0013161 02/17/2009

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Projected Publication Date: 08/19/2010

Non-Publication Request: No

Early Publication Request: No

Title

LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME

Preliminary Class

257

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Application Number

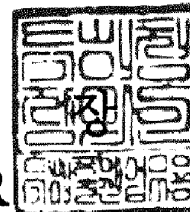
출 원 년 월 일 : 2009년 02월 17일
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특 허 청

COMMISSIONER



제출 일자 : 2009-02-17

【서지사항】

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【출원인코드】	1-1998-000285-5
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【포괄위임등록번호】	2008-025020-8
【발명의 국문명칭】	라이트 유닛
【발명의 영문명칭】	LIGHT UNIT
【발명자】	
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제출 일자 : 2009-02-17

위와 같이 특허청장에게 제출합니다.

대리인 허용록

(서명 또는 인)

【수수료】

【출원료】	0 면	38,000 원
【가산출원료】	18 면	0 원
【우선권주장료】	0 건	0 원
【심사청구료】	12 항	610,000 원
【합계】	648,000 원	

【요약서】

【요약】

실시 예는 라이트 유닛에 관한 것이다.

실시 예에 따른 라이트 유닛은, 복수개의 발광 다이오드를 구비하고, 상기 발광 다이오드를 통해 제1색좌표 분포를 갖는 제1광을 방출하는 발광 모듈; 상기 발광 모듈로부터 방출되는 제1색좌표 분포를 갖는 제1광을 타겟 색좌표 분포로 이 동시켜 주는 색좌표 변환물질을 포함하는 시트를 포함한다.

【대표도】

도 1

【색인어】

발광 모듈, 라이트 유닛, LED

【명세서】

【발명의 명칭】

라이트 유닛(LIGHT UNIT)

【발명의 상세한 설명】

【기술분야】

[0001] 실시 예는 라이트 유닛에 관한 것이다.

【배경기술】

[0002] 표시장치는 CRT(Cathode Ray Tube), 전계 광학적인 효과를 이용한 액정표시장치(Liquid Crystal Display :LCD), 가스방전을 이용한 플라즈마 표시소자(PDP : Plasma Display Panel) 및 전계 발광 효과를 이용한 EL 표시소자(ELD : Electro Luminescence Display) 등이 있으며, 그 중에서 액정표시장치에 대한 연구가 활발히 진행되고 있다.

[0003] 액정표시장치는 대부분이 외부에서 들어오는 광의 양을 조절하여 화상을 표시하는 수광성 장치이기 때문에, LCD 패널에 광을 조사하기 위한 별도의 광원 즉, 백라이트 유닛(BackLight unit)이 요구되고 있다.

【발명의 내용】

【해결하고자 하는 과제】

[0004] 실시 예는 발광 다이오드로부터 방출된 광의 색좌표 분포에 대한 색좌표 변환이 가능한 라이트 유닛을 제공한다.

제출 일자 : 2009-02-17

[0005] 실시 예는 타겟 색좌표 영역을 벗어난 색 좌표 분포를 타겟 방향으로 이동시켜 줄 수 있는 시트를 포함하는 라이트 유닛을 제공한다.

[0006] 실시 예는 색좌표 변환물질을 시트 표면에 코팅하거나 내부에 첨가하여 줄 있도록 한 라이트 유닛을 제공한다.

【과제 해결 수단】

[0007] 실시 예에 따른 라이트 유닛은, 복수개의 발광 다이오드를 구비하고, 상기 발광 다이오드를 통해 제1색좌표 분포를 갖는 제1광을 방출하는 발광 모듈; 상기 발광 모듈로부터 방출되는 제1색좌표 분포를 갖는 제1광을 타겟 색좌표 분포로 이동시켜 주는 색좌표 변환물질을 포함하는 시트를 포함한다.

【효과】

[0008] 실시 예는 발광 다이오드의 가용 수율을 개선시켜 줄 수 있다.

[0009] 실시 예는 라이트 유닛 상에서 색좌표 분포를 조절할 수 있는 효과가 있다.

[0010] 실시 예는 발광 다이오드의 LED 칩의 랭크를 넓게 사용할 수 있다.

【발명의 실시를 위한 구체적인 내용】

[0011] 이하, 첨부된 도면을 참조하여 설명하면 다음과 같다.

[0012] 도 1은 제1실시 예에 따른 표시 장치를 나타낸 사시도이다.

[0013] 도 1을 참조하면, 표시 장치(100)는 발광 모듈(110), 반사 플레이트(120), 광 가이드 플레이트(130), 광학 시트부(140), 색좌표 변환시트(145), 표시 패널(150)을 포함한다. 여기서, 상기 발광 모듈(110), 상기 반사 플레이트(120), 상기

광 가이드 플레이트(130), 상기 광학 시트부(140), 색좌표 변환시트(145)는 라이트 유닛으로 기능하게 된다.

[0014] 상기 발광 모듈(110)은 기판(115) 및 복수개의 발광 다이오드(112)를 포함한다. 상기 기판(115)은 리지드 기판, 플렉시블 기판, 메탈 코어 PCB 등을 포함할 수 있으며, 이에 대해 한정하지는 않는다.

[0015] 상기 복수개의 발광 다이오드(112)는 상기 기판(115)의 위 또는 아래에 탑재되고 서로 소정 간격으로 이격되게 배열될 수 있다. 상기 각 발광 다이오드(112)는 타겟 컬러(예: 백색)에 따라 청색 LED 칩, 황색 LED 칩, 녹색 LED 칩, 적색 LED 칩, UV LED 칩, 호박색 LED 칩, 청녹색 LED 칩 등으로 이루어지거나, 상기의 LED 칩(들)과 형광체의 조합으로 구현될 수 있다. 이러한 타겟 컬러 및 LED 칩의 종류는 변경될 수 있다.

[0016] 여기서, 상기 복수개의 발광 다이오드(112)는 제1색좌표 분포를 갖는 광을 방출하게 된다.

[0017] 상기 복수개의 발광 다이오드(112)는 멀티 색도 랭크(이하, 멀티 랭크로 약칭함)로 이루어질 수 있다. 여기서, 단일 랭크(Rank)가 아닌 멀티 랭크의 발광 다이오드(112)로부터 방출된 광의 제1색좌표 분포는 라이트 유닛에서 원하는 타겟 색좌표 분포를 벗어날 수 있다.

[0018] 여기서, 상기 랭크(Rank)는 발광 다이오드(112)의 각 LED 칩의 광 특성을 색좌표 또는 파장 등의 기준으로 세분화하여 분류되는 영역이거나, 발광 다이오드

(112)의 광 특성을 색도 또는/및 휘도 등의 기준으로 세분화한 영역일 수 있다.

[0019] 상기 단일 랭크는, 각 발광 다이오드(112)가 청색 LED 칩을 포함하는 경우, 동일한 파장의 랭크를 사용하는 경우이다. 예를 들면, 451~455nm의 청색 LED 칩을 1nm로 소팅하게 되면, 451nm, 452nm, 453nm, 454nm, 455nm 파장을 갖는 5개의 랭크로 구분되는데, 상기 5개의 랭크 중 어느 한 파장(즉, 동일 파장)을 갖는 랭크의 LED 칩으로 LED를 구현한 경우, 단일 랭크의 발광 다이오드라 한다. 이 경우, 나머지의 랭크의 LED 칩은 사용하지 못하게 된다.

[0020] 멀티 랭크는 상기의 예와 같이 5개의 파장을 갖는 5개의 랭크 중에서 동일 파장을 갖는 랭크가 아닌, 2개 이상의 파장을 갖는 랭크의 LED 칩으로 발광 다이오드(112)를 구현하게 된다. 이 경우, 상기 멀티 랭크의 발광 다이오드는 타겟 색도 랭크를 벗어날 수는 있지만, LED 칩의 사용 수율을 높여줄 수 있다.

[0021] 상기 발광 모듈(110)은 멀티 랭크의 발광 다이오드(112)를 포함하여 구현된다. 상기 멀티 랭크의 발광 다이오드(112)는 청색 LED 칩, 녹색 LED 칩 및 적색 LED 칩 등 중 적어도 하나를 서로 다른 랭크로 구현될 수 있다.

[0022] 이에 따라 복수개의 발광 다이오드(112)는 타겟 색도 범위를 벗어나는 LED 칩을 적용할 수 있으며, 이 경우 LED 칩 및 발광 다이오드(112)의 사용 수율을 개선시켜 줄 수 있다. 즉, 기존에는 청색 LED 칩이 453nm 파장의 랭크를 이용한 경우에는 453nm 파장의 청색 LED 칩만을 이용하고 나머지는 사용하지 못하는 문제가 있었다. 실시 예는 453nm 이외의 인접한 파장의 랭크도 이용할 수 있는 장점이 있다.

- [0023] 상기 발광 모듈(110)의 일측에는 광 가이드 플레이트(130)가 배치된다. 여기서, 상기 발광 모듈(110)이 복수개인 경우, 상기 발광 모듈(110)은 상기 광 가이드 플레이트(130)의 일측 및 타측에 배치되거나, 모든 측면에 배치될 수 있다.
- [0024] 상기 광 가이드 플레이트(130)는 PC 재질 또는 PMMA(Poly methy methacrylate) 재질로 이루어질 수 있으며, 하부에 반사 패턴이 형성될 수 있다.
- [0025] 상기 발광 모듈(110)의 발광 다이오드(112)로부터 방출된 제1색좌표 분포를 갖는 광은 광 가이드 플레이트(130)에 입사되며, 상기 광 가이드 플레이트(130)는 상기 발광 다이오드(112)로부터 입사되는 광을 전체 영역으로 가이드하여 면 광원으로 조사하게 된다.
- [0026] 상기 광 가이드 플레이트(130)의 하부에는 반사 플레이트(120)가 배치되고, 상부에는 광학 시트부(140) 및 색좌표 변환시트(145)가 배치된다.
- [0027] 상기 반사 플레이트(120)는 상기 광 가이드 플레이트(130)로부터 누설되는 광을 반사하며, 상기 광학 시트부(140)는 상기 광 가이드 플레이트(130)로부터 입사된 광을 균일한 휘도 분포로 상기 표시 패널(150)로 조사하게 된다.
- [0028] 여기서, 상기 광학 시트부(140)는 확산 시트(미도시), 수평 및 수직 프리즘 시트(미도시), 휘도 강화 필름(미도시) 등에서 적어도 하나를 포함할 수 있으며, 상기 확산 시트는 입사되는 광을 확산시켜 주고, 상기 수평 및 수직 프리즘 시트는 입사되는 광을 표시 영역으로 집광시켜 주며, 상기 휘도 강화 필름은 손실되는 광을 재사용하여 휘도를 향상시켜 준다.

[0029] 상기 색좌표 변환시트(145)는 플라스틱 또는 아크릴과 같은 투명한 시트에 형광 물질이 코팅되거나 내부에 혼합된 형태이다. 상기 형광 물질은 옐로우, 레드, 블루, 그린 등 다양한 컬러 중 적어도 하나의 물질을 포함할 수 있다.

[0030] 상기 색좌표 변환시트(145)는 상기 광학 시트부(140) 위에 배치되거나 내부 또는 아래에 배치될 수 있으며, 이에 대해 한정하지는 않는다. 상기 색좌표 변환시트(145)는 1장 또는 2장 이상으로 구성될 수 있다.

[0031] 상기 색좌표 변환시트(145)는 입사되는 제1색좌표 분포를 갖는 제1광을 타겟 색좌표 분포로 변환하는 광을 방출하게 된다. 예를 들면, 상기 색좌표 변환시트(145)는 상기 광 가이드 플레이트(130)에서 출사된 제1색좌표 분포를 갖는 제1광의 일부를 여기서 제2광을 방출하며, 상기 제2광은 상기 제1색좌표 분포를 갖는 광과 혼색되어 특정 방향(타겟 방향)의 색좌표 분포로 이동시켜 줄 수 있다.

[0032] 도 1 및 도 2를 참조하면, 복수개의 발광 다이오드(112)의 광 특성(광도 및 색도 등)을 측정하면, CIE_x 및 CIE_y 좌표 상에서 영역(C1, D1, B1 등) 내에 산포될 수 있다. 이는 멀티 랭크의 발광 다이오드(112)는 적어도 한 종류의 LED 칩을 멀티 랭크로 구성함으로써, 멀티 랭크의 발광 다이오드(112)는 색좌표 상에서 타겟 영역(A2)을 벗어나는 영역(A1)에 분포할 수 있다.

[0033] 광 가이드 플레이트(130)에서 발생된 제1색좌표 분포가 표준 영역(A1)의 C1 이고, 상기 색좌표 변환시트(145)은 옐로우계 형광물질을 구비한 경우, 상기 C1 색좌표 분포는 상기 옐로우계 광에 의해 타겟 영역(A2) 내의 지점(C2)으로 이동될 수

있다.

[0034] 상기 색좌표 변환시트(145)가 옐로우계 형광 시트인 경우 제1색좌표 분포 C1
는 C2 지점으로 이동되고, 레드계 형광 시트인 경우 제1색좌표 분포 D1는 D2 지점
으로 이동되며, 그린계 형광 시트인 경우 제1색좌표 분포 B1는 B2 지점으로 이동될
수 있다. 여기서, 상기 색좌표 변환시트(145)는 적어도 하나의 형광 물질 재료를
이용하여 타겟 색좌표 분포(A2)를 벗어난 영역(A1)에서 존재하는 제1색좌표 분포를
타겟 색좌표 분포(A2) 내로 이동시켜 줄 수 있다. 상기 도 2에 제시된 색좌표 값은
일 예이며, 상기 값에 대해 한정하지는 않는다.

[0035] 또한 상기 색좌표 변환시트(140)는 상기 발광 모듈(110)의 발광 다이오드
(112)로부터 방출된 광의 색도 랭크를 타겟 색도 랭크로 변환하는 기능을
수행한다.

[0036] 상기 색좌표 변환시트(140) 위에는 표시 패널(150)이 배치될 수 있다. 상기
표시 패널(150)은 예컨대, LCD 패널로서, 서로 대향되는 투명한 재질의 제 1 및 제
2기판, 그리고 제 1 및 제 2기판 사이에 개재된 액정층을 포함한다. 상기 표시 패
널(150)의 적어도 일면에는 편광판이 부착될 수 있으며, 이러한 편광판의 부착 구
조로 한정하지는 않는다.

[0037] 상기 표시 패널(150)은 상기 광학 시트부(140) 및 상기 색좌표 변환시트
(145)를 투과한 광에 의해 정보를 표시하게 된다.

[0038] 이러한 표시 장치(100)는 휴대 단말기, 노트북 컴퓨터의 모니터, 랩탑 컴퓨

터의 모니터, 텔레비전 등에 적용될 수 있다.

[0039] 도 3은 제2실시 예에 따른 표시장치를 나타낸 사시도이다. 상기 제2실시 예를 설명함에 있어서, 상기 제1실시 예와 동일한 부분에 대해서는 동일 부호로 처리하며 중복 설명은 생략하기로 한다.

[0040] 도 3를 참조하면, 표시장치(100A)는 발광 모듈(110), 반사 플레이트(120), 광 가이드 플레이트(130), 광학 시트부(140), 색좌표 변환물질을 갖는 확산 시트(141), 프리즘 시트(142), 표시 패널(150)을 포함한다.

[0041] 상기 확산 시트(141)의 상면(141A) 또는 하면에는 색좌표 변환 물질이 코팅될 수 있다. 상기 색좌표 변환 물질은 형광 물질로서, 엘로우, 레드, 블루, 그린 등 다양한 컬러 형광 물질 중 적어도 하나의 물질을 포함할 수 있다. 이 경우, 상기 입사되는 제1색좌표 분포와 타겟 색좌표 분포의 차이는 상기 색좌표 변환 물질과 보색 관계에 있을 수 있다.

[0042] 상기 확산시트(141)에 의해 확산된 광의 제1색좌표 분포는, 상기 형광 물질에 의해 타겟 방향으로 이동될 수 있다. 즉, 상기 형광 물질은 상기 입사되는 제1광의 일부를 여기시켜 다른 파장의 제2광을 발생하게 되며, 이때 상기 입사되는 제1광과 제2광이 혼합되어 타겟 색좌표 분포로 이동될 수 있다.

[0043] 실시 예는 상기 확산 시트(141)의 상면(141A)에 색좌표 변환 물질을 코팅한 예로 설명하였으나, 상기 확산 시트(141)의 제조시 그 내부에 상기 색좌표 변환 물질을 첨가하여 제조할 수 있다. 마찬가지로, 상기 확산 시트(141)가 아닌, 상기 프

리즘 시트(142)에 상기 색좌표 변환 물질을 코팅하거나 내부에 첨가하여 제조할 수 있다.

[0044] 상기와 같이 라이트 유닛에서 색좌표 분포가 타겟 영역을 벗어나는 경우, 상기 색좌표 변환 시트(도 1의 145)를 사용하거나, 색좌표 변환 물질을 이용한 광학 시트(예: 확산 시트, 프리즘 시트)를 이용함으로써, 색좌표 분포를 타겟 영역으로 이동시켜 줄 수 있다. 이에 따라 상기 발광 모듈(110)의 발광 다이오드(112)는 색좌표 분포가 벗어나는 인접한 랭크 즉, 멀티 랭크의 LED나 등의 랭크의 LED를 사용할 수 있다.

[0045] 또한 상기 발광 모듈(110)는 복수개의 발광 다이오드(112)를 구성하는 적어도 한 종류의 LED 칩을 멀티 랭크로 사용함으로써, LED 칩 및 발광 다이오드의 제품 사용 수율을 개선시켜 줄 수 있다.

[0046] 도 1의 설명은 사이드 타입의 라이트 유닛에 대해 설명하였으나, 직하 타입의 라이트 유닛에서도 상기의 적어도 한 장의 색좌표 변환시트를 적용할 수 있다. 상기 직하 타입의 라이트 유닛에는 광 가이드 플레이트를 구비하지 않을 수 있다.

[0047] 도 4는 실시 예에 따른 색좌표 변환시트를 제조하는 예를 나타낸 도면이다.

[0048] 도 4를 참조하면, 투명한 수지 재질의 시트 원단(161)에 특정 형광 염료가 혼합된 용제(162)를 이용하여 코팅 장비(153)를 이용하여 코팅하고, 롤러(165)를 통해 이동시킨 후 건조 장비(164)로 건조시켜 색좌표 변환시트((161A)를 제조할 수

제출 일자 : 2009-02-17

있다. 상기 색좌표 변환시트(161A)의 표면에는 상기 용제(162)가 코팅되며, 상기 코팅 방식은 예컨대, 라미네이팅 방식을 이용할 수 있다.

[0049] 여기서, 상기 형광 염료는 옐로우, 레드, 블루, 그린 등 다양한 컬러의 색소를 가진 파우더를 특정 점도를 가진 수지(예: 투명한 아크릴)에 알코올 등으로 소정 비율로 희석함으로써, 원하는 용제(162)를 얻을 수 있다. 상기의 형광 염료는 입사 광의 색좌표 분포와 타겟 광의 색좌표 분포의 차이에 대응되는 컬러의 색소와 분포량으로 조절할 수 있다.

[0050] 또한 상기에서 제조된 용제(162)를 시트 원 재료와 혼합하여 상기 용제가 내부에 첨가된 색좌표 변환시트를 제조할 수 있다.

[0051] 실시 예는 타겟 색좌표를 구현하기 위해 단일 랭크의 발광 다이오드를 이용하지 않고, 멀티 랭크의 발광 다이오드 즉, 타겟 색도 범위를 벗어나는 LED 칩을 이용한 발광 다이오드를 이용하고, 상기 타겟 색도 범위를 벗어난 색좌표 분포를 색좌표 변환 물질을 포함하는 시트로 타겟 색좌표로 이동시켜 줄 수 있다. 이에 따라 LED 칩과 발광 다이오드의 사용 수율을 개선시켜 줄 수 있다.

[0052] 이상에서는 실시 예를 중심으로 설명하였으나, 이는 단지 예시일 뿐 본 발명을 한정하는 것이 아니며, 본 발명이 속하는 분야의 통상의 지식을 가진 자라면 본 발명의 본질적인 특성을 벗어나지 않는 범위에서 이상에 예시되지 않은 여러 가지의 변형과 응용이 가능함을 알 수 있을 것이다.

[0053] 예를 들어, 본 발명의 실시 예에 구체적으로 나타난 각 구성 요소는 변형하

제출 일자 : 2009-02-17

여 실시할 수 있는 것이다. 그리고 이러한 변형과 응용에 관계된 차이점들은 첨부된 청구 범위에서 규정하는 본 발명의 범위에 포함되는 것으로 해석되어야 할 것이다.

【특허청구범위】

【청구항 1】

멀티 랭크를 갖는 복수개의 발광 다이오드를 구비하고, 상기 복수개의 발광 다이오드를 통해 제1색좌표 분포를 갖는 제1광을 방출하는 발광 모듈;

상기 발광 모듈로부터 방출되는 제1색좌표 분포를 갖는 제1광을 타겟 색좌표 분포로 이동시켜 주는 색좌표 변환물질을 포함하는 시트를 포함하는 라이트 유닛.

【청구항 2】

제1항에 있어서,

상기 시트는 투명한 색좌표 변환 시트이며,

상기 색좌표 변환 시트는 적어도 한 컬러의 형광물질을 포함하는 라이트 유닛.

【청구항 3】

제1항에 있어서,

상기 시트는 확산 시트 및 프리즘 시트 중 적어도 하나를 포함하는 라이트 유닛.

【청구항 4】

제3항에 있어서,

상기 색좌표 변환물질은 상기 확산 시트 및 프리즘 시트 중 적어도 한 시트의 표면에 코팅되거나 내부에 첨가된 라이트 유닛.

【청구항 5】

제1항에 있어서,
상기 시트의 아래에 배치된 확산 시트 또는 프리즘 시트를 포함하는 라이트
유닛.

【청구항 6】

제1항에 있어서,
상기 발광 모듈의 일측 및 상기 시트 아래에 배치된 광 가이드 플레이트를
포함하는 라이트 유닛.

【청구항 7】

제6항에 있어서,
상기 광 가이드 플레이트의 아래에 반사 플레이트를 포함하는 라이트 유닛.

【청구항 8】

제6항에 있어서,
복수개의 발광 모듈은 상기 광 가이드 플레이트의 양측에 배치되는 라이트
유닛.

【청구항 9】

제1항 내지 제8항 중 어느 한 항에 있어서,
상기 복수개의 발광 다이오드는 멀티 랭크의 LED 칩을 포함하는 라이트 유
닛.

【청구항 10】

제9항에 있어서,
상기 멀티 랭크의 LED 칩은 발광 파장 또는 색 좌표 분포의 랭크가 서로 다르며,
상기 LED 칩은 청색 LED 칩, 황색 LED 칩, 녹색 LED 칩, 적색 LED 칩, UV LED 칩, 호박색 LED 칩, 청녹색 LED 칩 중 적어도 하나를 포함하는 라이트 유닛.

【청구항 11】

제9항에 있어서,
상기 색좌표 변환 물질은 상기 제1색좌표 분포를 갖는 제1광의 일부를 여기서 제2광을 방출하며,
상기 제2광은 상기 제1색좌표 분포를 갖는 광과 혼색되어 상기 제1색좌표 분포를 타겟 색좌표 분포로 이동시켜 주는 라이트 유닛.

【청구항 12】

제11항에 있어서,
상기 색좌표 변환물질은 엘로우, 레드, 블루, 그린 계열의 형광 물질 중 적어도 하나를 포함하는 라이트 유닛.

【도면의 간단한 설명】

[0054] 도 1은 제1실시 예에 따른 표시장치의 사시도이다.

[0055] 도 2는 도 1의 색좌표 분포의 이동 예를 보여주기 위한 색좌표 도면이다.

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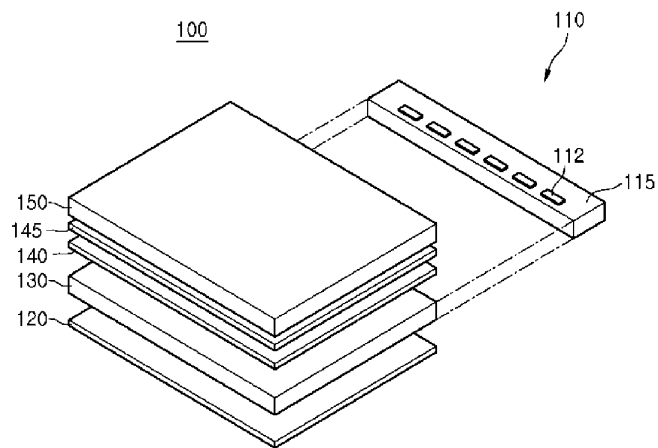
[0056] 도 3은 제2실시 예에 따른 표시장치의 사시도이다.

[0057] 도 4는 도 1의 색좌표 변환시트의 제조 과정을 나타낸 도면이다.

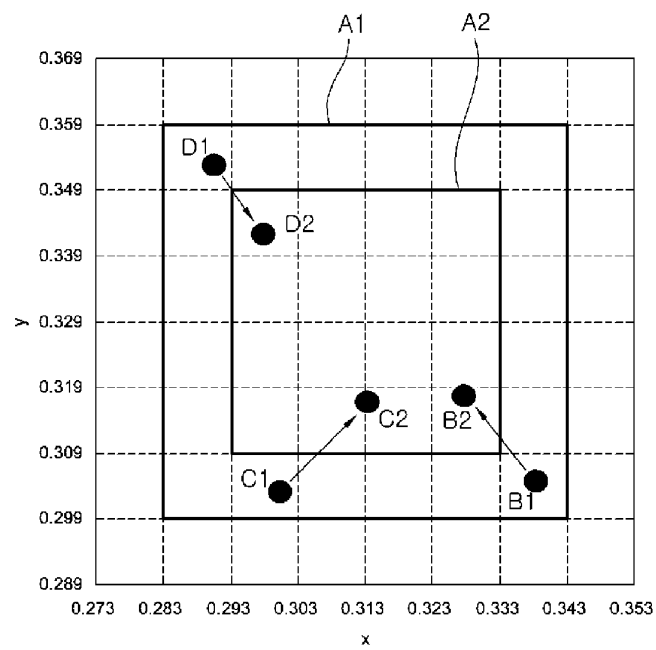
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【도면】

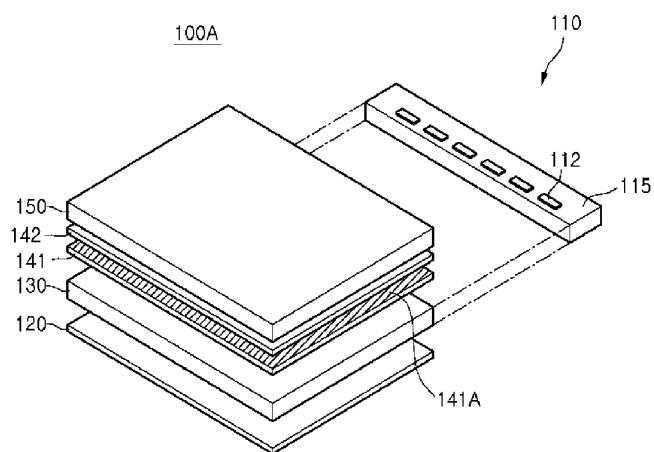
【도 1】



【도 2】

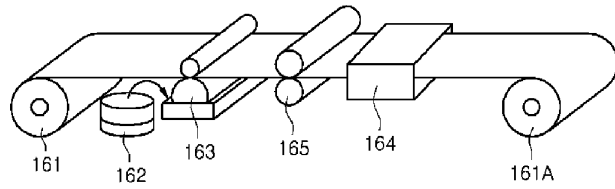


【도 3】



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【도 4】



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(54) Title: ILLUMINATION APPARATUS

(57) Abstract: An illumination apparatus, comprising at least one light emitting source embedded in a waveguide material is disclosed. The waveguide material is capable of propagating light generated by light emitting source(s), such that at least a portion of the light is diffused within the waveguide material and exits through at least a portion of its surface.

WO 2006/131924

PCT/IL2006/000667

1

ILLUMINATION APPARATUS

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to artificial illumination and, more particularly,
5 but not exclusively to an illumination apparatus capable of providing light at any
intensity profile and any color profile, including, without limitation, uniform white
light.

Artificial light can be generated in many ways, including, electroluminescent
illumination (*e.g.*, light emitting diodes), incandescent illumination (*e.g.*, conventional
10 incandescent lamps, thermal light sources) and gas discharge illumination (*e.g.*,
fluorescent lamps, xenon lamps, hollow cathode lamps). Light can also be emitted via
direct chemical radiation discharge of a photoluminescent (*e.g.*, chemoluminescence,
fluorescence, phosphorescence).

A light emitting diode (LED) is essentially a p-n junction semiconductor diode
15 that emits a monochromatic light when operated in a forward biased direction. In the
diode, current flows easily from the p-side to the n-side but not in the reverse
direction. When two complementary charge-carriers (an electron and a "hole")
collide, the electron-hole system experiences a transition to a lower energy level and
emits a photon. The wavelength of the light emitted depends on the difference
20 between the two energy levels, which in turn depends on the band gap energy of the
materials forming the p-n junction.

LEDs are used in various applications, including, traffic signal lamps, large-
sized full-color outdoor displays, various lamps for automobiles, solid-state lighting
devices, flat panel displays and the like. The basic structure of a LED consists of the
25 light emitting semiconductor material, also known as the bare die, and numerous
additional components designed for improving the performance of the LED. These
components include a light reflecting cup mounted below the bare die, a transparent
encapsulation, typically silicone, surrounding and protecting the bare die and the light
reflecting cup, and bonders, for supplying the electrical current to the bare die. The
30 bare die and the additional components are efficiently packed in a LED package.

Nowadays, the LED has won remarkable attention as a next-generation small-
sized light emitting source. The LED has heretofore had advantages such as a small
size, high resistance and long life, but has mainly been used as indicator illumination

WO 2006/131924

PCT/IL2006/000667

2

for various measuring meters or a confirmation lamp in a control state because of restrictions on a light emitting efficiency and light emitting output. However, in recent years, the light emitting efficiency has rapidly been improved, and it is said to be a matter of time that the light emitting efficiency exceeds that of a high-pressure mercury lamp or a fluorescent lamp of a discharge type which has heretofore been assumed to have a high efficiency. Due to the appearance of the high-efficiency high-luminance LED, a high-output light emitting source using the LED has rapidly assumed a practicability. In recent years, a blue LED has been brought into a practical use stage in addition to conventional red and green LEDs, and this has also accelerated the application of the LED.

The application of the high-efficiency high-luminance LED has been considered as a promising small-sized light emitting source of an illuminating unit which is requested to have a light condensing capability. The LED originally has characteristics superior to those of another light emitting source, such as life, durability, lighting speed, and lighting driving circuit. Furthermore, above all, blue is added, and three primary colors are all used in a self-light emitting source, and this has enlarged an application range of a full-color image displays.

Luminescence is a phenomenon in which energy is absorbed by a substance, commonly called a luminescent, and emitted in the form of light. The absorbed energy can be in a form of light (photons), electrical field or colliding particles (*e.g.*, electrons). The wavelength of the emitted light differs from the characteristic wavelength of the absorbed energy (the characteristic wavelength equals hc/E , where h is the Plank's constant, c is the speed of light and E is the energy absorbed by the luminescent).

The luminescence is a widely occurring phenomenon which can be classified according to the excitation mechanism as well as according to the emission mechanism. Examples of such classifications include photoluminescence, electroluminescence, fluorescence and phosphorescence. Similarly, luminescent materials are classified into photoluminescents materials, electroluminescent materials, fluorescent materials and phosphorescent materials, respectively.

A photoluminescent is a material which absorbs energy is in the form of light, an electroluminescent is a material which absorbs energy is in the form of electrical field, a fluorescent material is a material which emits light upon return to the base state

WO 2006/131924

PCT/IL2006/000667

3

from a singlet excitation, and a phosphorescent materials is a material which emits light upon return to the base state from a triplet excitation.

In fluorescent materials, or fluorophores, the electron de-excitation occurs almost spontaneously, and the emission ceases when the source which provides the
5 exciting energy to the fluorophore is removed.

In phosphor materials, or phosphors, the excitation state involves a change of spin state which decays only slowly. In phosphorescence, light emitted by an atom or molecule persists after the exciting source is removed.

Luminescent materials are selected according to their absorption and emission
10 characteristics and are widely used in cathode ray tubes, fluorescent lamps, X-ray screens, neutron detectors, particle scintillators, ultraviolet (UV) lamps, flat panel displays and the like.

Luminescent materials, particularly phosphors, are also used for altering the color of LEDs. Since blue light has a short wavelength (compared, e.g., to green or
15 red light), and since the light emitted by the phosphor has a longer wavelength than the absorbed light, blue light generated by a blue LED can be readily converted to produce visible light having a longer wavelength. For example, a blue LED coated by a suitable yellow phosphor can emit white light. The phosphor absorbs the light from the blue LED and emits in a broad spectrum, with a peak in the yellow region. The
20 photons emitted by the phosphor and the non-absorbed photons emitted of the LED are perceived together by the human eye as white light. The first commercially available phosphor based white led was produced by Nichia Co. The white LED consisted of a gallium indium nitride (InGaN) blue LED coated by a yellow phosphor.

In order to get sufficient brightness, a high intensity LED is needed to excite
25 the phosphor to emit the desired color. As commonly known white light is composed of various colors of the whole range of visible electromagnetic spectrum. In the case of LEDs, only the appropriate mixture of complementary monochromatic colors can cast white light. This is achieved by having at least two complementary light sources in the proper power ratio. A "fuller" light (similar to sunlight) can be achieved by
30 adding more colors. Phosphors are usually made of zinc sulfide or yttrium oxides doped with certain transition metals (Ag, Mn, Zn, *etc.*) or rare earth metals (Ce, Eu, Tb, *etc.*) to obtain the desired colors.

WO 2006/131924

PCT/IL2006/000667

4

In a similar mechanism, white LEDs can also be manufactured using fluorescent semiconductor material instead of a phosphor. The fluorescent semiconductor material serves as a secondary emitting layer, which absorbs the light created by the light emitting semiconductor and reemits yellow light. The fluorescent semiconductor material, typically an aluminum gallium indium phosphide (AlGaInP),
5 is bonded to the primary source wafer.

Another type of light emitting device is an organic light emitting diode (OLED) which makes use of thin organic films. An OLED device typically includes an anode layer, a cathode layer, and an organic light emitting layer containing an
10 organic compound that provides luminescence when an electric field is applied. OLED devices are generally (but not always) intended to emit light through at least one of the electrodes, and may include one or more transparent electrodes.

Combination of LEDs, OLEDs and luminescence is widely used in the field of electronic display devices.

15 Many efforts have been made to research and develop various electronic display devices. Electronic display devices may be categorized into active display devices and passive display devices. The active display devices include the cathode ray tube (CRT), the plasma display panel (PDP) and the electroluminescent display (ELD). The passive display devices include liquid crystal display (LCD), the
20 electrochemical display (ECD) and the electrophoretic image display (EPID).

In active display devices, each pixel radiates light independently. Passive display devices, on the other hand, do not produce light within the pixel and the pixel is only able to block light. In LCD devices, for example, an electric field is applied to liquid crystal molecules, and an alignment of the liquid crystal molecule is changed
25 depending on the electric field, to thereby change optical properties of the liquid crystal, such as double refraction, optical rotatory power, dichroism, light scattering, *etc.* Since LCD are passive, they display images by reflecting external light transmitted through an LCD panel or by using the light emitted from a light source, *e.g.*, a backlight assembly, disposed below the LCD panel.

30 An LCD includes a LCD panel and backlight assembly. The LCD panel includes an arrangement of pixels, which are typically formed of thin film transistors fabricated on a transparent substrate coated by a liquid crystal film. The pixels include three color filters, which transmit one third of the light produced by each pixel. Thus,

WO 2006/131924

PCT/IL2006/000667

5

each LCD pixels is composed of three sub-pixels. The thin film transistors are addressed by gate lines to perform display operation by way of the signals applied thereto through display signal lines. The signals charge the liquid crystal film in the vicinity of the respective thin film transistors to effect a local change in optical properties of the liquid crystal film.

Typical backlight assembly of LCD includes an array of white LEDs for emitting white light, a light guiding plate for guiding the light toward the LCD panel, a reflector, disposed under the light guiding plate to reflect the lights leaked from the light guiding plate toward the light guiding plate, and optical sheets for enhancing brightness of the light exited from the light guiding plate. Backlight assembly are designed to achieve many goals, including high brightness, large area coverage, uniform luminance throughout the illuminated area, controlled viewing angle, small thickness, low weight, low power consumption and low cost.

In operation, the backlight assembly produces white illumination directed toward the LCD pixels. The optical properties of the liquid crystal film are locally modulated by the thin film transistors to create a light intensity modulation across the area of the display. The color filters colorize the intensity-modulated light emitted by the pixels to produce a color output. By selective opacity modulation of neighboring pixels of the three color components, selected intensities of the three component colors are blended together to selectively control color light output. Selective the blending of three primary colors such as red, green, and blue (RGB) can generally produce a full range of colors suitable for color display purposes.

LCD devices are currently employed in many applications (cellular phones, personal acceptance devices, desktop monitors, portable computers, television displays, *etc.*), and there is a growing attention to devise backlight high-quality assemblies for improving the image quality inn these applications.

Since the back light must pass through the color filters it therefore must include the wavelength at which the respective filter is transparent. However, the use of white LED composed of a blue LED coated by a yellow phosphor, is not efficient for backlighting because, although such dichromatic light appears as white light for the human eye, it cannot efficiently pass through the RGB color filters. Another approach is to use red green and blue LEDs which match the central wavelength of each color filter. This approach significantly complicates the manufacturing process

WO 2006/131924

PCT/IL2006/000667

6

because the red, green and blue LEDs have to be accurately aligned in a multichip approach. An additional approach is to generate white light using a UV LED and three different phosphors each emitting light at a different wavelength (red, green and blue). The efficiency of this configuration, however, is very low because high amount
5 of heat is released due to the Stokes shift. Other configurations include, two LEDs and a phosphor (e.g., a blue LED a red LED and a green phosphor), three LEDs and a phosphor (e.g., a blue LED, a red LED, a cyan LED and a green phosphor), two LEDs and two phosphors (e.g., a blue LED, a red LED, a cyan phosphor and a green phosphor), and the like. Although these configurations show improvement in the
10 performances, the results are far from being optimal.

Presently known LED based backlight devices are limited by the size, price and performance of the LEDs. To date, the performance of the LED are controlled by its transparent encapsulation which provides the necessary light scatter, the phosphor or fluorescent semiconductor material which is responsible for color conversion, and
15 the lead frame which allows for heat evacuation, all of which significantly increase the size and cost of the LED. Since the performance, cost and size of the LED are conflicting features, some compromises are inevitable.

There is thus a widely recognized need for, and it would be highly advantageous to have a diode-based illumination apparatus, devoid of the above
20 limitations.

SUMMARY OF THE INVENTION

The background art does not teach or suggest illumination apparatus capable of generating light while, at the same time, propagating, diffusing and emitting the light
25 through its surface area or a portion thereof. The background art also does not teach or suggest such illumination apparatus having superior optical and/or geometrical properties, including, without limitation, a thickness of a few centimeters or less, and high light quality in terms of brightness, intensity and/or color profiles. The background art also does not teach such illumination apparatus that is useful for a
30 variety of different applications, e.g., passive displays, which can benefit from its superior properties.

The present embodiments overcome these deficiencies of the background art by providing an illumination apparatus, which generates and diffuses light. The

WO 2006/131924

PCT/IL2006/000667

7

illumination apparatus comprises one or more light emitting sources embedded in a waveguide material. The waveguide material is capable of propagating light generated by the light emitting source(s), such that at least a portion of the light is diffused within the waveguide material and exits through at least a portion of its surface. In various exemplary embodiments of the invention the light emitting source(s) comprise bare dies.

The apparatus of the present embodiments can be incorporated in a passive display device or it can serve for providing signage or for providing illumination at various decorative patterns of significant aesthetic interest. In various exemplary embodiments of the invention the apparatus serves as a component in a liquid crystal display device.

According to another aspect of the present invention there is provided a method of providing illumination, comprising applying forward bias on one or more light emitting sources embedded in a waveguide material to effect emission of light from the light emitting source(s). The waveguide material is capable of propagating the light such that at least a portion of the light is diffused within the waveguide material and exits through at least a portion of its surface, thereby providing the illumination.

According to yet another aspect of the present invention there is provided a liquid crystal display device, comprising a liquid crystal panel and a backlight unit, which preferably comprises the illumination apparatus described herein.

The present embodiments further comprise a portable computer system comprising the liquid crystal display device, a computer monitor comprising the liquid crystal display device, a personal digital assistant system comprising the liquid crystal display device, a cellular communication system comprising the liquid crystal display device, and a television system comprising the liquid crystal display device.

The present embodiments further comprise a signage panel for producing a signage under electronic control. The signage panel comprises a power source connected to the illumination apparatus described herein.

According to further features in preferred embodiments of the invention described below, the waveguide material is flexible.

WO 2006/131924

PCT/IL2006/000667

8

According to still further features in the described preferred embodiments the light emitting source(s) comprises at least one bare die and electrical contacts connected thereto.

5 According to still further features in the described preferred embodiments the light emitting source(s) is encapsulated by a transparent thermal isolating encapsulation.

According to still further features in the described preferred embodiments the light emitting source(s) is embedded near the second surface of the waveguide material.

10 According to still further features in the described preferred embodiments the light emitting source(s) is embedded near the second surface in a manner such that electrical contacts of the light emitting source(s) remain outside the waveguide material at the second surface.

15 According to still further features in the described preferred embodiments the illumination apparatus further comprises a printed circuit board electrically connected to the electrical contacts.

According to still further features in the described preferred embodiments the printed circuit board is capable of evacuating heat away from the light emitting source(s).

20 According to still further features in the described preferred embodiments the light emitting source(s) is embedded in the bulk of the waveguide material.

According to still further features in the described preferred embodiments the illumination apparatus further comprises an arrangement of electrical lines extending from the light emitting source(s) to at least one end of the waveguide material.

25 According to still further features in the described preferred embodiments the light emitting source(s) comprises at least one source configured to emit light at a first color, and at least one source configured to emit light at a second color.

30 According to still further features in the described preferred embodiments the liquid crystal panel comprises an arrangement of color filters operating at a plurality of distinct colors, and the light emitting source(s) comprises, for each color of the plurality of distinct colors, at least one source configured to emit light at the color.

WO 2006/131924

PCT/IL2006/000667

9

According to still further features in the described preferred embodiments the illumination apparatus further comprises a reflecting surface embedded in or attached to the waveguide material in a manner such that emission of light through the second surface is prevented and emission of light through the first surface is enhanced.

5 According to still further features in the described preferred embodiments the illumination apparatus further comprises at least one photoluminescent layer coating at least the portion of the first surface.

According to still further features in the described preferred embodiments the at least one photoluminescent layer and the light emitting source(s) are selected such
10 the illumination apparatus provides substantially white light.

According to still further features in the described preferred embodiments the liquid crystal panel comprises an arrangement of color filters operating at a plurality of distinct colors, wherein the at least one photoluminescent layer and the light emitting source(s) are selected such the illumination apparatus provides light at least at the a
15 plurality of distinct colors.

According to still further features in the described preferred embodiments the at least one photoluminescent layer comprises a plurality of photoluminescent layers, each being characterized by a different absorption spectrum, and the light emitting source(s) comprises, for each absorption spectrum, at least one light emitting source
20 characterized by an emission spectrum overlapping the absorption spectrum.

According to still further features in the described preferred embodiments the illumination apparatus further comprises a structured film deposited on or embedded in the waveguide material.

According to still further features in the described preferred embodiments the
25 illumination apparatus further comprises at least one optical element embedded in the waveguide material for enhancing diffusion of light within the waveguide material.

According to still further features in the described preferred embodiments the at least one optical element is embedded in the waveguide material near the first surface and configured to reflect light striking the at least one optical element at a
30 predetermined range of angles, and transmit light striking the at least one optical element at other angles.

According to still further features in the described preferred embodiments the at least one optical element comprises at least one microlens.

WO 2006/131924

PCT/IL2006/000667

10

According to still further features in the described preferred embodiments the waveguide material comprises a polymeric material.

According to still further features in the described preferred embodiments the waveguide material comprises a rubbery material.

5 According to still further features in the described preferred embodiments the waveguide material is formed by dip-molding in a dipping medium.

According to still further features in the described preferred embodiments the dipping medium comprises a hydrocarbon solvent in which a rubbery material is dissolved or dispersed.

10 According to still further features in the described preferred embodiments the dipping medium comprises additives selected from the group consisting of cure accelerators, sensitizers, activators, emulsifying agents, cross-linking agents, plasticizers, antioxidants and reinforcing agents

15 According to still further features in the described preferred embodiments the waveguide material comprises a dielectric material, and wherein a reflection coefficient of the dielectric material is selected so as to allow propagation of polarized light through the waveguide material and emission of the polarized light through the first surface.

20 According to still further features in the described preferred embodiments the waveguide material comprises a metallic material, and wherein a reflection coefficient of the metallic material is selected so as to allow propagation of polarized light through the waveguide material and emission of the polarized light through the first surface.

25 According to still further features in the described preferred embodiments the waveguide material is a multilayered material.

According to still further features in the described preferred embodiments the waveguide material comprises a first layer having a first refractive index, and a second layer being in contact with the first layer and having a second refractive index being larger than the first refractive index.

30 According to still further features in the described preferred embodiments the second layer comprises polyisoprene.

According to still further features in the described preferred embodiments the first layer comprises silicone.

WO 2006/131924

PCT/IL2006/000667

11

According to still further features in the described preferred embodiments the waveguide material further comprises a third layer being in contact with the second layer and having a third refractive index being smaller than the second refractive index.

5 According to still further features in the described preferred embodiments the third refractive index equals the first refractive index.

According to still further features in the described preferred embodiments at least one layer of waveguide material comprises at least one additional component designed and configured such as to allow the emission of the light through the at least
10 a portion of the surface.

According to still further features in the described preferred embodiments the at least one additional component is capable of producing different optical responses to different spectra of the light.

According to still further features in the described preferred embodiments the
15 different optical responses comprise different emission angles.

According to still further features in the described preferred embodiments the different optical responses comprise different emission spectra.

According to still further features in the described preferred embodiments the at least one additional component comprises at least one impurity capable of emitting
20 at least the portion of the light through the first surface.

According to still further features in the described preferred embodiments the at least one impurity comprises a plurality of particles capable of scattering the light.

According to still further features in the described preferred embodiments a size of the plurality of particles is selected so as to selectively scatter a predetermined
25 spectrum of the light.

The present invention successfully addresses the shortcomings of the presently known configurations by providing an illumination apparatus and various uses thereof.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which
30 this invention belongs. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, suitable methods and materials are described below. In case of conflict, the patent

WO 2006/131924

PCT/IL2006/000667

12

specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and not intended to be limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

5 The invention is herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in the cause of providing what is believed to be the most useful and
10 readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

15 In the drawings:

FIGs. 1a-b are schematic illustrations of a perspective view (Figure 1a) and a section view (Figure 1b) of an illumination apparatus, according to various exemplary embodiments of the present invention;

20 FIG. 1c is a schematic illustration of a perspective view of the apparatus in a preferred embodiment in which the apparatus comprises a non-planar waveguide material;

FIGs. 2a-b are schematic fragmentary views of the apparatus in a preferred embodiment in which a source or sources embedded in the bulk of the waveguide material (Figure 1a), and in another preferred embodiment in which the source or
25 sources are embedded near the surface of the waveguide material (Figure 1b);

FIG. 3 is a schematic illustration of a section view of the apparatus, in a preferred embodiment in which the apparatus comprises a structured film;

30 FIG. 4 is a schematic illustration of a fragmentary view of the apparatus in a preferred embodiment in which the apparatus comprises one or more embedded optical elements for enhancing the diffusion of light;

FIG. 5 is a block diagram schematically illustrating a liquid crystal display device, according to various exemplary embodiments of the present invention;

WO 2006/131924

PCT/IL2006/000667

13

FIG. 6a is a schematic illustration of the waveguide material in a preferred embodiment in which two layers are employed;

FIGs. 6b-c are schematic illustrations of the waveguide material in preferred embodiments in which three layers are employed;

5 FIG. 7a is a schematic illustration of the waveguide material in a preferred embodiment in which at least one impurity is used for scattering light;

FIG. 7b is a schematic illustration of the waveguide material in a preferred embodiment in which the impurity comprises a plurality of particles having a gradually increasing concentration;

10 FIG. 7c is a schematic illustration of the waveguide material in a preferred embodiment in which one layer thereof is formed with one or more diffractive optical elements for at least partially diffracting the light; and

FIG. 7d is a schematic illustration of the waveguide material in a preferred embodiment in which one or more regions have different indices of refraction so as to
15 prevent the light from being reflected.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present embodiments comprise an apparatus, device and system which can be used for providing illumination or displaying images. Specifically, the
20 embodiments can be used to provide light at any intensity profile and any color profile. The present embodiments are useful in many areas in which illumination is required, including, without limitation, display, signage and decoration applications.

The principles and operation of an apparatus, device and system according to the present invention may be better understood with reference to the drawings and
25 accompanying descriptions.

Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of the components set forth in the following description or illustrated in the drawings. The invention is capable of other
30 embodiments or of being practiced or carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein is for the purpose of description and should not be regarded as limiting.

WO 2006/131924

PCT/IL2006/000667

14

When a ray of light moves within a transparent substrate and strikes one of its internal surfaces at a certain angle, the ray of light can be either reflected from the surface or refracted out of the surface into the open air in contact with the substrate. The condition according to which the light is reflected or refracted is determined by

5 Snell's law, which is a mathematical relation between the impinging angle, the refracting angle (in case in case of refraction) and the refractive indices of both the substrate and the air. Broadly speaking, depending on the wavelength of the light, for a sufficiently large impinging angle (also known as the critical angle) no refraction can occur and the energy of the light is trapped within the substrate. In other words, the

10 light is reflected from the internal surface as if from a mirror. Under these conditions, total internal reflection is said to take place.

Many optical systems operate according to the total internal reflection phenomenon. One such optical system is the optical fiber. Optical fibers are transparent flexible rods of glass or plastic, basically composed of a core and cladding.

15 The core is the inner part of the fiber, through which light is guided, while the cladding surrounds it completely. The refractive index of the core is higher than that of the cladding, so that light in the core impinging the boundary with the cladding at a critical angle is confined in the core by total internal reflection.

As stated, total internal reflection occurs only for light rays impinging the

20 internal surface of the optical fiber with an angle which is larger than the critical angle. Thus, a calculation performed according to geometrical optics may provide the largest angle which is allowed for total internal reflection to take place. An important parameter of every optical fiber (or any other light transmitting optical system) is known as the "numerical aperture," which is defined as the sine of the largest incident

25 light ray angle that is successfully transmitted through the optical fiber, multiplied by the index of refraction of the medium from which the light ray enters the optical fiber.

Another optical system designed for guiding light is the graded-index optical fiber, in which the light ray is guided by refraction rather than by total internal reflection. In this optical fiber, the refractive index decreases gradually from the

30 center outwards along the radial direction, and finally drops to the same value as the cladding at the edge of the core. As the refractive index does not change abruptly at the boundary between the core and the cladding, there is no total internal reflection. However, although no total internal reflection takes place, the refraction bends the

WO 2006/131924

PCT/IL2006/000667

15

guided light rays back into the center of the core while the light passes through layers with lower refractive indexes.

Optical fibers are available in various lengths and core-diameters. For large core diameters, glass optical fibers are known to be more brittle and fragile than plastic optical fiber.

Another type of optical system is based on photonic materials, where the light ray is confined within a band gap material surrounding the light ray. In this type of optical system, also known as a photonic material waveguide, the light is confined in the vicinity of low-index region. One example of a photonic material waveguide is a silica fiber having an array of small air holes throughout its length. This configuration is capable of providing lossless light transmitting, *e.g.*, in either cylindrical or planar type waveguides.

The above description holds both for polarized and unpolarized light. When polarized light is used, an additional electromagnetic phenomenon influences the reflection of the light, as further explained hereinbelow.

Polarized light is produced when the direction of the electromagnetic fields in the plane perpendicular to the direction of propagation are constrained in some fashion. For the purpose of providing a simple explanation, only the electric field is discussed herein. A complementary explanation, regarding the magnetic field, can be easily obtained by one ordinarily skilled in the art by considering the magnetic field as being perpendicular to both the direction of propagation and the electric field.

The light is said to be elliptically polarized when two perpendicular components of the electric field have a constant phase difference, and the tip of the electric field vector traces out an ellipse in the plane perpendicular to the direction of propagation. Linearly polarized light is a special case of elliptically polarized light, where the two components oscillate in phase and the electric vector traces out a straight line.

Circularly polarized light is also a special case of elliptically polarized light in which the two components have a 90° phase difference and the electric field vector traces out a circle in the plane perpendicular to the direction of propagation. When viewed looking towards the source, a right circularly polarized beam at a fixed position as a function of time has a field vector that describes a clockwise circle, while

WO 2006/131924

PCT/IL2006/000667

16

left circularly polarized light has a field vector that describes a counter-clockwise circle.

When a polarized light strike a surface between two different materials, it is useful to define the polarization of the light relative to the surface, typically horizontal and vertical polarizations, with respect to the surface. When the light strikes a material having associated values of permeability, permittivity and conductivity, a portion of the energy carried by the light is lost due non-ideal conductivity of the material. The relative portion of the energy which is lost is defined as the reflection coefficient of the material. The reflective coefficient varies according to the angle of incidence, the polarization of the incoming wave, its frequency and the characteristics of the surface. For horizontal polarizations the coefficient may be generalized to a constant value, whereas for vertical polarizations however, the coefficient varies between 0 and 1.

When the reflective coefficient value goes to zero, the light is not reflected from the surface. This phenomenon is known as the Brewster effect, and the angle at which there is not reflection (for a particular polarization) is called the Brewster angle. This angle often referred to as the polarizing angle, since an unpolarized wave incident on an interface at this angle is reflected as a polarized wave with its electric vector being perpendicular to the plane of incidence.

The present embodiments successfully provide illumination apparatus which provides surface illumination at any brightness, intensity and color profile. As further detailed hereinunder, there is an additional physical phenomenon which may be exploited by the illumination apparatus of the present embodiments. This phenomenon is known as light scattering.

Unlike the above mention reflection, where radiation is deflected from the surface in one direction, some particles and molecules, also known as scatterers, have the ability to scatter radiation in more than one direction. Many types of scatterers are known. Broadly speaking, scatterers may be categorized into two groups: (i) selective scatterers, which are more effective at scattering a particular wavelength (*i.e.*, color), or a narrow range of wavelengths, of the light; and (ii) non-selective scatterers are capable of scattering light in a wide range of wavelengths.

WO 2006/131924

PCT/IL2006/000667

17

Referring now to the drawings, Figures 1a-b illustrate a perspective view (Figure 1a) and a section view along line A-A (Figure 1b) of an illumination apparatus 10, according to various exemplary embodiments of the present invention.

Apparatus 10 comprises one or more light emitting sources 12 embedded in a waveguide material 14 having a first surface 16 and a second surface 18. Waveguide material 14 is capable of propagating light generated by light source 12, such that at least a portion of the light is diffused within waveguide material 14 and exits through at least a portion of first surface 16.

The terms "light source" or "light emitting source", are used herein interchangeably and refer to any self light emitting element, including, without limitation, an inorganic light emitting diode, an organic light emitting diode or any other electroluminescent element. The term "light source" as used herein refers to one or more light sources.

As used herein, the term "organic" includes polymeric materials as well as small molecule organic materials that may be used to fabricate organic opto-electronic devices. "Small molecule" refers to any organic material that is not a polymer, and "small molecules" may actually be quite large. Small molecules may include repeat units in some circumstances. For example, using a long chain alkyl group as a substituent does not remove a molecule from the "small molecule" class. Small molecules may also be incorporated into polymers, for example as a pendent group on a polymer backbone or as a part of the backbone. Small molecules may also serve as the core moiety of a dendrimer, which consists of a series of chemical shells built on the core moiety. The core moiety of a dendrimer may be a fluorescent or phosphorescent small molecule emitter. A dendrimer may be a "small molecule," and it is believed that all dendrimers currently used in the field of OLEDs are small molecules.

Organic light emitting diodes suitable for the present embodiments can be bottom emitting OLEDs, top emitting OLEDs and side emitting OLEDs, having one or two transparent electrodes.

As used herein, "top" refers to furthest away from surface 18, while "bottom" refers to closest to surface 18.

The waveguide material according to embodiments of the present invention may be similar to, and/or be based on, the teachings of U.S. Patent Application Nos.

WO 2006/131924

PCT/IL2006/000667

18

11/157,190, 60/580,705 and 60/687,865, all assigned to the common assignee of the present invention and fully incorporated herein by reference. Alternatively, the waveguide material according to some embodiments of the present invention may also have other configurations and/or other methods of operation as further detailed
5 hereinunder.

Waveguide material 14 can be translucent or clear as desired. In any event, since waveguide material 14 propagates and emits the light emitted by light source 12, it is transparent at least to the characteristic emission spectrum of light source 12. The characteristic emission spectrum of the light source is also referred to herein as "the
10 color" of the light source. Thus, for example, a light emitting source characterized by a spectrum having an apex at a wavelength of from about 420 to about 500 nm, is referred to as a "blue light source", a light emitting source characterized by a spectrum having an apex at a wavelength of from about 520 to about 580 nm, is referred to as a
15 "green light source", a light emitting source characterized by a spectrum having an apex at a wavelength of about 620-680 nm, is referred to as a "red light source", and so on for other colors. This terminology is well-known to those skilled in the art of optics.

As used herein the term "about" refers to $\pm 10\%$.

Waveguide material 14 is optionally and preferably flexible, and may also have
20 a certain degree of elasticity. Thus, material 14 can be, for example, an elastomer. It is to be understood that although waveguide material appears to be flat in Figures 1a-b, this need not necessarily be the case since for some applications it may not be necessary for the illumination apparatus to be flat. Figure 1c schematically illustrates a perspective view of apparatus 10 in a preferred embodiment in which waveguide
25 material 14 is non-planar. Further, although apparatus 10 is shown as opaque from one direction, this is only for the clarity of presentation and need not necessarily be the case; the surfaces of apparatus 10 are not necessarily opaque.

According to a preferred embodiment of the present invention apparatus 10 comprises a reflecting surface 32 which prevents emission of light through surface 18
30 and therefore enhances emission of light through surface 16. Surface 32 can be made of any light reflecting material, and can be either embedded in or attached to waveguide material 14. Apparatus 10 can further comprise a printed circuit board (not

WO 2006/131924

PCT/IL2006/000667

19

shown, see reference numeral 26 in Figure 2b) which supplies the forward bias to the embedded light source.

There are several advantages for embedding the light source within the waveguide material. One advantage is that all the light emitted from the light source eventually arrives at the waveguide material. When the light source is externally coupled to the waveguide material, some of the light scatters at wide angle and does not impinge the waveguide material. Thus, the embedding of light source 12 in waveguide material 14 allows to efficiently collect the emitted light.

Another advantage is the optical coupling between the light source and the waveguide material in particular when the light source is a light emitting diode. When the diode is externally coupled to the waveguide material, the light emitted from the p-n junction should be transmitted out of the diode into the air, and subsequently from the air into the waveguide material. The mismatch of impedances in each such transition significantly reduces the coupling efficiency due to unavoidable reflections when the light passes from one medium to the other. On the other hand, when the diode is embedded in waveguide material, there is a direct transition of light from the diode to the waveguide material with higher overall transmission coefficient. To further improve the coupling efficiency, the waveguide material is preferably selected with a refraction index which is close to the refraction index of the diode. Typical difference in refraction indices is from about 1.5 to about 1.6.

Light source 12 can be a LED, which includes the bare die and all the additional components packed in the LED package, or, more preferably, light source 12 can include the bare die, excluding one or more of the other components (*e.g.*, reflecting cup, silicon, LED package and the like).

As used herein "bare die" refers to a p-n junction of a semiconductor material. When a forward biased is applied to the p-n junction through electrical contacts connected to the p side and the n side of the p-n junction, the p-n junction emits light at a characteristic spectrum.

Thus, in various exemplary embodiments of the invention light source 12 includes only the semiconductor p-n junction and the electrical contacts. Also contemplated are configurations in which several light sources are LEDs, and several light sources other are bare dies with electrical contacts connected thereto.

WO 2006/131924

PCT/IL2006/000667

20

The advantage of using a bare die rather than a LED is that some of the components in the LED package including the LED package absorb part of the light emitted from the p-n junction and therefore reduce the light yield.

Another advantage is that the use of bare die reduces the amount of heat generated during light emission. This is because heat is generated due to absorption of light by the LED package and reflecting cup. The consequent increase in temperature of the p-n junction causes thermal imbalance which is known to reduce the light yield. Since the bare die does not include the LED package and reflecting cup, the embedding of a bare die in the waveguide material reduces the overall amount of heat and increases the light yield. The elimination of the LED package permits the use of many small bare dies instead of each large packaged LED. Such configuration allows operating each bare die in low power while still producing sufficient overall amount of light, thereby to improving the p-n junction efficacy.

An additional advantage is light diffusion within the waveguide material. The minimization of redundant components in the vicinity of the p-n junction results in almost isotropic emission of light from the p-n junction which improves the diffusion of light. To further improve the coupling efficiency, the waveguide material is preferably selected with a refraction index which is close to the refraction index of the p-n junction.

Light source 12 can be embedded in the bulk of waveguide material 14 or near surface 18. Figure 2a is a fragmentary view schematically illustrating the embodiment in which light source 12 is embedded in the bulk of material 14 and Figure 2b is fragmentary view schematically illustrating the embodiment in which light source 12 is embedded near surface 18. It is to be understood that Figures 2a-b illustrate a single light source 12 for clarity of presentation and it is not intended to limit the scope of the present invention to such configuration. As stated, apparatus 10 can comprise one or more light emitting sources.

Referring to Figure 2a, when light source 12 is embedded in the bulk of the waveguide material, the electrical contacts 20 remain with material 14. In this embodiment, the forward bias can be supplied to light source 12 by electrical lines 22, such as flexible conductive wires, which are also embedded in material 14. Thus, lines 22 extend from contacts 20 to one or more ends 28 of waveguide material 14. Light source 12 including the electrical lines 22 can be embedded in material 14

WO 2006/131924

PCT/IL2006/000667

21

during the manufacturing process of the waveguide material. When a plurality of light sources are embedded in the waveguide material, they can be connected to an arrangement of electrical lines as known in the art and the entire of light sources and arrangement of electrical lines can be embedded in the material during the manufacturing process of the waveguide material.

In various exemplary embodiments of the invention light source 12 is operated with low power and therefore does not produce large amount of heat. This is due to the relatively large light yield of the embedded light source and the high optical coupling efficiency between the light source and the waveguide material. In particular, when light source 12 is a bare die, its light yield is significantly high while the produced heat is relatively low. Light source 12 can also be operated using pulsed electrical current which further reduces the amount of produced heat.

Preferably, but not obligatorily, light source 12 is encapsulated by a transparent thermal isolating encapsulation 24. Encapsulation 24 serves for thermally isolating the light source from material 14. This embodiment is particularly useful when light source 12 is a bare die, in which case the bare die radiate heat which may change the optical properties of material 14. Alternatively or additionally, waveguide material 14 can be made with high specific heat capacity to allow material 14 to receive heat from light source 12 with minimal or no undesired heating effects.

Referring to Figure 2b, when light source 12 is embedded near surface 18 of material 14, electrical contacts 20 can remain outside material 14 at surface 18 and can therefore be accessed without embedding electrical lines in material 14. The electrical contacts can be applied with forward bias using external electrical lines or directly from a printed circuit board 26. In this embodiment, board 26 can be made, at least in part, of heat conducting material so as to facilitate evacuation of heat away from light source 12. When the heat evacuation by board 26 is sufficient, light source 12 can be embedded without thermal isolating encapsulation 24.

As stated, waveguide material 14 is capable of propagating and diffusing the light until it exits through surface 16 or a portion thereof. It will be appreciated that this ability of the waveguide material, combined with the high light yield and efficient optical coupling between the embedded light sources and the waveguide material, provide apparatus 10 with properties suitable for many applications.

WO 2006/131924

PCT/IL2006/000667

22

As is further detailed hereinunder, there are many alternatives to construct the waveguide material, which provide flexibility in its design. In particular the waveguide material can be tailored according to the desired optical properties of the waveguide. Thus, the distribution of light sources within the waveguide material and/or the optical properties of the waveguide material can be selected to provide the most suitable illumination for the specific application for which apparatus **10** is used. More specifically apparatus **10** can provide illumination at a predetermined light profile, which is manifested by a predetermined intensity profile, predetermined brightness profile and predetermined color profile. Such illumination apparatus can therefore provide high light quality in terms of brightness, intensity and/or color profiles.

For example, light sources emitting different colors of light (*i.e.*, light sources having different characteristic emission spectra, which may or may not have spectral overlaps therebetween), say two, three or more different colors, can be distributed in the waveguide such that surface **16** emits light at a predetermined light profile. Additionally, the optical properties of the waveguide material can be made local and wavelength-dependent according to the predetermined light profile. More specifically, according to the presently preferred embodiment of the invention, different regions in the waveguide material have a different response to different light spectra.

In various exemplary embodiments of the invention apparatus **10** comprises one or more photoluminescent layers **30** coating surface **16** or a portion thereof. Photoluminescent layer **30** comprises a photoluminescent material which can be a phosphor or a fluorophore.

The term "photoluminescent layer" is commonly used herein to describe one photoluminescent layer or a plurality of photoluminescent layers. Additionally, a photoluminescent layer can comprise one or more types of photoluminescent molecules. In any event, a photoluminescent layer is characterized by an absorption spectrum (*i.e.*, a range of wavelengths of light which can be absorbed by the photoluminescent molecules to effect quantum transition to a higher energy level) and an emission spectrum (*i.e.*, a range of wavelengths of light which are emitted by the photoluminescent molecules as a result of quantum transition to a lower energy level). The emission spectrum of the photoluminescent layer is typically wider and shifted relative to its absorption spectrum. The difference in wavelength between the apex of

WO 2006/131924

PCT/IL2006/000667

23

the absorption and emission spectra of the photoluminescent layer is referred to as the Stokes shift of the photoluminescent layer.

The absorption spectrum of photoluminescent layer **30** preferably overlaps the emission spectrum of at least one of light sources **12**. More preferably, for each characteristic emission spectrum of an embedded light source, there is at least one photoluminescent layer having an absorption spectrum overlapping the emission spectrum the light source. According to a preferred embodiment of the present invention the apex of the light source's emission spectrum lies in the spectrum of the photoluminescent layer, and/or the apex of the photoluminescent layer's absorption spectrum lies in the spectrum of the light source.

Photoluminescent layer **30** serves for "converting" the wavelength of a portion of the light emitted by light sources **12**. More specifically, for each photon which is successfully absorbed by layer **30**, a new photon is emitted. Depending on the type of photoluminescent, the emitted photon can have a wavelength which is longer or shorter than the wavelength of the absorbed photon. Photons which do not interact with layer **30** propagate therethrough. The combination of converted light and non-converted light forms the light profile of apparatus **10**.

Phosphors are widely used for coating individual LEDs, typically in the white LEDs industry. However, photoluminescent layers covering an illuminating surface of a waveguide material such as the waveguide material of the present embodiments have not been employed. The advantage of using layer **30** over waveguide material **14**, as opposed to on each individual light emitting source **12**, is that waveguide material **14** first diffuses the light and thereafter emits it through surface **16**. Thus, instead of collecting light from a point light source (*e.g.*, a LED), layer **30** collects light from a surface light source having a predetermined area (surface **16** or a portion thereof). This configuration allows a better control on the light profile provided by apparatus **10**.

Many types of phosphorescent and fluorescent substance are contemplated. Representative examples include, without limitation the phosphors disclosed in U.S. Patents Nos. 5,813,752, 5,813,753, 5,847,507, 5,959,316, 6,155,699, 6,351,069, 6,501,100, 6,501,102, 6,522,065, 6,614,179, 6,621,211, 6,635,363, 6,635,987, 6,680,004, 6,765,237, 6,853,131, 6,890,234, 6,917,057, 6,939,481, 6,982,522, 7,015,510, 7,026,756 and 7,045,826 and 7,005,086.

WO 2006/131924

PCT/IL2006/000667

24

The various possible light profile options make the apparatus of the present embodiments suitable for providing illumination in many applications. Representative examples of uses of apparatus 10, including, without limitation, architectural highlighting, decorative lighting, medical lighting, signage for displaying commercial or decorative expressions, visual guidance (*e.g.*, landing strips, aisles), display, exhibit lighting, roadway lighting, automotive lighting and the like. The flexibility of the waveguide material makes apparatus 10 attachable to many surfaces, including, without limitation, walls of a building (either external or internal), windows, boxes (*e.g.*, jewelry boxes), toys and the like.

Although apparatus 10 can be designed to provide any light profile, for many applications it is desired to construct apparatus 10 to provide substantially uniform illumination. The apparatus of the present embodiments can provide illumination characterized by a uniformity of at least 70 %, more preferably at least 80 %, even more preferably at least 90 %. This is particularly useful when apparatus 10 is incorporated in a backlight unit of a passive display device.

White light illumination can be provided in more than one way. In one embodiment, the waveguide material is embedded with red light sources, green light sources, blue light sources and optionally light sources of other colors (*e.g.*, orange, yellow, green-yellow, cyan, amber, blue-violet) which are distributed such that the combination of red light, green light, blue light and optionally light in the other colors appears as a substantially uniform white light across the area of surface 16 or a portion thereof.

In another embodiment, layer 30 serves for complementing the light emitted by light sources 12 to a white light, *e.g.*, using dichromatic, trichromatic, tetrachromatic or multichromatic approach.

For example, a blue-yellow dichromatic approach can be employed, in which case blue light sources (*e.g.*, bare dies of InGaN with a peak emission wavelength at about 460 nm), can be distributed in waveguide material 14, and layer 30 can be made of phosphor molecules with absorption spectrum in the blue range and emission spectrum extending to the yellow range (*e.g.*, cerium activated yttrium aluminum garnet, or strontium silicate europium). Since the scattering angle of light sharply depends on the frequency of the light (fourth power dependence for Rayleigh scattering, or second power dependence for Mie scattering), the blue light generated

WO 2006/131924

PCT/IL2006/000667

25

by the blue light sources is efficiently diffused in the waveguide material and exits, substantially uniformly, through surface 16 into layer 30. Layer 30 which has no preferred directionality, emits light in its emission spectrum and complements the blue light which is not absorbed to white light.

5 In another dichromatic configurations, ultraviolet light sources (*e.g.*, bare dies of GaN, AlGaN and/or InGaN with a peak emission wavelength between 360 nm and 420 nm), can be distributed in waveguide material 14. Light of such ultraviolet light sources is efficiently diffused in the waveguide material and exits, substantially uniformly, through surface 16. To provide substantially white light, two
10 photoluminescent layers are preferably deposited on surface 16. One layer can be characterized by an absorption spectrum in the ultraviolet range and emission spectrum in the orange range (with peak emission wavelength from about 570 nm to about 620 nm), and another layer characterized by an absorption spectrum in the ultraviolet range and emission spectrum in the blue-green range (with peak emission
15 wavelength from about 480 nm to about 500 nm). The orange light and blue-green light emitted by the two photoluminescent layers blend to appear as white light to a human observer. Since the light emitted by the ultraviolet light sources is above or close to the end of visual range it is not seen by the human observer. The two photoluminescent layers are preferably deposited one on top of the other such as to
20 improve the uniformity. Alternatively, a single layer having two types of photoluminescent with the above emission spectra can be deposited.

In another embodiment a trichromatic approach is employed. For example, blue light sources can be distributed in the waveguide material as described above, with two photoluminescent layers deposited on surface 16. A first photoluminescent
25 layer can be made of phosphor molecules with absorption spectrum in the blue range and emission spectrum extending to the yellow range as described above, and a second photoluminescent layer absorption spectrum in the blue range and emission spectrum extending to the red range (*e.g.*, cerium activated yttrium aluminum garnet doped with a trivalent ion of praseodymium, or europium activated strontium sulphide). The
30 unabsorbed blue light, the yellow light and the red light blend to appear as white light to a human observer.

Also contemplated is a configuration in which light sources with different emission spectra are distributed and several photoluminescent layers are deposited,

WO 2006/131924

PCT/IL2006/000667

26

such that the absorption spectrum of each photoluminescent layer overlaps one of the emission spectra of the light sources, and all the emitted colors (of the light sources and the photoluminescent layers) blend to appear as white light. The advantage of such multi-chromatic configuration is that it provides high quality white balance because it allows better control on the various spectral components of the light in a local manner across the surface of the illumination apparatus.

The color composite of the white output light depends on the intensities and spectral distributions of the emanating light emissions. These depend on the spectral characteristics and spatial distribution of the light sources, and, in the embodiments in which one or more photoluminescent layers are employed, on the spectral characteristics of the photoluminescent layer(s) and the amount of unabsorbed light. The amount of light that is unabsorbed by the photoluminescent layer(s) is in turn a function of the thickness of the photoluminescent layer(s), the density of photoluminescent material(s) and the like. By judiciously selecting the emission spectra of light emitting source 12 and optionally the thickness, density, and spectral characteristics (absorption and emission spectra) of layer 30, apparatus 10 can be made to serve as an illumination surface (either planar or non planar, either stiff or flexible) which provides substantially uniform white light.

In any of the above embodiments, the "whiteness" of the light can be tailored according to the specific application for which apparatus 10 is used. For example, when apparatus 10 is incorporated for backlight of an LCD device, the spectral components of the light provided by apparatus 10 can be selected in accordance with the spectral characteristics of the color filters of the liquid crystal panel. In other words, since a typical liquid crystal panel comprises an arrangement of color filters operating at a plurality of distinct colors, the white light provided by apparatus 10 includes at least at the distinct colors of the filters. This configuration significantly improves the optical efficiency as well as the image quality provided by the LCD device, because the optical losses due to mismatch between the spectral components of the backlight unit and the color filters of the liquid crystal panel are reduced or eliminated.

Thus, in the embodiment in which the white light is achieved by light sources emitting different colors of light (e.g., red light, green light and blue light), the emission spectra of the light sources are preferably selected to substantially overlap

WO 2006/131924

PCT/IL2006/000667

27

the characteristic spectra of the color filters of the LCD panel. In the embodiment in which apparatus 10 is supplemented by one or more photoluminescent layers the emission spectra of the photoluminescent layers and optionally the emission spectrum or spectra of the light sources are preferably selected to overlap the characteristic spectra of the color filters of the LCD panel. Typically the overlap between a characteristic emission spectrum and a characteristic filter spectrum is about 70 % spectral overlap, more preferably about 80 % spectral overlap, even more preferably about 90 %.

Reference is now made to Figure 3 which is a section view along line A-A of Figure 1a, according to a preferred embodiment in which apparatus 10 comprises a structured film 34. Structured film 34 can be, for example, a brightness enhancement film and it can be deposited on or embedded in waveguide material 14. Film 34 collimates the light emitted from light sources 12 thereby increasing the brightness of the illumination provided by apparatus 10. This embodiment is particularly useful when apparatus 10 is used for backlight of an LCD device. The increased brightness enables a sharper image to be produced by the liquid crystal panel and allows operating the light sources at low power to produce a selected brightness. The structured film can operate according to principles and operation of prisms. Thus, light rays arriving the structured film at small angles relative to the normal to the structured film are reflected, while other light rays are refracted. The reflected light rays continue to propagate and diffuse in the waveguide material until they arrive at the structured film at a sufficiently large angle. In the embodiment in which apparatus 10 comprises the reflecting surface 32 it prevents the light which is reflected from film 34 to exit through surface 18. Structured films are known in the art and are found in the literature, see, e.g., International Patent Application Publication No. WO 96/023649.

Reference is now made to Figure 4 which is a fragmentary view schematically illustrating an embodiment in which apparatus 10 comprises one or more optical elements 36 embedded waveguide material 14 for enhancing the diffusion of light. One skilled in the art will recognize that several components of apparatus 10 have been omitted from Figure 4 for clarity of presentation. Element 36 can be embedded in material 14 near surface 16 or at any other location. The embedding of element near surface 16 is more and

WO 2006/131924

PCT/IL2006/000667

28

In various exemplary embodiments of the invention element 36 operates as an angle-selective light transmissive element. Specifically, element 36 is preferably configured to reflect light striking element 36 at a predetermined range of angles (say, $\pm 10^\circ$ from the normal to surface 16), and transmit light striking element 36 at other angles. Element 36 can be a mini prism, a structured surface similar to surface 34 above, a microlens and the like. Element 36 can be embedded in material 14 during the manufacturing process of material 14 in parallel to the embedding of light source 12 or any other component. The size of element 36 is selected to allow the collection of light rays at the predetermined range of angles and therefore depends on the distance between surface 16 and light source 12. Thus, in the embodiments in which light source 12 is embedded near surface 18, element 36 has larger size compared to its size in the embodiments in which light source 12 is embedded in the bulk of material 14.

Reference is now made to Figure 5 which is a block diagram schematically illustrating a liquid crystal display device 40, according to various exemplary embodiments of the present invention. Device 40 comprises a liquid crystal panel 42 and a backlight unit 44. Backlight unit 44 can be or it can comprise comprises illumination apparatus 10 as further detailed hereinabove. Several components of apparatus 10 have been omitted from Figure 5 for clarity of presentation, but one of ordinary skill in the art, provided with the details described herein would know how to construct apparatus 10 according to the various exemplary embodiments described above.

Panel 42 comprises a matrix of thin film transistors 46 fabricated on a substrate 48 of glass or another transparent material. A liquid crystal film 50 is disposed over substrate 48 and transistors 46. A polarizer 56 is disposed on a backside of substrate 48. Transistors 16 can be addressed by gate lines (not shown) deposited on the substrate 48 during the fabrication of transistors 16 as is well known in the art. Each particular transistor applied by voltage conducts electrical current and charges film 50 in its vicinity. The charging of the liquid crystal film alters the opacity of the film, and effects a local change in light transmission of the liquid crystal film 20. Hence, transistors 16 define display cells 52 (e.g., pixels) in liquid crystal film 50. Typically, the opacity of each display cells is charged to one of several discrete opacity levels to implement an intensity gray scale. Thus, the display

WO 2006/131924

PCT/IL2006/000667

29

cells serves as a gray scale picture elements. However, pixel opacity also can be controlled in a continuous analog fashion or a digital (on/off) fashion.

Color-selective filters **54** are distributed on cells **52** across the display area of panel **42** to produce a color display. Typically, but not obligatorily, there are three types of color filters (designated in Figure 5 by **54a**, **54b** and **54c**) where each filter allows transmission of one of the three primary additive colors red, green and blue. The schematic block diagram of Figure 5 illustrates a single three-component cell which includes a first component color (e.g., red output by cell **52** covered by filter **54a**), a second component color (e.g., green output by cell **52** covered by filter **54b**), and a third component color (e.g., blue output by the cell **52** covered by the filter **54c**) that are selectively combined or blended to generate a selected color.

In operation, backlight unit **44** produces a substantially uniform white illumination as detailed above, and polarizer **56** optimizes the light polarization with respect to polarization properties of liquid crystal film **20**. The opacity of the cells **52** is modulated using transistors **46** as detailed above to create a transmitted light intensity modulation across the area of device **40**. Color filters **54** colorize the intensity-modulated light emitted by the pixels to produce a color output. By selective opacity modulation of neighboring display cells **52** of the three color components, selected intensities of the three colors are blended together to selectively control color light output. As is known in the art, selective blending of three primary colors such as red, green, and blue can generally produce a full range of colors suitable for color display purposes. Spatial dithering is optionally and preferably used to provide further color blending across neighboring color pixels

Display device **40** can be incorporated in many applications. Representative examples include, without limitation, a portable computer system (e.g., a laptop), a computer monitor, a personal digital assistant system, a cellular communication system (e.g., a mobile telephone), a portable navigation system, a television system and the like.

Additional objects, advantages and features of the present embodiments will become apparent to one ordinarily skilled in the art upon examination of the following examples for constructing waveguide material **14**, which are not intended to be limiting. According to a preferred embodiment of the present invention waveguide material **14** comprises a polymeric material. The polymeric material may optionally

WO 2006/131924

PCT/IL2006/000667

30

comprise a rubbery or rubber-like material. According to a preferred embodiment of the present invention material 14 is formed by dip-molding in a dipping medium, for example, a hydrocarbon solvent in which a rubbery material is dissolved or dispersed. The polymeric material optionally and preferably has a predetermined level of cross-linking, which is preferably between particular limits. The cross-linking may optionally be physical cross-linking, chemical cross-linking, or a combination thereof. A non-limiting illustrative example of a chemically cross-linked polymer comprises cross-linked polyisoprene rubber. A non-limiting illustrative example of a physically cross-linked polymer comprises cross-linked comprises block co-polymers or segmented co-polymers, which may be cross-linked due to micro-phase separation for example. Material 14 is optionally cross-linked through application of a radiation, such as, but not limited to, electron beam radiation and electromagnetic radiation.

Although not limited to rubber itself, the material optionally and preferably has the physical characteristics of rubber, such as parameters relating to tensile strength and elasticity, which are well known in the art. For example, material 14 is preferably characterized by a tensile set value which is below 5 %. The tensile set value generally depends on the degree of cross-linking and is a measure of the ability of flexible material 14, after having been stretched either by inflation or by an externally applied force, to return to its original dimensions upon deflation or removal of the applied force.

The tensile set value can be determined, for example, by placing two reference marks on a strip of material 14 and noting the distance between them along the strip, stretching the strip to a certain degree, for example, by increasing its elongation to 90 % of its expected ultimate elongation, holding the stretch for a certain period of time, *e.g.*, one minute, then releasing the strip and allowing it to return to its relaxed length, and re-measuring the distance between the two reference marks. The tensile set value is then determined by comparing the measurements before and after the stretch, subtracting one from the other, and dividing the difference by the measurement taken before the stretch. In a preferred embodiment, using a stretch of 90% of its expected ultimate elongation and a holding time of one minute, the preferred tensile set value is less than 5%. Also contemplated are materials having about 30 % plastic elongation and less than 5 % elastic elongation.

WO 2006/131924

PCT/IL2006/000667

31

The propagation and diffusion of light through material 14 can be done in any way known in the art, such as, but not limited to, total internal reflection, graded refractive index and band gap optics. Additionally, polarized light may be used, in which case the propagation of the light can be facilitated by virtue of the reflective coefficient of material 14. For example, a portion of material 14 can be made of a dielectric material having a sufficient reflective coefficient, so as to trap the light within at least a predetermined region.

In any event, material 14 is preferably designed and constructed such that at least a portion of the light propagates therethrough at a plurality of directions, so as to allow the diffusion of the light in material 14 and the emission of the light through more than one point in surface 16.

Reference is now made to Figures 6a-b, which illustrates material 14 in an embodiment in which total internal reflection is employed. In this embodiment material 14 comprises a first layer 62 and a second layer 64. Preferably, the refractive index of layer 66, designated in Figures 6a-b by n_1 , is smaller than the refractive index, n_2 , of layer 64. In such configuration, when the light, shown generally at 58, impinges on internal surface 65 of layer 64 at an impinging angle, θ , which is larger than the critical angle, $\theta_c \equiv \sin^{-1}(n_1/n_2)$, the light energy is trapped within layer 64, and the light propagates therethrough in a predetermined propagation angle, α . Figures 6b-c, schematically illustrate embodiments in which material 14 has three layers, 62, 64 and 66, where layer 64 is interposed between layer 62 and layer 66. In this embodiment, the refractive index of layers 62 and 64 is smaller than the refractive index of layer 66. As shown, light source 12 can be embedded in layer 64 (see Figure 6b) or it can be embedded in a manner such that it extends over two layers (e.g., layers 62 and 64 see Figure 6c).

The light may also propagate through waveguide material 14 when the impinging angle is smaller than the critical angle, in which case one portion of the light is emitted and the other portion thereof continue to propagate. This is the case when material 14 comprises dielectric or metallic materials, where the reflective coefficient depends on the impinging angle, θ .

The propagation angle, α , is approximately $\pm(\pi/2 - \theta)$, in radians. α depends on the ratio between the indices of refraction of the layers. Specifically, when n_2 is much larger than n_1 , α is large, whereas when the ratio n_2/n_1 is close to, but above, unity, α

WO 2006/131924

PCT/IL2006/000667

32

is small. According to a preferred embodiment of the present invention the thickness of the layers of material 14 and the indices of refraction are selected such that the light propagates in a predetermined propagation angle. A typical thickness of each layer is from about 10 μm to about 3 mm, more preferably from about 50 μm to about 500 μm , most preferably from about 100 μm to about 200 μm . The overall thickness of material 14 depends on the height of light source 12. For example, when light source 12 is a LED device of size 0.6 mm (including the LED package), the height of material 14 is preferably from about 0.65 mm to about 0.8 mm. When light source 12 is a bare die of size 0.1 mm, the height of material 14 is preferably from about 0.15 mm to about 0.2 mm.

The difference between the indices of refraction of the layers is preferably selected in accordance with the desired propagation angle of the light. According to a preferred embodiment of the present invention, the indices of refraction are selected such that propagation angle is from about 2 degrees to about 15 degrees. For example, layer 64 may be made of poly(cis-isoprene), having a refractive index of about 1.52, and layers 62 and 66 may be made of Poly(dimethyl siloxane) having a refractive index of about 1.45, so that $\Delta n \equiv n_2 - n_1 \approx 0.07$ and $n_2/n_1 \approx 0.953$ corresponding to a propagation angle of about ± 19 degrees.

The emission of the light from surface 16 of material 14 may be achieved in more than one way. Broadly speaking, one or more of the layers of waveguide material 14 preferably comprises at least one additional component 71 (not shown, see Figures 7a-d) designed and configured so as to allow the emission of the light through the surface. Following are several examples for the implementation of component 71, which are not intended to be limiting.

Referring to Figure 7a, in one embodiment, component 71 is implemented as at least one impurity 70, present in second layer 64 and capable of emitting light, so as to change the propagation angle of the light. Impurity 70 may serve as a scatterer, which, as stated, can scatter radiation in more than one direction. When the light is scattered by impurity 70 in such a direction that the impinging angle, θ , which is below the aforementioned critical angle, θ_c , no total internal reflection occurs and the scattered light is emitted through surface 16. According to a preferred embodiment of the present invention the concentration and distribution of impurity 70 is selected such that the scattered light is emitted from a predetermined region of surface 16. More

WO 2006/131924

PCT/IL2006/000667

33

specifically, in regions of waveguide material 14 where larger portion of the propagated light is to be emitted through the surface, the concentration of impurity 70 is preferably large, while in regions where a small portion of the light is to be emitted the concentration of impurity 70 is preferably smaller.

5 As will be appreciated by one ordinarily skilled in the art, the energy trapped in waveguide material 14 decreases each time a light ray is emitted through surface 16. On the other hand, it is often desired to use material 14 to provide a uniform surface illumination. Thus, as the overall amount of energy decreases with each emission, a uniform surface illumination can be achieved by gradually increasing the ratio
10 between the emitted light and the propagated light. According to a preferred embodiment of the present invention, the increasing emitted/propagated ratio is achieved by an appropriate selection of the distribution of impurity 70 in layer 64. More specifically, the concentration of impurity 70 is preferably an increasing function of the optical distance which the propagated light travels.

15 Optionally, impurity 70 may comprise any object that scatters light and which is incorporated into the material, including but not limited to, beads, air bubbles, glass beads or other ceramic particles, rubber particles, silica particles and so forth, any of which may optionally be fluorescent particles or biological particles, such as, but not limited to, Lipids.

20 Figure 7b further details the presently preferred embodiment of the invention. In Figure 7b, impurity 70 is optionally and preferably implemented as a plurality of particles 42, distributed in an increasing concentration so as to provide a light gradient. Particles 42 are preferably organized so as to cause light to be transmitted with substantially lowered losses through scattering of the light. Particles 42 may
25 optionally be implemented as a plurality of bubbles in a solid plastic portion, such as a tube for example. According to a preferred embodiment of the present invention the size of particles 42 is selected so as to selectively scatter a predetermined range of wavelengths of the light. More specifically small particles scatter small wavelengths and large particles scatter both small and large wavelengths.

30 Particles 42 may also optionally act as filters, for example for filtering out particular wavelengths of light. Preferably, different types of particles 42 are used at different locations in waveguide material 14. For example, particles 42 which are specific to scattering of a particular spectrum may preferably be used within

WO 2006/131924

PCT/IL2006/000667

34

waveguide material **14**, at locations where such particular wavelength is to be emitted from waveguide material **14** to provide illumination.

According to a preferred embodiment of the present invention impurity **70** is capable of producing different optical responses to different wavelengths of the light.

5 The difference optical responses can be realized as different emission angles, different emission wavelengths and the like. For example, different emission wavelengths may be achieved by implementing impurity **70** as beads each having predetermined combination of color-components, *e.g.*, a predetermined combination of fluorophore molecules.

10 When a fluorophore molecule embedded in a bead absorbs light, electrons are boosted to a higher energy shell of an unstable excited state. During the lifetime of excited state (typically 1–10 nanoseconds) the fluorochrome molecule undergoes conformational changes and is also subject to a multitude of possible interactions with its molecular environment. The energy of excited state is partially dissipated, yielding
15 a relaxed singlet excited state from which the excited electrons fall back to their stable ground state, emitting light of a specific wavelength. The emission spectrum is shifted towards a longer wavelength than its absorption spectrum. The difference in wavelength between the apex of the absorption and emission spectra of a fluorochrome (also referred to as the Stokes shift), is typically small.

20 Thus, in this embodiment, the wavelength (color) of the emitted light is controlled by the type(s) of fluorophore molecules embedded in the beads. Other objects having similar or other light emission properties may be also be used. Representative examples include, without limitation, fluorochromes, chromogenes, quantum dots, nanocrystals, nanoprisms, nanobarcodes, scattering metallic objects,
25 resonance light scattering objects and solid prisms.

Referring to Figure 7c, in another embodiment, component **71** is implemented as one or more diffractive optical elements **72** formed with layer **64**, for at least partially diffracting the light. Thus, the propagated light reaches optical element **72** where a portion of the light energy is coupled out of material **14**, while the remnant
30 energy is redirected through an angle, which causes it to continue its propagation through layer **64**. Optical element **70** may be realized in many ways, including, without limitation, non-smooth surfaces of layer **64**, a mini-prism or grating formed on internal surface **65** and/or external surface **67** of layer **64**. Diffraction Gratings are

WO 2006/131924

PCT/IL2006/000667

35

known to allow both redirection and transmission of light. The angle of redirection is determined by an appropriate choice of the period of the diffraction grating often called "the grating function." Furthermore, the diffraction efficiency controls the energy fraction that is transmitted at each strike of light on the grating. Hence, the diffraction efficiency may be predetermined so as to achieve an output having predefined light intensities; in particular, the diffraction efficiency may vary locally for providing substantially uniform light intensities. Optical element 70 may also be selected such that the scattered light has a predetermined wavelength. For example, in the embodiment in which optical element 70 is a diffraction grating, the grating function may be selected to allow diffraction of a predetermined range of wavelengths.

Referring to Figure 7d, in an additional embodiment, one or more regions 74 of layer 62 and/or 66 may have different indices of refraction so as to prevent the light from being reflected from internal surface 65 of second layer 64. For example, denoting the index of refraction of region 74 by n_3 , a skilled artisan would appreciate that when $n_3 > n_2$, no total internal reflection can take place, because the critical angle, θ_c , is only defined when the ratio n_3/n_2 does not exceed the value of 1. The advantage of this embodiment is that the emission of the light through surface 16 is independent on the wavelength of the light.

As stated, flexible material 14 preferably comprises polymeric material. The polymeric material may optionally comprise natural rubber, a synthetic rubber or a combination thereof. Examples of synthetic rubbers, particularly those which are suitable for medical articles and devices, are taught in US Patent No. 6,329,444, hereby incorporated by reference as if fully set forth herein with regard to such illustrative, non-limiting examples. The synthetic rubber in this patent is prepared from cis-1,4-polyisoprene, although of course other synthetic rubbers could optionally be used. Natural rubber may optionally be obtained from *Hevea brasiliensis* or any other suitable species.

Other exemplary materials, which may optionally be used alone or in combination with each other, or with one or more of the above rubber materials, include but are not limited to, crosslinked polymers such as : polyolefins, including but not limited to, polyisoprene, polybutadiene, ethylene-propylene copolymers, chlorinated olefins such as polychloroprene (neoprene) block copolymers, including diblock-, triblock-, multiblock- or star-block-, such as: styrene-butadiene-styrene

WO 2006/131924

PCT/IL2006/000667

36

copolymers, or styrene-isoprene-styrene copolymers (preferably with styrene content from about 1% to about 37 %), segmented copolymers such as polyurethanes, polyether-urethanes, segmented polyether copolymers, silicone polymers, including copolymers, and fluorinated polymers and copolymers.

5 For example, optionally and preferably, the second layer comprises polyisoprene, while the first layer optionally and preferably comprises silicone. If a third layer is present, it also optionally and preferably comprises silicone.

According to an optional embodiment of the present invention, the flexible material is formed by dip-molding in a dipping medium. Optionally, the dipping
10 medium comprises a hydrocarbon solvent in which a rubbery material is dissolved or dispersed. Also optionally, the dipping medium may comprise one or more additives selected from the group consisting of cure accelerators, sensitizers, activators, emulsifying agents, cross-linking agents, plasticizers, antioxidants and reinforcing agents.

15

It is expected that during the life of this patent many relevant wave guiding techniques will be developed and the scope of the term waveguide material is intended to include all such new technologies *a priori*.

20

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination.

25

Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad
30 scope of the appended claims. All publications, patents and patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated herein

WO 2006/131924

PCT/IL2006/000667

37

by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present invention.

WO 2006/131924

PCT/IL2006/000667

38

WHAT IS CLAIMED IS:

1. An illumination apparatus, comprising at least one light emitting source embedded in a waveguide material having a first surface and a second surface, said waveguide material being capable of propagating light generated by said at least one light emitting source, such that at least a portion of said light is diffused within said waveguide material and exits through at least a portion of said first surface.
2. A method of providing illumination, comprising applying forward bias on at least one light emitting source embedded in a waveguide material having a first surface and a second surface to effect emission of light from said at least one light emitting source, wherein said waveguide material is capable of propagating said light such that at least a portion of said light is diffused within said waveguide material and exits through at least a portion of said first surface, thereby providing the illumination.
3. A liquid crystal display device, comprising a liquid crystal panel and a backlight unit, wherein said backlight unit comprises the apparatus of claim 1.
4. A portable computer system comprising the liquid crystal display device of claim 3.
5. A computer monitor comprising the liquid crystal display device of claim 3.
6. A personal digital assistant system comprising the liquid crystal display device of claim 3.
7. A cellular communication system comprising the liquid crystal display device of claim 3.
8. A television system comprising the liquid crystal display device of claim 3.

WO 2006/131924

PCT/IL2006/000667

39

9. A signage panel for producing a signage under electronic control, comprising a power source connected to the apparatus of claim 1.

10. The apparatus, method or device of claim 1, 2 or 3, wherein said waveguide material is flexible.

11. The apparatus, method or device of claim 1, 2 or 3, wherein said at least one light emitting source comprises at least one bare die and electrical contacts connected thereto.

12. The apparatus, method or device of claim 1, 2 or 3, wherein said at least one light emitting source is encapsulated by a transparent thermal isolating encapsulation.

13. The apparatus, method or device of claim 1, 2 or 3, wherein said at least one light emitting source is embedded near said second surface of said waveguide material.

14. The apparatus, method or device of claim 13, wherein said at least one light emitting source is embedded near said second surface in a manner such that electrical contacts of said at least one light emitting source remain outside said waveguide material at said second surface.

15. The apparatus, method or device of claim 14, wherein the illumination apparatus further comprises a printed circuit board electrically connected to said electrical contacts.

16. The apparatus, method or device of claim 15, wherein said printed circuit board is capable of evacuating heat away from said at least one light emitting source.

17. The apparatus, method or device of claim 1, 2 or 3, wherein said at least one light emitting source is embedded in the bulk of said waveguide material.

WO 2006/131924

PCT/IL2006/000667

40

18. The apparatus, method or device of claim 17, wherein the illumination apparatus further comprises an arrangement of electrical lines extending from said at least one light emitting source to at least one end of said waveguide material.

19. The apparatus, method or device of claim 1, 2 or 3, wherein said at least one light emitting source comprises at least one source configured to emit light at a first color, and at least one source configured to emit light at a second color.

20. The device of claim 3, wherein said liquid crystal panel comprises an arrangement of color filters operating at a plurality of distinct colors, and said at least one light emitting source comprises, for each color of said plurality of distinct colors, at least one source configured to emit light at said color.

21. The apparatus or device of claim 1 or 3, wherein the illumination apparatus further comprises a reflecting surface embedded in or attached to said waveguide material in a manner such that emission of light through said second surface is prevented and emission of light through said first surface is enhanced.

22. The apparatus or device of claim 1 or 3, wherein the illumination apparatus further comprises at least one photoluminescent layer coating at least said portion of said first surface.

23. The apparatus or device of claim 22, wherein said at least one photoluminescent layer and said at least one light emitting source are selected such the illumination apparatus provides substantially white light.

24. The device of claim 22, wherein said liquid crystal panel comprises an arrangement of color filters operating at a plurality of distinct colors, wherein said at least one photoluminescent layer and said at least one light emitting source are selected such the illumination apparatus provides light at least at said a plurality of distinct colors.

WO 2006/131924

PCT/IL2006/000667

41

25. The apparatus or device of claim 23, wherein said at least one photoluminescent layer comprises a plurality of photoluminescent layers, each being characterized by a different absorption spectrum, and said at least one light emitting source comprises, for each absorption spectrum, at least one light emitting source characterized by an emission spectrum overlapping said absorption spectrum.

26. The apparatus or device of claim 1 or 3, wherein the illumination apparatus further comprises a structured film deposited on or embedded in said waveguide material.

27. The apparatus or device of claim 1 or 3, wherein the illumination apparatus further comprises at least one optical element embedded in said waveguide material for enhancing diffusion of light within said waveguide material.

28. The apparatus or device of claim 27, wherein said at least one optical element is embedded in said waveguide material near said first surface and configured to reflect light striking said at least one optical element at a predetermined range of angles, and transmit light striking said at least one optical element at other angles.

29. The apparatus or device of claim 27, wherein said at least one optical element comprises at least one microlens.

30. The apparatus, method or device of claim 1, 2 or 3, wherein said waveguide material comprises a polymeric material.

31. The apparatus, method or device of claim 1, 2 or 3, wherein said waveguide material comprises a rubbery material.

32. The apparatus, method or device of claim 1, 2 or 3, wherein said waveguide material is formed by dip-molding in a dipping medium.

WO 2006/131924

PCT/IL2006/000667

42

33. The apparatus, method or device of claim 32, wherein said dipping medium comprises a hydrocarbon solvent in which a rubbery material is dissolved or dispersed.

34. The apparatus or device of claim 32 or 33, wherein said dipping medium comprises additives selected from the group consisting of cure accelerators, sensitizers, activators, emulsifying agents, cross-linking agents, plasticizers, antioxidants and reinforcing agents

35. The apparatus, method or device of claim 1, 2 or 3, wherein said waveguide material comprises a dielectric material, and wherein a reflection coefficient of said dielectric material is selected so as to allow propagation of polarized light through said waveguide material and emission of said polarized light through said first surface.

36. The apparatus, method or device of claim 1, 2 or 3, wherein said waveguide material comprises a metallic material, and wherein a reflection coefficient of said metallic material is selected so as to allow propagation of polarized light through said waveguide material and emission of said polarized light through said first surface.

37. The apparatus, method or device of claim 1, 2 or 3, wherein said waveguide material is a multilayered material.

38. The apparatus, method or device of claim 1, 2 or 3, wherein said waveguide material comprises a first layer having a first refractive index, and a second layer being in contact with said first layer and having a second refractive index being larger than said first refractive index.

39. The apparatus, method or device of claim 38, wherein said second layer comprises polyisoprene.

WO 2006/131924

PCT/IL2006/000667

43

40. The apparatus, method or device of claim 38, wherein said first layer comprises silicone.

41. The apparatus, method or device of claim 38, wherein said waveguide material further comprises a third layer being in contact with said second layer and having a third refractive index being smaller than said second refractive index.

42. The apparatus, method or device of claim 41, wherein said third refractive index equals said first refractive index.

43. The apparatus, method or device of claim 37, wherein at least one layer of waveguide material comprises at least one additional component designed and configured such as to allow said emission of the light through said at least a portion of said surface.

44. The apparatus, method or device of claim 43, wherein said at least one additional component is capable of producing different optical responses to different spectra of said light.

45. The apparatus, method or device of claim 44, wherein said different optical responses comprise different emission angles.

46. The apparatus, method or device of claim 45, wherein said different optical responses comprise different emission spectra.

47. The apparatus, method or device of claim 43, wherein said at least one additional component comprises at least one impurity capable of emitting at least said portion of said light through said first surface.

48. The apparatus, method or device of claim 47, wherein said at least one impurity comprises a plurality of particles capable of scattering said light.

WO 2006/131924

PCT/IL2006/000667

44

49. The apparatus, method or device of claim 48, wherein a size of said plurality of particles is selected so as to selectively scatter a predetermined spectrum of said light.

WO 2006/131924

PCT/IL2006/000667

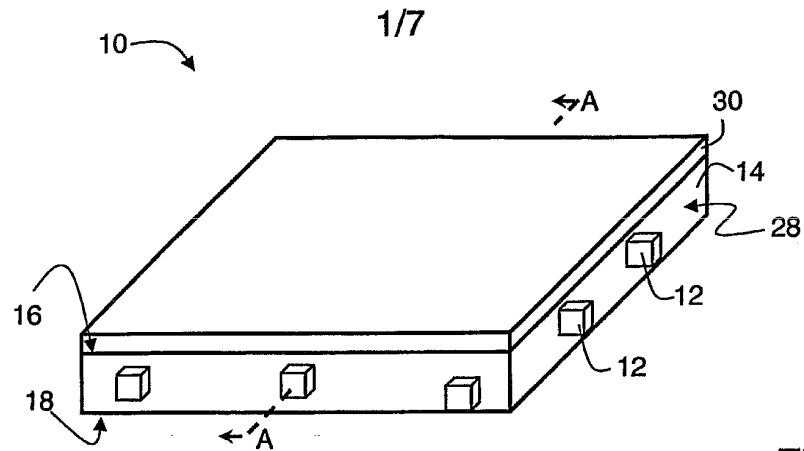


Fig. 1a

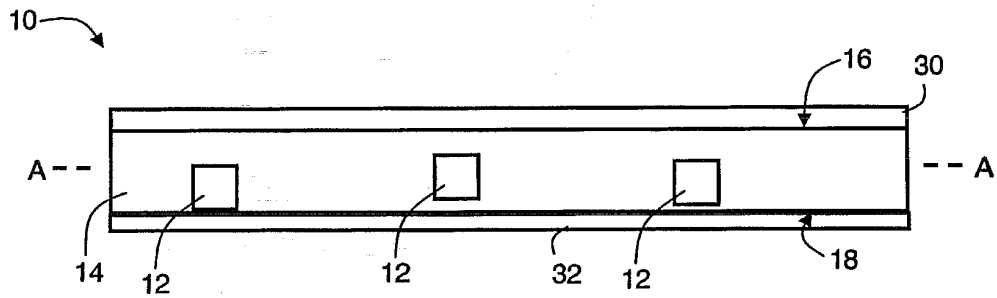


Fig. 1b

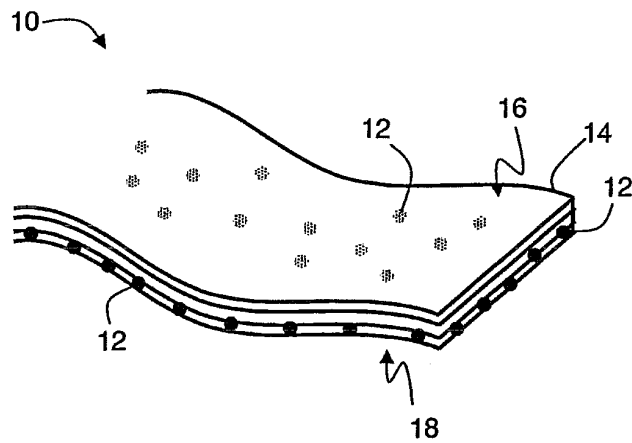


Fig. 1c

WO 2006/131924

PCT/IL2006/000667

2/7

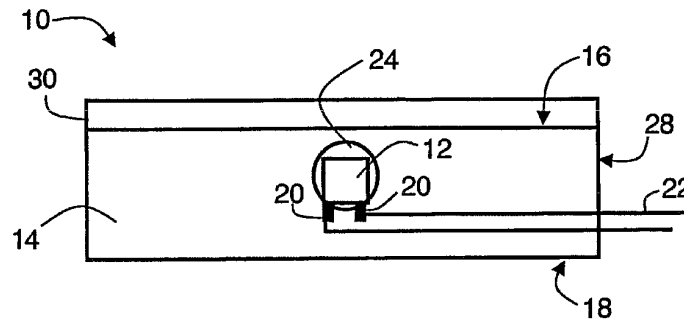


Fig. 2a

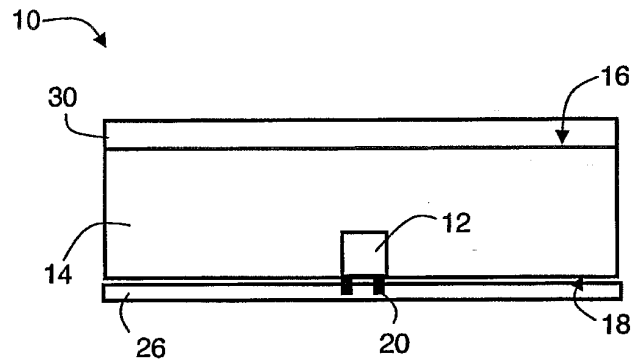


Fig. 2b

WO 2006/131924

PCT/IL2006/000667

3/7

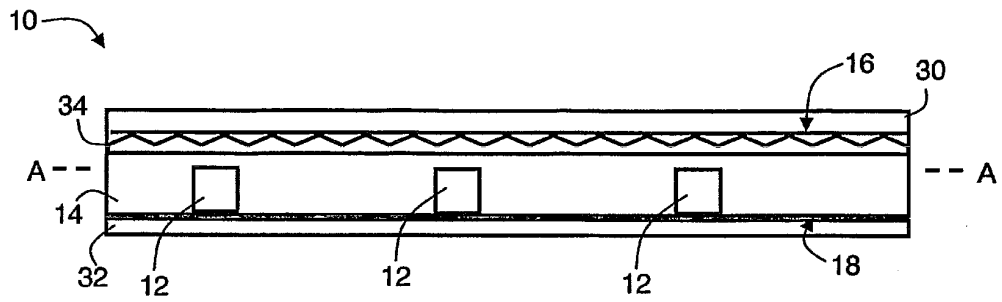


Fig. 3

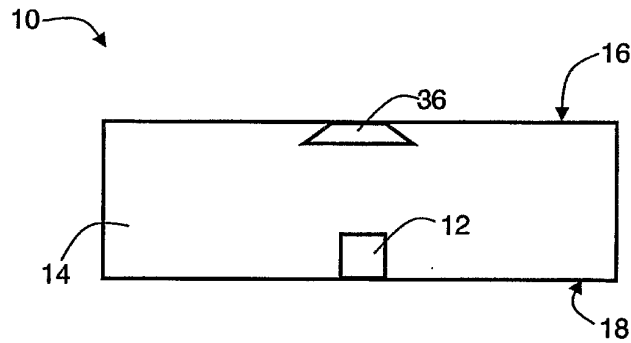


Fig. 4

WO 2006/131924

PCT/IL2006/000667

4/7

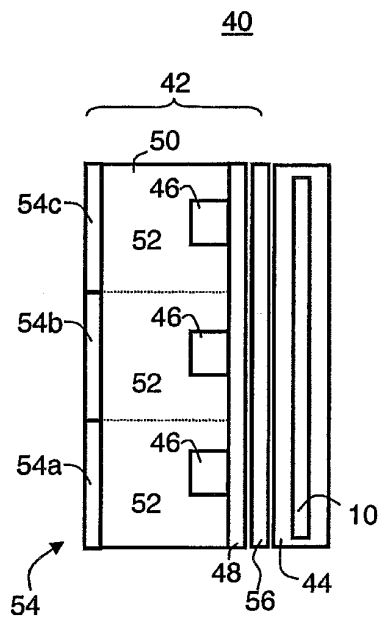


Fig. 5

WO 2006/131924

PCT/IL2006/000667

Fig. 6a

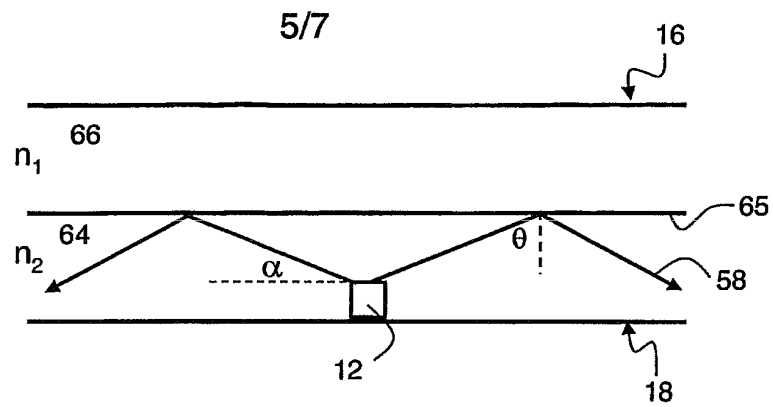


Fig. 6b

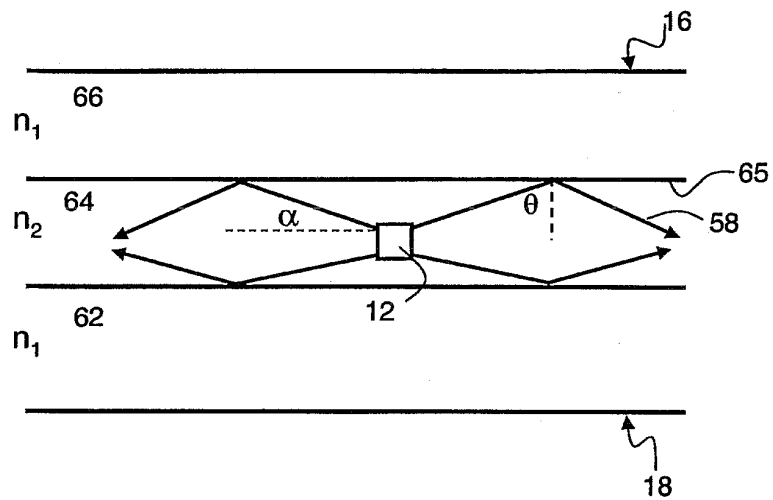
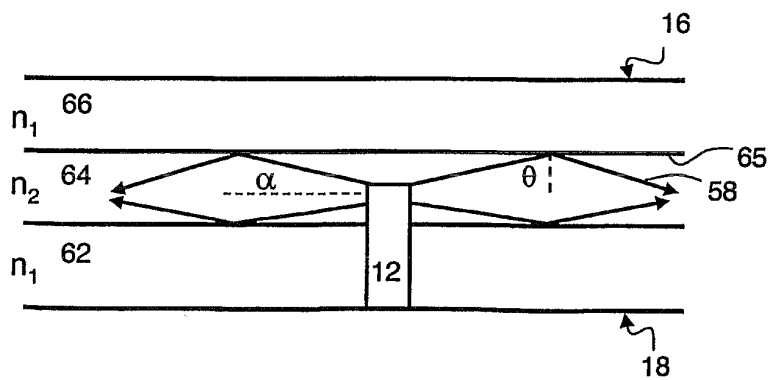


Fig. 6c



WO 2006/131924

PCT/IL2006/000667

6/7

Fig. 7a

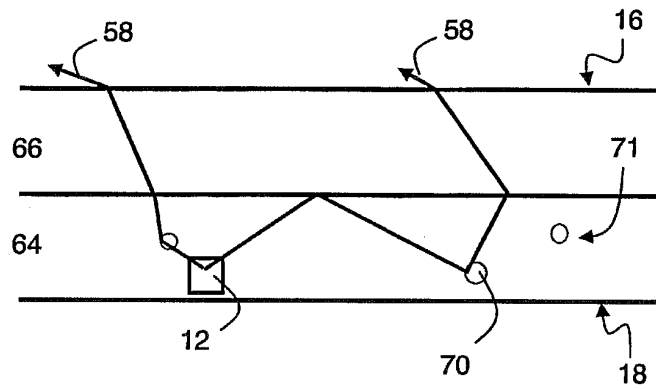
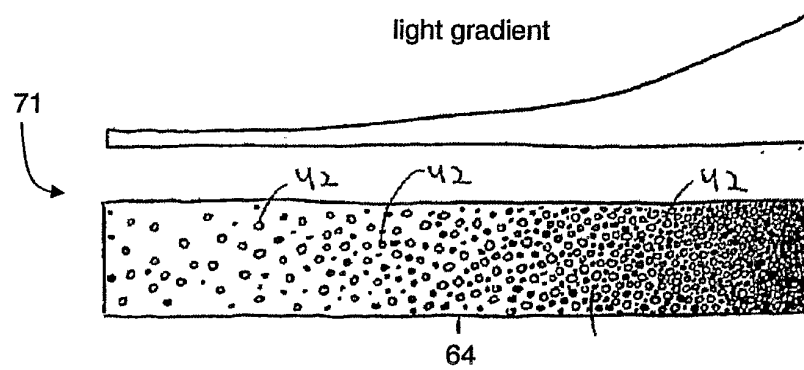


Fig. 7b



WO 2006/131924

PCT/IL2006/000667

7/7

Fig. 7c

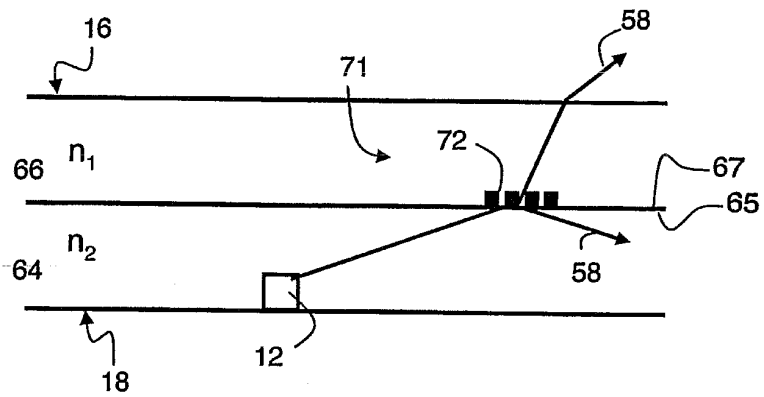
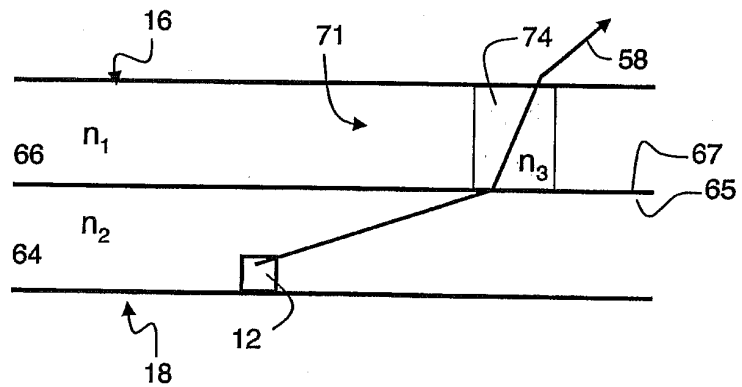


Fig. 7d



LIGHT EMITTING DEVICE, LIGHTING SYSTEM, ELECTROOPTICAL DEVICE AND ELECTRONIC APPARATUS

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Inventor(s): KAWAKAMI HISATOKU +

Applicant(s): EPSON IMAGING DEVICES CORP +

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- European:

Application number: JP20050302738 20051018

Priority number(s): JP20050269660 20050916; JP20050302738 20051018

Abstract of JP 2007109616 (A)

PROBLEM TO BE SOLVED: To provide a lighting system capable of easily adjusting white balance of white light. ; **SOLUTION:** This lighting system is provided with a light emitting device having a first light emitting means, a second light emitting means and a blue light wavelength conversion means. The first light emitting means is a blue LED 24a and emits first blue light having a predetermined wavelength at a peak. The second light emitting means is a blue LED 24b and emits second blue light having a wavelength at a peak different from the predetermined wavelength. The blue light wavelength conversion means is a YAG (yttrium-aluminum-garnet)-based phosphor 23 and converts a part of the first and second blue light rays to yellow light. The lighting system is adjusted to predetermined chromaticity by adjusting both brightness values of the first and second blue light rays.; Thereby, the value of the Y-axis of an xy chromaticity diagram of white light emitted by the lighting system can be changed only by using the light emitting means emitting blue light, and white light adjusted to predetermined white light chromaticity can be emitted. ; COPYRIGHT: (C)2007,JPO&INPIT

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H O 1 L 33/00 (2006.01)	H O 1 L 33/00 L	5 F O 4 1
G O 2 F 1/13357 (2006.01)	G O 2 F 1/13357	
F 2 1 Y 101/02 (2006.01)	H O 1 L 33/00 N	
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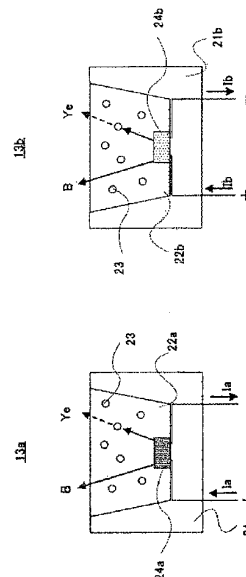
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(33) 優先権主張国	日本国 (JP)	(72) 発明者	川上 久徳 東京都港区浜松町二丁目4番1号 三洋エ プソンイメージングデバイス株式会社内
		Fターム (参考)	2H091 FA02Y FA14Z FA23Z FA43Z FA44Z FA45Z FD22 FD24 GA13 KA10 LA15 最終頁に続く

(54) 【発明の名称】 発光装置、照明装置、電気光学装置及び電子機器

(57) 【要約】

【課題】 白色光のホワイトバランスの調整を容易に行うことのできる照明装置を提供する。

【解決手段】 照明装置は、第1の発光手段と、第2の発光手段と、青色光波長変換手段とを有する発光装置を備える。第1の発光手段は、青色LED 24aであり、所定の波長をピークに持つ第1の青色光を発光する。第2の発光手段は、青色LED 24bであり、所定の波長と異なる波長をピークに持つ第2の青色光を発光する。青色光波長変換手段は、YAG (イットリウム・アルミニウム・ガーネット) 系蛍光体 23であり、第1及び第2の青色光の一部を黄色光に変換する。第1および第2の青色光の光度の両方が調整されることによって、所定の色度に調整されている。これにより、青色光を発光する発光手段のみを用いて、照明装置より発光される白色光のx y色度図のY軸の値を変えることができ



【特許請求の範囲】

【請求項1】

発光装置を備える照明装置であって、
前記発光装置は、
所定の波長をピークに持つ第1の青色光を発光する第1の発光手段と、
前記所定の波長と異なる波長をピークに持つ第2の青色光を発光する第2の発光手段と

、
前記第1の青色光の一部及び前記第2の青色光の一部を黄色光に変換する青色光波長変換手段と、を備え、

前記第1の青色光と前記第2の青色光と前記黄色光の合成光たる白色光が、所定の色度となるように、前記第1の青色光の光度と前記第2の青色光の光度の両方が調整されてなることを特徴とする照明装置。

【請求項2】

前記第1の青色光のピークとなる波長は、前記第2の青色光のピークとなる波長と10nm以上の差を有することを特徴とする請求項1に記載の照明装置。

【請求項3】

前記第1の青色光及び前記第2の青色光は、波長430nm～480nmの範囲内の波長をピークに持つことを特徴とする請求項1又は2に記載の照明装置。

【請求項4】

請求項1乃至3のいずれか一項に記載の照明装置と、
前記照明装置によって照明されてなる表示パネルと、を有することを特徴とする電気光学装置。

【請求項5】

所定の波長をピークに持つ第1の青色光を発光する第1の発光手段と、
前記所定の波長と異なる波長をピークに持つ第2の青色光を発光する第2の発光手段と

、
前記第1の青色光の一部及び前記第2の青色光の一部を黄色光に変換する青色光波長変換手段と、を備え、

前記第1の青色光と前記第2の青色光と前記黄色光の合成光たる白色光が、所定の色度となるように、前記第1の青色光の光度と前記第2の青色光の光度の両方が調整されてなる照明装置と、

前記照明装置から出射された光が入射する複数の表示画素を備えた表示パネルと、を有し、

前記表示パネルの1つの表示画素は、複数のサブ画素を備え、前記サブ画素には、波長に応じて色相が変化する可視光領域のうち、青系の色相の着色領域、赤系の色相の着色領域、青から黄までの色相の中で選択された2種の色相の着色領域からなる4種の着色領域のうちのいずれかを備えることを特徴とする電気光学装置。

【請求項6】

青から黄までの色相の中で選択された前記2種の色相の着色領域の一方の着色領域が青から緑の色相であることを特徴とする請求項5に記載の電気光学装置。

【請求項7】

青から黄までの色相の中で選択された前記2種の色相の着色領域の他方の着色領域が緑から橙の色相であることを特徴とする請求項5に記載の電気光学装置。

【請求項8】

所定の波長をピークに持つ第1の青色光を発光する第1の発光手段と、
前記所定の波長と異なる波長をピークに持つ第2の青色光を発光する第2の発光手段と

、
前記第1の青色光の一部及び前記第2の青色光の一部を黄色光に変換する青色光波長変換手段と、を備え、

前記第1の青色光と前記第2の青色光と前記黄色光の合成光たる白色光が、所定の色度となるように、前記第1の青色光の光度と前記第2の青色光の光度の両方が調整されてなる照明装置と、

前記照明装置から出射された光が入射する複数の表示画素を備えた表示パネルと、を有し、

前記表示パネルの1つの表示画素は、複数のサブ画素を備え、前記サブ画素には、透過光の波長のピークが、415～500nmにある第1着色領域と、600nm以上にある第2着色領域と、485～535nmにある第3着色領域と、500～590nmにある第4着色領域とからなる4種の着色領域のうちのいずれかを備えることを特徴とする電気光学装置。

【請求項9】

前記第3着色領域の透過光の波長のピークが495～520nmにあることを特徴とする請求項8に記載の電気光学装置。

【請求項10】

前記第4着色領域の透過光の波長のピークが510～585nmにあることを特徴とする請求項8に記載の電気光学装置。

【請求項11】

所定の波長をピークに持つ第1の青色光を発光する第1の発光手段と、前記所定の波長と異なる波長をピークに持つ第2の青色光を発光する第2の発光手段と、前記第1の青色光の一部及び前記第2の青色光の一部を黄色光に変換する青色光波長変換手段と、を備えた照明装置と、

複数の表示画素を備え、前記照明装置から出射された光が入射する表示パネルと、を有し、

前記表示パネルの1つの表示画素は、複数のサブ画素を備え、前記サブ画素は、赤、緑、青、シアンの各色の着色層のいずれかを備えることを特徴とする電気光学装置。

【請求項12】

請求項4乃至11のいずれか一項に記載の電気光学装置を表示部に備えることを特徴とする電子機器。

【請求項13】

所定の波長をピークに持つ第1の青色光を発光する第1の発光手段と、

前記所定の波長と異なる波長をピークに持つ第2の青色光を発光する第2の発光手段と、

前記第1の青色光の一部及び前記第2の青色光の一部を黄色光に変換する青色光波長変換手段と、を備えることを特徴とする発光装置。

【請求項14】

異なる波長をピークに持つ2つの青色光を夫々発光する2つの発光手段と、前記青色光の一部を黄色光に変換する青色光波長変換手段を有する発光装置を備えた電気光学装置の製造方法であって、

前記発光装置を有する照明装置を作製する照明装置作製工程と、

表示パネルを作製する表示パネル作製工程と、

前記照明装置と前記表示パネルを組み合わせる組み合わせ工程と、

前記2つの青色光の光度を独立に調整する光度調整工程と、を備えることを特徴とする電気光学装置の製造方法。

【請求項15】

前記光度調整工程は、前記組み合わせ工程の前工程で行われ、前記照明装置より出光される光を基に、前記2つの青色光の光度の両方の調整を行うことでホワイトバランスの調整を行うことを特徴とする請求項14に記載の電気光学装置の製造方法。

【請求項16】

前記光度調整工程は、前記組み合わせ工程の後工程で行われ、前記表示パネルより出光される光を基に、前記2つの青色光の光度の両方の調整を行うことでホワイトバランスの

調整を行うことを特徴とする請求項14に記載の電気光学装置の製造方法。

【請求項17】

前記表示パネルは複数の表示画素を備え、

夫々の前記表示画素は、波長に応じて色相が変化する可視光領域のうち、青系の色相の着色領域、赤系の色相の着色領域、青から黄までの色相の中で選択された2種の色相の着色領域の各色のサブ画素から構成されていることを特徴とする請求項16に記載の電気光学装置の製造方法。

【請求項18】

前記表示パネルは複数の表示画素を備え、

夫々の前記表示画素は、透過光の波長のピークが、415～500nmにある第1着色領域と、600nm以上にある第2着色領域と、485～535nmにある第3着色領域と、500～590nmにある第4着色領域の各色のサブ画素から構成されていることを特徴とする請求項16に記載の電気光学装置の製造方法。

【請求項19】

前記表示パネルは複数の表示画素を備え、

夫々の前記表示画素は、赤、緑、青、シアンの各色のサブ画素から構成されていることを特徴とする請求項16に記載の電気光学装置の製造方法。

【発明の詳細な説明】

【技術分野】

【0001】

本発明は、電気光学装置の照明装置用の光源として用いられる発光装置に関する。

【背景技術】

【0002】

液晶表示装置に代表される電気光学装置は、2枚の基板間などに液晶などの電気光学物質を保持してなる構造を有している。例えば、液晶表示装置においては、透過表示を行うために液晶表示パネルの背面側に照明装置が設けられる。照明装置には、その光源たる発光装置として、複数のシングルチップ方式の白色LED (Light Emitting Diode) を用いるものがある。シングルチップ方式の白色LEDは、波長430～480nmの青色光を出光する青色LEDと、YAG (イットリウム・アルミニウム・ガーネット) 系蛍光体より構成される。シングルチップ方式の白色LEDは、内部の青色LEDからの青色光でYAG系蛍光体を励起することによって黄色光を生成し、青色光と黄色光を混光することで白色光を生成する。液晶表示装置は、照明装置より出光された白色光を、液晶表示パネルの基板上に積層されている赤 (R)、緑 (G)、青 (B) のそれぞれの波長の光を透過するカラーフィルタに透過させることにより、カラー表示を実現している。

【0003】

このようなシングルチップ方式の白色LEDでは、青色LEDより出光される青色光の波長や、YAG系蛍光体の量により、発光色度のばらつきが生じる。なお、以下の特許文献1では、上述した白色LEDと共に色度補正用のLEDを配置することにより、発光色度のばらつきを補償する方法が記載されている。

【0004】

【特許文献1】特開2001-209049号公報

【発明の開示】

【発明が解決しようとする課題】

【0005】

しかしながら、RGBのカラーフィルタを有する液晶表示パネルに、照明装置から出光した白色光を透過させた場合、白色光の青色光の成分が吸収されてしまうことにより、液晶表示パネルで白色表示を行う際における白色光の色度が、照明装置から出光された白色光の色度と大きく異なることがある。最近では、RGBのカラーフィルタの他にシアン (C) の波長の光を透過するカラーフィルタも有する液晶表示装置も考えられているが、このRGBCのカラーフィルタを有する液晶表示パネルでは、RGBのカラーフィルタを有する液晶表示パネルと比較して、Cのカラーフィルタを追加したことにより、白色点が、

より緑色側にシフトする傾向がある。

【0006】

本発明は上記の点に鑑みてなされたものであり、白色光のホワイトバランスの調整を容易に行うことの可能な照明装置を提供することを課題とする。

【課題を解決するための手段】

【0007】

本発明の1つの観点では、発光装置を備える照明装置であって、前記発光装置は、所定の波長をピークに持つ第1の青色光を発光する第1の発光手段と、前記所定の波長と異なる波長をピークに持つ第2の青色光を発光する第2の発光手段と、前記第1の青色光の一部及び前記第2の青色光の一部を黄色光に変換する青色光波長変換手段と、を備え、前記第1の青色光と前記第2の青色光と前記黄色光の合成光たる白色光が、所定の色度となるように、前記第1の青色光の光度と前記第2の青色光の光度の両方が調整されてなる。

【0008】

上記の照明装置は、例えば、表示パネルのバックライトとして機能するものであり、光源部として発光装置を備える。前記発光装置は、第1の発光手段と、第2の発光手段と、青色光波長変換手段と、を備える。前記第1の発光手段は、例えば青色LEDであり、所定の波長をピークに持つ第1の青色光を発光する。前記第2の発光手段は、例えば青色LEDであり、前記所定の波長と異なる波長をピークに持つ第2の青色光を発光する。前記青色光波長変換手段は、例えばYAG（イットリウム・アルミニウム・ガーネット）系蛍光体であり、前記第1の青色光の一部及び前記第2の青色光の一部を黄色光に変換する。前記第1の青色光の光度と前記第2の青色光の光度の両方が調整されることによって、所定の色度に調整されている。これにより、前記照明装置より発光される白色光は、 xy 色度図の Y 軸の値が変えられることによって、所定の白色光の色度に調整されることとなる。また、前記照明装置は、青色光を発光する発光手段のみを用いて、所定の白色光の色度に調整された白色光を出光することができる。

【0009】

上記の照明装置の一態様では、前記第1の青色光のピークとなる波長は、前記第2の青色光のピークとなる波長と10nm以上の差を有する。このとき、 xy 色度図の調整できる Y 軸の最大幅が、人間が色の違いを視覚できる色度の最小値である0.015程度となる。つまり、このようにすることで、人間が色の違いを視覚できる色度範囲で、白色光のホワイトバランスの調整が行われることとなる。

【0010】

上記の照明装置の好適な実施例では、前記照明装置は、前記第1の青色光及び前記第2の青色光は、波長430nm～480nmの範囲内の波長をピークに持つ。

【0011】

本発明の他の観点では、上記の照明装置と、前記照明装置によって照明されてなる表示パネルを備えることを特徴とする電気光学装置を構成することができる。電気光学装置は、例えば液晶表示装置であり、表示パネルは、例えば液晶表示パネルである。ここで、表示パネルにおいて、1つの表示画素が赤、緑、青のサブ画素で構成されている場合には、照明装置より出光した白色光が表示パネルを透過する際、その青色光の成分が吸収され、白色光のホワイトバランスが崩れてしまう。上記の照明装置では、青色光の光度を調整することができるので、表示パネルで吸収された白色光の青色光の成分を補うことができる。

【0012】

本発明のさらなる他の観点では、電気光学装置は、所定の波長をピークに持つ第1の青色光を発光する第1の発光手段と、前記所定の波長と異なる波長をピークに持つ第2の青色光を発光する第2の発光手段と、前記第1の青色光の一部及び前記第2の青色光の一部を黄色光に変換する青色光波長変換手段と、を備え、前記第1の青色光と前記第2の青色光と前記黄色光の合成光たる白色光が、所定の色度となるように、前記第1の青色光の光度と前記第2の青色光の光度の両方が調整されてなる照明装置と、前記照明装置から出射

された光が入射する複数の表示画素を備えた表示パネルと、を有し、前記表示パネルの1つの表示画素は、複数のサブ画素を備え、前記サブ画素には、波長に応じて色相が変化する可視光領域のうち、青系の色相の着色領域、赤系の色相の着色領域、青から黄までの色相の中で選択された2種の色相の着色領域からなる4種の着色領域のうちのいずれかを備える。このような表示パネルは、広い色相範囲での表示が可能であり、上記の照明装置を備えることにより、表示パネルで吸収された白色光の青色光の成分を補って高い色再現性を有する電気光学装置を提供することができる。また、この場合、青から黄までの色相の中で選択された前記2種の色相の着色領域の一方の着色領域が青から緑の色相であることが好ましい。あるいは、青から黄までの色相の中で選択された前記2種の色相の着色領域の他方の着色領域が緑から橙の色相であることが好ましい。これによれば、前記2種の色相の着色領域の設定が最適化され、よりホワイトバランスがとれた白色光を得ることができる。

【0013】

本発明のさらなる他の観点では、電気光学装置は、所定の波長をピークに持つ第1の青色光を発光する第1の発光手段と、前記所定の波長と異なる波長をピークに持つ第2の青色光を発光する第2の発光手段と、前記第1の青色光の一部及び前記第2の青色光の一部を黄色光に変換する青色光波長変換手段と、を備え、前記第1の青色光と前記第2の青色光と前記黄色光の合成光たる白色光が、所定の色度となるように、前記第1の青色光の光度と前記第2の青色光の光度の両方が調整されてなる照明装置と、前記照明装置から出射された光が入射する複数の表示画素を備えた表示パネルと、を有し、前記表示パネルの1つの表示画素は、複数のサブ画素を備え、前記サブ画素には、透過光の波長のピークが、415～500nmにある第1着色領域と、600nm以上にある第2着色領域と、485～535nmにある第3着色領域と、500～590nmにある第4着色領域とからなる4種の着色領域のうちのいずれかを備える。このような表示パネルは、広い色相範囲での表示が可能であるが、上記の照明装置を備えることにより、表示パネルで吸収された白色光の青色光の成分を補って高い色再現性を有する電気光学装置を提供することができる。また、この場合、前記第3着色領域の透過光の波長のピークが495～520nmにあることが好ましい。あるいは、前記第4着色領域の透過光の波長のピークが510～585nmにあることが好ましい。これによれば、前記第3着色領域または前記第4着色領域の設定が最適化され、よりホワイトバランスがとれた白色光を得ることができる。

【0014】

本発明のさらなる他の観点では、電気光学装置は、所定の波長をピークに持つ第1の青色光を発光する第1の発光手段と、前記所定の波長と異なる波長をピークに持つ第2の青色光を発光する第2の発光手段と、前記第1の青色光の一部及び前記第2の青色光の一部を黄色光に変換する青色光波長変換手段と、を備えた照明装置と、複数の表示画素を備え、前記照明装置から出射された光が入射する表示パネルと、を有し、前記表示パネルの1つの表示画素は、複数のサブ画素を備え、前記サブ画素は、赤、緑、青、シアンの各色の着色層のいずれかを備える。前記表示パネルの1つの表示画素は、赤、緑、青、シアンの各色の着色層のいずれかを備えたサブ画素から構成されている。つまり、前記表示パネルは、1つの表示画素は、赤、緑、青、シアンのサブ画素で構成されている。このような表示パネルは、1つの表示画素が赤、緑、青のサブ画素で構成されている表示パネルよりも、Cのサブ画素を追加したことにより、白色点が、より緑色側にシフトする傾向がある。従って、1つの表示画素が赤、緑、青、シアンの各色のサブ画素から構成されている表示パネルの照明装置として、上記の照明装置を用いることで、白色光の青色光の成分を多くすることができ、緑色側にシフトした白色光の白色点を最適な白色点に調整することができる。

【0015】

本発明のさらなる他の観点では、上記の電気光学装置を表示部に備えることを特徴とする電子機器を構成することができる。

【0016】

本発明のさらなる他の観点では、発光装置は、所定の波長をピークに持つ第1の青色光を発光する第1の発光手段と、前記所定の波長と異なる波長をピークに持つ第2の青色光を発光する第2の発光手段と、前記第1の青色光の一部及び前記第2の青色光の一部を黄色光に変換する青色光波長変換手段と、を備える。これにより、前記発光装置は、青色光を発光する発光手段のみを用いて、所定の色度の白色光を出光することができる。

【0017】

本発明のさらなる他の観点では、異なる波長をピークに持つ2つの青色光を夫々発光する2つの発光手段と、前記青色光の一部を黄色光に変換する青色光波長変換手段を有する発光装置を備えた電気光学装置の製造方法は、前記発光装置を有する照明装置を作製する照明装置作製工程と、表示パネルを作製する表示パネル作製工程と、前記照明装置と前記表示パネルを組み合わせる組み合わせ工程と、前記2つの青色光の両方の光度を調整する光度調整工程と、を備える。このようにして、電気光学装置の製造工程中において、白色光のホワイトバランスの調整を行うことができる。

【0018】

上記の電気光学装置の製造方法の好適な一態様では、前記光度調整工程は、前記組み合わせ工程の前工程で行われ、前記照明装置より出光される光を基に、前記2つの青色光の光度の両方の調整を行うことでホワイトバランスの調整を行う。

【0019】

上記の電気光学装置の製造方法の他の一態様では、前記光度調整工程は、前記組み合わせ工程の後工程で行われ、前記表示パネルより出光される光を基に、前記2つの青色光の光度の両方の調整を行うことでホワイトバランスの調整を行う。これにより、観測者が実際に視認する表示画面に映し出される白色光のホワイトバランスを調整することができる。

【0020】

上記の電気光学装置の製造方法の好適な一態様では、前記表示パネルは複数の表示画素を備え、夫々の前記表示画素は、波長に応じて色相が変化する可視光領域のうち、青系の色相の着色領域、赤系の色相の着色領域、青から黄までの色相の中で選択された2種の色相の着色領域の各色のサブ画素から構成されている。

【0021】

上記の電気光学装置の製造方法の好適な他の一態様では、前記表示パネルは複数の表示画素を備え、夫々の前記表示画素は、透過光の波長のピークが、415～500nmにある第1着色領域と、600nm以上にある第2着色領域と、485～535nmにある第3着色領域と、500～590nmにある第4着色領域の各色のサブ画素から構成されている。

【0022】

上記の電気光学装置の製造方法の好適なさらなる一態様では、前記表示パネルは複数の表示画素を備え、夫々の前記表示画素は、赤、緑、青、シアンの各色のサブ画素から構成されている。

【発明を実施するための最良の形態】

【0023】

以下、図面を参照して本発明を実施するための最良の形態について説明する。

【0024】

〔液晶表示装置の構成〕

まず、図1～図3を参照して、本実施形態に係る液晶表示装置100の構成等について説明する。

【0025】

図1は、本実施形態に係る液晶表示装置100の概略構成を模式的に示す平面図である。図1では、紙面手前側（観察側）にカラーフィルタ基板92が、また、紙面奥側に素子基板91が夫々配置されている。なお、図1では、紙面縦方向（列方向）をY方向と、また、紙面横方向（行方向）をX方向と規定する。また、図1において、R（赤）、G（緑）

)、B(青)C(シアン)に対応する各領域は1つのサブ画素SGを示していると共に、R、G、B、Cに対応する1行4列のサブ画素SGは、1つの画素領域AGを示している。

【0026】

図2は、液晶表示装置100における切断線A-A'に沿った1つの画素領域AGの拡大断面図である。図2に示すように、液晶表示装置100は、液晶表示パネル30と照明装置10より構成される。液晶表示パネル30は、素子基板91と、その素子基板91に対向して配置されるカラーフィルタ基板92とが枠状のシール材5を介して貼り合わされ、そのシール材5の内側に液晶が封入されて液晶層4が形成されてなる。液晶表示パネル30の素子基板91の外面上には、照明装置10が備えられている。

【0027】

本実施形態に係る液晶表示装置100は、RGBCの4色を用いて構成されるカラー表示用の液晶表示装置であると共に、スイッチング素子としてa-Si型TFT(Thin Film Transistor)素子を用いたアクティブマトリクス駆動方式の液晶表示装置である。

【0028】

素子基板91の平面構成について説明する。素子基板91の内面上には、主として、複数のソース線32、複数のゲート線33、複数のa-Si型TFT素子37、複数の画素電極34、ドライバIC40、外部接続用配線35及びFPC(Flexible Printed Circuit)41などが形成若しくは実装されている。

【0029】

図1に示すように、素子基板91は、カラーフィルタ基板92の一辺側から外側へ張り出してなる張り出し領域31を有しており、その張り出し領域31上には、ドライバIC40が実装されている。ドライバIC40の入力側の端子(図示略)は、複数の外部接続用配線35の一端側と電気的に接続されていると共に、複数の外部接続用配線35の他端側はFPC41と電気的に接続されている。各ソース線32は、Y方向に延在するように且つX方向に適宜の間隔をおいて形成されており、各ソース線32の一端側は、ドライバIC40の出力側の端子(図示略)に電気的に接続されている。

【0030】

各ゲート線33は、Y方向に延在するように形成された第1配線33aと、その第1配線33aの終端部からX方向に延在するように形成された第2配線33bとを備えている。各ゲート線33の第2配線33bは、各ソース線32と交差する方向、即ちX方向に延在するように且つY方向に適宜の間隔をおいて形成されており、各ゲート線33の第1配線33aの一端側は、ドライバIC40の出力側の端子(図示略)に電気的に接続されている。各ソース線32と各ゲート線33の第2配線33bの交差に対応する位置にはTFT素子37が設けられており、各TFT素子37は各ソース線32、各ゲート線33及び各画素電極34等に電気的に接続されている。各TFT素子37及び各画素電極34は、ガラスなどの基板1上の各サブ画素SGに対応する位置に設けられている。各画素電極34は、例えばITO(Indium-Tin Oxide)などの透明導電材料により形成されている。

【0031】

1つの画素領域AGがX方向及びY方向に複数個、マトリクス状に並べられた領域が有効表示領域V(2点鎖線により囲まれる領域)である。この有効表示領域Vに、文字、数字、図形等の画像が表示される。なお、有効表示領域Vの外側の領域は表示に寄与しない額縁領域38となっている。また、各ソース線32、各ゲート線33、各TFT素子37、及び各画素電極34等の内面上には、図示しない配向膜が形成されている。

【0032】

次に、カラーフィルタ基板92の平面構成について説明する。図2に示すように、カラーフィルタ基板92は、ガラスなどの基板2上に、遮光層(一般に「ブラックマトリクス」と呼ばれ、以下では、単に「BM」と略記する)、R、G、B、Cの4色の着色層6R、6G、6B、6C及び共通電極8などを有する。BMは、各サブ画素SGを区画する位置に形成されている。なお、以下の説明もしくは図面において、色を問わずに構成要素を

示す場合には、単に「着色層6」のように記し、色を区別して構成要素を示す場合には、例えば「着色層6R」のように記すこととする。この着色層6がカラーフィルタを構成する。共通電極8は、画素電極と同様にITOなどの透明導電材料からなり、カラーフィルタ基板92の略一面に亘って形成されている。共通電極8は、シール材5の隅の領域E1において配線36の一端側と電氣的に接続されていると共に、当該配線36の他端側は、ドライバIC40のCOMに対応する出力端子と電氣的に接続されている。

【0033】

次に照明装置10について説明する。照明装置10は、導光板11と光源部12より構成される。光源部12は、導光板11の端面11cに対し光Lを出光する。光源部12は、点光源たる複数の白色LED13a、13bを備える。ここで、白色LED13a、13bは、後に詳しく述べるが、シングルチップ方式の白色LEDである。図3に、本実施形態に係る照明装置10の平面図を示す。図3に示すように、白色LED13a、13bは夫々、同数ずつ光源部12に配置される。光源部12より出光される光Lは、白色LED13a、13bの夫々より出光された白色光を混光した合成光である。

【0034】

光源部12より出光した光Lは、導光板11の端面（以下、「入光端面」と称す）11cより導光板11内へ入り、導光板11の出光面11a、反射面11bで反射を繰り返すことにより方向を変え、導光板11の出光面11aと光Lのなす角が臨界角を超えると、導光板11の出光面11aから照明光Lとして液晶表示パネル30へ夫々出光する。液晶表示装置100は、光Lが液晶表示パネル30を透過することによって照明される。これにより、液晶表示装置100は、文字、数字、図形等の画像を表示することができ、観測者が画像を視認することができる。

【0035】

液晶表示装置100では、電子機器のメイン基板等と接続されたFPC41側からの信号及び電力等に基づき、ドライバIC40によって、G1、G2、・・・、Gm-1、Gm（mは自然数）の順にゲート線33が順次排他的に1本ずつ選択されるとともに、選択されたゲート線33には、選択電圧のゲート信号が供給される一方、他の非選択のゲート線33には、非選択電圧のゲート信号が供給される。そして、ドライバIC40は、選択されたゲート線33に対応する位置にある画素電極34に対し、表示内容に応じたソース信号を、それぞれ対応するS1、S2、・・・、Sn-1、Sn（nは自然数）のソース線32及びTFT素子37を介して供給する。その結果、液晶層4の配向状態が制御され、液晶表示装置100の表示状態が、非表示状態または中間表示状態に切り替えられることとなる。

【0036】

なお、図2に示すように、本実施形態に係る液晶表示装置100における1つの画素領域AGは、RGBCの4色の着色層6より構成されるとしているが、これに限られない。

この代わりに、本実施形態に係る液晶表示装置100における1つの画素領域AGが、一般的な画素領域の構成であるRGBの3色の着色層6より構成されとすることもできる。

【0037】

さらには、各着色層6R、6G、6B、6Cが設けられた各着色領域は、各サブ画素SGに対応するものであり、4色（4種）の着色領域で1つの画素領域AGを構成する。4色の着色領域は、波長に応じて色相が変化する可視光領域（380～780nm）のうち、青系の色相の着色領域、赤系の色相の着色領域と、青から黄までの色相の中で選択された2種の色相の着色領域からなるとしてもよい。ここで系と用いているが、例えば青系であれば純粋の青の色相に限定されるものでなく、青紫や青緑等を含むものである。赤系の色相であれば、赤に限定されるものでなく橙を含む。また、これら着色領域は単一の着色層で構成されても良いし、複数の異なる色相の着色層を重ねて構成されても良い。また、これら着色領域は色相で述べているが、当該色相は、彩度、明度を適宜変更し、色を設定し得るものである。

【0038】

4色の着色領域の具体的な色相の範囲は、例えば、青系の色相の着色領域は、青紫から青緑であり、より好ましくは藍から青である。赤系の色相の着色領域は、橙から赤である。青から黄までの色相で選択される一方の着色領域は、青から緑であり、より好ましくは青緑から緑である。青から黄までの色相で選択される他方の着色領域は、緑から橙であり、より好ましくは緑から黄である。もしくは緑から黄緑である。ここで、各着色領域は、同じ色相を用いることはない。例えば、青から黄までの色相で選択される2つの着色領域で緑系の色相を用いる場合は、他方は一方の緑に対して青系もしくは黄緑系の色相を用いる。これにより、従来のRGBの着色領域よりも広範囲の色再現性を実現することができる。

【0039】

また、広範囲の色再現性を色相で述べたが、着色領域の色相の設定は、これを透過した透過光の波長のピークを基に定めてもよい。例えば、青系の着色領域は、波長のピークが415-500nmにある着色領域、好ましくは、435-485nmにある着色領域である。赤系の着色領域は、波長のピークが600nm以上にある着色領域で、好ましくは、605nm以上にある着色領域である。青から黄までの色相で選択される一方の着色領域は、波長のピークが485-535nmにある着色領域で、好ましくは、495-520nmにある着色領域である。青から黄までの色相で選択される他方の着色領域は、波長のピークが500-590nmにある着色領域、好ましくは510-585nmにある着色領域、もしくは530-565nmにある着色領域である。

【0040】

また、xy色度図で4色の着色領域の設定を行ってもよい。青系の着色領域は、 $x \leq 0.151$ 、 $y \leq 0.056$ にある着色領域であり、好ましくは、 $0.134 \leq x \leq 0.151$ 、 $0.034 \leq y \leq 0.056$ にある着色領域である。赤系の着色領域は、 $0.643 \leq x$ 、 $y \leq 0.333$ にある着色領域であり、好ましくは、 $0.643 \leq x \leq 0.690$ 、 $0.299 \leq y \leq 0.333$ にある着色領域である。青から黄までの色相で選択される一方の着色領域は、 $x \leq 0.164$ 、 $0.453 \leq y$ にある着色領域であり、好ましくは、 $0.098 \leq x \leq 0.164$ 、 $0.453 \leq y \leq 0.759$ にある着色領域である。青から黄までの色相で選択される他方の着色領域は、 $0.257 \leq x$ 、 $0.606 \leq y$ にある着色領域であり、好ましくは、 $0.257 \leq x \leq 0.357$ 、 $0.606 \leq y \leq 0.670$ にある着色領域である。

【0041】

これら4色の着色領域は、サブ画素に透過領域と反射領域を備えた場合、透過領域及び反射領域も上述した範囲で適用することができるものである。

【0042】

上記4色の着色領域の構成の例として、以下のものが挙げられる。

- (1) 色相が、赤、青、緑、シアン（青緑）の着色領域。
- (2) 色相が、赤、青、緑、黄の着色領域。
- (3) 色相が、赤、青、深緑、黄の着色領域。
- (4) 色相が、赤、青、エメラルド、黄の着色領域。
- (5) 色相が、赤、青、深緑、黄緑の着色領域。
- (6) 色相が、赤、青緑、深緑、黄緑の着色領域。

【0043】

また、本実施形態に係る液晶表示装置100は、完全透過型の液晶表示装置として示しているが、これに限られず、代わりに半透過反射型の液晶表示装置を用いるとすることもできる。さらに、図1に示すように、スイッチング素子としては、TFT素子37を用いているが、これに限られず、代わりにTFD (Thin Film Diode) 素子を用いるとすることもできる。

【0044】

〔LEDの構成〕

図4に、本実施形態に係る白色LED13a、13bの構成を夫々示す。白色LED13a、13bは、シングルチップ方式の白色LEDである。白色LED13aは、主に、

反射棒体21aと、青色LED24aと、YAG（イットリウム・アルミニウム・ガーネット）系蛍光体23より構成され、白色LED13bは、主に、反射棒体21bと、青色LED24bと、YAG系蛍光体23より構成される。

【0045】

青色LED24a、24bとしては、波長430nm～480nmの範囲内の波長をピークに持つ青色光を出光するものが用いられる。ただし、青色LED24bは、青色LED24aより出光される青色光の波長とは異なった波長をピークに持つ青色光を出光する。青色LED24a、24bは夫々、電流Ia、Ibが流されることにより青色光を出光する。ここで、電流Ia、Ibの電流量を夫々大きくすれば、青色LED24a、24bより出光される青色光の光度は、夫々大きくなり、電流Ia、Ibの電流量を夫々小さくすれば、青色LED24a、24bより出光される青色光の光度は、夫々小さくなる。電流Ia、Ibの電流量は、図示しない制御装置によって夫々独立に制御される。制御装置は、LEDの駆動回路、LEDのコントロール回路と合わせてFPC41上に配置されている。本実施形態に係る照明装置10では、一例として、白色LED13aにおける青色LED24aとしては、波長450nmにピークを持つ青色光を出光するものが用いられ、白色LED13bにおける青色LED24bとしては、波長460nmにピークを持つ青色光を出光するものが用いられるとする。

【0046】

反射棒体21a、21bは、樹脂などにより形成され、すり鉢状の凹部を有しており、凹部の内面にはメッキ処理等により光を反射する反射膜が形成されている。青色LED24a、24bは、夫々反射棒体21a、21bの凹部の底面に設置され、YAG系蛍光体23が混ざられた透明な樹脂22a、22bによって夫々封止されてなる。

【0047】

青色LED24a、24bより出光した青色光は、YAG系蛍光体23を励起することによって黄色光（図4における破線矢印Ye）を生成する光と、樹脂22a、22bをそのまま透過して青色光として出光する光（図4における実線矢印B）とに分かれる。白色LED13a、13bは、樹脂22a、22bをそのまま透過した青色光とYAG系蛍光体23が励起されることによって出光した黄色光を混光することで、白色光を生成する。

白色LED13a、13bでは、どちらも同じYAG系蛍光体23が用いられ、YAG系蛍光体23の量は、樹脂22a、22bの両方に同じ割合で含まれている。これにより、白色LED13a、13bより出光する黄色光は、どちらも同じ波長分布を示し、かつほぼ同じ光度となる。

【0048】

青色LEDより出光される青色光は、その光のエネルギーが大きい。従って、シングルチップ方式の白色LEDでは、チップとして青色LEDを用いることにより、蛍光体が励起されることによって出光した他の色の光も、高い光度を有することができる。

【0049】

図5は、本実施形態に係る白色LED13a、13bより出光される夫々の白色光のスペクトル分布を示しており、横軸は光の波長[nm]を、縦軸は光度を夫々示す。図5において、実線で示すグラフ151は、白色LED13aより出光される光のスペクトル分布を示し、破線で示すグラフ152は、白色LED13bより出光される光のスペクトル分布を示す。グラフ151は、白色LED13aにおいて、波長450nmをピークに有する青色光を出光する青色LED24aが用いられるので、波長450nmのところに鋭いピークを有する。一方、グラフ152は、白色LED13bにおいて、波長460nmをピークに有する青色光を出光する青色LED24bが用いられるので、波長460nmのところに鋭いピークを有する。また、白色LED13a、13bは、同じYAG系蛍光体23が用いられるので、グラフ151、152は、どちらも波長540nm付近において頂点となる裾野の広い小さな山を有する。

【0050】

図6は、色度範囲を示す国際照明委員会（CIE）のxy色度図を示す。色度範囲20

1は、人間の目の波長感度特性による色度範囲であり、人間が見分けることのできる色度範囲を示している。図中のR、G、B、Yeは、赤、緑、青、黄の大まかな色度を示している。図6において、白色LED13aにおける青色LED24a（波長450nm）の色度点を点Sで示し、白色LED13bにおける青色LED24b（波長460nm）の色度点を点Pで示し、YAG系蛍光体23の色度点を点Qで示している。また、直線210は、点Sと点Qを結ぶ直線であり、直線211は、点Pと点Qを結ぶ直線である。さらに、図6において、一点破線で示す色度範囲202は、所定の白色領域を示している。

【0051】

図7に、この白色領域の色度範囲202の拡大図を示す。色度範囲202は、具体的には、4つの点p01、p02、p03、p04で規定される。色度範囲202における、Xの値の範囲は0.287～0.311、Yの値の範囲は0.276～0.315となる。

【0052】

図7では、色度範囲202を4つの領域P1～P4に分けている。領域P1は、4つの点p01、p06、p09、p05で規定され、Xの値の範囲は0.291～0.302、Yの値の範囲は0.276～0.294となる。領域P2は、4つの点p06、p02、p07、p09で規定され、Xの値の範囲は0.287～0.298、Yの値の範囲は0.287～0.304となる。領域P3は、4つの点p05、p09、p08、p04で規定され、Xの値の範囲は0.298～0.311、Yの値の範囲は0.282～0.305となる。領域P4は、4つの点p09、p07、p03、p08で規定され、Xの値の範囲は0.296～0.308、Yの値の範囲は0.294～0.315となる。

【0053】

このように、色度範囲202を4つの領域P1～P4に分けると、例えば、領域P3、P4は、領域P1、P2よりも図6のxy色度図におけるYeに近い位置にある。従って、領域P3、P4に色度点を有する白色光は、領域P1、P2に色度点を有する白色光よりも黄色みがかかった白色光となる。また、領域P3は、領域P4よりも図6のxy色度図におけるRに近い位置にある。従って、領域P3に色度点を有する白色光は、領域P4に色度点を有する白色光よりも赤みがかかった白色光となる。一方、領域P4は、領域P3よりも図6のxy色度図におけるGに近い位置にある。従って、領域P4に色度点を有する白色光は、領域P3に色度点を有する白色光よりも緑がかかった白色光となる。

【0054】

本実施形態に係る照明装置10では、光源部12より出光される白色光は、白色LED13a、13bの夫々より出光される白色光を混光したものである。従って、白色LED13a、13bにおける青色LED24a、24bより出光される2つの波長の青色光の光度の両方を調整することにより、光源部12より出光される白色光の色度の値を、図6に示す直線210及び直線211の間の範囲Y1の間で変えることができる。具体的には、ある所定のX座標の値に対し、直線210より求められるY座標の値と、直線211より求められるY座標の値が、色度範囲202に収まる色度点を点T、Uとすると、青色LED24a、青色LED24bより出光される青色光の光度の両方を調整することにより、所定のX座標の値に対し、Y座標の値を変化量YLenの範囲内で変えることができる。例えば、青色LED24aより出光される青色光の光度を、青色LED24bより出光される青色光の光度よりも大きくすれば、光源部12より出光する白色光は、その色度が点Tに近づくこととなり、赤みがかかった白色となる。一方、青色LED24bより出光される青色光の光度を、青色LED24aより出光される青色光の光度よりも大きくすれば、光源部12より出光する白色光は、その色度が点Uに近づくこととなり、緑がかかった白色となる。

【0055】

このことから分かるように、青色LED24a、24bより出光される青色光の光度を調整することにより、範囲Y1で、所定の白色光の色度に調整することができる。即ち、光源部12より出光される白色光のホワイトバランスの調整を行うことが可能となる。

【0056】

本実施形態における照明装置10の場合には、青色LED24a、青色LED24bの波長の差が10nmであり、このときの色度のY軸方向の変化量YLenは0.015程度となる。xy色度図において、人間が色の違いを視覚できる色度の変化量の最小値も0.015程度となるので、青色LED24aと青色LED24bの波長の差は10nm以上となるのが望ましい。これにより、人間が色の違いを視覚できる色度範囲で、白色光のホワイトバランスの調整を行うことが可能となる。また、青色LED24aと青色LED24bの波長の差を広げれば広げるほど、範囲Y1の幅を大きくすることができ、変化量YLenを大きくすることができる。即ち、xy色度図におけるY軸方向の調整可能な色度の変化量の幅を大きくすることができる。

【0057】

なお、白色光の色度の値を、直線210及び直線211に沿った方向に調整するには、白色光の黄色光の光度を変える必要がある。従って、白色光の色度の値のX座標を大きく変化させるには、白色LED13a、13bの樹脂22におけるYAG系蛍光体23の割合を調節する必要がある。言い換えれば、白色光の色度の値のX座標は、主に樹脂22におけるYAG系蛍光体23の量によって決まる。

【0058】

一般的な照明装置には、RGBの各色のLEDを用いて白色光を生成しているものがある。このような照明装置においては、各色のLEDの光度は、温度変化や経時変化などによっても変化し、その変化の特性は、各色のLEDによって異なる。そのため、各色のLEDに流す電流量を製品出荷時に予め設定した電流量のままにしておくと、温度変化や経時変化などにより、各色のLEDから出光された光の光度がそれぞれ変化してしまうので、各色のLEDから出光する光を混光しても当初設定していた白色光と同じ白色光とならなくなる。例えば、温度が上昇すると、青色LEDは明るくなる性質を有し、赤色LEDは暗くなる性質を有する。そのため、気温が高い場所では、液晶表示パネルの表示画面で表示された白色は、青みがかった白色になる。また、RGBのLEDのうち、青色LEDは、劣化が最も早く、時間が経過するにつれて暗くなるのに対し、赤色LEDは、劣化が最も遅い。よって、時間が経過するにつれて、液晶表示パネルの表示画面で表示された白色は、赤みがかった白色になる。

【0059】

本実施形態に係る照明装置10では、白色LED13a、13bは、そのチップとして青色LEDのみが用いられている。白色光を生成する場合、RGBの各色のLEDが用いられている一般的な照明装置では、3種類の性質の異なるRGBの各色のLEDに流す電流量を調整する必要があるのに対し、本実施形態に係る照明装置10では、青色LED24a、24bに流す電流量を調整するだけで良い。従って、RGBの各色のLEDが用いられている一般的な照明装置と比較して、本実施形態に係る照明装置10では、白色光を簡単に生成することができる。また、白色LED13a、13bでは、1種類の青色LEDのみが用いられているので、白色LED13a、13bの温度変化や経時変化による光の光度の変化は、夫々同じ割合で変化する。従って、上述したようなRGBの各色のLEDを混光して白色光を生成する照明装置と比較して、本実施形態に係る照明装置10では、温度変化や経時変化による白色光のホワイトバランスの崩れ方を緩やかなものとすることができる。

【0060】

〔白色光のホワイトバランスの調整〕

光源部12より出光された白色光のホワイトバランスを調整する方法として、照明装置10より出光した直後の白色光のホワイトバランスを調整する方法と、液晶表示パネル30を透過した後の白色光のホワイトバランスを調整する方法の2つの方法が考えられる。

【0061】

図8に照明装置10より出光した直後の白色光のホワイトバランスを調整する場合の液晶表示装置100の製造方法のフローチャートを示し、図9に液晶表示パネル30を透過

した白色光のホワイトバランスを調整する場合の液晶表示装置100の製造方法のフローチャートを示す。

【0062】

照明装置10より出光した直後の白色光のホワイトバランスを調整する場合、図8に示すように、まず、照明装置作製工程たる照明装置10の作製(ステップS11)を行い、表示パネル作製工程たる液晶表示パネル30の作製(ステップS12)を行う。その後、光度調整工程として、照明装置10より出光した直後の白色光の色度を観測しつつ、白色LED13a、13bの青色LED24a、24bに流す電流Ia、Ibを調整することにより、青色LED24a、24bより出光される青色光の光度の両方を調整して、照明装置10より出光した直後の白色光のホワイトバランスを調整する(ステップS13)。

ホワイトバランスの調整を終えた後、組み合わせ工程として、照明装置10と液晶表示パネル30を組み合わせることにより(ステップS14)、液晶表示装置100は完成する。

【0063】

一方、液晶表示パネル30を透過した光を調整することで白色光を生成する場合、図9に示すように、照明装置作製工程たる照明装置10の作製(ステップS21)を行い、表示パネル作製工程たる液晶表示パネル30の作製(ステップS22)を行う。その後、組み合わせ工程として、照明装置10と液晶表示パネル30を組み合わせる(ステップS23)。このように液晶表示装置100の装置構成を一通り完成させた後、光度調整工程として、液晶表示パネル30を透過して出光される白色光の色度を観測しつつ、白色LED13a、13bの青色LED24a、24bに流す電流Ia、Ibを調整することにより、青色LED24a、24bより出光される青色光の光度の両方を調整して、液晶表示パネルを出光した白色光のホワイトバランスを調整する(ステップS24)。

【0064】

以上に述べた2つの液晶表示装置100の製造方法により、液晶表示装置100の製造工程において、白色光のホワイトバランスの調整を行うことができる。

【0065】

一般的なRGBの着色層を有する液晶表示装置において、液晶表示パネルにおける着色層の光の透過率は、その着色層の厚さなどによって異なるため、LEDから出光した光は、着色層を透過することにより、RGBの各色の光の光度がそれぞれ変化する。そのため、照明装置側において、所定の白色光が生成されても、着色層6を透過した後の白色光の色が、その所定の白色光の色と同じになるとは限らない。言い換えれば、表示画面で白色表示を行うときに、観測者が視認する白色が、その照明装置側で生成された所定の白色光の色と同じになるとは限らない。このように、白色光を構成するRGBの各色の光の光度の割合が、着色層の透過率により変化するため、観測者は、表示画面に映し出される白色と、照明装置側で生成した所定の白色光の色とが異なって見えてしまう。特に、RGBの各色の光の中では、着色層による青色光の吸収が最も大きいため、白色光における青色光の成分が不足する。また、本実施形態に係る液晶表示装置100のように、RGBの着色層6を有する液晶表示パネル30で白色表示を行った場合には、先に述べたRGBの着色層6を有する液晶表示パネルで白色表示を行うよりも、Cの着色層6を追加したことにより、白色点が、より緑色側にシフトする傾向がある。

【0066】

このように、液晶表示パネル30を透過した後の表示画面に映し出される白色光と、照明装置10で生成した白色光とは、色度が異なってしまう。従って、観測者が実際に視認する表示画面に映し出される白色光のホワイトバランスを調整する方が、照明装置10より出光した直後の白色光のホワイトバランスを調整するよりも適切な表示を行うことができる。

【0067】

本実施形態に係る照明装置10では、白色LED13a、13bの青色LED24a、24bより出光される青色光の光度を調整することができる。言い換えれば、液晶表示パ

ネルで吸収され、白色光の青色光の成分が不足している場合には、その青色光の成分を補うことができる。また、本実施形態に係る液晶表示装置100のようにRGBCの着色層6を有する液晶表示パネル30に対し、照明装置10を用いることにより、白色光の青色光の成分を多くすることができ、緑色側にシフトした白色光の白色点を最適な白色点に調整することができる。

【0068】

〔変形例〕

次に本実施形態に係る照明装置10の変形例について述べる。図10は、本実施形態に係る照明装置10の変形例に係る白色LED13を示す図である。本実施形態に係る照明装置10では、白色LED13a、13bが、夫々同数ずつ、光源部12に配列されるしたが、これに限られない。光源部12に、白色LED13a、13bを配列する代わりに、図10に示す白色LED13を配列することとしても良い。白色LED13では、青色LED24a、24bは両方とも、1つの反射枠体21の凹部の底面に設置され、YAG系蛍光体23が混ざられた透明な樹脂22によって封止されてなる構造を有する。青色LED24a、24bは夫々、電流Ia、Ibが流されることにより、青色光を出光する。電流Ia、Ibの電流量は、図示しない制御装置によって独立に制御される。青色LED24a、24bより出光した青色光は、YAG系蛍光体23を励起することによって黄色光(図10における破線矢印Ye)を生成する光と、樹脂22をそのまま透過して青色光として出光する光(図10における実線矢印B)とに分かれる。白色LED13は、樹脂22をそのまま透過した青色光とYAG系蛍光体23が励起されることによって出光した黄色光を混光することで、白色光を生成する。この白色LED13によっても、上述したように、xy色度図におけるY軸方向の色度範囲を調節することができ、光源部12より出光される白色光のホワイトバランスの調整を行うことができる。

【0069】

また、光源部12に配置される発光素子としては、上述したような白色LEDには限られない。白色LEDの代わりに、2つの波長の異なる、蛍光体を励起して白色発光を行うことのできる有機EL(electroluminescence)発光素子を用いることもできる。

さらに、上記実施形態では、表示パネルとして液晶表示パネルを用いているが、これに限られるものではなく、代わりに表示パネルとして、電気泳動ディスプレイパネルなどの他の表示パネルを用いることもできる。

【0070】

〔電子機器〕

次に、本実施形態に係る液晶表示装置100を適用可能な電子機器の具体例について図11を参照して説明する。

【0071】

まず、本発明に係る液晶表示装置100を、可搬型のパーソナルコンピュータ(いわゆるノート型パソコン)の表示部に適用した例について説明する。図11(a)は、このパーソナルコンピュータの構成を示す斜視図である。同図に示すように、パーソナルコンピュータ710は、キーボード711を備えた本体部712と、本発明に係る液晶表示装置100を適用した表示部713とを備えている。

【0072】

続いて、本発明に係る液晶表示装置100を、携帯電話機の表示部に適用した例について説明する。図11(b)は、この携帯電話機の構成を示す斜視図である。同図に示すように、携帯電話機720は、複数の操作ボタン721のほか、受話口722、送話口723とともに、本発明に係る液晶表示装置100を適用した表示部724を備える。

【0073】

なお、本発明に係る液晶表示装置100を適用可能な電子機器としては、図11(a)に示したパーソナルコンピュータや図11(b)に示した携帯電話機の他にも、液晶テレビ、ビューファインダ型・モニタ直視型のビデオテープレコーダ、カーナビゲーション装置、ページャ、電子手帳、電卓、ワードプロセッサ、ワークステーション、テレビ電話、

POS端末、デジタルスチルカメラなどが挙げられる。

【図面の簡単な説明】

【0074】

【図1】本実施形態に係る液晶表示装置の平面図。

【図2】本実施形態に係る液晶表示装置の断面図。

【図3】本実施形態に係る照明装置10の平面図。

【図4】本実施形態に係る白色LEDの構成を示す模式図。

【図5】本実施形態に係る白色LEDより出光される白色光のスペクトル分布。

【図6】色度範囲を示す国際照明委員会(CIE)のxy色度図。

【図7】白色領域の色度範囲の拡大図。

【図8】液晶表示装置の製造方法のフローチャート図。

【図9】液晶表示装置の製造方法のフローチャート図。

【図10】本実施形態に係る白色LEDの変形例を示す図。

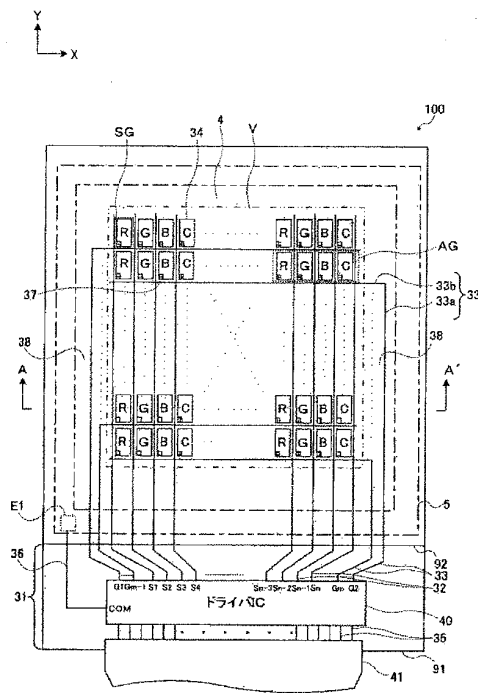
【図11】本実施形態の液晶表示装置を適用した電子機器の例を示す図。

【符号の説明】

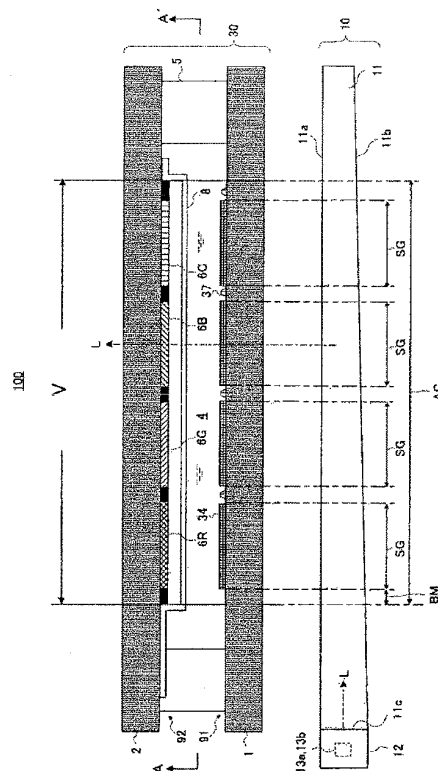
【0075】

11…導光板、12…発光装置としての光源部、13a、13b…第1の発光手段としての白色LED、24a、24b…第2の発光手段としての青色LED、23…青色光波長変換手段としてのYAG系蛍光体、10…照明装置、30…表示パネルとしての液晶表示パネル、100…電気光学装置としての液晶表示装置。

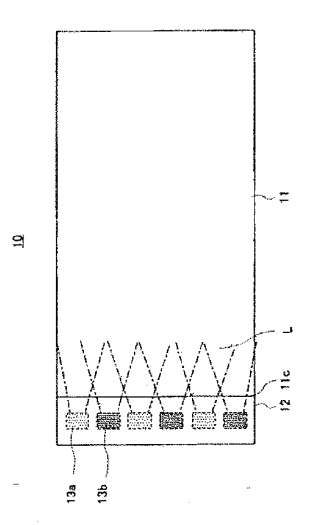
【図1】



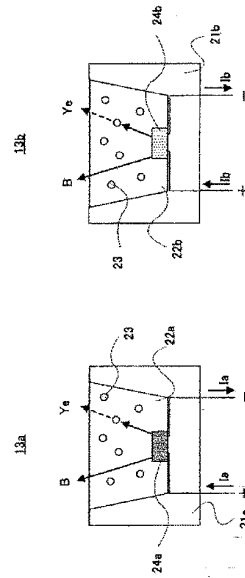
【図2】



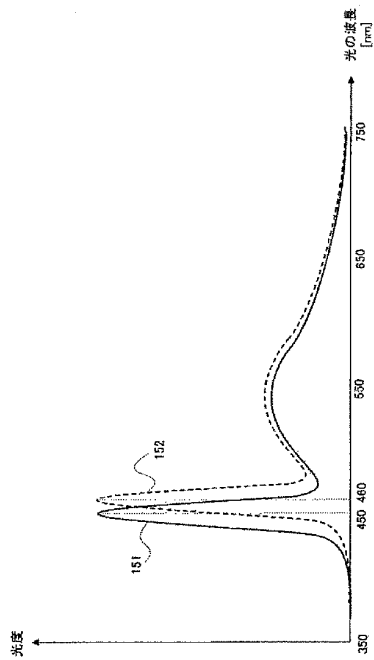
【図3】



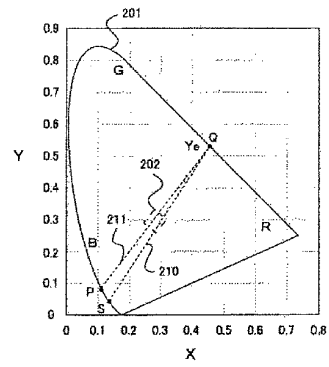
【図4】



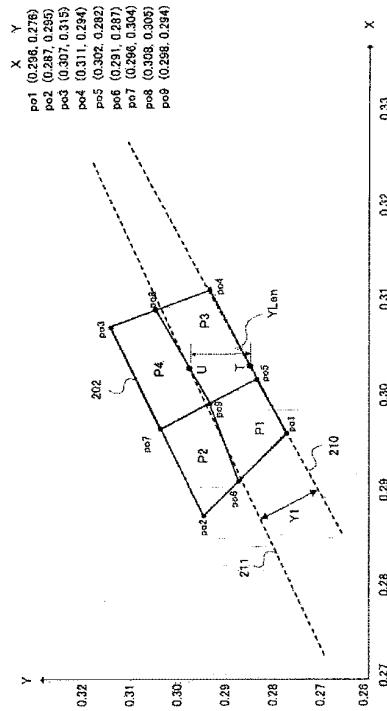
【図5】



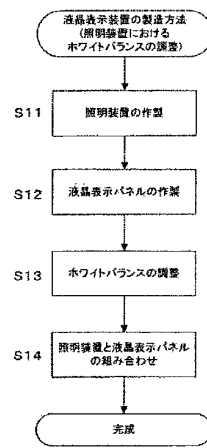
【図6】



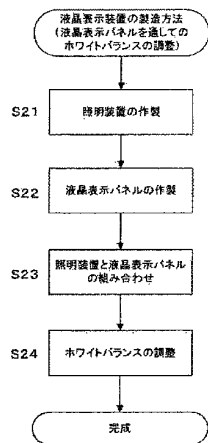
【図7】



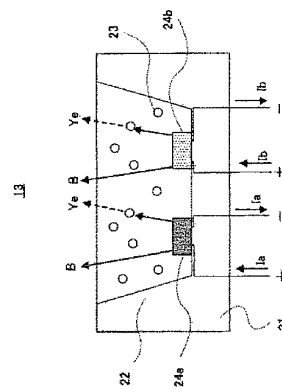
【図8】



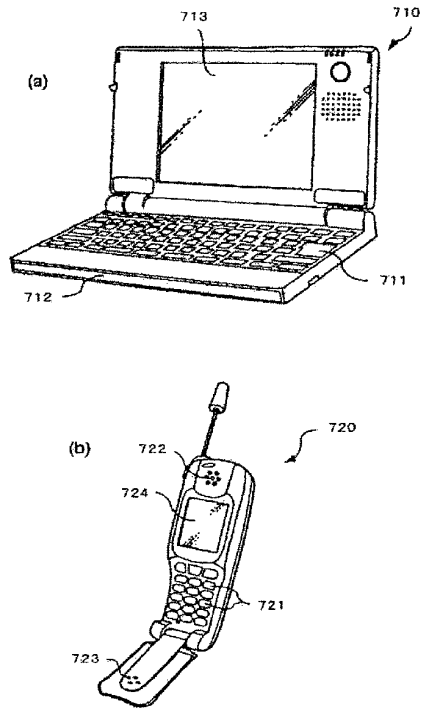
【図9】



【図10】



【図11】



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【要約の続き】

、所定の白色光の色度に調整された白色光を出光することができる。

【選択図】図4

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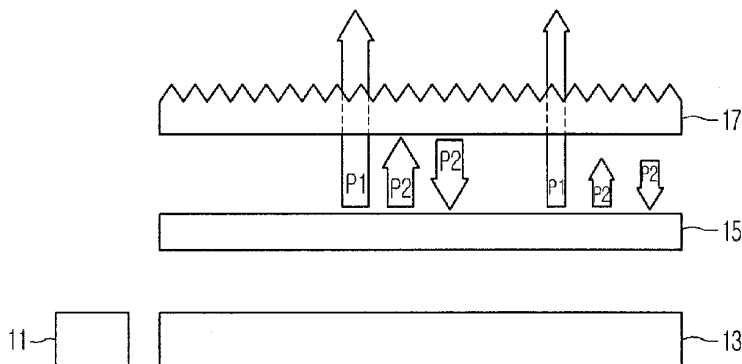
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: BACKLIGHT UNIT AND LCD HAVING THE SAME



(57) Abstract: Provided is a backlight unit and an LCD device having the same. The backlight unit includes a light guide plate, a light emitting element, a fluorescent exciting sheet, and a transreflective polarizing prism sheet. The light emitting element provides the colored light to the light guide plate. The fluorescent exciting sheet is formed on the light guide plate, and the transreflective polarizing prism sheet is formed on the fluorescent exciting sheet. The fluorescent exciting sheet receives the colored light incident thereon through the light guide plate to emit white light.

WO 2007/086657 A1

Description

BACKLIGHT UNIT AND LCD HAVING THE SAME

Technical Field

- [1] The present invention relates to a backlight unit and a liquid crystal display (LCD) device having the same.

Background Art

- [2] A cathode ray tube (CRT) display device has been most widely used until recently as one of display devices for displaying image data on a screen. However, the CRT display device causes a lot of inconvenience due to its large volume and heavy weight for its display area.
- [3] A thin film type flat panel display device, which has a slim profile and a large display area and thus can be used conveniently anywhere, has been developed and is gradually replacing the CRT.
- [4] A liquid crystal display (LCD) device is one of the thin film type flat panel display devices, which are widely used at the present time. The LCD device uses optical anisotropy and polarization properties of liquid crystal molecules. Alignment of liquid crystal molecules has a specific direction and polarization properties because a liquid crystal has a thin and long structure. The alignment direction can be controlled by applying an electric field to the liquid crystal. Accordingly, when the alignment direction is controlled, due to the optical anisotropy of the liquid crystal, light rays may pass through or be cut off by the liquid crystal according to the alignment direction of the liquid crystal molecules so that colors and images are displayed.
- [5] Meanwhile, the liquid crystal display device generally uses light provided by an external light source or a backlight unit to display images because the liquid crystal is not self-luminous.
- [6] Vigorous efforts are being made to develop the backlight unit, particularly having high emission brightness and excellent color uniformity over positions along with a slim profile.

Disclosure of Invention

Technical Problem

- [7] An embodiment of the present invention provides a backlight unit having high emission brightness and excellent color uniformity over positions along with a slim profile.
- [8] An embodiment of the present invention provides an LCD device and a mobile communication terminal including a backlight unit having high emission brightness and excellent color uniformity over positions along with a slim profile, so that it can be

manufactured to have a slimmer profile.

Technical Solution

- [9] An embodiment of the present invention provides a backlight unit comprising: a light guide plate; a light emitting element for providing the colored light to the light guide plate; a fluorescent exciting sheet formed on the light guide plate to receive the colored light incident thereon through the light guide plate and emit white light; and a transfective polarizing prism sheet formed on the fluorescent exciting sheet.
- [10] An embodiment of the present invention provides a liquid crystal display device comprising: a backlight unit having a light guide plate, a light emitting element for providing the colored light to the light guide plate, a fluorescent exciting sheet formed on the light guide plate to receive the colored light incident thereon through the light guide plate and emit white light, and a transfective polarizing prism sheet formed on the fluorescent exciting sheet; a liquid crystal panel receiving light provided by the backlight unit; a first polarizer formed under the liquid crystal panel; and a second polarizer formed on the liquid crystal panel.
- [11] An embodiment of the present invention provides a mobile communication terminal comprising: a backlight unit having a light guide plate, a light emitting element for providing the colored light to the light guide plate, a fluorescent exciting sheet formed on the light guide plate to receive the colored light incident thereon through the light guide plate and emit white light, and a transfective polarizing prism sheet formed on the fluorescent exciting sheet; a liquid crystal panel receiving light provided by the backlight unit; a first polarizer formed under the liquid crystal panel; a second polarizer formed on the liquid crystal panel; a communication unit for performing communication with an outside; and a control unit for controlling the backlight unit, the liquid crystal panel, and the communication unit.

Advantageous Effects

- [12] According to the present invention, it is possible to provide a backlight unit having high emission brightness and excellent color uniformity over positions along with a slim profile.
- [13] According to the present invention, it is also possible to provide an LCD device and a mobile communication terminal including a backlight unit having high emission brightness and excellent color uniformity over positions along with a slim profile, so that it can be manufactured to have a slimmer profile.

Brief Description of the Drawings

- [14] FIG. 1 is a schematic view illustrating a backlight unit according to an embodiment of the present invention; and
- [15] FIG. 2 is a schematic view illustrating a liquid crystal display device according to

an embodiment of the present invention.

Best Mode for Carrying Out the Invention

- [16] It will be understood that when a layer, a region, a pattern or a structure is referred to as being "on" or "under" a substrate, a layer, a region, a pad or a pattern in the descriptions of the embodiments, the term "on" may denote "directly on", or "indirectly on", and the term "under" may denote "directly under" or "indirectly under".
- [17] Hereinafter, preferred embodiments of the present invention will be described in detail with reference to accompanying drawings.
- [18] FIG. 1 is a schematic view illustrating a backlight unit according to an embodiment of the present invention.
- [19] A backlight unit according to an embodiment of the present invention includes a light emitting element 11, a light guide plate 13, a fluorescent exciting sheet 15, and a transfective polarizing prism sheet 17.
- [20] For example, the light emitting element 11 may provide the light guide plate with blue light. The light emitting element 11 may be realized as, for example, a blue light emitting diode. Blue light emitted from the light emitting element 11 passes through the light guide plate 13, and then is incident on the fluorescent exciting sheet 15. A pattern may be formed on a lower surface of the light guide plate 13. For example, projections may be formed on the lower surface of the light guide plate 13. The projections contribute to making the light emitted from the light emitting element 11 be received by the fluorescent exciting sheet 15. Also, a reflector may be further formed on a lower portion of the light guide plate 13. The reflector reflects light that has leaked to a lower portion of the light guide plate 13 back in an upper direction.
- [21] The fluorescent exciting sheet 15 receives blue light emitted from the light emitting element 11 to emit white light. The fluorescent exciting sheet 15 may be realized to include a yellow phosphor or a red/green phosphor. Here, the phosphor may be contained inside the fluorescent exciting sheet 15 or coated on outer surfaces of the fluorescent exciting sheet 15.
- [22] For another example, the light emitting element 11 may provide blue/green light. The light emitting element 11 may be realized as a blue light emitting diode and a green light emitting diode. Also, the light emitting element 11 may be realized to be mounted as a light emitting diode package including a blue light emitting chip and a green light emitting chip. The blue/green light may be expressed as cyan light.
- [23] Blue/green light emitted from the light emitting element 11 passes through the light guide plate 13, and then is incident on the fluorescent exciting sheet 15. A pattern may be formed on a lower surface of the light guide plate 13. For example, projections may be formed on the lower surface of the light guide plate 13. The projections contribute

to making the light emitted from the light emitting element 11 be received by the fluorescent exciting sheet 15. In addition, a reflector may be further formed on a lower surface of the light guide plate 13. The reflector reflects light that has leaked to a lower portion of the light guide plate 13 back in an upper direction.

- [24] The fluorescent exciting sheet 15 receives blue/green light emitted from the light emitting element 11 to emit white light. The fluorescent exciting sheet 15 may be realized to include a red phosphor. Here, the phosphor may be contained inside the fluorescent exciting sheet 15 or coated on outer surfaces of the fluorescent exciting sheet 15.
- [25] Meanwhile, white light emitted from the fluorescent exciting sheet 15 is incident on the transfective polarizing prism sheet 17. The transfective polarizing prism sheet 17 transmits light (P1) polarized in a first direction, whereas reflects light (P2) polarized in a second direction perpendicular to the first direction. Also, light that has been reflected from the transfective polarizing prism sheet 17 is reflected back from the fluorescent exciting sheet 15 disposed under the transfective polarizing prism sheet 17, so that a portion of the reflected light (P1) can now pass through the transfective polarizing prism sheet 17. Accordingly, a backlight unit has 30 % higher brightness when using the transfective polarizing prism sheet 17 than when using a general prism sheet. Upper surface of the transfective polarizing prism sheet 17 has a prism shape.
- [26] White light emitted from the fluorescent exciting sheet 15 is unpolarized light including both a polarization component in a first direction (P1) and a polarization component in a second direction (P2). The transfective polarizing prism sheet 17 transmits light having the polarization component in the first direction (P1), whereas reflects light having the polarization component in the second direction (P2) according to a characteristic of the polarization axis thereof. Also, as described above, light that has been reflected from the transfective polarizing prism sheet 17 is reflected back from the fluorescent exciting sheet 15 disposed under the transfective polarizing prism sheet 17, so that a portion of the reflected light (P1) having the polarization component in the first direction (P1) can now pass through the transfective polarizing prism sheet 17. Light excited to white light through the fluorescent exciting sheet 15 does not affect a color coordinate of the backlight though it recycles repeatedly.
- [27] A backlight unit having the above described structure can be manufactured to have a slim profile. In addition, the fluorescent exciting sheet 15 receives blue light emitted from the light emitting element 11 to emit white light. Thus, a backlight unit according to an embodiment of the present invention secures high emission brightness and excellent color uniformity over positions.
- [28] FIG. 2 is a schematic view illustrating a liquid crystal display device according to an embodiment of the present invention.

- [29] A liquid crystal display device according to an embodiment of the present invention includes the above described backlight unit, a first polarizer 21, a liquid crystal panel 23, and a second polarizer 25. The backlight unit includes a light emitting element 11, a light guide plate 13, a fluorescent exciting sheet 15, and a transfective polarizing prism sheet 17.
- [30] For example, the light emitting element 11 may provide the light guide plate 13 with blue light. The light emitting element 11 may be realized as, for example, a blue light emitting diode. Blue light emitted from the light emitting element 11 passes through the light guide plate 13, and then is incident on the fluorescent exciting sheet 15. A pattern may be formed on a lower surface of the light guide plate 13. For example, projections may be formed on the lower surface of the light guide plate 13. The projections contribute to making the light emitted from the light emitting element 11 be received by the fluorescent exciting sheet 15. Also, a reflector may be further formed on a lower portion of the light guide plate 13. The reflector reflects light that has leaked to a lower portion of the light guide plate 13 back in an upper direction.
- [31] The fluorescent exciting sheet 15 receives blue light emitted from the light emitting element 11 to emit white light. The fluorescent exciting sheet 15 may be realized to include a yellow phosphor or a red/green phosphor.
- [32] For another example, the light emitting element 11 may provide blue/green light. The light emitting element 11 may be realized as a blue light emitting diode and a green light emitting diode. Also, the light emitting element 11 may be realized to be mounted as a light emitting diode package including a blue light emitting chip and a green light emitting chip.
- [33] Blue/green light emitted from the light emitting element 11 passes through the light guide plate 13, and then is incident on the fluorescent exciting sheet 15. A pattern may be formed on a lower surface of the light guide plate 13. For example, projections may be formed on the lower surface of the light guide plate 13. The projections contribute to making the light emitted from the light emitting element 11 be received by the fluorescent exciting sheet 15. In addition, a reflector may be further formed on a lower surface of the light guide plate 13. The reflector reflects light that has leaked to a lower portion of the light guide plate 13 back in an upper direction.
- [34] The fluorescent exciting sheet 15 receives blue/green light emitted from the light emitting element 11 to emit white light. The fluorescent exciting sheet 15 may be realized to include a red phosphor.
- [35] The transfective polarizing prism sheet 17 condenses light emitted from the fluorescent exciting sheet 15, onto the liquid crystal panel 23. The liquid crystal panel 23 uses light incident thereon through the transfective polarizing prism sheet 17 to display image.

- [36] The transflective polarizing prism sheet 17 transmits light polarized in a set direction, whereas reflects light polarized in the other directions. For example, the transflective polarizing prism sheet 17 may be realized to have a transmission axis parallel with that of the polarizer 21 attached on the bottom of the liquid crystal panel 23. In this case, light polarized to pass through the first polarizer 21 attached on the bottom of the liquid crystal panel 23 passes through the transflective polarizing prism sheet 17, and then is incident on the liquid crystal panel 23. Also, light reflected from the transflective polarizing prism sheet 17 is reflected back from elements disposed below the transflective polarizing prism sheet 17. A portion of the light reflected back passes through the transflective polarizing prism sheet 17, and then is incident on the liquid crystal panel 23. Accordingly, a backlight unit has 30 % higher brightness when using the transflective polarizing prism sheet 17 than when using a general prism sheet. Upper surface of the transflective polarizing prism sheet 17 has a prism shape, and condenses light incident thereon from the fluorescent exciting sheet 15, onto the liquid crystal panel 23.
- [37] The second polarizing panel 25 may have a transmission axis either parallel with or nonparallel with that of the first polarizing panel 21 according to driving characteristics of the liquid crystal panel 23. According to the driving of the liquid crystal panel 23, the second polarizer 25 allows or prohibits a transmission of light incident thereon through the first polarizer 21.
- [38] The backlight unit or the liquid crystal display device described above may be applied to a mobile communication terminal to realize a slim mobile communication terminal.
- [39] A mobile communication terminal according to an embodiment of the present invention includes a communication unit for performing communication with the outside. A mobile communication terminal according to an embodiment of the present invention includes the communication unit and a control unit for controlling the backlight unit or the liquid crystal display device.

Mode for the Invention

- [40] While the present invention has been described and illustrated herein with reference to the preferred embodiments thereof, it will be apparent to those skilled in the art that various modifications and variations can be made therein without departing from the spirit and scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention that come within the scope of the appended claims and their equivalents.

Industrial Applicability

- [41] According to the present invention, it is possible to provide a backlight unit having

high emission brightness and excellent color uniformity over positions along with a slim profile.

- [42] According to the present invention, it is also possible to provide an LCD device and a mobile communication terminal including a backlight unit having high emission brightness and excellent color uniformity over positions along with a slim profile, so that it can be manufactured to have a slimmer profile.

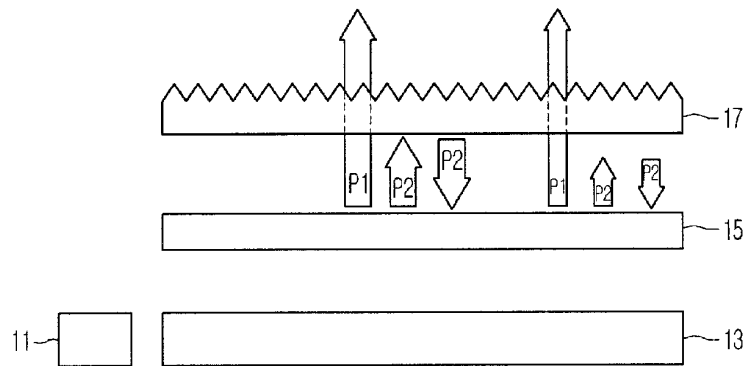
Claims

- [1] A backlight unit comprising:
 - a light guide plate;
 - a light emitting element for providing the colored light to the light guide plate;
 - a fluorescent exciting sheet formed on the light guide plate to receive the colored light incident thereon through the light guide plate and emit white light; and
 - a transfective polarizing prism sheet formed on the fluorescent exciting sheet.
- [2] The backlight unit according to claim 1, wherein the light emitting element comprises a blue light emitting diode, and the fluorescent exciting sheet comprises one of a yellow phosphor and a red/green phosphor.
- [3] The backlight unit according to claim 1, wherein the light emitting element comprises a blue light emitting diode and a green light emitting diode, and the fluorescent exciting sheet comprises a red phosphor.
- [4] The backlight unit according to claim 1, wherein the transfective polarizing prism sheet transmits light polarized in a first direction, whereas reflects light polarized in a second direction perpendicular to the first direction, and an upper surface thereof has a prism shape.
- [5] The backlight unit according to claim 1, comprising a reflector formed in a lower portion of the light guide plate.
- [6] The backlight unit according to claim 1, wherein a pattern is formed on a lower surface of the light guide plate.
- [7] The backlight unit according to claim 1, wherein white light emitted from the fluorescent exciting sheet is unpolarized light.
- [8] A liquid crystal display device comprising:
 - a backlight unit including a light guide plate, a light emitting element for providing the colored light to the light guide plate, a fluorescent exciting sheet formed on the light guide plate to receive the colored light incident thereon through the light guide plate and emit white light, and a transfective polarizing prism sheet formed on the fluorescent exciting sheet;
 - a liquid crystal panel receiving light provided by the backlight unit;
 - a first polarizer formed under the liquid crystal panel; and
 - a second polarizer formed on the liquid crystal panel.
- [9] The liquid crystal display device according to claim 8, wherein the transfective polarizing prism sheet has a transmission axis parallel with a transmission axis of the first polarizer.
- [10] The liquid crystal display device according to claim 8, wherein the light emitting element comprises a blue light emitting diode, and the fluorescent exciting sheet

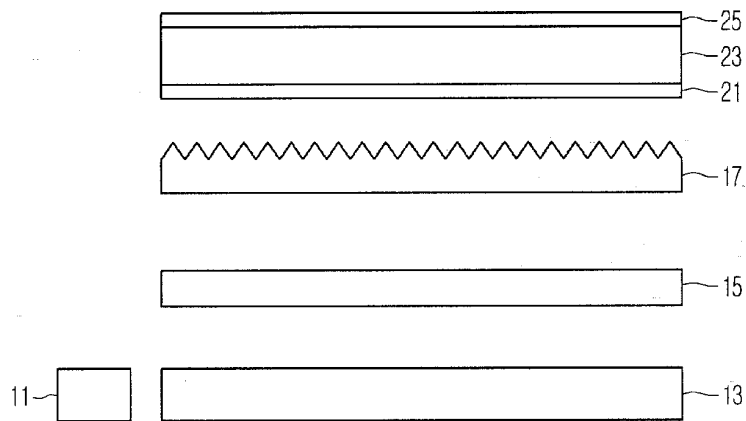
- comprises one of a yellow phosphor and a red/green phosphor.
- [11] The liquid crystal display device according to claim 8, wherein the light emitting element comprises a blue light emitting diode and a green light emitting diode, and the fluorescent exciting sheet comprises a red phosphor.
- [12] The liquid crystal display device according to claim 8, wherein the transfective polarizing prism sheet transmits light polarized in a first direction, whereas reflects light polarized in a second direction perpendicular to the first direction, and an upper surface thereof has a prism shape.
- [13] The liquid crystal display device according to claim 8, comprising a reflector formed under the light guide plate.
- [14] The liquid crystal display device according to claim 8, wherein white light emitted from the fluorescent exciting sheet is unpolarized light.
- [15] A mobile communication terminal comprising:
a backlight unit including a light guide plate, a light emitting element for providing the colored light to the light guide plate, a fluorescent exciting sheet formed on the light guide plate to receive the colored light incident thereon through the light guide plate and emit white light, and a transfective polarizing prism sheet formed on the fluorescent exciting sheet;
a liquid crystal panel receiving light provided by the backlight unit;
a first polarizer formed under the liquid crystal panel;
a second polarizer formed on the liquid crystal panel;
a communication unit for performing communication with an outside; and
a control unit for controlling the backlight unit, the liquid crystal panel, and the communication unit.
- [16] The mobile communication terminal according to claim 15, wherein the transfective polarizing prism sheet has a transmission axis parallel with a transmission axis of the first polarizer.
- [17] The mobile communication terminal according to claim 15, wherein the light emitting element comprises a blue light emitting diode, and the fluorescent exciting sheet comprises one of a yellow phosphor and a red/green phosphor.
- [18] The mobile communication terminal according to claim 15, wherein the light emitting element comprises a blue light emitting diode and a green light emitting diode, and the fluorescent exciting sheet comprises a red phosphor.
- [19] The mobile communication terminal according to claim 15, wherein the transfective polarizing prism sheet transmits light polarized in a first direction, whereas reflects light polarized in a second direction perpendicular to the first direction, and an upper surface thereof has a prism shape.
- [20] The mobile communication terminal according to claim 15, wherein white light

emitted from the fluorescent exciting sheet is unpolarized light.

[Fig. 1]



[Fig. 2]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/000033**A. CLASSIFICATION OF SUBJECT MATTER***G02F 1/13357(2006.01)i*

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)

IPC 8: G02F, F21V, H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility models since 1975

Japanese Utility models and application for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS (KIPO internal) & keywords: "blue*", "green*", "red*", "white*", "led*", "light emitting diode", "prism"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2002-0014130 A (LS TECH CO., LTD.) 25 February 2002 abstract; figures 4-7 and their corresponding descriptions	1-20
Y	KR 10-2005-0093329 A (N HI-TECH CO., LTD.) 23. September 2005 abstract; figures 2-4 and their corresponding descriptions	1-20
Y	US 2003-0164914 A1 (WEBER, MICHAEL F. et al.) 04 September 2003 abstract; figures 6-14 and their corresponding descriptions; paragraphs [0122]-[0147]	1-20
A	KR 10-2005-0105823 A (SAMSUNG ELECTRO-MECHANICS CO., LTD.) 08 November 2005 abstract; figures 2-5 and their corresponding descriptions	1-20

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"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

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YOON, Seong Ju

Telephone No. 82-42-481-5987



Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2007/000033

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR 10-2002-0014130 A	25.02.2002	None	
KR 10-2005-0093329 A	23.09.2005	None	
US 2003-0164914 A1	04.09.2003	AU 1434795 A1	10.07.1995
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Form PCT/ISA/210 (patent family annex) (April 2005)

PHOSPHOR CHROMATICITY CORRECTION PLATE

Publication number: JP2003222861 (A)

Publication date: 2003-08-08

Inventor(s): OKUWAKI DAISAKU +

Applicant(s): CITIZEN ELECTRONICS +

Classification:

- international: *F21V3/00; F21V5/00; F21V7/00; F21V8/00; G02B6/00; G02F1/13357; H01L33/50; F21Y101/02; F21V3/00; F21V5/00; F21V7/00; F21V8/00; G02B6/00; G02F1/13; H01L33/00; (IPC1-7): F21V8/00; F21Y101/02; G02B6/00; G02F1/13357; H01L33/00*

- European:

Application number: JP20020020794 20020129

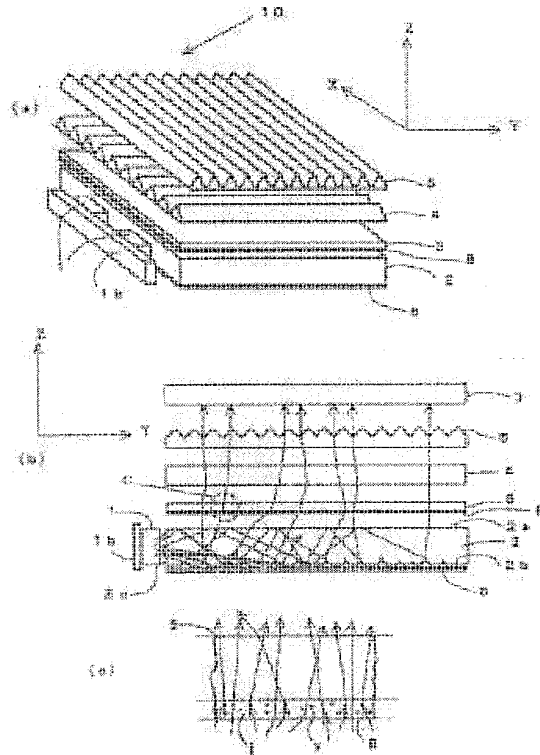
Priority number(s): JP20020020794 20020129

Also published as:

JP4039551 (B2)

Abstract of JP 2003222861 (A)

PROBLEM TO BE SOLVED: To improve the dispersion of the chromaticity of a white light emitting diode being a light emitting source so as to be matched with the color filter characteristics of a liquid crystal panel in an illumination means such as a back light or a front light for color liquid crystal display. ; **SOLUTION:** The phosphor chromaticity correction plate 8 having a YAG phosphor y is provided in an optical path from the light emission of the illuminator 10 of a liquid crystal panel 7 whose light emitting source is the white light emitting diode 1 to illumination, and the chromaticity of the emitted light of the white light emitting diode 11 is corrected matched with the color filter characteristics of the liquid crystal panel by the fluorescence of the YAG phosphor y excited by the emitted light of the white light emitting diode 1. ; COPYRIGHT: (C)2003,JPO



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F 2 1 V 8/00	6 0 1	F 2 1 V 8/00	6 0 1 A 2 H 0 9 1
			6 0 1 C 5 F 0 4 1
			6 0 1 D
			6 0 1 E

審査請求 未請求 請求項の数 8 O L (全 13 頁) 最終頁に続く

(21) 出願番号 特願2002-20794(P2002-20794)

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2H091 FA14Z FA21X FA23Z FA45Z

FA50Z FB02 FB13 FD06

LA30

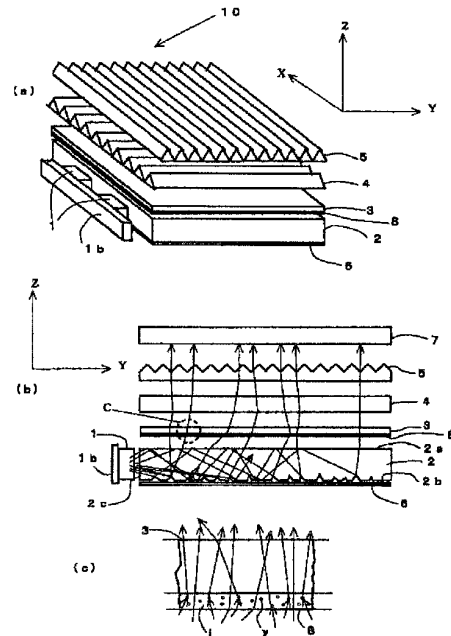
5F041 AA10 AA11 EE25 FF11

(54) 【発明の名称】 蛍光体色度補正板

(57) 【要約】

【課題】 カラー液晶表示用のバックライト又はフロントライト等の照明手段において、発光源である白色用発光ダイオードの色度のバラツキを液晶パネルのカラーフィルタ特性にマッチするように改善する。

【解決手段】 YAG蛍光体 y を有する蛍光体色度補正板8を、白色用発光ダイオード1を発光源とする液晶パネル7の照明装置10の発光から照明に至る光路に設け、その白色用発光ダイオード1の発光により励起されるYAG蛍光体 y の蛍光により、白色用発光ダイオード1の発光の色度を液晶パネルのカラーフィルタ特性に合わせて補正する。



【特許請求の範囲】

【請求項1】 YAG蛍光体を有する蛍光体色度補正板であって、LEDを発光源とする照明装置の発光から照明に至る光路に設けられ、そのLEDの発光により励起されるYAG蛍光体の蛍光により、LEDの発光の色度を補正することを特徴とする蛍光体色度補正板。

【請求項2】 前記の蛍光体色度補正板はバックライトユニットの拡散板、又はプリズムシートの上下面の両側もしくはいずれか片側にYAG蛍光体をシリコン樹脂等の樹脂に配合したものを塗布して形成されたものであることを特徴とする請求項1に記載の蛍光体色度補正板。

【請求項3】 前記の蛍光体色度補正板は、バックライトユニットの反射シートの上面にYAG蛍光体をシリコン樹脂等の樹脂に配合したものを塗布して形成されたものであることを特徴とする請求項1に記載の蛍光体色度補正板。

【請求項4】 前記の蛍光体色度補正板は、PC（ポリカーボネード）、PMMA（アクリル）等よりなる透明板又は透明シートの上下面の両側もしくはいずれか片側にYAG蛍光体をシリコン樹脂等の樹脂に配合したものを塗布して形成された蛍光体色度補正板であって、バックライトユニットの導光板と反射シートの間、導光板と拡散板の間、拡散板とプリズムシートの間又はLEDと導光板の間の少なくとも1つの隙間に挿入して配置されることを特徴とする請求項1に記載の蛍光体色度補正板。

【請求項5】 前記の蛍光体色度補正板は、PC（ポリカーボネード）、PMMA（アクリル）等よりなる透明板又は透明シートの内にYAG蛍光体を混入して形成された蛍光体色度補正板であって、バックライトユニットの導光板と反射シートの間、導光板と拡散板の間、拡散板とプリズムシートの間又はLEDと導光板の間の少なくとも1つの隙間に挿入して配置されることを特徴とする請求項1に記載の蛍光体色度補正板。

【請求項6】 前記の蛍光体色度補正板は、PC（ポリカーボネード）、PMMA（アクリル）等よりなる透明板又は透明シートの上下面の両側もしくはいずれか片側にYAG蛍光体をシリコン樹脂等の樹脂に配合したものを塗布して形成された蛍光体色度補正板であって、フロントライトユニットのLEDとガイドロッドの間、ガイドロッドとガイドプレートとの間の少なくとも1つの隙間に挿入して配置されることを特徴とする請求項1に記載の蛍光体色度補正板。

【請求項7】 前記の蛍光体色度補正板は、PC（ポリカーボネード）、PMMA（アクリル）等よりなる透明板又は透明シートの内にYAG蛍光体を混入して形成された蛍光体色度補正板であって、フロントライトユニットのLEDとガイドロッドの間、ガイドロッドとガイドプレートとの間の少なくとも1つの隙間に挿入して配置されることを特徴とする請求項1に記載の蛍光体色度補正

板。

【請求項8】 前記蛍光体色度補正板はYAG蛍光体を混入して形成されたバックライトユニットの拡散板又はプリズムシートであることを特徴とする請求項1に記載の蛍光体色度補正板。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】この発明は例えば液晶パネルを背面より照射するバックライト又は液晶パネルを前面より照明するフロントライトに使用される色度補正手段に関し、特に蛍光体色度補正板に関する。

【0002】

【従来の技術】近年、ブック型のワードプロセッサやコンピュータ、又は携帯電話機、携帯TVのような小型、薄型の情報機器の表示装置として、薄型でしかも見易い照明機構を有する液晶表示装置が用いられている。このような液晶表示用の照明機構としてバックライトおよびフロントライトが従来より知られている。ここで液晶表示用バックライトとは、液晶パネルを背後から全面にわたり照射する面状の光源であり、液晶表示用フロントライトとは液晶パネルを前面より照明する面状の光源であり、いずれも蛍光ランプ、LED（発光ダイオード）等よりなる発光源と、その発光源の光束を液晶パネルに照射する面状の光束に変換する導光板等の光路変換手段を備えている。この中で、特に近年は、更なる小型、薄型化と長寿命化を目的として発光源としてLEDを用いたものが多く使用されるようになってきている。

【0003】かかる面状光源により白色の照明光を出射させ、パネル等に対し白色の照明をしようとするときは、発光源として白色の蛍光ランプを用いるか、LEDの場合にはR、G、Bの3種類のLEDを同時点灯、又は時分割点灯して白色光を合成することが一般的であった。更に最近では、LEDの場合、単独で白色に近い光を発光する白色用LEDが開発され、利用できるようになってきた。このような白色用LEDを用いることにより、小型で簡単な構成で白色照明を目的とする液晶表示用バックライトまたは液晶表示用フロントライトを形成することが可能となった。図10はこのようなLEDの発光源を持ち、カラー液晶パネルの白色照明を目的とした従来の液晶表示用バックライトの主要部を示す図であり、(a)は斜視図、(b)におけるA-A断面図である。

【0004】図10において、110はカラー表示用の液晶パネルの照明を目的としたバックライトであり、導光板101と発光源としてLED102を有している。導光板102は無色透明なプラスチック材等の透光部材よりなる板状で略直方体形状をしており、その一方の主面を光出射面101aとし、該光出射面101aと対向する面には、発光源からの光を前記光出射面101aに向けて反射させるための手段として、その表面に複数の

微小なシボ又は複数個の半球状ドット等を有する光拡散面101bが形成されている。LED102はLED基板103に支持されて導光板101の入光側面101cに対向する位置に配設され、図示しない駆動回路より所定の電流が供給されて、後述するような白色を目的とした光を発光、出射する。

【0005】図11(a)は白色発光を目的とするLED102の内部構造を示す図である。図11(b)は発光部はLED102の発光部の詳細を示す図である。図において、102aは青色を発光する発光ダイオード素子、102bは発光ダイオード素子102aを保持する端子A、102cは他方の端子Bである。発光ダイオード素子102aのn電極102anおよびp電極102apはそれぞれボンディングワイヤー102dにより、端子A(102b)及び端子B(102c)に接続されている。端子A(102b)の凹部内には発光ダイオード素子102aを被うようにしてYAG蛍光体yを混入、分散した樹脂層よりなる蛍光体層102fが充填されている。102gは透光性を有する封止部材であり、端子A(102b)及び端子B(102c)の突出部を除き上記の部材全体を封止し、保護する。このようなLED102において、発光ダイオード素子102aが青色発光をすると、その青色発光の一部がYAG蛍光体yに吸収されて黄緑色の励起光を発する。これにより、蛍光体層102fの上面からは、蛍光体層102fを透過した青色光とYAG蛍光体yで励起された励起光(蛍光)である黄緑色の光が混ざり合って出射し、封止部材102gを透過してLED102の外部に出射する。かかるLED102の発光の色度は、青色と黄緑色の光の強度の比率により変化するが、これらの比率を適切に設定すれば、理論的には真の白色又はその近傍において、所望の色度を得ることができる。(しかし、実際には、不可避な製造条件のバラツキにより、発光ダイオード素子102aの青色発光の強度が変動し、YAG蛍光体yの濃度(又は成分)のバラツキにより黄緑色の励起光の強度はかなり変動するので、これらの加法混色によるLED102の発光の色度を所望の範囲に入れることは容易ではない。)

【0006】図10に示すように、LED102からの出射光は導光板101に入り、大部分の光は上面である光出射面101aで全反射、下面である光拡散面101bでは全反射又は乱反射を1回又は複数回行った後に上面である光出射面101aより照明光105として外部に出射する。外部に出射した照明光105は(b)に示すように図示しないカラーフィルタを有する透過型もしくは半透過型の液晶パネル(又は液晶表示板)107を背後から照明する。なお、前記照明する面内の輝度の均一性を確保するために上記下面101b内のシボの粗さを調整したり、半球状ドットの形状、密度を場所により変えたりする。

【0007】次に図12は白色を目的としたLEDの発光源を持ち、カラー表示用液晶パネルの白色照明を目的とした従来の液晶表示用フロントライトの構成を示す図であり、(a)は斜視図、(b)は上面図、(c)は側面図である。図12において、120はフロントライトであり、発光源である白色用LED102と光路変換部材であるガイドロッド112、ガイドプレート113、反射板114を有している。117は図示しないカラーフィルタを有する反射型液晶パネル(又は反射型液晶表示板)であり、後述するように前記フロントライト120の照明の対象であると共に、その反射作用により、光路変換部材としての役割もなすものである。前記のガイドロッド112は透光性の樹脂等よりなり略四角柱状をなし、長手方向に平行な一方の端面は複数のV溝112vを有する反射面112bとなっており、この反射面112bに対向する側面は平滑な出射面112cとなっている。ガイドロッド112の長手方向に直交する端面112dは白色用LED102の発光の入射面となっている。ガイドロッド112の前記端面112dに対向して白色用LED102が配置され、反射面112bに対向して反射板114が配置されている。ガイドプレート113は全体的には四角の平板状で、その一方の側面が前記ガイドロッド112に対向した入射面113aとなっている。ガイドプレート113の上面113bには入射面113aに平行な方向に延びる複数のV溝プリズム113vが設けられている。ガイドプレートの下面113cは平滑で、後述するように内部に対する反射面と反射型液晶表示板117に対する出射面及び入射面の役割を兼用する。

【0008】今、白色用LED102が発光するとその発光の光線はガイドロッド112の前記端面112dから入射し、ガイドロッド112内において、主としてV溝112vにおける反射により出射面112cから、ガイドプレート113に向けて出射光を発する。ここで、反射板114はガイドロッド112の前記反射面112bから後方に漏れた光を反射させて、再びガイドロッド内112に入射させ、光の利用効率を高める作用をなす。ガイドロッド112からの出射光はV溝112vの作用により、ガイドロッドの長手方向全体にわたって略均一に出射し、線状光源として機能する。この出射光はガイドプレート113の入射面113aよりガイドプレート内に入り、内部に入った光線の大部分は、図102(c)に示すように直接に又は上面113bのV溝プリズム以外の部分による反射又は下面113cによる反射等を経て上面のV溝プリズム113vの斜面に達しここで全反射されて下面113cを経て反射型液晶表示板117に入射する。反射型液晶表示板117に入射した光はその反射膜117bにおいて反射され、その反射光は画像情報を有する光線として、再びガイドプレート113に入射し、これを透過して外部に表示のための光線を出

射する。

【0009】

【発明が解決しようとする課題】このようにして、図10に示して説明した小型・薄型のバックライト110及び図12に示して説明した小型・薄型のフロントライト120により、共にカラーLCD用白色照明を目的とした液晶パネルの照明がなされる。しかしながら、上記のバックライト110フロントライト120等の従来の液晶表示用の照明手段においては、以下に述べるような問題点がある。即ち、上記のような反射型又は透過型もしくは半透過型の液晶パネルは、カラー表示のために、その内部に図示しないカラーフィルタを有しているが、カラーフィルタの特性が各メーカーごとに異なっている。一方、液晶パネルの表示する画像の色度はカラーフィルタの特性（透過率の波長特性）と照明光の色度即ち発光源である白色用LED（102）の色度に依存して定まる。例えば、R、G、Bの各カラーフィルタの特性のバランスが完全にとれている場合には、白色用LEDの色度が完全に白色であれば、カラー信号が白色のときは、液晶パネルの表示色は白色となる。

【0010】しかし、R、G、Bの各カラーフィルタの特性のバランスがR、Gに傾いているときは、白色用LEDの色度が完全に白色であっても、液晶パネルの表示色は黄緑がかった色となり、所望の白色の表示色は得られない。この場合、所望の白色の表示色を得るには、白色用LEDの色度を完全な白色とせず、R、G、よりもBが勝った青みがかった白色すなわち、カラーフィルタと補色関係にある色度とすることが必要である。このことは、白色を表示する場合に限らず、カラー信号により指定された種々の色度の色を忠実に表示しようとする場合にも成立つことである。よって、液晶パネルのメーカーはカラーフィルタの特性のバラツキにあわせて、この特性を補償できる色度の白色用LEDを色度のランクを指定してランク別に要求するようになってきた。

【0011】図14は前記白色用LED102の発光の色度を示すCIE色度図である。ここで、xはRの割合を、yはGの割合を示す。そして、図には示していないが、zはBの割合としたとき、常に

$$x + y + z = 1 \cdots (1)$$

の関係があるとしている。（C0はR、G、Bの成分比が1:1:1である色度の点を示し、この場合、座標は略 $x=0.33$ 、 $y=0.33$ 、（ $z=0.33$ ）となっている。）ここで、b1は指定されたランクb1の色度の範囲を示し、b2は指定されたランクb2の色度の範囲を示す。ところが、かかる指定された領域b1、b2内に色度を入れることを目的にLEDを製造しても実際の製品の色度はすでに説明したような製造上の不可避な理由により、ばらつき、上記ランクb1、b2を大きくはみ出でた領域S内にばらついてしまう。図14において、c0は白色の色度（R、G、Bの比率は略 0、

33:0.33:0.33）、c12およびc13は上記ランクb1、b2から外れた白色用LEDの色度を示す。

【0012】ここで、図13は前記のc12、c13、c0の色度に対応する発光のスペクトル示す図である。ここで、H12、H13、H0はそれぞれ、前記色度点c12、c13、c0に対応するスペクトルを示す。これらの、スペクトル図において、横軸は波長を示し、625nmの前後がRの領域、560nm前後がGの領域、450nmの近傍がBの領域である。縦軸はスペクトルの相対強度を示す。図13（a）に示すスペクトルH12は、R、G、Bの比率が0.28:0.25:0.47となり、かなりBの成分が他の成分よりかなり大となっている。この場合は白色LED102を構成する青色発光ダイオード素子の輝度に対してYAG蛍光体の濃度が少ない場合に対応し領域b1、b2よりも更に青みがかった色度となる。図13（b）に示すスペクトルH13は、R、G、Bの比率が0.32:0.38:0.3となりR、Gの成分がBの成分より大となっている。この場合は、前記の発光ダイオード素子の輝度とのバランスでYAG蛍光体の濃度が大きすぎる場合に対応し、領域b1、b2よりも黄緑がかった色度となる。このように、白色LED102を製造する際にその構成要素の不可避なバラツキにより、その発光の色度が指定されたランク（b1、b2）に入らない場合を生ずる。

【0013】白色LEDの発光の色度が指定されたランクのいずれにも入らない場合は、その白色LEDは無駄になってしまう。又、発光の色度が指定されたランク（b1、b2）に入るものについても、ランクb1に入る白色LEDとランクb2に入る白色LEDの個数の比率がマッチングする液晶パネルの個数の比率と一致しない場合は、結果的に無駄を生ずる。例えば、ランクb1の白色LEDを必要とする液晶パネルが50個、ランクb2の白色LEDを必要とする液晶パネルが50個あるとき、200個の白色LEDの中にランクb1に入るものが50個、ランクb2に入るものが100個、ランクb1にも、ランクb2にも入らないものが50個あったとすると、無駄になるのはランク外の50個だけではなく、ランクb2に入るものの内50個はあまってしまって使われないので、結果的に無駄となる。この場合、実際に使用できる白色LED100個を得るために白色LEDを200個入手する必要があり、結果的に100個が無駄となる。このように、カラー表示を目的とした液晶パネルの照明手段であるバックライト又はフロントライトの照明光の色度は従来は白色LEDの色度そのものであるため、液晶パネルのカラーフィルタの特性にマッチするようにユーザーから指定された色度のランクを狙って白色LEDを生産したとしても、ランクからは外れて、バックライト又はフロントライトに使用できないものが多数生じ、不良品又は在庫が増える結果となる。更

に最近ではユーザーの指定する色度のランクは細かく要求されるので、指定の色度に入れることがますます困難な状態となってきている。

【0014】そこで本発明は、カラー表示用の液晶パネルに用いられる照明手段であるバックライト又はフロントライトにおいて、所望の色度ランク入らない白色LEDの色度を補正して照明光の色度を所望の色度ランクに入れるように改善することを目的とする。この発明の前記ならびにそのほかの目的と新規の特徴は本明細書の記述および添付図面から明らかになるであろう。

【0015】

【課題を解決するための手段】上記の課題を解決するためにその第1の手段として本発明は、YAG蛍光体を有する蛍光体色度補正板であって、LEDを発光源とする照明装置の発光から照明に至る光路に設けられ、そのLEDの発光により励起されるYAG蛍光体の蛍光により、LEDの発光の色度を補正することを特徴とする。

【0016】上記の課題を解決するためにその第2の手段として本発明は、前記第1の手段において、前記の蛍光体色度補正板はバックライトユニットの拡散板、又はプリズムシートの上下面の両側もしくはいずれか片側にYAG蛍光体をシリコン樹脂等の樹脂に配合したものを塗布して形成されたものであることを特徴とする。

【0017】上記の課題を解決するためにその第3の手段として本発明は、前記第1の手段において、前記の蛍光体色度補正板は、バックライトユニットの反射シートの上面にYAG蛍光体をシリコン樹脂等の樹脂に配合したものを塗布して形成されたものであることを特徴とする。

【0018】上記の課題を解決するためにその第4の手段として本発明は、前記第1の手段において、前記の蛍光体色度補正板は、PC（ポリカーボネード）、PMM A（アクリル）等よりなる透明板又は透明シートの上下面の両側もしくはいずれか片側にYAG蛍光体をシリコン樹脂等の樹脂に配合したものを塗布して形成された蛍光体色度補正板であって、バックライトユニットの導光板と反射シートの間、導光板と拡散板の間、拡散板とプリズムシートの間又はLEDと導光板の間の少なくとも1つの隙間に挿入して配置されることを特徴とする。

【0019】上記の課題を解決するためにその第5の手段として本発明は、前記第1の手段において、前記の蛍光体色度補正板は、PC（ポリカーボネード）、PMM A（アクリル）等よりなる透明板又は透明シートの内にYAG蛍光体を混入して形成された蛍光体色度補正板であって、バックライトユニットの導光板と反射シートの間、導光板と拡散板の間、拡散板とプリズムシートの間又はLEDと導光板の間の少なくとも1つの隙間に挿入して配置されることを特徴とする。

【0020】上記の課題を解決するためにその第6の手段として本発明は、前記第1の手段において、前記の蛍

光体色度補正板は、PC（ポリカーボネード）、PMM A（アクリル）等よりなる透明板又は透明シートの上下面の両側もしくはいずれか片側にYAG蛍光体をシリコン樹脂等の樹脂に配合したものを塗布して形成された蛍光体色度補正板であって、フロントライトユニットのLEDとガイドロッドの間、ガイドロッドとガイドプレートの間の少なくとも1つの隙間に挿入して配置されることを特徴とする。

【0021】上記の課題を解決するためにその第7の手段として本発明は、前記第1の手段において、前記の蛍光体色度補正板は、PC（ポリカーボネード）、PMM A（アクリル）等よりなる透明板又は透明シートの内にYAG蛍光体を混入して形成された蛍光体色度補正板であって、フロントライトユニットのLEDとガイドロッドの間、ガイドロッドとガイドプレートの間の少なくとも1つの隙間に挿入して配置されることを特徴とする。

【0022】上記の課題を解決するためにその第8の手段として本発明は、前記第1の手段において、前記蛍光体色度補正板はYAG蛍光体を混入して形成されたバックライトユニットの拡散板又はプリズムシートであることを特徴とする。

【0023】

【発明の実施の形態】以下に、図面に基づいて本発明の第1実施形態につき図面を用いて説明する。図1は本発明の第1実施形態に係る蛍光体色度補正板を用いたバックライト10の構成を示す図であり、(a)は斜視図、(b)は断面図である。(c)は(b)に示すC部の拡大図である。図1において、1は白色用発光ダイオード（又は白色用LED）、2は導光板、3は拡散板、8は拡散板3の下面に形成された蛍光体色度補正板である。前記色度補正板8は、図1(c)に示すようにYAG蛍光体yをシリコン樹脂等の樹脂jに配合したものを塗布することにより形成される。4はPyプリズムシート、5はPxプリズムシート、6は反射板、7はカラー表示用の透過型もしくは半透過型の液晶表示板であり、図示しないカラーフィルタを有している。白色用発光ダイオード1は導光板2の側面2cに対向する位置に配置され、導光板1の上方には拡散板3、Pyプリズムシート4、Pxプリズムシート5が順次重ねて配置される。反射シート6は導光板2の下面2bに対向、近接して配置される。白色用発光ダイオード1の発光は導光板2の側面2cから入射し、導光板2の上面2aと下面2bの間で反射を繰り返しながらその内部を伝播し、その間に平滑な上面2aから（上方に）出射する。下面2bは細かな凹凸を有する乱反射面となっており、光を種々の方向に拡散できるようになっている。反射板6は乱反射面である下面2bから外部に出ようとする光を反射させて内部に戻し、光の利用効率を上げる作用をなす。

【0024】導光板2の上面2aからの出射光は蛍光体色度補正板8を経て拡散板3に達し、ここで光の方向が

中程度の範囲に絞られる。更に、Pyプリズムシート4によりy方向の角度が絞られ、Pxプリズムシート5によりx方向の角度が絞られ、最終的には出射光を略z方向に揃える。このz方向に揃った光線が液晶表示板7に入射することにより液晶を透過する光の状態を理想的なものとし、鮮明でSNの高い表示を可能とする。

【0025】本第1実施の形態の特徴とするところは、すでに述べたように、拡散板3の下面に形成された色補正板8の内部にYAG蛍光体yが混入されていることである。ここで、白色用発光ダイオード1の発光のスペクトルを図2(a)のスペクトルH12に示す。又このスペクトルH12に対応する色度を図3の色度図の色度点c12に示す。(これらは従来例の説明において図13(a)および図14にそれぞれ示したスペクトルH12及び色度点c12と同一である。なお、本実施形態においては、白色用発光ダイオード1を2個用いているが、スペクトルH12は2個の平均的なスペクトルである。)このスペクトルH12に対応する図3の色度点c12は、指定された色度のランクb1、b2よりも左下方に外れており、スペクトルH12のR、G、Bの比率は略0.28:0.25:0.47となっており、図2(a)に示すように460nmをピークとする青色光の強度が、550nmをピークとする黄緑色の光の強度に比してかなり大となっている。このため白色用発光ダイオード1の発光色は、かなり青みがかった白色となっている。

【0026】この白色用発光ダイオード1の発光光線が上記のように導光板2を経て拡散板3の下面に形成された蛍光体色度補正板8に入射し、図1(c)に示すように、蛍光体色度補正板8の内部において入射光のうち青色成分(460nmをピーク)の一部がYAG蛍光体yに吸収され、550nmをピークとした黄緑色の励起スペクトルを発生する。これにより、YAG蛍光体yの混入量を適切に設定しておけば、図2(a)に示すように白色用発光ダイオード1の発光のスペクトルH12の青色成分を減少させ、黄緑色の成分を増加させ、図に示すスペクトルH2(R、G、Bの比率は略0.3:0.3:0.4)の光線となって蛍光体色度補正板8を透過して拡散板3に入射させることができる。この拡散板3に入射するスペクトルH2の光線の色度は図3の点c2となっており、ランクb2の領域に入っている。ここでYAG蛍光体yの励起スペクトル自体の色度は図3のc3となっており、蛍光体色度補正板8から拡散板3に入射する光線の色度は、YAG蛍光体yの混入量が増加するに従って点c12と点c3を結ぶ点線上をたどってc3に向かって移動する。上記の例においては、蛍光体yの混入量を、色度が領域b2内にある点c2となるように設定したが、蛍光体y混入量を更に若干増やすことにより、図2(b)に示すように前記発光スペクトルH12

の青色成分を更に減少させ、黄緑色の成分を増加させてスペクトルH1(R、G、Bの比率は略0.32:0.34:0.34)に補正することができる。ここでスペクトルH1に対応する色度は図3の点c1となり、光線の色度をランクb1内に入れることができる。蛍光体yの混入料は蛍光体色度補正板8の厚さに比例するので、本実施の形態の場合は蛍光体色度補正板8の厚さを適切に設定することにより光線の色度をb1のランクでも、b2のランクでも所望のランクに入れることができる。

【0027】なお、YAG蛍光体の成分の調製によりその発光スペクトルの色度は図3に示すc3を含む円弧状の曲線Srの上を移動する。このような性質を利用すれば、白色用発光ダイオード1の色度c12を、YAG蛍光体yの含有量及び成分を適切に設定することにより、破線で囲まれた領域DS内で補正することができる。従って、用途によって、完全な白色が必要とされる場合でも、白色の色度点c1(R、G、Bの比率は略0.33:0.33:0.33)は図3に示すように前記領域DS内にあるので、白色用発光ダイオード1の色度c12を完全な白色に補正することもできる。このようにして、一般に青色成分が過大なために、所望のランクから外れている白色用発光ダイオードの色度を所望のランクに入れるように補正することができる。ただし、本発明においては、発光ダイオードのスペクトルの青色成分を減少させて、黄緑色成分を増加させる補正はできるが、その逆に青色成分を増加させて、黄緑色成分を減少させる補正はできない。例えば、すでに図13(b)に示したスペクトルH13の場合(その色度点はc13)は、青色成分に比して黄緑色成分が過大となっているが、このような場合に上記蛍光体色度補正板を用いても所望の色度ランクb1又はb2に入るように色度を補正することはできない。(その意味において、所望の色度の補正光を得ようすれば、白色発光ダイオード(1)として当初より、ある程度青みがかった白色用発光ダイオードを狙って作り込んでおくことが望ましい。)

【0028】このようにして、色度が所望の色度に補正されて蛍光体色度補正板8から出た光は、すでに説明した原理により、拡散板3、y方向プリズムシート4、x方向プリズムシート5を順次経てz方向に揃った所望の色度のランクに入る照明光として透過型の液晶表示板7に入射する。このようにして、透過型の液晶表示板7のカラーフィルタ特性にマッチした照明がなされ、色度の再現性に優れたカラー画像の表示をすることができる。なお本実施の形態のバックライトは、白黒表示用の透過型の液晶表示板等の照明手段として用いる場合には、青みがかった色度の白色用を用い、すでに説明した原理を用いて色度補正をすることにより、純粋の白色またはこれに極近い照明光を出射することができる。なお、図示は省略するが、拡散板3の上下両面、又上面に上記と同

様の蛍光体色度補正板を形成した場合も本第1実施形態と同様の効果が得られる。

【0029】次に、図4は図1に示した第1実施形態の変形例であるバックライト20の構成を示す図である。図2に示すようにバックライト20においては、拡散板3の下面に形成した前記色補正板8（図1）の代わりに、同様の材料により、Pyプリズムシート4の下面およびPxプリズムシート5の下面にそれぞれ蛍光体色度補正板8が塗布等により形成されている。その他の構成については図1に示したバックライト10と同様である。このような構成において、白色用発光ダイオード1の発光はすでに説明した光路を経て前記蛍光体色度補正板8yに入射する。そして、ここで色度補正がなされた光がPyプリズムシート4を経て前記蛍光体色度補正板8xに入射し、ここで更なる色度補正がなされた後、Pxプリズムシート5を経て、照明光として透過型液晶表示板7に入射する。このように白色用発光ダイオード1の発光は2回わたって色度補正されるが、色度補正の原理そのものは、すでに説明したものと同様であり、照明光の色度は最終的に所望の色度のランクb1又はb2に入るように補正される。なお、蛍光体色度補正板は8x及び8yのどちらかでもよい。

【0030】以下に、図面に基づいて本発明の第2実施形態につき図面を用いて説明する。図5は本発明の第2実施形態に係る蛍光体色度補正板を用いたバックライト30の構成を示す断面図であり、(a)は全体図、(b)、(c)は蛍光体色度補正板の拡大図である。本第2実施形態に係るバックライト30の蛍光体色度補正板を除いた基本的な構成は、図1に示すバックライト10の基本的構成と同様である。図5において9は別体として製作された蛍光体色度補正板であり、(b)に示すようにPC（ポリカーボネイト）やPMMA（アクリル）よりなる透明板（又は透明シート）9aの上下面の両側もしくはどちらか片側にYAG蛍光体yを樹脂（シリコン樹脂等）jに配合したものを塗布して硬化することにより形成する。この形状は板状又はシート状である。蛍光体色度補正板9は(c)に示すように前記の透明板（又は透明シート）9a内にYAG蛍光体yが混入されたものを使用してもよい。このような蛍光体色度補正板9が、導光板2と反射板6の間、導光板2と拡散板3の間、拡散板3とPyプリズムシート4の間、およびPyプリズムシート4とPxプリズムシート5の間にそれぞれ1枚ずつ挿入されている。

【0031】この挿入は密着状態で挿入してもよいし、ホルダー等を用い、若干の隙間をおいて挿入、保持するようにしてもよい。本第2実施形態においても、光が蛍光体色度補正板9を通過する度に、すでに説明した原理により光線の色度補正が行われ、最終的には所望のランクに入る色度の照明光となって、透過型液晶表示板7に入射する。本第2実施形態においては、予めYAG蛍光

体の含有量を種々に変えた蛍光体色度補正板9を何種類か準備しておき、もとの白色用発光ダイオード1の発光の色度に対応し、所望の色度ランクに入れるために必要な補正の程度に応じて、適切なYAG蛍光体の含有量の蛍光体色度補正板9を選択して使用することにより、きめ細かく目的に応じた色度補正ができる。なお本実施の形態はこれに限らず、蛍光体色度補正板9が挿入された上記の場所のいずれか1又は1以上の場所に、蛍光体色度補正板9が挿入された場合も効果を有する。又、前記のように導光板2と反射板6の間に蛍光体色度補正板9を挿入する代わりに、図示は省略するが、反射シートの上にYAG蛍光体を樹脂（シリコン樹脂等）に配合したものを塗布して効果させたものを用いても同様の色度補正の効果を有する。

【0032】次に、図6は図5に示した第2実施形態の変形例であるバックライト40の構成を示す図である。図6に示すようにバックライト40においては、図5のバックライト30に使用したのと同様の、別体として製作された蛍光体色度補正板9が白色用発光ダイオード1と導光板2の入光側面2cの間に挿入されて配置されている。白色用発光ダイオード1の発光は蛍光体色度補正板9を通過する際に所望の色度に補正され、色度が補正された光が側面2cより導光板2内に入り、以後、すでに説明したような光路を経て、所望の色度に補正された照明光として透過型の液晶表示板7に入射する。この場合も、上記と同様の原理により、きめ細かく目的に応じた色度補正ができる。

【0033】以下に、図面に基づいて本発明の第3実施形態につき図面を用いて説明する。図7は本発明に係る蛍光体色度補正板を用いたフロントライト50の構成を示す図であり、(a)は斜視図、(b)は上面図、

(c)、(d)は断面図である。図において、1は白色用発光ダイオード、9は蛍光体色度補正板であり、12はガイドロッド、13はガイドプレート、14は反射板、17は反射型液晶表示板である。ガイドロッド12は透光性の樹脂等よりなり略四角柱状をなし、長手方向に平行な一方の端面は複数のV溝12vを有する反射面12bとなっており、この反射面12bに対向する側面は平滑な出射面12cとなっている。ガイドロッド12の長手方向に直交する端面12dは白色用発光ダイオード1の発光の入射面となっている。ガイドロッド12の前記端面12dに対向して白色用発光ダイオード1が配置され、反射面12bに対向して反射板14が配置されている。ガイドプレート13は全体的には四角の平板状で、その一方の側面が前記ガイドロッド12に対向した入射面13aとなっている。ガイドプレート13の上面13bには入射面13aに平行な方向に延びる複数のV溝プリズム13vが設けられている。ガイドプレートの下面13cは平滑で、後述するように内部に対する反射面と反射型液晶表示板17に対する出射面及び入射面の

役割を兼用する。

【0034】図7に示すように、フロントライト50においては、蛍光体色度補正板9がガイドロッド12の端面12dと白色用発光ダイオード1の隙間に挿入されている。この点が本第3実施形態の特徴とするところであり、その他の構成については図12に示した従来のフロントライト120と同様である。なお本実施の形態で使用する蛍光体色度補正板9は別体として製作されたものであり、図5(b)に示す色補正板9と同様に、透明板（又は透明シート）の上下面の両側もしくはどちらか片側にYAG蛍光体を樹脂に配合したものを塗布して硬化することにより形成されたものか、又は図5(c)に示すものと同様に前記の透明板（又は透明シート）内にYAG蛍光体yが混入されて形成されたものである。蛍光体色度補正板9の挿入は隙間なく密着されて挿入される場合と、適切なホルダーに保持されて、又はガイドロッド12の端面12d等に透明な接着剤により接着されて、若干の隙間をもって挿入される場合がある。

【0035】今、白色用発光ダイオード1が発光するとその発光の光線は前記蛍光体色度補正板9を透過してガイドロッド12内に前記端面12dから入る。光線が前記蛍光体色度補正板9を透過する際に、光線の色度は白色用発光ダイオード1の本来の色度から所望のランクに入る色度に補正される。この補正された色度の光線が端面12dから入射し、ガイドロッド12内において、主としてV溝12vにおける反射により出射面12cから、ガイドプレート13に向けて出射光となる。ここで、反射板14はガイドロッド12の前記反射面12bから後方に漏れた光を反射させて、再びガイドロッド12に入射させ、光の利用効率を高める作用をなす。ガイドロッド12からの出射光はV溝12vの作用により、ガイドロッドの長手方向全体にわたって略均一に出射し、線状光源として機能する。この出射光はガイドプレート13の入射面13aよりガイドプレート内に入り、内部に入った光線の大部分は、図7(c)に示すように直接に又は下面13cによる反射等を経て上面のV溝プリズム13vの斜面に達しここで全反射されて下面13cを経て反射型液晶表示板17に色度補償された照明光として入射する。反射型液晶表示板17に入射した光はその反射膜17bにおいて反射され、その反射光は画像情報を有する光線として、再びガイドプレート13に入射し、これを透過して外部に表示のための光線を出射する。ここで、反射型液晶表示板17はカラー化のために図示しないカラーフィルタを有している。このように、本実施の形態においては、蛍光体色度補正板9の効果により、カラー表示用の反射型液晶表示板17に所望の色度ランクに入るように色度補正された照明光を入射することができ、これにより表示画像の色度の再現性を向上し、画質を向上させることができる。

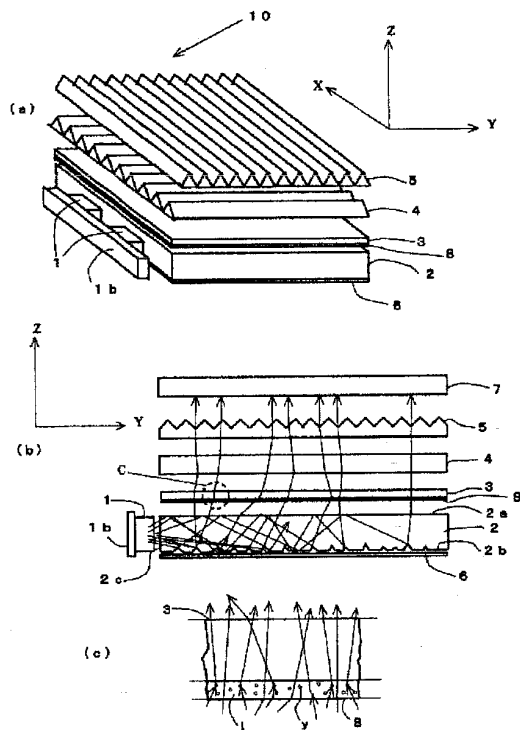
【0036】図7(d)に示すガイドプレート23は図

7(c)に示したガイドプレート13の変形例であり、入射面は23aであり、その上面23bには階段状の階段プリズム23pが設けられている。階段プリズム23pの一方の斜面の傾斜はガイドプレート13の前記V溝プリズム13vの斜面の傾斜よりかなりゆるやかになっている。ガイドプレート23は、階段プリズム23pの反射作用により、基本的には前記ガイドプレート13と同様の原理により、平滑な下面23cから反射型液晶表示板17に対し照明光を出射し、その反射光を下面23cから再入射させ、上面23bから表示光として出射させる。ガイドプレート13に比較すると、プリズム面からの反射光の傾きが大きくなり、斜め漏れの光が増え、光の利用効率は低下するが、ガイドプレートを製造するための成形型の磨耗が少なくなり、結果的に製造コストを低減する利点を有する。図7(c)に示すガイドプレート13のの代わりに図7(d)に示すガイドプレートを使用した場合もカラー表示用の反射型液晶表示板17に所望の色度ランクに入るように色度補正された照明光を入射することができ、上記と同様の色度補正の効果を得ることができる。

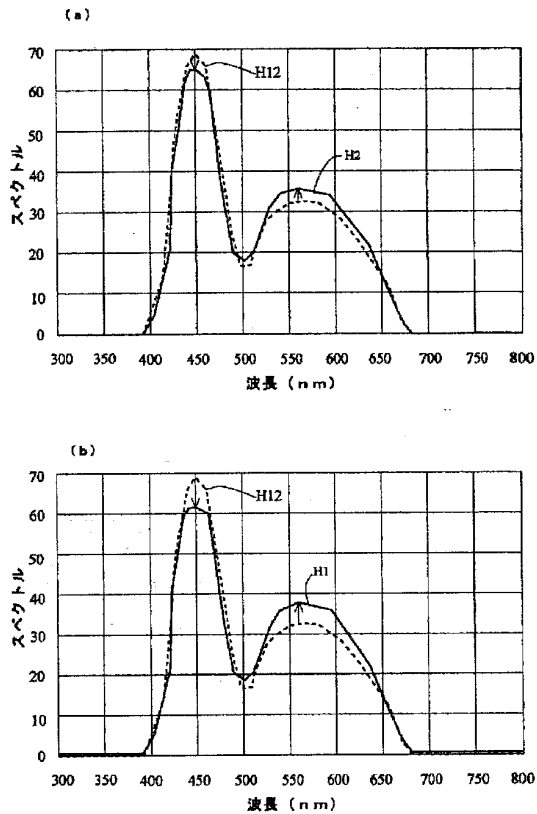
【0037】以下に、図面に基づいて本発明の第4実施形態につき図面を用いて説明する。図8は本第4実施形態に係る蛍光体色度補正板9を用いたフロントライト60の構成を示す図であり、(a)は上面図、(b)、(c)は断面図である。図8(a)に示すように本第4実施形態においては、ガイドロッド12の出射面となる側面12cとガイドプレート13の入射面13aとの隙間に蛍光体色度補正板9が挿入されている、本第4実施形態のフロントライト60に使用する蛍光体色度補正板9は図7に示す第3実施形態のフロントライト50に使用する蛍光体色度補正板9に比較して細長い形状となっているが、材料的にはYAG蛍光体を含み、同様の構成となっている。フロントライト60のその他の構成は前記フロントライト50と同様である。白色発光ダイオード1が発光するとその発光は図7に示した第3実施形態のフロントライト20と基本的には同様の経路を経て外部に出射する。この間、ガイドロッド12の側面12cとガイドプレート13の入射面13aとの隙間に挿入された蛍光体色度補正板9内を光線が通過するが、この際、すでに述べたのと同様の原理により、光線の色度が所望のランクに色度補正されてガイドプレート13に入射する。この結果、ガイドプレート13の出射光として所望のランクに色度補正された照明光が反射型液晶表示板17に入射し、以下第3実施形態のフロントライト50の場合と同様にして、色度の再現性に優れた画像表示をすることができる。

【0038】図8(c)はガイドプレート13の代わりに階段プリズム23pを有する階段プリズム型のガイドプレート23を用い、ガイドロッド12の出射面12cとガイドプレート23の入射面23aの間に蛍光体色度

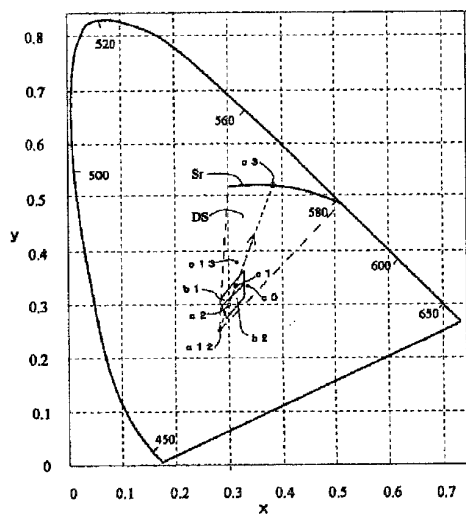
【図1】



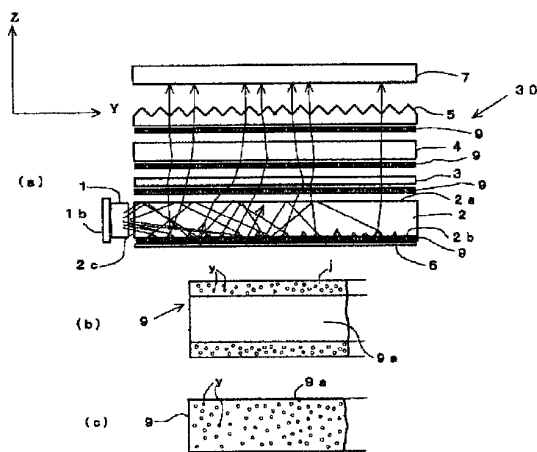
【図2】



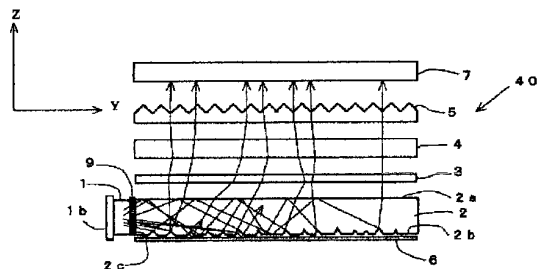
【図3】



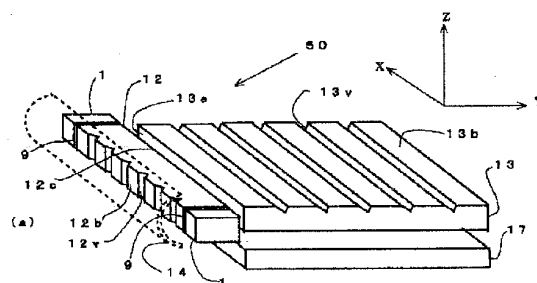
【図5】



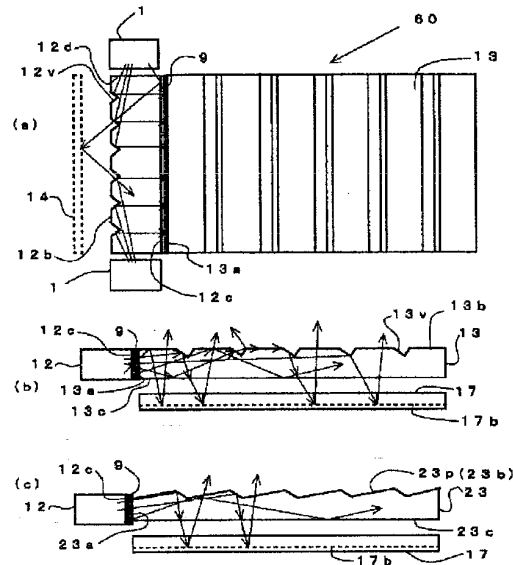
【图6】



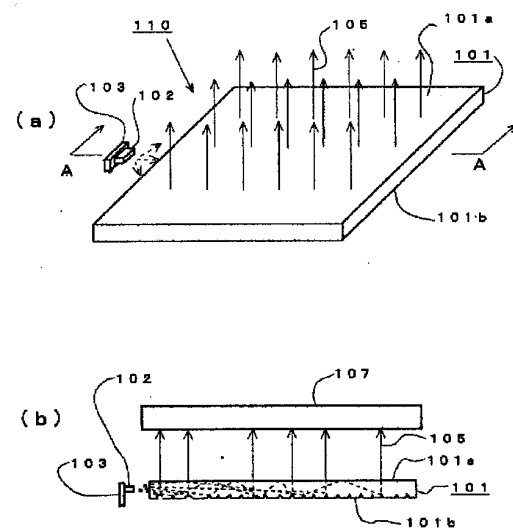
【図7】



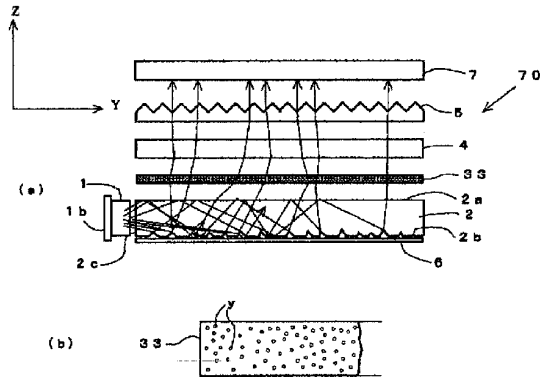
【図8】



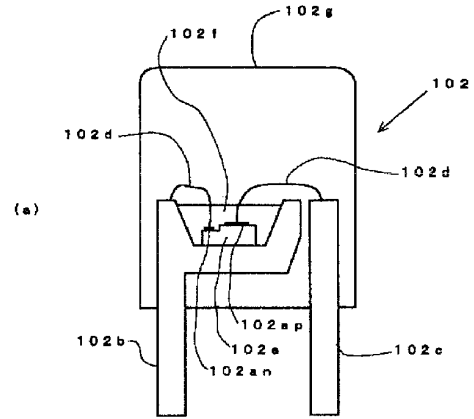
【図10】



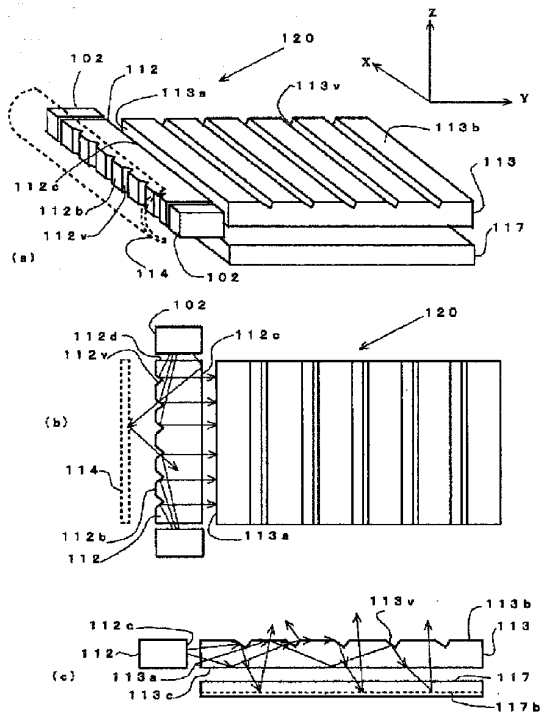
【図9】



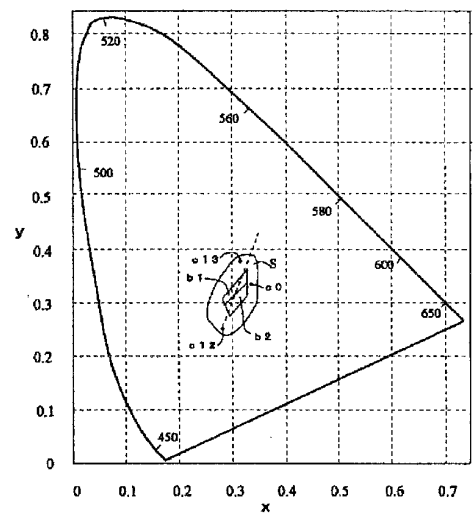
【図11】



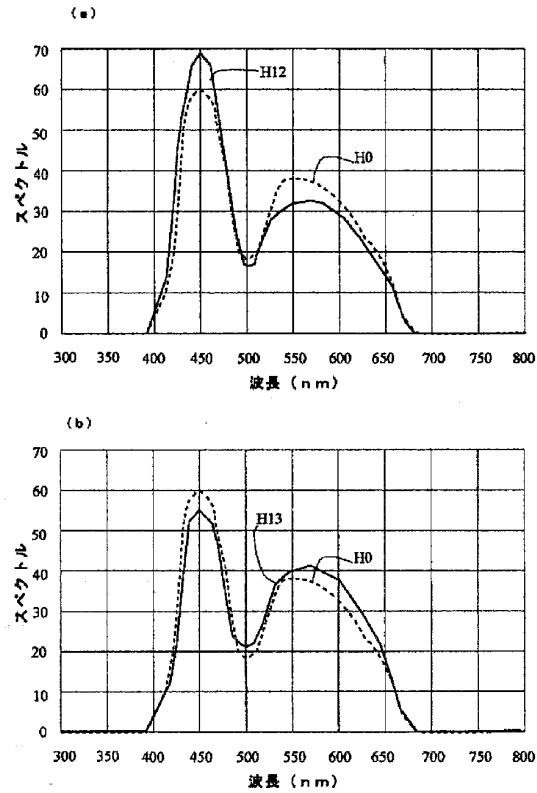
【図12】



【図14】



【図13】



フロントページの続き

(51)Int.Cl.⁷

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H 0 1 L 33/00

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G 0 2 B 6/00

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F 2 1 Y 101:02

サーチコード(参考)

3 3 1

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Electronic Acknowledgement Receipt	
EFS ID:	8004241
Application Number:	12698478
International Application Number:	
Confirmation Number:	4085
Title of Invention:	LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME
First Named Inventor/Applicant Name:	Hyung Hwa PARK
Customer Number:	34610
Filer:	Joanna K. Mason/Lisa Dyer
Filer Authorized By:	Joanna K. Mason
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Time Stamp:	14:47:17
Application Type:	Utility under 35 USC 111(a)

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		HI-0434IDS.pdf	649917	yes	3
			164123d14625277f64706ff4220844eb231d bedc		

	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Filed (SB/08)		3	3	
Warnings:					
Information:					
2	NPL Documents	HI-0434EPSR.pdf	397550	no	5
			3e0a1249d91cc910f072848f0ff90bda2e75d47e		
Warnings:					
Information:					
3	Foreign Reference	HI-0434WO924.pdf	5301243	no	52
			61369b49fec78d4ee529346d04c16081f2cf21d9		
Warnings:					
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4	Foreign Reference	HI-0434JP616.pdf	2985442	no	21
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Warnings:					
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5	Foreign Reference	HI-0434WO657.pdf	1334673	no	14
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6	Foreign Reference	HI-0434JP861.pdf	2668217	no	14
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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.

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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 OFFICEIn re Application of
Hyung Hwa PARK

Confirmation No.: 4085

Group Art Unit: 2811

Serial No.: 12/698,478

Examiner:

Filed: 2/2/2010

Customer No.: 34610

For: LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME

INFORMATION DISCLOSURE STATEMENTU.S. Patent and Trademark Office
Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Sir:

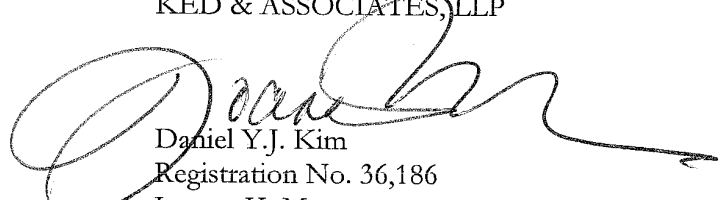
Pursuant to 37 C.F.R. §1.56, the attention of the Patent and Trademark Office is hereby directed to the reference(s) listed on the attached PTO-1449. One copy of each reference is attached. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the reference(s) be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

Applicants have listed publication dates on the attached PTO-1449 based on information presently available to the undersigned. However, the listed publication dates should not be construed as an admission that the information was actually published on the indicated date. Applicant reserves the right to establish the patentability of the claimed invention over any of the information provided herewith, and/or to prove that this information may not be prior art, and/or to prove that this information may not be enabling for the teachings purportedly offered. This statement should not be construed as a representation that a search has been made, that information cited in the statement is considered to be and/or is material to patentability, or that information more material to the examination of the present patent application does not exist. The Examiner is specifically requested not to rely solely on the material submitted herewith. It is further understood that the Examiner will consider information that was cited or submitted to the U.S. Patent and Trademark Office in a prior application relied on under 35 U.S.C. §120. 1138 OG 37, 38 (May 19, 1992).

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- ☐ 2. This Information Disclosure Statement is being filed more than three months after the U.S. filing date AND after the mailing date of the first Office Action on the merits, but before the mailing date of a Final Rejection OR Notice of Allowance OR an action that otherwise closes prosecution in the application. 37 C.F.R. §1.97(c).
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- ☒ 4. The references were cited in a corresponding foreign application in a Search Report dated May 31, 2010.
- ☒ 5. To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 16-0607 and please credit any excess fees to such deposit account.

Respectfully submitted,
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Date: July 13, 2010



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
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CONFIRMATION NO. 4085

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34610
KED & ASSOCIATES, LLP
P.O. Box 221200
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Title: LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME

Publication No. US-2010-0208495-A1

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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/>.

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Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

LIST OF ART CITED BY APPLICANT (PTO-1449)				ATTORNEY, DOCKET NO. HI-0434		APPLICATION SERIAL NO. 12/698,478	
				APPLICANT(S) Hyung Hwa PARK			
				FILING DATE February 2, 2010		GROUP 2885	
U.S. PATENT DOCUMENTS							
EXAMINER'S INITIALS	*PATENT NO.	*ISSUE DATE	*INVENTOR NAME	CLASS	SUBCLASS	FILING DATE	
	5,982,092	11-09-1999	Chen				
U.S. PATENT APPLICATION PUBLICATIONS							
EXAMINER'S INITIALS	*APPLICATION PUBLICATION NO.	*PUBLICATION DATE	*INVENTOR	CLASS	SUBCLASS	FILING DATE	
	2008/067536	03-20-2008	Komoto et al.				
	2007/090383	04-26-2007	Ota et al.				
	2008/302977	12-11-2008	Yao et al.				
U.S. PATENT APPLICATIONS							
EXAMINER'S INITIALS	*APPLICATION NO.	*FILING DATE	*INVENTOR	CLASS	SUBCLASS	FILING DATE	
FOREIGN PATENT DOCUMENTS							
EXAMINER'S INITIALS	PATENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	Translation	
						Yes	No
	JP 2000-133006	05-12-2000	Japan (full Japanese text and English abstract)			X	
	KR 20-1998-065685	12-05-1998	Korea (full Korean text and English abstract)			X	
	WO 2007/138724	12-06-2007	PCT (full Japanese text and English abstract)			X	
	JP 2003-279985	10-02-2003	Japan (full Japanese text and English abstract)			X	
OTHER ART (Including Author, Title, Date, Pertinent Pages, Publisher, Place of Publication, Etc.)							
	Korean Office Action issued in KR Application No. 10-2009-0013161 dated July 30, 2010.						
	European Search Report issued in EP Application No. 10153414.7 dated August 10, 2010.						
EXAMINER				DATE CONSIDERED			

EXAMINER: Initial if reference has been 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.
 256653

SURFACE LIGHT SOURCE

Publication number: JP2000133006 (A)

Publication date: 2000-05-12

Inventor(s): HAKATA KUNIHICO +

Applicant(s): SANYO ELECTRIC CO; TOKYO SANYO ELECTRIC CO +

Classification:

- **international:** *F21S2/00; F21V9/08; G02F1/1335; G02F1/13357; F21S2/00; F21V9/00; G02F1/13; (IPC1-7): F21S2/00; F21V9/08; G02F1/1335*

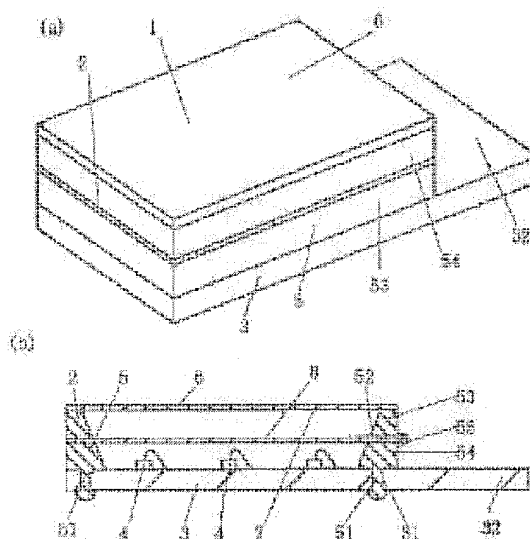
- **European:**

Application number: JP19980308745 19981029

Priority number(s): JP19980308745 19981029

Abstract of JP 2000133006 (A)

PROBLEM TO BE SOLVED: To provide a surface light source which has a good light utilizing efficiency and is adapted for high luminance and low power consumption. **SOLUTION:** A first and a second light diffusion sheets 6, 8 are supported vertically at a prescribed distance by a frame body 5 above a substrate 3 on which are disposed a plurality of blue color type LEDs 4, and one of the light diffusion sheets, 6, integrally provided with a fluorescent material which emits fluorescence according to light of the LED 4. The frame body 5 is constructed by combining an upper and a lower frames 53, 54, and the light diffusion sheet 8 is held between the upper and the lower frames 53, 54.



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(P2000-133006A)

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(51) Int.Cl. ⁷	識別記号	F I	テマコード (参考)
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F 2 1 V 9/08		F 2 1 V 9/08	B
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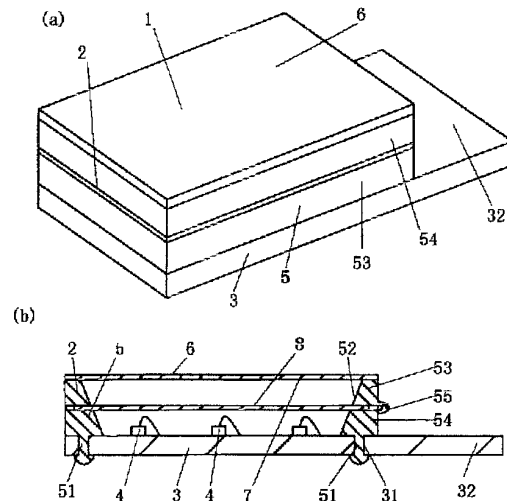
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Fターム (参考) 2H091 FA43Z FA45Z FD06 LA11
LA30

(54) 【発明の名称】 面光源

(57) 【要約】

【目的】 光の利用効率が良く高輝度化あるいは低消費電力化に適した面光源を提供すること。

【構成】 青色系のLED4を複数配置した基板3の上方に、枠体5によって第1、第2の光拡散シート6、8を上下に所定の間隔をもって支持し、一方の光拡散シート6に前記LED4の光によって蛍光を発する蛍光物質を一体的に設けたことを特徴とする。前記枠体5は、上下の枠53、54を組合わせて構成し、光拡散シート8を上下の枠53、54の間に挟持した。



【特許請求の範囲】

【請求項1】 上面が開いたケースの底部にLEDを複数個配置し、前記ケースの開口を覆うように光拡散シートを設けた面光源において、前記LEDとして発光色が青色系のLEDを用い、前記光拡散シートとして前記LEDの光によって蛍光を発する蛍光物質を一体に備えるシートを用いたことを特徴とする面光源。

【請求項2】 青色系のLEDを複数配置した基板の上方に、枠体によって第1、第2の光拡散シートを上下に所定の間隔をもって支持し、前記一方の光拡散シートに前記LEDの光によって蛍光を発する蛍光物質を一体的に設けたことを特徴とする面光源。

【請求項3】 前記枠体は、上下の枠を組合わせて構成し、前記光拡散シート的一方を前記上下の枠の間に挟持したことを特徴とする請求項2記載の面光源。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、光源としてLEDを用いる面光源に関する。

【0002】

【従来の技術】LEDを利用した従来の面光源は、赤系や緑系のLEDを利用した着色光源となっていたが、高輝度青色LEDの製品化に伴い、この青色LEDと黄色系の蛍光物質の組合わせによって白色光源とすることが提案されている（例えば、特開平8-7614号公報等）。上記の白色面光源は、導光板の一側面にLEDを配置して導光板の上面から光を取り出す構成としており、導光板の上下の一方に蛍光物質を含む層を配置して構成している。このように構成することにより、LEDから発せられて蛍光物質に照射される光の経路を長く確保して蛍光物質から発生する蛍光のムラなくし、青色と黄色の混色による白色化を図ることができる。

【0003】しかしながら、上記のような導光板タイプの面光源は、薄型化に適している反面、LED光源の近傍とその反対側とでの輝度差が大きいため、光の利用効率が悪くという問題を有している。

【0004】

【発明が解決しようとする課題】本発明は上記の点を考慮し、光の利用効率が高く高輝度化あるいは低消費電力化に適した面光源を提供することを課題の1つとする。また、薄型化に適した面光源を提供することを課題の1つとする。また、その組立作業性を良好とすることを課題の1つとする。

【0005】

【課題を解決するための手段】本発明の面光源は、上面が開いたケースの底部にLEDを複数個配置し、前記ケースの開口を覆うように光拡散シートを設けた面光源において、前記LEDとして発光色が青色系のLEDを用い、前記光拡散シートとして前記LEDの光によって蛍光を発する蛍光物質を一体に備えるシートを用いたこ

とを特徴とする。

【0006】また、本発明の面光源は、青色系のLEDを複数配置した基板の上方に、枠体によって第1、第2の光拡散シートを上下に所定の間隔をもって支持し、前記一方の光拡散シートに前記LEDの光によって蛍光を発する蛍光物質を一体的に設けたことを特徴とする。前記枠体は、上下の枠を組合わせて構成し、前記光拡散シート的一方を前記上下の枠の間に挟持することができる。

【0007】

【発明の実施の形態】以下本発明の実施例について図面を参照して説明する。まず第1の実施例について図1を参照して説明する。

【0008】図において、面光源1は、中空ケース2の底部を構成するプリント基板などからなる基板3と、基板3の表面に複数個配置したチップ形態のLED（発光ダイオード）4と、ケース2の側面を構成する樹脂枠等からなる枠体5と、ケース2の上面開口部を覆うように、枠体5に接着剤などによって貼付して支持された光拡散シート6とによって構成している。

【0009】ケース2は、枠体5に一体形成したリブ51を基板3のスルーホール31を介して基板3の裏側に突出させ、突出部分を溶着することによって基板3と枠体5を一体化して構成しているが、これ以外の構成とすることもできる。

【0010】基板3は、その表面、必要に応じて表裏両面に、前記LED4に対する配線用のリードパターン（図示せず）が形成され、そのリードパターンに対する入力端子（図示せず）を前記枠体5の外に位置する端子部32に配置している。基板3の表面には、光反射性の良好な白色レジスト等を形成しておくことが好ましい。

【0011】LED4は、発光波長が500nm以下で短波長の青色系LEDによって構成し、基板3の表面にマトリックス状に配置している。

【0012】枠体5は、ケース2の4つの内側面に傾斜側面51を形成した樹脂製で、反射性を高めるために、白色系の樹脂を用いて構成している。

【0013】光拡散シート6は、透明な薄膜樹脂シートに光拡散性を持たせて構成しているので、外観は光拡散性によって白色状態を呈する。この光拡散シート6は、その表面もしくは裏面に、蛍光物質を含む被膜7を塗布等して一体に形成している。この例では、シート6の裏面に被膜7を形成した例を示している。蛍光物質は波長変換によって発生する蛍光の色相に応じて種々のものを利用することができるが、この例では、蛍光が黄色の色相を呈する蛍光物質を利用している。したがって、被膜7並びにこの被膜7一体に備える光拡散シート6の外観は、薄い黄色を呈する。そして、被膜7を一体に備える光拡散シート6は、枠体5の天面に接着剤などを用いて貼付され支持される。

【0014】上記の構成において、基板3の端子部32よりLED4に所定の電源供給を行うと、LED4が青色系の発光を行う。この光は直接もしくはケース2によって反射して間接的に被膜7に当たり、その一部が被膜7の蛍光物質を刺激することによって黄色系の蛍光に波長変化される。この黄色系の蛍光とLEDから発せられる青色系の光がケース2の内部や光拡散シート6を通過する際に加色混合され、白色に合成される。

【0015】この面光源1は、光出射面となる光拡散シート6の下方にLED4が光源として位置し、光源からの光経路が短いので、導光板タイプに比べて高輝度化を図ることができるとともに、LED光源からの距離の相違による輝度ムラの発生を防止することができる。

【0016】次に、第2の実施例について図2、図3を参照して説明する。ここで、第1の実施例と同一構成要素は同一の図番を付しその説明を省略する。第1の実施例と基本的に相違する点は、上記光拡散シート6のほか、被膜7（蛍光物質）を含まない光拡散シート8を備える点と、これらの光拡散シート6、8を支持するための枠体5が上下に分割した構造となっている点である。

【0017】枠体5は、図3に示すように、枠体を上下に2分割することによって形成された形態の上下2つの枠53、54を備え、その一端を連結部55によって連結して形成される。上下の枠53、54には、両者を固定するための突起56とこれが嵌合する大きさの穴57が一体的に複数形成され、これら突起56と穴57を位置決めして嵌合することによって、上下の枠53、54が一体化される。光反射シート8には、前記突起56と対応した位置に突起56を遊挿する穴（図示せず）が形成されている。

【0018】次にこの第2の実施例に係る光源1の組み立て手順について説明する。まず始めに、基板3を準備し、この基板3にLED4をチップボンド、並びにワイヤボンドして装着する。これと前後して、枠体5を準備し、上枠53に第1の光拡散シート6を接着剤によって貼付して支持する。ここで、光拡散シート6は、被膜7を配置した面を上にして支持しても良いが、被膜7の損傷を防止するために、被膜7がケース2の内側に位置するように貼付するのが好ましい。次に、第2の光拡散シート8をそれに形成された穴を下枠54の突起56に位置決めして配置することによって仮固定した後、上枠53の穴57を下枠54の突起56に位置きめして配置し、穴57と突起56を嵌合することによって、上下の枠53、54を一体化する。ここで、光拡散シート8は、上下の枠53、54の間に挟持固定される。その結果、枠体5によって第1、第2の光拡散シート6、8が上下に所定の間隔をもって支持される。

【0019】次に、上記のように光拡散シート6、8を支持した枠体5を、基板3に固定する。基板3への固定は、上記第1実施例と同様に、突起51の溶着によって

行われる。尚、第2光拡散シート8の挟持は、枠体5の基板3への固定後に行っても良い。このようにして光源1は、図2のように組み立てられるが、上下の枠53、54が連結部55を介して一体化され、また、その間に光拡散シート8を挟んで固定するので、組み立て作業性を良好にすることができる。

【0020】そして、LED4の通電によって発生した青色系の光は、第2の光拡散シート8によって拡散された後、第1の光拡散シート6によって更に拡散され、輝度分布が均一な状態で出射する。ここで、蛍光物質を含んだ被膜7を第1の光拡散シート6に設けているので、前記均一に拡散された青色系の光が蛍光物質を刺激することにより黄色の蛍光が発生し、それらが青色系の光と加色混合されることにより、白色の光源が得られる。ここで、蛍光物質を含んだ被膜7を第2の光拡散シート8の上に設けても良い。この場合は、第2の光拡散シート8の上側の面に被膜7を形成することが望ましい。このようにすることにより、第1、第2の光拡散シート6、8の間で反射を繰り返す光によって被膜7に含まれる蛍光物質を均一に刺激することができる。

【0021】しかしながら、種々検討の結果、第1、第2の光拡散シート6、8の配置は、図2に示すように、被膜7を設けない光拡散シート8の上に被膜7付の光拡散シート6を配置するのが、その逆の配置に比べて、蛍光を発生させるための青色系の光をより均一化することができ、青色系と黄色系の光のムラが少ない白色の光源を得られる点で好ましいことが分かった。

【0022】このように、点光源であるLED4を出射面の後方に複数配置した面光源においては、高輝度化できる反面、点光源の位置する部分とその中間部分とで輝度分布が相違してムラが生じ易い欠点があり、第1の実施例の光源は比較的厚くなる。しかしながら、第2実施例の面光源は、第2の光拡散シート8をLED4と蛍光物質付きの第1光拡散シートの間に配置しているので、輝度ムラを大幅に抑制することができ、面光源の厚みを第1実施例に比べて2～3割低減して薄型構造とすることができる。

【0023】

【発明の効果】以上説明したように本発明の面光源によれば、導光板方式に比べて高輝度化（同一輝度であれば低消費電力化）を図ることができる。また、光拡散シートを所定間隔をもって配置することにより、一方のシートに一体化した蛍光物質を刺激する光を均一化して色ムラ、輝度ムラの発生を抑制することができるとともに、LEDから上側の光拡散シートまでの間隔を短くして装置の薄型化を図ることができる。また、枠体を上下の枠で構成し、その間にシートを挟持する構成とすることにより、組立作業性を良好にすることができる。

【図面の簡単な説明】

【図1】本発明の一実施例の斜視図（a）と、その断面

図 (b) である。

【図2】本発明の他の実施例の斜視図 (a) と、その断面図 (b) である。

【図3】本発明の他の実施例に用いる棒体の平面図 (a) と、その断面図 (b) である。

【符号の説明】

1 面光源

2 中空ケース

3 基板

4 LED

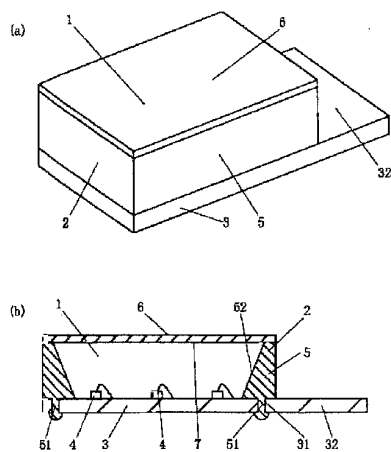
5 棒体

6 光拡散シート (第1の光拡散シート)

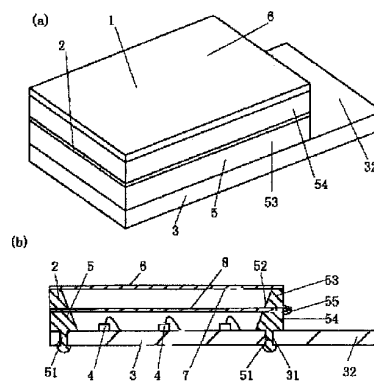
7 被膜 (蛍光物質含有)

8 第2の光拡散シート

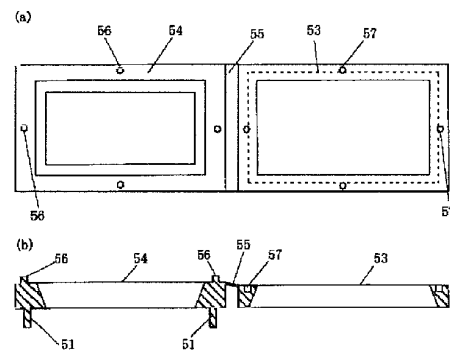
【図1】



【図2】



【図3】



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(54) LIQUID CRYSTAL DISPLAY DEVICE

ABSTRACT

Disclosed is a liquid crystal display device. The liquid crystal device includes top and bottom substrates having an ITO electrode pattern, a liquid crystal layer interposed between the top and bottom substrates, a liquid guide plate located below the bottom substrate and a light source for irradiating light to the light guide plate. Luminescence material is coated on a lateral side of the liquid guide plate. The liquid crystal display device can reproduce backlight having various colors so that wide color coordinate can be realized.

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(54) 액정표시장치		

요약

액정표시장치에 관하여 개시한다. 본 고안은 ITD전극 패턴이 형성되어 있는 상하부 기판과, 상기 상하부 기판 사이에 개재된 액정층과, 상기 하부기판의 하측에 위치된 도광판 및 상기 도광판에 빛을 조사하는 광원을 포함하는 액정표시장치에 있어서, 상기 도광판은 그 측면에 형광물질이 도포되어 있는 것을 특징으로 하며 다양한 컬러의 배면광을 구현할 수 있고 따라서 보다 넓은 범위의 색좌표 변환을 할 수 있다.

대표도

도3

명세서

도면의 간단한 설명

도 1은 종래의 배면광원장치를 구비한 액정표시장치를 도시한 부분 사시도.

도 2는 종래의 배면광원장치를 구비한 액정표시장치를 도시한 단면도.

도 3은 본 고안에 따른 배면광원장치를 구비한 액정표시장치를 도시한 부분 사시도.

도 4는 본 고안에 따른 배면광원장치를 구비한 액정표시장치를 도시한 단면도.

도면의 주요 부분에 대한 부호의 설명

11,110:액정표시패널 13a,113a:상부기판
13b,113b:하부기판 15,115:액정층
17,117:확산판 19,119:도광판
21,121:반사판 23:형광램프
123:광원 25,125:배면광원장치
130:입사부면

고안의 상세한 설명

고안의 목적

고안이 속하는 기술분야 및 그 분야의 종래기술

본 고안은 액정표시장치(LCD)에 관한 것으로서, 보다 상세하게는 색좌표변환을 위하여 도광판 입사부면에 형광체가 도포된 액정표시장치에 관한 것이다.

어떤 정보를 디스플레이상에 나타내는 방법은 여러 가지가 있다. 열전자 방출 및 형광물질의 발광을 이용한 음극선관(CRT), 음극선관의 원리와 유사하지만 전자 방출을 하는 음극이 실선구조로 되어있고 전체적인 형태가 주로 평판형으로 되어있는 형광표시판(VFD), 액정의 전기광학적 특성을 이용한 액정표시소자, 대전된 양 전극 사이에서의 기체 방전 현상을 이용한 플라즈마 표시소자(POP) 등 각각 그 특성에 따라 개발 및 응용이 다양하게 전개되고 있다.

이중에서도 특히 액정표시소자는 여타의 표시장치에 비해 소비전력이 적고, 초소형으로부터 대형에 이르기까지 다양한 크기의 생산이 가능하며, 표시패턴을 여러 형태로 구성할 수 있고, 저전압 구동이 가능하며, LSI(C-MOS)와의 인터페이스가 극히 용이하다는 등의 장점으로 가장 광범위하게 사용되고 있는 표시소자라 할 수 있다.

그러나, 통상적인 액정표시소자는 그 자체가 발광하여 화상을 형성하지 못하고 외부로부터 빛을 받아 화상을 형성하는 수광형 발광소자 이므로, 어두운 곳에서는 화상을 식별할 수 없다는 문제점이 있다. 따라서, 액정표시소자의 배면에 빛을 발하는 배면광원을 설치하여 액정표시소자의 배면에서 빛을 조사함으로써, 어두운 곳에서도 화상을 볼 수 있도록 하고 있다.

이러한 액정표시소자의 배면광(back light)에 이용되는 조명광원을 형태별로 나누면 백열전구, 백색 할로겐 램프등의 점광원, 형광램프(열음극, 냉음극)등의 선광원, 전자발광이나 매트릭스 형상의 발광 다이오드(LED)에 의한 평면광원이 있다.

도 1은 상술한 바와 같은 액정표시장치의 일부분을 개략적으로 나타낸 사시도이다.

도면을 참조하면, 액정표시장치는 크게 액정표시패널(11)과 배면광원장치(25)로 이루어져 있다. 액정표시패널(11)은 IT0 전극 패턴이 형성되어 있는 상 하부 기판(13a, 13b)과, 상기 상 하부기판(13a, 13b) 사이에 개재되는 액정층(15)을 포함하는 구조로 되어있다. 또한 상기 배면광원장치(25)에는 입사되는 빛을 도파시키면서 그 내벽에 부딪치는 빛의 광로를 상부로 변경시키는 도광판(19)과, 상기 도광판(19)의 측면과 대향되게 설치되어 색좌표 변환을 위해 임의의 색을 발광하는 형광램프(23)와, 상기 도광판의 상면 및 하면에 각각 확산판(17)과 반사판(21)이 설치되어 있다.

상기와 같이 구성되어 있는 액정표시장치의 동작은 다음과 같이 이루어 진다.

전기를 공급받은 형광램프(23)는 색좌표 변환목적에 대응하는 임의의 색을 발광하게되며 상기 발광된 빛은, 상기 형광램프(23)에 대향되어 위치한 도광판(19)의 측면에 조사되고, 상기 도광판(19)의 측면에 조사된 빛은 도광판(19)의 내부에 입사된다. 상기 도광판(19)의 내부로 입사된 빛은 상기 도광판(19)의 상면에 위치한 확산판(17)에 예각의 각도로 직접 투사되거나 또는 상기 도광판(19)의 하면에 위치한 반사판(21)에서 반사된 후 상기 확산판(17)에 투사된다. 상기와 같이 확산판(17)에 투사된 빛은 상기 확산판(17)을 통과하면서 확산되어 상부에 마련되어 있는 액정표시패널(11)의 하부기판(13b)에 조사되고, 색좌표 변환을 위한 배면광원을 얻는다.

상술한 바와 같은 배면광원장치에서 얻을 수 있는 배면광의 칼라는 결국 형광램프에서 발광된 빛의 칼라이다. 그런데 형광램프의 제작기술상 다양한 칼라의 형광램프를 제작하기가 어려우므로, 다양한 칼라의 배면광을 얻기가 어렵고 그에 따라 넓은 범위의 색좌표변환의 구현에도 제한이 생기는 등의 문제점이 있다.

고안이 이루고자 하는 기술적 과제

본 고안은 상기와 같은 문제점을 해결하기 위하여 안출된 것으로서, 도광판의 측면에 임의의 색을 가진 형광물질이 도포함으로써, 보다 넓은 색좌표 변환을 구현 할 수 있는 액정표시장치를 제공함에 있다.

고안의 구성 및 작용

상기의 목적을 달성하기 위하여 본 고안은, IT0전극 패턴이 형성되어 있는 상 하부기판과, 상기 상 하부기판 사이에 개재된 액정층과, 상기 하부기판의 하측에 위치한 도광판 및 상기 도광판에 빛을 조사하는 광원을 포함하는 액정표시장치에 있어서, 상기 도광판은 그 측면에 형광물질이 도포되어 있는 것을 특징으로 하며 상기 도포되는 형광물질의 칼라는 여하한 것이라도 가능하다.

이하, 본 고안을 첨부된 도면에 도시된 일 실시예를 참고로 보다 상세히 설명하기로 한다.

도 3 또는 도 4는 본 고안에 따른 액정표시장치에 관한 개략적인 도면이다. 도 4를 참조하면, 액정표시장치는 크게 액정표시패널(110)과 배면광원장치(125)로 이루어져 있다. 액정 표시패널(110)은 IT0전극 패턴이 형성되어 있는 상 하부기판(113a, 113b)과, 상기 상 하부기판(113a, 113b) 사이에 개재된 액정층(115)을 포함하는 구조로 되어 있다. 상기 배면광원장치(125)에는 도광판(119)이 마련되어 있고, 상기 도광판의 측면에 형광물질이 도포되어 있다. 상기 형광물질은 목적하는 색좌표의 특성에 대응하여 여하한 칼라의 것이라도 사용 가능하므로 도포되는 형광물질의 칼라는 임의로 선택될 수 있다. 또한 상기 도광판의 측면에 대향하여 위치한 광원(123)을 구비하고 있으며, 아울러 상기 도광판의 상면 및 하면에는 각각 확산판(117) 및 반사판(121)이 설치되어 있다.

이상과 같은 구성을 가지는 본 고안에 따른 액정표시장치의 작용을 설명하면 다음과 같다.

전기를 공급받은 광원(123)으로부터 발광된 빛은, 임의로 선택된 칼라의 형광체가 도포된 입사부면(130)을 통하여 도광판(119)에 입사된다. 따라서 도광판내로 입사된 빛은 상기 선택된 형광체의 칼라와, 광원으로부터 발광되는 빛의 칼라가 혼합되어진 칼라를 가진다. 상기와 같은 칼라로 입사된 빛은 상기 도광판(119)의 상면에 위치한 확산판(117)에 예각의 각도로 직접 투사되거나 또는 상기 도광판(119)의 하면에 위치한 반사판(121)에서 반사된 후 상기 확산판(117)에 투사된다. 상기와 같이 확산판(117)에 투사된 빛은 상기 확산판(117)을 통과하면서 확산되어 상부에 마련되어 있는 액정표시패널(110)의 하부기판(113b)에 조사되고, 색좌표변환을 위한 배면광원을 얻는다.

고안의 효과

이상의 설명에서와 같이 본 고안에 따른 액정표시장치는 도광판의 입사부면에 임의로 선택된 칼라의 형광체를 도포함으로써 다음과 같은 효과를 갖는다.

첫째: 도광판의 입사부면에 도포되는 형광물질의 칼라는 여하한 것이라도 가능하므로 다양한 칼라의 배면 광을 구현할 수 있고 따라서 보다 넓은 범위의 색좌표 변환을 할 수 있다.

둘째: 색 발광램프를 사용하지 않아도 되므로 광원 제작상의 비용을 절감할 수 있다.

(57) 청구의 범위

청구항 1

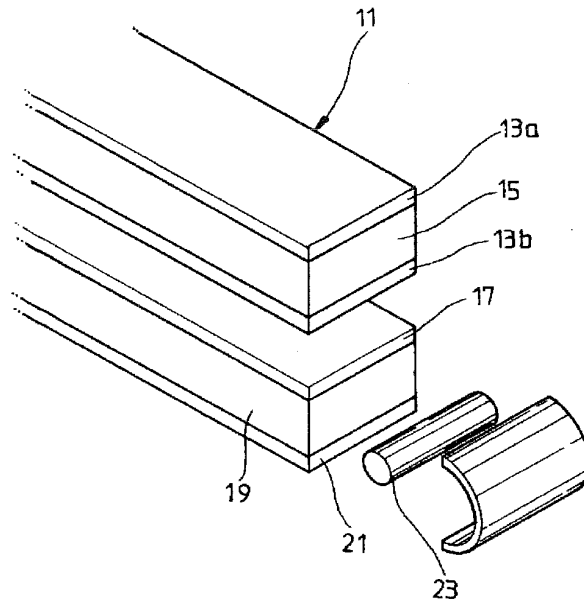
ITO전극 패턴이 형성되어 있는 상하부 기판과, 상기 상하부 기판 사이에 개재된 액정층과, 상기 하부기판의 하측에 위치된 도광판 및 상기 도광판에 빛을 조사하는 광원을 포함하는 액정표시장치에 있어서, 상기 광원으로부터 입사된 빛이 통과 하는 상기 도광판의 측면에 형광물질이 도포되어 있는 것을 특징으로 하는 액정표시장치.

청구항 2

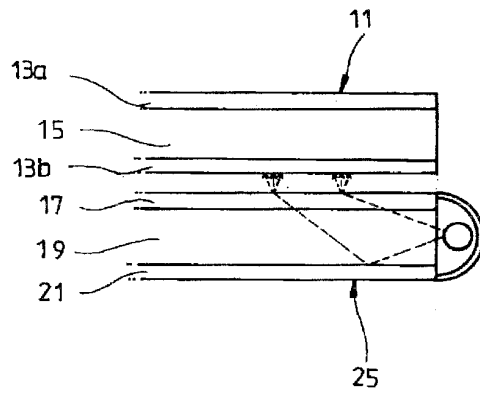
제1항에 있어서, 상기 도광판에 도포되는 형광물질은 소정의 색좌표 변환에 따라 임의로 선택되는 것을 특징으로 하는 액정표시장치.

도면

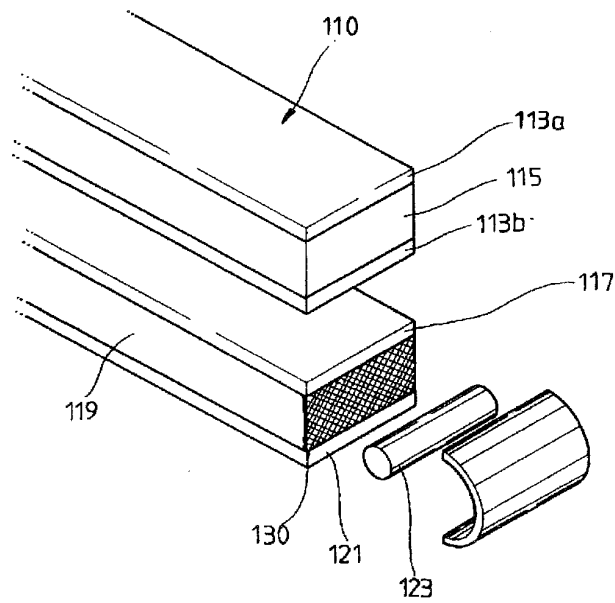
도면1



도면2



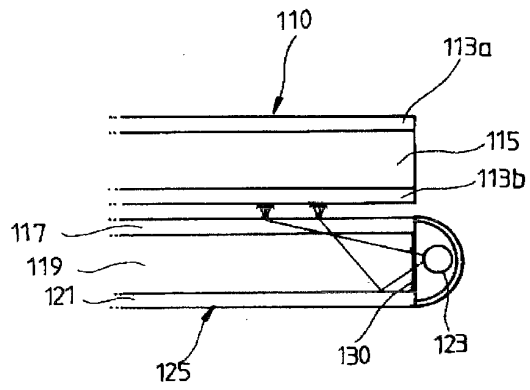
도면3



5-4

5-4

도면4



5-5

5-5

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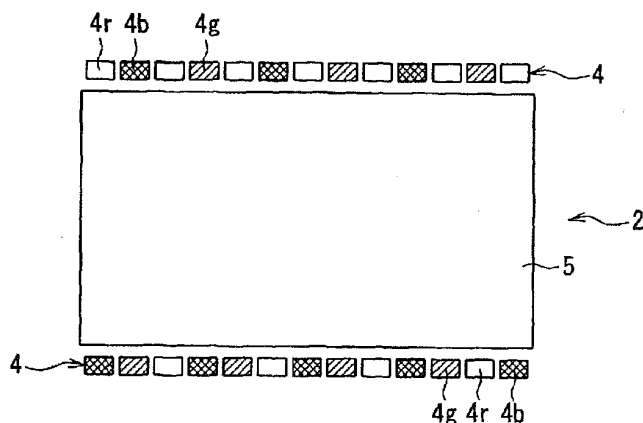
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(54) Title: BACKLIGHT DEVICE AND DISPLAY DEVICE USING SAME

(54) 発明の名称: バックライト装置、及びこれを用いた表示装置



(57) Abstract: In a backlight device (2), an upper side region and a lower side region are arranged on the upper side and the lower side of a light guide plate (5) as arrangement regions for arranging a plurality of light emitting diodes (4), respectively. Furthermore, in the upper side region and the lower side region, the light emitting diodes (4) are arranged apart from each other so that each light quantity is within a prescribed range.

(57) 要約: バックライト装置 (2) において、導光板 (5) の上側及び下側に発光ダイオード (4) をそれぞれ

設置する設置領域としての上側領域及び下側領域を設ける。さらに、これらの上側領域及び下側領域では、光量が互いに所定の範囲内となるように、複数の発光ダイオード (4) を分散して設置する。

WO 2007/138724 A1

WO 2007/138724

PCT/JP2006/323564

1

明 細 書

バックライト装置、及びこれを用いた表示装置

技術分野

- [0001] 本発明は、バックライト装置、特に光源としての発光ダイオードを有するバックライト装置、及びこれを用いた表示装置に関する。

背景技術

- [0002] 近年、例えば液晶表示装置は、在来のブラウン管に比べて薄型、軽量などの特長を有するフラットパネルディスプレイとして、液晶テレビ、モニター、携帯電話などに幅広く利用されている。このような液晶表示装置には、光を発光するバックライト装置と、バックライト装置に設けられた光源からの光に対しシャッターの役割を果たすことで所望画像を表示する液晶パネルとが含まれている。
- [0003] また、上記バックライト装置には、冷陰極管や熱陰極管からなる線状光源を液晶パネルの側方または下方に配置したエッジライト型または直下型のものが提供されている。しかるに、上記のような冷陰極管等には水銀が含まれており、廃棄する冷陰極管のリサイクル等を行い難かった。そこで、水銀を使用していない発光ダイオード(LED)を光源に用いたバックライト装置が提案されている(例えば、特開2004-21147号公報参照。)
- [0004] また、上記従来のバックライト装置では、赤色(R)、緑色(G)、及び青色(B)の各色光を発光する三色の発光ダイオードを設けて、これら三色の色光を混色することで白色光を得ていた。また、この従来のバックライト装置では、発光ダイオードからの光を検出するセンサーを設置し、その検出結果を基にRGBの各発光ダイオードの光量を調整することにより、対応する発光ダイオードの輝度や色度の経時的な変化を抑制可能とされていた。

発明の開示

発明が解決しようとする課題

- [0005] ところで、上記のような発光ダイオードでは、その光量のバラツキが非常に大きいものであった。すなわち、発光ダイオードでは、型番や形式、あるいは光度、定格電流

WO 2007/138724

PCT/JP2006/323564

2

値、指向角等の諸特性の設計値などが同じ製品どうしても、その半導体素材の品質や特性などによって製品毎の光量が著しく異なることがあった。また、発光ダイオードでは、使用環境の変化、特に周囲温度の変動により、冷陰極管などに比べて発光効率が変わり易く、光量もまた比較的变化し易かった。

[0006] このため、上記のように、複数の発光ダイオードを設けた従来のバックライト装置では、発光ダイオード毎の光量のバラツキや周囲環境の変化に伴う発光効率の変化に起因して、当該複数の各発光ダイオードの光量が不均一となり、液晶パネル(外部)への光に輝度ムラが生じ易いという問題点があった。ことに、液晶表示装置での大画面化や高輝度化などに応じて、発光ダイオードの設置数を増加させたときには、設置数の増加及びこれに伴う発熱量の増大等により、光量の不均一の幅(最も明るい発光ダイオードと最も暗い発光ダイオードとの光量差)が著しく大きくなることがあった。この結果、従来のバックライト装置では、発光ダイオードの設置数を増加させたときには、外部への光に輝度ムラが発生するのを防ぐことは極めて困難となった。

[0007] なお、発光ダイオードでは、一般的に、光量を揃えて販売されてはおらず、光量や輝度などを指定して購入する場合には、発光ダイオードの単価が高騰して、バックライト装置のコストアップが生じるのを防ぐことが甚だ困難になるという新たな問題点を発生するおそれがあった。

[0008] 上記の課題を鑑み、本発明は、発光ダイオードの設置数を増加させるときでも、輝度ムラの発生を防ぐことができるバックライト装置、及びこれを用いた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

[0009] 上記の目的を達成するために、本発明にかかるバックライト装置は、複数の発光ダイオードと、

互いに異なる箇所に設定されるとともに、前記複数のいずれかの発光ダイオードを設置する複数の設置領域とを備え、

前記複数の設置領域では、光量が互いに所定の範囲内となるように、前記複数の発光ダイオードを分散して設置していることを特徴とするものである。

[0010] 上記のように構成されたバックライト装置では、発光ダイオードの設置領域が互いに

WO 2007/138724

PCT/JP2006/323564

3

異なる複数の箇所を設定されている。また、複数の設置領域では、光量が互いに所定の範囲内となるように、発光ダイオードが設置されている。これにより、上記従来例と異なり、発光ダイオードの設置数を増加させるときでも、バックライト装置から外部に発光される光に、発光ダイオード毎の光量のバラツキや周囲環境の変化に起因する輝度ムラが生じるのを防ぐことができる。

- [0011] また、上記バックライト装置において、前記発光ダイオードを点灯駆動する駆動回路を備えるとともに、
- 複数の前記設置領域は、前記発光ダイオードが前記駆動回路によって点灯駆動されたときの温度分布を用いて、互いに異なる箇所を設定されていることが好ましい。
- [0012] この場合、各設置領域では、その温度分布が把握された状態で、発光ダイオードが適切に設置されるので、各設置領域での光量を容易に所定の範囲内とすることができる。これにより、各設置領域での温度分布が異なる場合でも、外部への光に輝度ムラが生じるのを確実に防ぐことができる。
- [0013] また、上記バックライト装置において、前記複数の設置領域は、外部装置にて発生した熱による温度上昇分を含んだ前記温度分布を用いて、互いに異なる箇所を設定されてもよい。
- [0014] この場合、外部装置からの発生熱に起因する周囲温度変動の悪影響を確実に排除した状態で、各設置領域での光量をより容易に所定の範囲内とすることができ、外部への光に輝度ムラが生じるのをより確実に防ぐことができる。
- [0015] また、上記バックライト装置において、前記複数の設置領域は、使用状態において重力が作用する鉛直方向での位置が互いに異なる箇所を設定されていることが好ましい。
- [0016] この場合、複数の設置領域は実際の使用状態に応じて上記鉛直方向で互いに異なる位置に設定されることとなり、使用されるときに発生する熱の自然対流に起因する外部への光の輝度ムラの発生を確実に防ぐことができる。
- [0017] また、上記バックライト装置において、前記複数の設置領域では、設置される発光ダイオードの個数を互いに変更することにより、前記光量が互いに所定の範囲内とされてもよい。

WO 2007/138724

PCT/JP2006/323564

4

- [0018] この場合、各発光ダイオードへの供給電流値を同一にしたときでも、複数の設置領域での各光量の調整を簡単に行うことが可能となり、上記輝度ムラの発生防止を確実に、かつ容易に行うことができる。
- [0019] また、上記バックライト装置において、前記複数の設置領域では、設置される発光ダイオードの発光面の大きさを互いに変更することにより、前記光量が互いに所定の範囲内とされてもよい。
- [0020] この場合、複数の各設置領域での発光ダイオードの組込作業の簡単化を図りつつ、光量調整を簡単に行うことができ、上記輝度ムラの発生防止を確実に、かつ容易に行うことができる。
- [0021] また、上記バックライト装置において、前記複数の設置領域では、設置される発光ダイオードへの供給電流値を互いに変更することにより、前記光量が互いに所定の範囲内とされてもよい。
- [0022] この場合、高精度な光量調整を簡単に行うことができ、上記輝度ムラの発生防止をより確実に行うことができる。
- [0023] また、上記バックライト装置において、前記複数の発光ダイオードには、発光色が互いに異なる複数種類の発光ダイオードが含まれてもよい。
- [0024] この場合、白色の光を発光する白色の発光ダイオードを用いる場合に比べ対応する上記発光色の色純度を向上させることができ、色度分布などの発光品位に優れたバックライト装置を容易に構成することができる。
- [0025] また、上記バックライト装置において、前記複数の発光ダイオードには、赤色、緑色、及び青色の光をそれぞれ発光する赤色、緑色、及び青色の発光ダイオードが含まれていることが好ましい。
- [0026] この場合、赤色、緑色、及び青色の各発光色の色純度を向上させることができ、より優れた発光品位のバックライト装置を容易に構成することができる。
- [0027] また、上記バックライト装置において、前記複数の設置領域では、前記複数の発光ダイオードのうち、赤色の光を発光する赤色の発光ダイオードの個数、発光面の大きさ、及び供給電流値の大きさの少なくとも一つを互いに変更することにより、赤色光の光量が互いに所定の範囲内とされていることが好ましい。

WO 2007/138724

PCT/JP2006/323564

5

- [0028] この場合、複数の設置領域では周囲温度の変動に応じて発光効率及び光量が最も変化し易い赤色の発光ダイオードに対して、その赤色光の光量が互いに所定の範囲内とされているので、上記輝度ムラの発生防止を確実に、かつ容易に行うことができる。しかも、バックライト装置の発光品位(色度分布)をより容易に向上させることができる。
- [0029] また、上記バックライト装置において、前記複数の設置領域では、緑色の光を発光する緑色の発光ダイオードの個数、発光面の大きさ、及び供給電流値の大きさの少なくとも一つを互いに変更することにより、緑色光の光量が互いに所定の範囲内とされていることが好ましい。
- [0030] この場合、複数の設置領域では上記赤色の発光ダイオードに加えて、周囲温度の変動に応じて発光効率及び光量が比較的变化し易い緑色の発光ダイオードに対して、その緑色光の光量が互いに所定の範囲内とされているので、上記輝度ムラの発生防止をより確実に行うことができる。しかも、バックライト装置の発光品位(色度分布)をより容易に向上させることができる。
- [0031] また、上記バックライト装置において、前記複数の設置領域では、色度が互いに所定の範囲内とされていることが好ましい。
- [0032] この場合、より優れた発光品位のバックライト装置を確実に構成することができる。
- [0033] また、上記バックライト装置において、前記複数の発光ダイオードからの光が導入される導光板を備えてもよい。
- [0034] この場合、上記輝度ムラの発生が確実に防がれたエッジライト型のバックライト装置を構成することが可能となり、薄型化されたバックライト装置を容易に得ることができる。
- [0035] また、上記バックライト装置において、前記複数の発光ダイオードでは、発光面が被照射物に対して直線上に配置されてもよい。
- [0036] この場合、上記輝度ムラの発生が確実に防がれた直下型のバックライト装置を構成することができ、高輝度化されたバックライト装置を容易に得ることができる。
- [0037] また、本発明の表示装置は、表示部を備えた表示装置であって、前記表示部には、上記いずれかのバックライト装置からの光が照射されることを特

WO 2007/138724

PCT/JP2006/323564

6

徴とするものである。

- [0038] 上記のように構成された表示装置では、発光ダイオードの設置数を増加させるときでも、輝度ムラの発生を防ぐことが可能なバックライト装置からの光を表示部に照射させているので、当該表示部の高輝度化及び大画面化を図ったときでも、表示性能に優れた表示装置を容易に構成することができる。

発明の効果

- [0039] 本発明によれば、発光ダイオードの設置数を増加させるときでも、輝度ムラの発生を防ぐことができるバックライト装置、及びこれを用いた表示装置を提供することが可能となる。

図面の簡単な説明

- [0040] [図1]本発明の第1の実施形態にかかるバックライト装置及び液晶表示装置を説明する模式図である。
- [図2]図1に示したバックライト装置の要部構成を示す平面図である。
- [図3]図2に示した発光ダイオードの温度特性の具体例を示すグラフである。
- [図4]本発明の第2の実施形態にかかるバックライト装置の要部構成を示す平面図である。
- [図5]本発明の第3の実施形態にかかるバックライト装置及び液晶表示装置を説明する模式図である。
- [図6]図5に示したバックライト装置における発光ダイオードの配置例を示す平面図である。
- [図7]本発明の第4の実施形態にかかるバックライト装置における発光ダイオードの配置例を示す平面図である。
- [図8]本発明の第5の実施形態にかかるバックライト装置における発光ダイオードの配置例を示す平面図である。

発明を実施するための最良の形態

- [0041] 以下、本発明のバックライト装置、及びこれを用いた表示装置の好ましい実施形態について、図面を参照しながら説明する。なお、以下の説明では、本発明を透過型の液晶表示装置に適用した場合を例示して説明する。

WO 2007/138724

PCT/JP2006/323564

7

[0042] [第1の実施形態]

図1は本発明の第1の実施形態にかかるバックライト装置及び液晶表示装置を説明する模式図であり、図2は図1に示したバックライト装置の要部構成を示す平面図である。図1及び図2において、本実施形態では、本発明のバックライト装置2と、バックライト装置2からの光が照射される表示部としての液晶パネル3とが設けられており、これらバックライト装置2と液晶パネル3とが透過型の液晶表示装置1として一体化されている。

[0043] バックライト装置2は、光源としての複数の発光ダイオード4と、複数の各発光ダイオード4からの光が導入される導光板5とを備えており、導光板5から液晶パネル3側に平面状の照明光を照射するようになっている。また、バックライト装置2では、複数の発光ダイオード4は図2に例示するように、導光板5に対し、同図2の上側及び下側にそれぞれ設定された上側領域及び下側領域のいずれか一方の発光ダイオード4の設置領域に設けられている。これらの上側領域と下側領域とは、液晶パネル3に設けられた表示面(図示せず)の横方向での上側部分及び下側部分にそれぞれ対向するように、液晶表示装置1の内部に組み込まれる。また、これら上側領域と下側領域とは、液晶表示装置1の使用時において、重力が作用する鉛直方向の上側及び下側にそれぞれ配置されるようになっており、当該液晶表示装置1の使用時での温度分布(温度上昇範囲)が互いに異なっている(詳細は後述。)

[0044] また、複数の発光ダイオード4には、赤色(R)、緑色(G)、及び青色(B)の光をそれぞれ発光する赤色、緑色、及び青色の発光ダイオード4r、4g、及び4bが含まれている。また、これらの赤色、緑色、及び青色の発光ダイオード4r、4g、及び4bは、図2にハッチングなし、ハッチング、及びクロスハッチングにてそれぞれ図示している(後掲の図4、図6、図7、及び図8においても同様。)。さらに、これらの赤色、緑色、及び青色の各発光ダイオード4r、4g、及び4bでは、後に詳述するように、導光板5に向かって発光される光量が上側領域と下側領域とで互いに所定の範囲内となるように、上側領域での設置数と下側領域での設置数とが異なる個数に設定されている。但し、図2では、図面の簡略化のために、発光ダイオード4r、4g、及び4bの各設置数を適宜少なくして示している(後掲の図4及び図6乃至図8においても同様。)。なお、例え

WO 2007/138724

PCT/JP2006/323564

8

ば対角20インチ以上の液晶表示装置1の場合には、発光ダイオード4r、4g、及び4bの具体的な設置数は各々数十個単位である。

[0045] また、液晶表示装置1では、液晶パネル3と導光板5との間に、例えば偏光シート6、プリズム(集光)シート7、及び拡散シート8が設置されており、これらの光学シートによって、バックライト装置2からの上記照明光の輝度上昇などが適宜行われて、液晶パネル3の表示性能を向上させるようになっている。

[0046] また、液晶表示装置1では、液晶パネル3に含まれた液晶層(図示せず)がFPC(Flexible Printed Circuit)9を介在させて駆動制御回路10に接続されており、当該駆動制御回路10が上記液晶層を画素単位に駆動可能に構成されている。また、駆動制御回路10は、CPU等の演算部を備えており、発熱源として働く、バックライト装置2の外部装置に含まれている。また、駆動制御回路10は、図1に示すように、バックライト装置2の導光板5の裏側で、例えば上記上側領域の近傍に取り付けられている。つまり、駆動制御回路10は、導光板5の液晶パネル3の非表示面側で、上記表示面の横方向に沿って上記鉛直方向の上側に設置されている。

[0047] また、駆動制御回路10の近傍には、複数の発光ダイオード4を点灯駆動する駆動回路としての点灯駆動回路11が、例えば鉛直方向の上側と下側との中間箇所で、導光板5の裏側に設置されている。この点灯駆動回路11には、各発光ダイオード4への電力源を構成する電源回路や発光ダイオード4毎の点灯駆動を制御する制御(IC)チップなどが含まれており、発光ダイオード4とともに、バックライト装置2側の発熱源を構成している。

[0048] 導光板5には、例えば透明なアクリル樹脂などの合成樹脂が用いられている。また、導光板5では、図1に例示するように、断面矩形状のものが使用されている。そして、この導光板5では、上記上側領域及び下側領域の各発光ダイオード4からの光が上側側面及び下側側面に対してそれぞれ入射される。その後、導光板5では、拡散シート8に対向配置された発光面から照明光が液晶パネル3に向かって出射される。

[0049] 具体的には、上側領域及び下側領域の各発光ダイオード4及び導光板5は図示しない筐体に收容されており、各発光ダイオード4からの光は、外部への光漏れが極力防がれた状態で、対応する上側側面または下側側面から導光板5の内部に対し、直

WO 2007/138724

PCT/JP2006/323564

9

接的にまたはリフレクターを介在させて間接的に効率よく導入されるようになっている。これにより、バックライト装置2では、各発光ダイオード4の光利用効率を容易に向上させることができ、上記照明光の高輝度化を簡単に図ることができる。

[0050] また、バックライト装置2では、発光ダイオード4の設置領域である上記の上側領域及び下側領域は液晶表示装置1の使用時での温度分布を用いて、互いに異なる箇所を設定されている。詳細にいえば、バックライト装置2では、液晶表示装置1の使用時での上記筐体内部の温度分布が実測またはシミュレーションなどによって求められており、液晶表示装置1の使用時に上記鉛直方向の上側に配置される上側領域の方が鉛直方向の下側に配置される下側領域に比べ、例えば10～15℃程度温度の高い領域であることが予め把握されている。つまり、液晶表示装置1の使用状態では、上側領域の温度はその内部に設置された発光ダイオード4からの熱だけでなく、下側領域の設置された発光ダイオード4、駆動制御回路10、及び点灯駆動回路11からの各熱の影響(熱の自然対流)により、下側領域の温度に比べ上記10～15℃程度の温度上昇が生じていることが予め判別されて、使用時での温度分布が互いに異なる上側領域及び下側領域として設定されている。

[0051] また、複数の発光ダイオード4には、上述したように、RGBの各色光を発光する発光ダイオード4r、4g、4bが含まれており、この導光板5では、導入されたRGBの各色光を白色光に混色して、当該白色光を上記発光面から照明光として出光するようになっている。これにより、バックライト装置2では、照明光の発光品位を向上させ、フルカラー画像に適切な照明光を液晶パネル3に入射させることが可能となり、液晶パネル3の表示品位を簡単に向上できる。

[0052] また、複数の発光ダイオード4では、液晶パネル3の大きさや当該液晶パネル3で要求される輝度や表示品位等の表示性能などに応じて、RGBの各発光ダイオード4r、4g、4bの設置数や種類、サイズ等が選択されている。具体的にいえば、各発光ダイオード4には、例えば消費電力が1W程度のパワーLEDあるいは70mW程度の消費電力のチップLEDが適宜使用されるようになっている。

[0053] さらに、バックライト装置2では、上側領域及び下側領域での各温度分布を用いて、これらの上側領域及び下側領域から導光板5に向かって発光される光量が互いに所

WO 2007/138724

PCT/JP2006/323564

10

定の範囲内となるように、上側領域及び下側領域の各々において発光ダイオード4r、4g、4bの各設置数が決定されている。これにより、バックライト装置2では、液晶表示装置1の使用時において、温度分布が異なる上側領域及び下側領域での相対的な光量差を所定の範囲内として、上記照明光に輝度ムラが生じるのを極力防げるようになっている。

[0054] すなわち、バックライト装置2では、発光ダイオード毎の光量のバラツキ(製品毎の光量バラツキ)がある場合でも、そのバラツキが解消(相殺)されるように、上側領域及び下側領域に対して、各色の発光ダイオード4r、4g、4bが適切に分散されて設置されている。また、予め求められた液晶表示装置1の使用時での上側領域及び下側領域での各温度分布に基づいて、上側領域及び下側領域での周囲温度の相違による光量差を極力生じないように、当該上側領域及び下側領域での発光ダイオード4r、4g、4bの各設置数は定められている。

[0055] 具体的にいえば、発光ダイオード4は、周囲温度に応じて、発光効率が変化して光量も変化する。また、発光ダイオード4では、その発光色の相違、つまり発光色の種類により、周囲温度に対する発光効率及び光量の各変化の割合が異なる。すなわち、図3に例示するように、常温(25℃)のときの光量を1としたときに、赤色の発光ダイオードでは、曲線50rにて示すように、周囲温度が高くなるにつれて、発光効率が低下して、相対光度(光量)も低下する。また、緑色の発光ダイオードでは、曲線50gにて示すように、周囲温度が高くなるにつれて、発光効率が若干低下して、相対光度も若干低下する。一方、青色及び白色(擬似白色)の発光ダイオードでは、曲線50b及び曲線50wにてそれぞれ示すように、周囲温度が高くなるにつれて、発光効率が僅かに向上して、相対光度も僅かに大きくなる。

[0056] それ故、バックライト装置2では、図2に例示するように、赤色の発光ダイオード4rの設置数は、液晶表示装置1の使用時に低温である下側領域よりも、高温である上側領域の方が多くなるよう配置されており、使用時での赤色光の光量が上側領域及び下側領域で所定の範囲内とされている。また、同様に、緑色の発光ダイオード4g及び青色の発光ダイオード4b各々においても、図3に示した温度特性に応じて、上側領域及び下側領域での設置数が定められ、使用時での緑色光及び青色光の光量

WO 2007/138724

PCT/JP2006/323564

11

が上側領域及び下側領域で所定の範囲内とされている。

[0057] 以上のように構成された本実施形態では、発光ダイオード4の設置領域として、液晶表示装置1の使用時での温度分布が互いに異なる上側領域及び下側領域が設定されている。また、複数の設置領域では、光量が互いに所定の範囲内となるように、発光ダイオード4が設置されている。これにより、本実施形態では、上記従来例と異なり、発光ダイオード4の設置数を増加させるときでも、バックライト装置2から外部に発光される照明光に、発光ダイオード毎の光量のバラツキや周囲環境の変化に起因する輝度ムラが生じるのを防ぐことができる。また、このように、発光ダイオード4の設置数を増加させるときでも、輝度ムラの発生が防がれたバックライト装置2を用いることにより、本実施形態では、液晶パネル(表示部)3の高輝度化及び大画面化を図ったときでも、表示性能に優れた液晶表示装置1を容易に構成することができる。

[0058] [第2の実施形態]

図4は、本発明の第2の実施形態にかかるバックライト装置の要部構成を示す平面図である。図において、本実施形態と上記第1の実施形態との主な相違点は、導光板5の左側側面及び右側側面に複数の発光ダイオードを対向して配置した点である。なお、上記第1の実施形態と共通する要素については、同じ符号を付して、その重複した説明を省略する。

[0059] すなわち、図4に示すように、本実施形態では、複数の発光ダイオード4が導光板5の左側側面及び右側側面に対向して配置されており、これらの左側側面及び右側側面から光を導光板5の内部に導入するようになっている。また、導光板5では、液晶表示装置1の使用時において、図4の上側部分が上記鉛直方向の上側となるように、バックライト装置2内に組み込まれており、本実施形態では、図4の上下方向の中間部を境界として、発光ダイオード4の設置領域が上側領域と下側領域とに分けて設定されている。つまり、これらの上側領域と下側領域とは、第1の実施形態と同様に、駆動制御回路10の温度上昇分を含んだ液晶表示装置1の使用時での温度上昇値を用いて定められており、互いに異なる箇所に設定されている。

[0060] また、本実施形態では、第1の実施形態と同様に、上側領域及び下側領域から導光板5に向かって発光される光量が互いに所定の範囲内となるように、上側領域及

WO 2007/138724

PCT/JP2006/323564

12

び下側領域の各々において発光ダイオード4r、4g、4bの各設置数が決定されている。例えば、図4に示すように、赤色の発光ダイオード4rの設置数が、液晶表示装置1の使用時に低温である下側領域よりも、高温である上側領域の方が多くなるよう配置されており、使用時での赤色光の光量が上側領域及び下側領域で所定の範囲内とされている。

[0061] 以上のように、本実施形態では、第1の実施形態と同様に、液晶表示装置1の使用時において、温度分布が異なる上側領域及び下側領域での相対的な光量差を所定の範囲内としているので、第1の実施形態と同様な作用・効果を奏することができる。

[0062] [第3の実施形態]

図5は本発明の第3の実施形態にかかるバックライト装置及び液晶表示装置を説明する模式図であり、図6は図5に示したバックライト装置における発光ダイオードの配置例を示す平面図である。図において、本実施形態と上記第2の実施形態との主な相違点は、複数の発光ダイオードを液晶パネルの下方側に配置した直下型のバックライト装置を構成した点である。なお、上記第2の実施形態と共通する要素については、同じ符号を付して、その重複した説明を省略する。

[0063] すなわち、図5に示すように、本実施形態では、複数の発光ダイオード4は上端部側が開いた有底状のケース12の内部に收容されている。また、ケース12の開口部側には、拡散シート8の代わりに、拡散板13が当該開口部を塞ぐように設置されている。そして、本実施形態では、導光板5を備えたエッジライト型のバックライト装置と異なり、各発光ダイオード4の発光面が導光板5を介在させることなく、液晶パネル(被照射物)3に対して、直線上に配置された直下型のバックライト装置が構成されている。

[0064] また、図6に例示するように、複数の発光ダイオード4は、図6の上下方向で4列に並べられて配置されており、各列が発光ダイオード4の設置領域に設定されている。つまり、本実施形態では、例えば図6に矢印Yにて示す上記鉛直方向の下側から上側に向かう方向(つまり、重力の作用方向とは反対の方向)に沿って、第1、第2、第3、及び第4の設置領域が設定されている。また、これらの第1～第4の設置領域は、液晶表示装置1の使用時におけるケース12の内部温度分布を基に設定されたもので

WO 2007/138724

PCT/JP2006/323564

13

あり、最下列の第1の設置領域での温度上昇が最も低温の領域であり、第2、第3、及び第4の設置領域の順番で温度上昇が高温の領域とされている。

[0065] また、本実施形態では、上記実施形態と同様に、第1～第4の設置領域から液晶パネル3に向かって発光される光量が互いに所定の範囲内となるように、第1～第4の設置領域の各々において発光ダイオード4r、4g、4bの各設置数が決定されている。例えば、図6に示すように、赤色の発光ダイオード4rの設置数が、液晶表示装置1の使用時に低温である下方側の領域よりも、高温である上方側の領域の方が多くなるよう配置されており、使用時での赤色光の光量が第1～第4の設置領域で互いに所定の範囲内とされている。

[0066] 以上のように、本実施形態では、上記実施形態と同様に、液晶表示装置1の使用時において、温度分布が異なる第1～第4の設置領域での相対的な光量差を所定の範囲内としているので、上記実施形態と同様な作用・効果を奏することができる。

[0067] [第4の実施形態]

図7は、本発明の第4の実施形態にかかるバックライト装置における発光ダイオードの配置例を示す平面図である。図において、本実施形態と上記第3の実施形態との主な相違点は、ケースの内部温度分布に応じて、複数の各設置領域での発光ダイオードの設置総数を変更した点である。なお、上記第3の実施形態と共通する要素については、同じ符号を付して、その重複した説明を省略する。

[0068] すなわち、図7に示すように、本実施形態では、複数の発光ダイオード4は、最下列の第1の設置領域での発光ダイオード4の設置総数(つまり、発光ダイオード4r、4g、4bの各設置数の合計数)が一番少ない数に設定されている。そして、液晶表示装置1の使用時における温度上昇が高くなるにつれて、発光ダイオード4の設置総数は増加されている。すなわち、第2、第3、及び第4の設置領域での発光ダイオード4の設置総数がこの順番で順次増やされている。

[0069] また、本実施形態では、上記第3の実施形態と同様に、第1～第4の設置領域から液晶パネル3に向かって発光される光量が互いに所定の範囲内となるように、第1～第4の設置領域の各々において発光ダイオード4r、4g、4bの各設置数が決定されている。例えば、図7に示すように、赤色の発光ダイオード4rの設置数が、液晶表示装

WO 2007/138724

PCT/JP2006/323564

14

置1の使用時に低温である下方側の領域よりも、高温である上方側の領域の方が多くなるよう配置されており、使用時での赤色光の光量が第1～第4の設置領域で互いに所定の範囲内とされている。

[0070] 以上のように、本実施形態では、上記第3の実施形態と同様に、液晶表示装置1の使用時において、温度分布が異なる第1～第4の設置領域での相対的な光量差を所定の範囲内としているので、上記第3の実施形態と同様な作用・効果を奏することができる。また、第1～第4の各設置領域での発光ダイオード4の設置総数をケース12の内部温度分布に応じて、増減しているので、本実施形態は、第3の実施形態よりも、液晶表示装置1の使用時におけるケース12の内部温度分布に幅が広く、第1の設置領域と第4の設置領域との温度差が大きいものにより容易に対応して、上記照明光に輝度ムラが発生するのを防止できる。

[0071] [第5の実施形態]

図8は、本発明の第5の実施形態にかかるバックライト装置における発光ダイオードの配置例を示す平面図である。図において、本実施形態と上記第3の実施形態との主な相違点は、複数の設置領域での発光ダイオードの個数を変更する代わりに、発光ダイオードの発光面の大きさを変更することにより、これらの設置領域での光量を互いに所定の範囲内とした点である。なお、上記第3の実施形態と共通する要素については、同じ符号を付して、その重複した説明を省略する。

[0072] すなわち、図8に示すように、本実施形態では、複数の発光ダイオード4は、図8の上下方向で5列に並べられて配置されており、各列が発光ダイオード4の設置領域に設定されている。つまり、本実施形態では、例えば図8に矢印Yにて示す上記鉛直方向の下側から上側に向かう方向（つまり、重力の作用方向とは反対の方向）に沿って、第1、第2、第3、第4、及び第5の設置領域が設定されている。また、これら第1～第5の設置領域は、液晶表示装置1の使用時におけるケース12の内部温度分布を基に設定されたものであり、最下側の第1の設置領域での温度上昇が最も低温の領域であり、第2、第3、第4、及び第5の設置領域の順番で温度上昇が高温の領域とされている。

[0073] また、本実施形態では、第1～第5の設置領域から液晶パネル3に向かって発光さ

WO 2007/138724

PCT/JP2006/323564

15

れる光量が互いに所定の範囲内となるように、第1～第5の設置領域の各々において発光ダイオード4r、4g、4bの各発光面の大きさが決定されている。具体的には、本実施形態では、例えば、図8に示すように、赤色の発光ダイオード4rにおいて、発光面の大きさが異なる製品が使用されている。つまり、この発光ダイオード4rでは、赤色発光素子(赤色チップ)の個数が相違する、例えば1パッケージに複数個の赤色チップが含まれた、いわゆるスリーインワン(3in1)やフォーインワン(4in1)等のLEDチップサイズ(定格電流値)が異なるものが使用されている。そして、図8に示したように、液晶表示装置1の使用時に低温である下方側の領域よりも、高温である上方側の領域の方が発光面の大きいものが設置されて、使用時での赤色光の光量が第1～第5の設置領域で互いに所定の範囲内とされている。

- [0074] 以上のように、本実施形態では、上記実施形態と同様に、液晶表示装置1の使用時において、温度分布が異なる第1～第5の設置領域での相対的な光量差を所定の範囲内としているので、上記実施形態と同様な作用・効果を奏することができる。
- [0075] 尚、上記の実施形態はすべて例示であって制限的なものではない。本発明の技術的範囲は特許請求の範囲によって規定され、そこに記載された構成と均等の範囲内のすべての変更も本発明の技術的範囲に含まれる。
- [0076] 例えば、上記の説明では、本発明を透過型の液晶表示装置に適用した場合について説明したが、本発明のバックライト装置はこれに限定されるものではなく、光源の光を利用して、画像、文字などの情報を表示する非発光型の表示部を備えた各種表示装置に適用することができる。具体的には、半透過型や反射型の液晶表示装置、あるいはリアプロジェクション等の投写型表示装置に本発明のバックライト装置を好適に用いることができる。
- [0077] また、上記の説明以外に、本発明は、レントゲン写真に光を照射するシャウカステンあるいは写真ネガ等に光を照射して視認をし易くするためのライトボックスや、看板や駅構内の壁面などに設置される広告等をライトアップする発光装置のバックライト装置として好適に用いることができる。
- [0078] また、上記の説明では、表示面が鉛直方向に平行となるように設置される液晶表示装置に本発明を適用した場合について説明したが、本発明は鉛直方向に対して所

WO 2007/138724

PCT/JP2006/323564

16

定角度にて傾けられる表示面を備えた液晶表示装置に適用することもできる。

[0079] また、上記の説明では、液晶表示装置の使用時での温度分布を用いて、発光ダイオードの設置領域を複数設定する場合について説明したが、本発明は互いに異なる箇所にも複数の設置領域を設定するとともに、これら設置領域での光量が互いに所定の範囲内となるように、複数の発光ダイオードを分散して設置するものであれば何等限定されない。

[0080] 但し、上記実施形態のように、発光ダイオードが点灯駆動回路(駆動回路)によって点灯駆動されたときでの温度分布を用いて、互いに異なる箇所にも複数の設置領域を設定する場合の方が好ましい。すなわち、このように構成した場合には、各設置領域において、その温度分布が把握された状態で、発光ダイオードが適切に設置される。この結果、各設置領域での温度分布が異なる場合でも、外部への光(照明光)に輝度ムラが生じるのを確実に防ぐことができるからである。

[0081] さらに、上記実施形態のように、液晶パネルの駆動制御回路(外部装置)にて発生した熱による温度上昇分を含んだ温度分布を用いて、互いに異なる箇所にも複数の設置領域を設定する場合の方がより好ましい。つまり、この場合には、外部装置からの発生熱に起因する周囲温度変動の悪影響を確実に排除した状態で、各設置領域での光量をより容易に所定の範囲内とすることが可能となり、照明光の輝度ムラの発生をより確実に防ぐことができるからである。言い換えれば、複数の設置領域は、バックライト装置自体が本来的に有する発光ダイオード等の発熱源(内的要因)だけでなく、当該バックライト装置が組み込まれる液晶パネル側の発熱源(外乱)に起因する温度上昇分も含んだ温度分布を用いて、互いに異なる箇所にも設定されることとなり、各設置領域での光量調整を行う際に、外乱の悪影響をより確実に排除できる点で好ましい。

[0082] また、上記の説明では、バックライト装置の外部装置として液晶パネルの駆動制御回路を例示した場合について説明したが、本発明の外部装置はこれに限定されるものではなく、外部装置にはバックライト装置に適宜取り付けられて、使用時に熱を発生して発熱源を構成する各種電気部品、電気回路等が含まれる。具体的には、液晶パネルに含まれた一方の一方の基板上に実装されるドライバICの発熱による温度上

WO 2007/138724

PCT/JP2006/323564

17

昇分を考慮して、複数の設置領域を設定することもできる。

- [0083] また、上記の説明では、複数の設置領域において、設置される発光ダイオードの個数または発光面の大きさを互いに変更することにより、相対的な光量差を所定の範囲内とする場合について説明したが、本発明はこれに限定されるものではなく、複数の設置領域において、設置される発光ダイオードへの供給電流値を互いに変更することにより、光量が互いに所定の範囲内とする構成でもよい。また、複数の各設置領域での個数、発光面の大きさ、及び供給電流値の大きさの少なくとも一つを変更する構成でもよい。
- [0084] 尚、上記第1～第4の実施形態のように、発光ダイオードの個数を互いに変更することにより、複数の設置領域での光量を互いに所定の範囲内とした場合には、複数の設置領域での各光量の調整を簡単に行うことが可能となり、上記輝度ムラの発生防止を確実に、かつ容易に行うことができる点で好ましい。
- [0085] また、上記第5の実施形態のように、発光ダイオードの発光面の大きさを互いに変更することにより、複数の設置領域での光量が互いに所定の範囲内とした場合には、複数の各設置領域での発光ダイオードの組込作業の簡単化を図りつつ、光量調整を簡単に行うことができ、上記輝度ムラの発生防止を確実に、かつ容易に行うことができる点で好ましい。
- [0086] また、発光ダイオードへの供給電流値を互いに変更することにより、複数の設置領域での光量を互いに所定の範囲内とした場合には、高精度な光量調整を簡単に行うことができ、上記輝度ムラの発生防止をより確実に行うことができる点で好ましい。
- [0087] また、上記の説明では、RGBの対応する色光を発光する赤色、緑色、及び青色の発光ダイオードを用いた場合について説明したが、本発明はこれに限定されるものではなく、白色光を発光する白色の発光ダイオードだけを光源として含んだバックライト装置に適用して、複数の白色の発光ダイオードを複数の設置領域に分散設置して、これらの設置領域からの光量を所定の範囲内に揃えさせてもよい。また、発光色が互いに異なるとともに、白色光に混色可能な少なくとも二色、例えば黄色と青色の各発光ダイオードを使用したバックライト装置に本発明を適用することもできる。
- [0088] 但し、上記実施形態のように、赤色、緑色、及び青色の発光ダイオードを用いる場

WO 2007/138724

PCT/JP2006/323564

18

合の方が、照明光に含まれる赤色、緑色、及び青色の各発光色の色純度を向上させることが可能となり、バックライト装置の発光品位を容易に向上できるとともに、表示品位(表示性能)を高めた表示装置を容易に構成できる点で好ましい。

- [0089] また、上記の説明では、赤色、緑色、及び青色の各発光ダイオードについて、複数の各設置領域での個数または発光面の大きさを変更する場合について説明したが、本発明はこれに限定されるものではなく、赤色、緑色、及び青色のいずれか一色の発光ダイオードだけについて、複数の各設置領域での個数、発光面の大きさ、及び供給電流値の大きさの少なくとも一つを変更する構成でもよい。
- [0090] 但し、少なくとも赤色の発光ダイオードについて、複数の各設置領域での個数、発光面の大きさ、及び供給電流値の大きさの少なくとも一つを変更することが好ましい。すなわち、この場合には、複数の設置領域において、周囲温度の変動に応じて発光効率及び光量が最も変化し易い赤色の発光ダイオードに対して、その赤色光の光量が互いに所定の範囲内とされるので、上記輝度ムラの発生防止を確実に、かつ容易に行うことができるからである。さらには、バックライト装置の発光品位(色度分布)をより容易に向上させることができる。
- [0091] また、赤色の発光ダイオードに加えて、緑色の発光ダイオードについて、複数の各設置領域での個数、発光面の大きさ、及び供給電流値の大きさの少なくとも一つを変更することが好ましい。すなわち、この場合には、複数の設置領域において、周囲温度の変動に応じて発光効率及び光量が比較的变化し易い緑色の発光ダイオードに対して、その緑色光の光量が互いに所定の範囲内とされるので、上記輝度ムラの発生防止をより確実に行うことができ、しかもバックライト装置の発光品位(色度分布)をより容易に向上させることができるからである。
- [0092] また、上記の説明以外に、複数の各発光ダイオードについて、予め同一の測定条件にて点灯させることにより、対応する発光ダイオードの光量(光束量や光度)を測定して、その測定結果を基に複数のいずれかのランクに振り分けられた発光ダイオードを使用することもできる。このように、発光ダイオード個別の光量について予めランク分けされた発光ダイオードを使用することにより、複数の設置領域での光量を互いに揃える調整作業を簡単化することができる。

WO 2007/138724

PCT/JP2006/323564

19

[0093] また、上記の説明以外に、複数の設置領域において、色度が互いに所定の範囲内となるように、複数の発光ダイオードを分散して設置する構成でもよい。このように構成した場合には、バックライト装置の発光品位(色度分布)をより確実に向上させることができる。さらには、発光ダイオードの発光スペクトルを予め測定して、その測定結果を基に発光ダイオードの色純度を複数のいずれかのランクに予め振り分けて、互いに異なる設置領域に配置する構成でもよい。このように、光量ランクに加えて、発光スペクトルについてランク分けして、互いに異なる設置領域に配置する場合には、発光品位に優れたバックライト装置及び優れた表示品位の表示装置をより容易に構成できる点で好ましい。

[0094] また、上記の説明以外に、各設置領域に温度センサーを設けて、その温度検出結果を基に対応する設置領域内の発光ダイオードへの供給電流値を微調整したり、各設置領域に光量を測定する光センサーを設置して、その光量測定結果を基に対応する設置領域内の発光ダイオードへの供給電流値を微調整したりすることにより、バックライト装置の照明光に輝度ムラが生じるのを防止する構成でもよい。

産業上の利用可能性

[0095] 本発明にかかるバックライト装置及びこれを用いた表示装置は、発光ダイオードの設置数を増加させるときでも、輝度ムラが発生するのを防ぐことができるので、大型画面を有する表示部に対し高輝度な光を照射可能なバックライト装置及び当該表示部を備えた表示装置に対して有効である。

WO 2007/138724

PCT/JP2006/323564

20

請求の範囲

- [1] 複数の発光ダイオードと、
互いに異なる箇所に設定されるとともに、前記複数のいずれかの発光ダイオードを
設置する複数の設置領域とを備え、
前記複数の設置領域では、光量が互いに所定の範囲内となるように、前記複数の
発光ダイオードを分散して設置していることを特徴とするバックライト装置。
- [2] 前記発光ダイオードを点灯駆動する駆動回路を備えるとともに、
前記複数の設置領域は、前記発光ダイオードが前記駆動回路によって点灯駆動さ
れたときの温度分布を用いて、互いに異なる箇所に設定されている請求項1に記載
のバックライト装置。
- [3] 前記複数の設置領域は、外部装置にて発生した熱による温度上昇分を含んだ前記
温度分布を用いて、互いに異なる箇所に設定されている請求項2に記載のバックライ
ト装置。
- [4] 前記複数の設置領域は、使用状態において重力が作用する鉛直方向での位置が
互いに異なる箇所に設定されている請求項1～3のいずれか1項に記載のバックライ
ト装置。
- [5] 前記複数の設置領域では、設置される発光ダイオードの個数を互いに変更すること
により、前記光量が互いに所定の範囲内とされている請求項1～4のいずれか1項に
記載のバックライト装置。
- [6] 前記複数の設置領域では、設置される発光ダイオードの発光面の大きさを互いに変
更することにより、前記光量が互いに所定の範囲内とされている請求項1～5のいず
れか1項に記載のバックライト装置。
- [7] 前記複数の設置領域では、設置される発光ダイオードへの供給電流値を互いに変
更することにより、前記光量が互いに所定の範囲内とされている請求項1～6のいず
れか1項に記載のバックライト装置。
- [8] 前記複数の発光ダイオードには、発光色が互いに異なる複数種類の発光ダイオード
が含まれている請求項1～7のいずれか1項に記載のバックライト装置。
- [9] 前記複数の発光ダイオードには、赤色、緑色、及び青色の光をそれぞれ発光する赤

WO 2007/138724

PCT/JP2006/323564

21

色、緑色、及び青色の発光ダイオードが含まれている請求項1～8のいずれか1項に記載のバックライト装置。

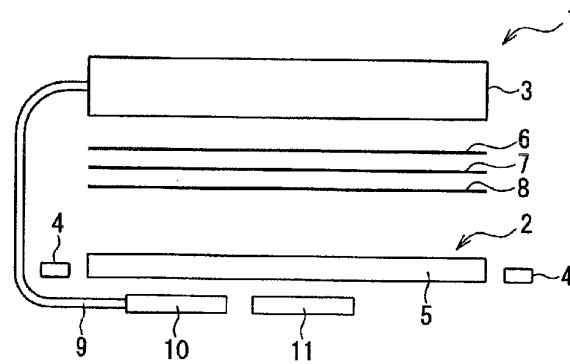
- [10] 前記複数の設置領域では、前記複数の発光ダイオードのうち、赤色の光を発光する赤色の発光ダイオードの個数、発光面の大きさ、及び供給電流値の大きさの少なくとも一つを互いに変更することにより、赤色光の光量が互いに所定の範囲内とされている請求項8または9に記載のバックライト装置。
- [11] 前記複数の設置領域では、緑色の光を発光する緑色の発光ダイオードの個数、発光面の大きさ、及び供給電流値の大きさの少なくとも一つを互いに変更することにより、緑色光の光量が互いに所定の範囲内とされている請求項10に記載のバックライト装置。
- [12] 前記複数の設置領域では、色度が互いに所定の範囲内とされている請求項1～11のいずれか1項に記載のバックライト装置。
- [13] 前記複数の発光ダイオードからの光が導入される導光板を備えている請求項1～12のいずれか1項に記載のバックライト装置。
- [14] 前記複数の発光ダイオードでは、発光面が被照射物に対して直線上に配置されている請求項1～12のいずれか1項に記載のバックライト装置。
- [15] 表示部を備えた表示装置であって、
前記表示部には、請求項1～14のいずれか1項に記載のバックライト装置からの光が照射されることを特徴とする表示装置。

WO 2007/138724

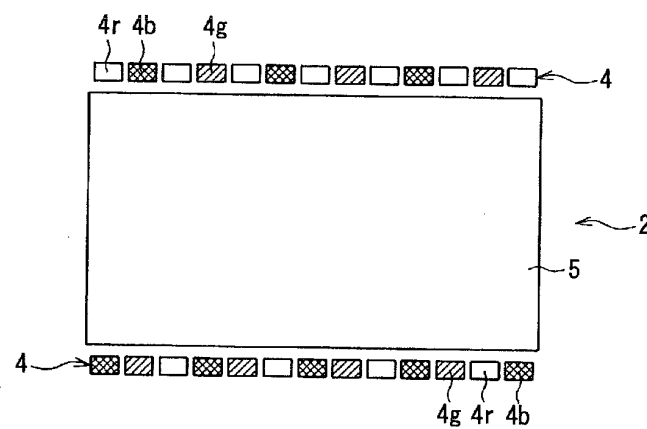
1/3

PCT/JP2006/323564

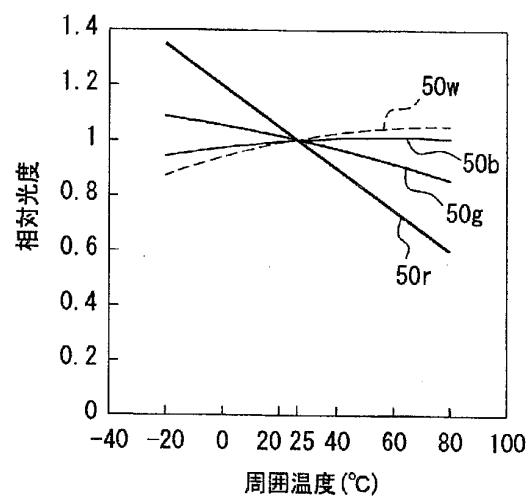
[図1]



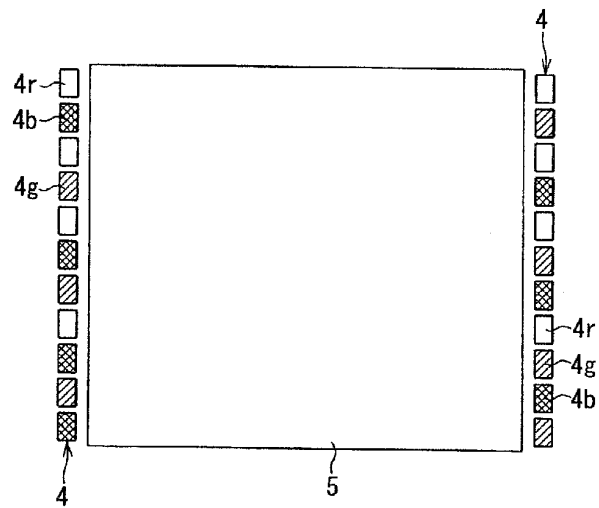
[図2]



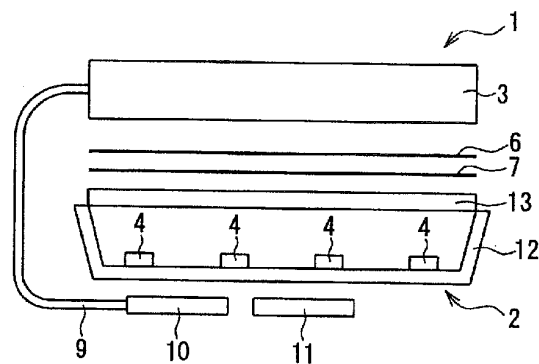
[図3]



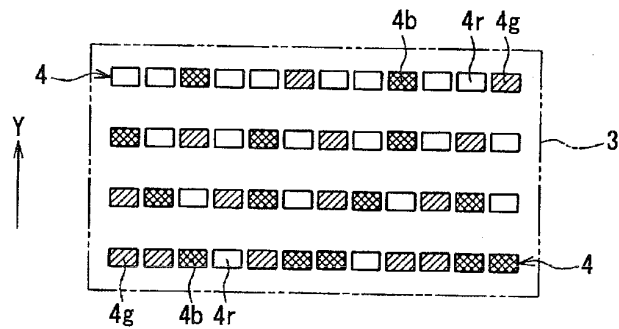
[圖4]



[圖5]



[圖6]

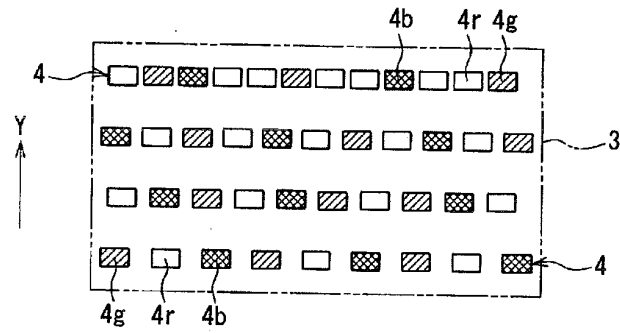


WO 2007/138724

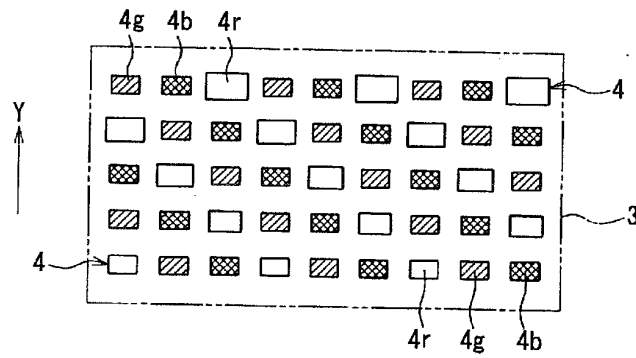
3/3

PCT/JP2006/323564

[図7]



[図8]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/323564

A. CLASSIFICATION OF SUBJECT MATTER

F21S2/00(2006.01)i, F21V8/00(2006.01)i, G02F1/13357(2006.01)i, H01L33/00(2006.01)i, G02B6/00(2006.01)i, F21Y101/02(2006.01)n

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)

F21S2/00, F21V8/00, G02F1/13357, H01L33/00, G02B6/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007
Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/006537 A1 (Sony Corp.), 19 January, 2006 (19.01.06),	1-4, 7-12, 14, 15
Y	Full text; Figs. 1 to 17 & EP 1672706 A1 Full text; Figs. 1 to 17 & CN 1842923 A	5, 6, 13
Y	JP 2003-207780 A (Harison Toshiba Lighting Corp.), 25 July, 2003 (25.07.03), Par. No. [0032] (Family: none)	5
Y	JP 2006-133721 A (Sony Corp.), 25 May, 2006 (25.05.06), Figs. 3, 7 to 10, 13 to 15 & WO 2006/040937 A1	5

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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
07 February, 2007 (07.02.07)

Date of mailing of the international search report
13 February, 2007 (13.02.07)

Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/323564

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 10-247411 A (Omron Corp.), 14 September, 1998 (14.09.98), Par. Nos. [0031] to [0035]; Figs. 10 to 12 (Family: none)	5, 13
Y	JP 2005-196989 A (Fujitsu Display Technologies Kabushiki Kaisha), 21 July, 2005 (21.07.05), Par. Nos. [0061] to [0067]; Figs. 9, 10 & US 2005/0141244 A1 Par. Nos. [0097] to [0102]; Figs. 9, 10 & KR 10-2005-0066943 A & CN 1637523 A	5, 13
Y	JP 11-162233 A (Matsushita Electric Works, Ltd.), 18 June, 1999 (18.06.99), Par. No. [0017]; Fig. 2 (Family: none)	6

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2006/323564

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

It is clear that the feature common to claims 1-15 is not novel, since it is disclosed in the document below. As a result, since the above mentioned common feature does not make contribution over the prior art, the common feature is not a "special technical feature" in the meaning of PCT Rule 13.2, second sentence.

WO 2006/006537 A1 (Sony Corp.), 19 January, 2006 (19.01.06), whole text and Fig. 1-17

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest
the

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, payment of a protest fee..
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (2)) (April 2005)

国際調査報告		国際出願番号 PCT/J P 2 0 0 6 / 3 2 3 5 6 4	
A. 発明の属する分野の分類 (国際特許分類 (IPC)) Int.Cl. F21S2/00(2006.01)i, F21V8/00(2006.01)i, G02F1/13357(2006.01)i, H01L33/00(2006.01)i, G02B6/00(2006.01)i, F21Y101/02(2006.01)n			
B. 調査を行った分野 調査を行った最小限資料 (国際特許分類 (IPC)) Int.Cl. F21S2/00, F21V8/00, G02F1/13357, H01L33/00, G02B6/00			
最小限資料以外の資料で調査を行った分野に含まれるもの 日本国実用新案公報 1922-1996年 日本国公開実用新案公報 1971-2007年 日本国実用新案登録公報 1996-2007年 日本国登録実用新案公報 1994-2007年			
国際調査で使用した電子データベース (データベースの名称、調査に使用した用語)			
C. 関連すると認められる文献			
引用文献の カテゴリー*	引用文献名 及び一部の箇所が関連するときは、その関連する箇所の表示	関連する 請求の範囲の番号	
X	WO 2006/006537 A1 (ソニー株式会社) 2006.01.19, 全文, 図1-17 & EP 1672706 A1, 全文, 図1-17 & CN 1842923 A	1-4, 7-12, 14, 15	
Y		5, 6, 13	
Y	JP 2003-207780 A (ハリソン東芝ライティング株式会社) 2003.07.25, 段落0032 (ファミリーなし)	5	
☒ C欄の続きにも文献が列挙されている。 ☐ パテントファミリーに関する別紙を参照。			
* 引用文献のカテゴリー 「A」 特に関連のある文献ではなく、一般的技術水準を示すもの 「E」 国際出願日前の出願または特許であるが、国際出願日後に公表されたもの 「L」 優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献 (理由を付す) 「O」 口頭による開示、使用、展示等に言及する文献 「P」 国際出願日前で、かつ優先権の主張の基礎となる出願 の日の後に公表された文献 「T」 国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの 「X」 特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの 「Y」 特に関連のある文献であって、当該文献と他の1以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの 「&」 同一パテントファミリー文献			
国際調査を完了した日 07.02.2007		国際調査報告の発送日 13.02.2007	
国際調査機関の名称及びあて先 日本国特許庁 (ISA/J P) 郵便番号100-8915 東京都千代田区霞が関三丁目4番3号		特許庁審査官 (権限のある職員) 永田 和彦 電話番号 03-3581-1101 内線 3372	

様式PCT/ISA/210 (第2ページ) (2005年4月)

国際調査報告

国際出願番号 PCT/J P 2 0 0 6 / 3 2 3 5 6 4

第II欄 請求の範囲の一部の調査ができないときの意見 (第1ページの2の続き)

法第8条第3項 (PCT規則17条(2)(a))の規定により、この国際調査報告は次の理由により請求の範囲の一部について作成しなかった。

1. ☐ 請求の範囲 _____ は、この国際調査機関が調査をすることを要しない対象に係るものである。つまり、
2. ☐ 請求の範囲 _____ は、有意義な国際調査をすることができる程度まで所定の要件を満たしていない国際出願の部分に係るものである。つまり、
3. ☐ 請求の範囲 _____ は、従属請求の範囲であってPCT規則6.4(a)の第2文及び第3文の規定に従って記載されていない。

第III欄 発明の単一性が欠如しているときの意見 (第1ページの3の続き)

次に述べるようにこの国際出願に二以上の発明があるとこの国際調査機関は認めた。

請求の範囲1-15に共通の事項である、請求の範囲1記載の事項は、下記文献に開示されているから、新規でないことが明らかとなった。結果として、前記共通の事項は、先行技術の域を出るものではないから、PCT規則13.2の第2文の意味において、前記共通の事項は「特別な技術的特徴」ではない。

WO 2006/006537 A1 (ソニー株式会社) 2006.01.19, 全文, 図1-17

1. ☐ 出願人が必要な追加調査手数料をすべて期間内に納付したので、この国際調査報告は、すべての調査可能な請求の範囲について作成した。
2. ☒ 追加調査手数料を要求するまでもなく、すべての調査可能な請求の範囲について調査することができたので、追加調査手数料の納付を求めなかった。
3. ☐ 出願人が必要な追加調査手数料を一部のみしか期間内に納付しなかったので、この国際調査報告は、手数料の納付のあった次の請求の範囲のみについて作成した。
4. ☐ 出願人が必要な追加調査手数料を期間内に納付しなかったので、この国際調査報告は、請求の範囲の最初に記載されている発明に係る次の請求の範囲について作成した。

追加調査手数料の異議の申立てに関する注意

- ☐ 追加調査手数料及び、該当する場合には、異議申立手数料の納付と共に、出願人から異議申立てがあった。
- ☐ 追加調査手数料の納付と共に出願人から異議申立てがあったが、異議申立手数料が納付命令書に示した期間内に支払われなかった。
- ☐ 追加調査手数料の納付を伴う異議申立てがなかった。

様式PCT/ISA/210 (第1ページの続葉(2)) (2005年4月)

国際調査報告

国際出願番号 PCT/JP2006/323564

C (続き) . 関連すると認められる文献		
引用文献の カテゴリー*	引用文献名 及び一部の箇所が関連するときは、その関連する箇所の表示	関連する 請求の範囲の番号
Y	JP 2006-133721 A (ソニー株式会社) 2006.05.25, 図3, 7-10, 13-15 & WO 2006/040937 A1	5
Y	JP 10-247411 A (オムロン株式会社) 1998.09.14, 段落0031-0035, 図10-12 (ファミリーなし)	5, 13
Y	JP 2005-196989 A (富士通ディスプレイテクノロジーズ株式会社) 2005.07.21, 段落0061-0067, 図9, 10 & US 2005/0141244 A1, 段落0097-0102, 図9, 10 & KR 10-2005-0066943 A & CN 1637523 A	5, 13
Y	JP 11-162233 A (松下電工株式会社) 1999.06.18, 段落0017, 図2 (ファミリーなし)	6

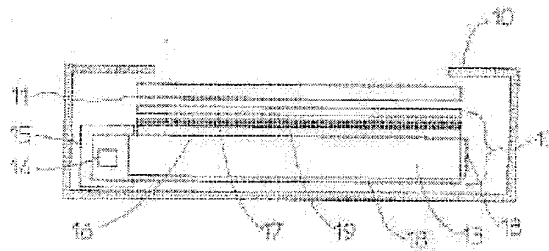
様式PCT/ISA/210 (第2ページの続き) (2005年4月)

LIQUID CRYSTAL DISPLAY DEVICE

Publication number: JP2003279985 (A)
Publication date: 2003-10-02
Inventor(s): NISHINO KENJI +
Applicant(s): KYOCERA CORP +
Classification:
- international: *F21V8/00; G02B5/02; G02B5/22; G02F1/1335; G02F1/13357; F21Y101/02; F21V8/00; G02B5/02; G02B5/22; G02F1/13; (IPC1-7): F21V8/00; F21Y101/02; G02B5/02; G02B5/22; G02F1/1335; G02F1/13357*
- European:
Application number: JP20020086541 20020326
Priority number(s): JP20020086541 20020326

Abstract of JP 2003279985 (A)

PROBLEM TO BE SOLVED: To convert the color tone of the light emitted from a backlight without increasing the number of members or member costs and to achieve miniaturization and cost reduction. ;
SOLUTION: A liquid crystal display device is composed of a liquid crystal display part 11 and an LED backlight 12. The LED backlight 12 is provided with a light guide plate 13, and an LED 14 is arranged on the side face of the light guide plate 13. A reflection sheet 18 is provided on one principal surface of the light guide plate 13, and a light diffusion plate 16 for uniformly diffusing light emitted from the surface of the light guide plate 13 is further arranged. A coloring layer 19 including a pigment is provided on the surface of the light diffusion plate 16. ; COPYRIGHT: (C)2004,JPO



Data supplied from the **espacenet** database — Worldwide

(19) 日本国特許庁 (J P)

(12) 公 開 特 許 公 報 (A)

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特開2003-279985
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(51) Int.Cl. ⁷	識別記号	F I	テ-マコ-ト* (参考)
G 0 2 F 1/13357		G 0 2 F 1/13357	2 H 0 4 2
F 2 1 V 8/00	6 0 1	F 2 1 V 8/00	6 0 1 A 2 H 0 4 8
G 0 2 B 5/02		G 0 2 B 5/02	A 2 H 0 9 1
	5/22		5/22
G 0 2 F 1/1335		G 0 2 F 1/1335	

審査請求 未請求 請求項の数 4 O L (全 5 頁) 最終頁に続く

(21) 出願番号 特願2002-86541(P2002-86541)

(22) 出願日 平成14年3月26日 (2002. 3. 26)

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F タ-ム (参考) 2H042 BA01 BA02 BA12 BA14 BA20

2H048 CA14 CA19 CA24

2H091 FA08Z FA11Z FA14Z FA23Z

FA41Z FA45Z GA01 GA02

GA06 GA13 HA07 HA10 LA11

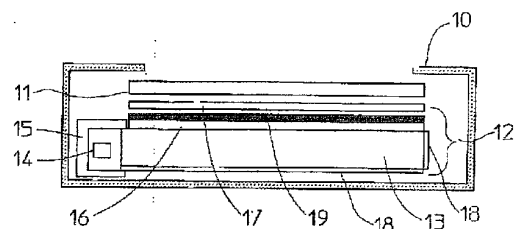
LA12 LA30

(54) 【発明の名称】 液晶表示装置

(57) 【要約】

【課題】 部材点数および部材費を増加させないで、バックライトの出射光の色調を変換させる。また、小型化かつ低コスト化を達成する。

【解決手段】 液晶表示部 11 と LED バックライト 12 とからなり、LED バックライト 12 は導光板 13 を備え、この導光板 13 の側面に LED 14 を配置している。導光板 13 の一方の主面には反射シート 18 を設け、さらに導光板 13 の表面より出射された光を均一に拡散させるための光拡散板 16 が配置される。そして、光拡散板 16 の表面に顔料を含む着色層 19 を設ける。



【特許請求の範囲】

【請求項1】透明材料から成る平板もしくはクサビ状の導光板の端面に光源を配し、この導光板の一主面に上記光源からの光を光出射面へ導くための光反射層を形成し、さらに光出射面に光出射光を拡散させるための光散乱部材を配置したバックライトと、このバックライトの光拡散部材の上に液晶表示部を配設した液晶表示装置において、前記光拡散部材に対し顔料を用いて着色化せしめたことを特徴とする液晶表示装置。

【請求項2】前記光拡散部材の表面に顔料を含む合成樹脂材を層状に塗着して着色化せしめたことを特徴とする請求項1に記載の液晶表示装置。

【請求項3】前記光拡散部材を成す合成樹脂材に対し、あらかじめ顔料を含有させていることを特徴とする請求項1に記載の液晶表示装置。

【請求項4】前記光拡散部材の表面に、カラープリンタもしくはカラーコピー機を用いて顔料を印刷せしめたことを特徴とする請求項1に記載の液晶表示装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明はバックライトを備えた液晶表示装置の改良に関するものである。

【0002】

【従来の技術】一般に液晶表示装置は画像表示を行う表示部を照明するために、いわゆるバックライトを備えている。そして、近年の液晶市場における低消費電力化という市場要求に応え、このバックライトの光源に、従来の冷陰極管より電力を大幅に削減できる発光ダイオード（以下、この発光ダイオードをLEDと略記する）を実装した液晶表示装置が台頭してきた。とくに携帯電話用途等の小型液晶パネルのバックライトにおいては、現在ではそのほとんどがLEDバックライトを採用している。

【0003】従来のLEDバックライト型液晶表示装置を図2により説明する。図2はこの装置の断面概略図である。

【0004】LEDバックライト型液晶表示装置は画像表示を行う液晶表示部11と、この液晶表示部11に対し光出射させるLEDバックライト12と、さらに液晶表示部11とLEDバックライト12とを保護し、および保持するベゼル10から構成されている。

【0005】液晶表示部11とLEDバックライト12とは、双方間にて、表示面にて平行となるように配置されている。そして、LEDバックライト12によれば、合成樹脂からなる透明な導光板13を備え、この導光板13の側面に対向するようにLED14を配置している。また、導光板13の一方の主面には光散乱樹脂などからなる反射シート18を設け、LED14から放たれた光が導光板13内に進入し、その反射シート18により液晶表示部11に向けて光出射させるようになって

いる。

【0006】また、LED14はリフレクター15により固定されており、リフレクター15はLED14から導光板13の反対側に向かう光を反射させ、導光板13内部に導くために設けられている。

【0007】さらに導光板13の光出射面には、出射光を拡散させるための光拡散板16を設けたり、さらにはこの光拡散板16の上に拡散光を集光させるためのレンズシート17を1枚、あるいは2枚配置している。

【0008】しかしながら、前述した構成の液晶表示装置によれば、LEDの発光色を自由に変更できず、これにより、LEDバックライトの出射光を所望の色度値に設定することができないという課題があった。

【0009】この課題を解消するために、着色シートを設ける技術が提案されている（特開1996-146228号公報参照）。

【0010】この技術を図3により説明する。同図は液晶表示装置の概略断面図である。なお、図2に示す液晶表示装置と同一箇所には同一符号を付す。

【0011】この液晶表示装置によれば、拡散板16の上に着色シート20を重ねた構成である。

【0012】このように拡散板16を透過した光が着色シート20を通過することで、着色化させ、これにより、LEDバックライト12の出射光の色調を変換させることができた。

【0013】

【発明が解決しようとする課題】しかしながら、特開1996-146228号公報にて提案されたように、着色シートを設けた液晶表示装置によれば、さらに着色シートを追加した構成であり、そのために部材点数および部材費の増加を招き、しかも、この着色シートの厚み分、LEDバックライトの総厚が増加していた。

【0014】よって、とくに近年、薄型軽量化という厳しい市場要求に応えることができず、小型液晶モジュール市場においては、着色シート1枚分の厚み増加といえども、それが欠陥につながってしまうことも決して珍しいことではない。

【0015】本発明者上記事情に鑑みて鋭意研究に努めた結果、光拡散部材自体を着色化させることで、さまざまな着色化技術を創意工夫し、本発明を完成させるに至った。

【0016】したがって本発明の目的は上記知見に鑑みて完成されたものであり、その目的は部材点数および部材費を増加させないで、バックライトの出射光の色調を変換させることができた液晶表示装置を提供することにある。

【0017】本発明の他の目的は、小型化かつ低コスト化を達成した液晶表示装置を提供することにある。

【0018】

【課題を解決するための手段】本発明の液晶表示装置

は、透明材料から成る平板もしくはクサビ状の導光板の端面に光源を配し、この導光板の一主面に上記光源からの光を光出射面へ導くための光反射層を形成し、さらに光出射面に射出光を拡散させるための光散乱部材を配置したバックライトと、このバックライトの光拡散部材の上に液晶表示部を配設し、そして、前記光拡散部材に対し顔料を用いて着色化せしめたことを特徴とする。

【0019】本発明の他の液晶表示装置は、前記光拡散部材の表面に顔料を含む合成樹脂材を層状に塗着して着色化せしめたことを特徴とする。

【0020】本発明のさらに他の液晶表示装置は、前記光拡散部材を成す合成樹脂材に対し、あらかじめ顔料を含有させていることを特徴とする。

【0021】また、本発明の他の液晶表示装置は、前記光拡散部材の表面に、カラープリンタもしくはカラーコピー機を用いて顔料を印刷せしめたことを特徴とする。

【0022】

【発明の実施の形態】以下、本発明の液晶表示装置を図面にて説明する。

【0023】(例1)図4は液晶表示装置の概略断面図であり、前述した図2と図3に示す液晶表示装置と同一箇所には同一符号を付す。

【0024】この液晶表示装置は、画像表示を行う液晶表示部11と、この液晶表示部11の裏面側に平行に配置されるLEDバックライト12で構成され、さらに必要に応じて配するが、液晶表示部11とLEDバックライト12とを保護し、および保持するベゼル10から構成されている。

【0025】上記液晶表示部11は電極としてパターンニングされた2枚のガラス基板がシール材である接着剤を介して貼り合わされた後、液晶を封入し、所定の寸法に切り出されたものである。電極上には配向膜を形成し、さらにカラーフィルタや偏光板、位相差板、反射板、半透過板などの機能性の板を設ける。

【0026】かかる液晶表示部11はTNやSTNなどの単純マトリックス型液晶表示部であっても、TFTなどのアクティブ型の液晶表示部でもよい。

【0027】LEDバックライト12については、合成樹脂からなる透明な導光板13を備え、この導光板13の側面にLED14を配置している。また、導光板13の一方の主面には光散乱樹脂などからなる反射シート18を設けている。また、反射シート18は導光板13側面にも配置させてある。LED14から放たれた光が導光板13内に進入し、その反射シート18により液晶表示部11に向けて光出射させるようになっている。

【0028】また、LED14はリフレクター15により固定されており、リフレクター15はLED14から導光板13の反対側に向かう光を反射させ、導光板13内部に導くために設けられている。

【0029】上記導光板13については、たとえば透明

なアクリル樹脂から成り、それをもって成形することで、平板もしくはクサビ状にする。

【0030】そして、導光板13の表面より出射された光を均一に拡散させるための前記光拡散部材である光拡散板16が配置される。さらにその上に拡散された光を集めるためのレンズシート17を重ねてもよい。

【0031】そして、本発明によれば、かかる構成のバックライト12において、光拡散板16の表面に顔料を含む合成樹脂材を層状に塗着して着色化させることで、この光拡散板16に対し顔料を用いて着色化せしめた構成にする。

【0032】このように層状に塗着して着色化するには、光拡散板16の表面をスプレー塗装もしくはエアブラシ等によって着色層19を設ける。

【0033】かくして本例の液晶表示装置によれば、光拡散板16の表面に着色層19を設けて一体化することで、従来のごとき、別途、着色シートを用いなくなり、これにより、部材点数および部材費を増加させないで、バックライトの出射光の色調を変換させることができた。しかも、小型化かつ低コスト化を達成した液晶表示装置となった。

【0034】(例2)図5は液晶表示装置の概略断面図であり、図6は図5に示す装置の要部Aの拡大図である。なお、前述した図4に示す液晶表示装置と同一箇所には同一符号を付す。

【0035】本例のバックライト12によれば、これに用いる前記光拡散部材である光拡散板16を成す合成樹脂材に対し、あらかじめ顔料21を含有させている。

【0036】このような構成は顔料21を光拡散板16の材料自体に練り込んで、射出形成などの成形技術を用いればよい。

【0037】かくして本例の液晶表示装置によれば、光拡散板16自体が着色化されることで、従来のごとき、別途、着色シートを用いなくなり、同様に部材点数および部材費を増加させないで、バックライトの出射光の色調を変換させることができた。しかも、小型化かつ低コスト化を達成した液晶表示装置となった。

【0038】(例3)本例の液晶表示装置は、上述した(例1)と(例2)の各液晶表示装置をさらに改良したものである。

【0039】(例1)に示す液晶表示装置によれば、光拡散板16の表面に着色層19を設けて一体化するに当たり、着色層19の塗装膜厚を均一化することにむずかしい点があり、そのために膜厚のばらつきに起因して、バックライト上に色ムラが発生することもある。

【0040】しかも、光拡散板16を導光板13に取り付ける際、もしくは導光板13をバックライト12に組み込む際、他部材とのこすれ、光拡散板自体のヨレ等により、着色層19の塗装膜表面が剥がれ、その屑が液晶画面から見えることで表示品位を低下させることがあ

る。

【0041】また、(例2)に示す液晶表示装置によれば、顔料21を拡散板材料中に均一に分散することはむずかしく、これによって着色ムラが発生することがあった。しかも、顔料21の含有量設定および所望の色にするための調合作業が微妙な加減を要し、非常に困難な作業となり、さらに所望の着色状態を得るために多大な実験量と部材量を必要とし、そのために拡散板の単価が高くなる。その上、一度完成した拡散板の色を容易に変更することが難しいと言える。

【0042】したがって、本例の液晶表示装置によれば、かかる課題をも解消し得る改良型の液晶表示装置であって、この装置を図1に示す。

【0043】図1は液晶表示装置の概略断面図であり、図4と図5に示す(例1)(例2)の液晶表示装置と同一箇所には同一符号を付す。

【0044】本例によれば、前記光拡散部材である光拡散板16の表面にカラープリンタもしくはカラーコピー機を用いて顔料を印刷することで着色層19を形成し、この光拡散板16に対し顔料を用いて着色化せしめた構成にする。

【0045】このように着色層19は、汎用のカラープリンタまたはカラーコピー機を用いて設けられるが、以下、具体的な手法を説明する。

【0046】一般に市販されている画像処理ソフト(例、Adobe Photoshop等)を用い、カラープリンタもしくはカラーコピー機に接続されたパソコン上で光拡散板16に印刷する着色層19の色を設定する。

【0047】画像処理ソフト上における印刷色の設定は自在であり、任意に所望の色を設定することができる。また、実際に光拡散板16に着色層19を印刷する前に紙を用いて試し刷りすることができる。試し刷りの印刷色の具合を判断して、再度、着色層19の色設定を容易に変更することができる。

【0048】さらに、画像処理ソフトの例として挙げたAdobe Photoshopについては、色の透明度(0~100%)を任意に設定することができる。

【0049】この透明度については、印刷色の濃淡の度合いを表し、そして、印刷膜厚の厚みの度合いに置き換えて説明できる。

【0050】たとえば、透明度40%時では印刷膜厚が厚すぎると思われるときは、透明度を80%にすることで印刷濃度を淡く、また、印刷膜厚を薄くすることができる。このようにして導光板13から出射された光が拡散板16を通過する際の色調変換の度合いを調節することができる。

【0051】叙上のごとく、画像処理ソフトの特徴を有効利用し、数回の試し刷りと色設定を変更し、最終的な着色層19の色を決定する。所望の着色層19の色が得られたならば、その後は必要枚数分の光拡散板16を連

続印刷すればよい。近年、汎用カラープリンタまたはカラーコピー機の印刷処理速度の向上により、本手法を利用することで、量産化を容易に行なうことができる。

【0052】しかも、本発明に係る着色層19は(例1)に示すような塗装方法に比べ、強固に拡散板表面に付着し、これにより、インク剥がれ等によるゴミ問題の発生は皆無になった。

【0053】また、顔料を拡散板材料自体に練り込む(例2)と比較しても、着色層の色設定が非常に容易であり、実験量を極めて少なく抑えることができ、着色に関わる製造コストを1/10~1/15程度に低減することができた。

【0054】加えて、本例の液晶表示装置によれば、光拡散板16の表面に着色層19を設けて一体化することで、従来のごとき、別途、着色シートを用いなくなり、これにより、部材点数および部材費を増加させないで、バックライトの出射光の色調を変換させることができた。しかも、小型化かつ低コスト化を達成した液晶表示装置となった。

【0055】このように光拡散板16上に印刷した着色層19であれば、導光板13からの出射光が光拡散板16を通過する際に出射光の色調を変換させることができ、所望の色調が黄色味である場合、黄色系の着色層19を、または、青色味である場合、青色系の着色層19を拡散板16表面に設ければよい。

【0056】

【発明の効果】以上のとおり、本発明の液晶表示装置によれば、透明材料から成る平板もしくはクサビ状の導光板の端面に光源を配し、この導光板の一主面上記光源からの光を光出射面へ導くための光反射層を形成し、さらに光出射面に射出光を拡散させるための光散乱部材を配置したバックライトを備え、そして、光拡散部材に対し顔料を用いて着色化せしめたことで、部材点数および部材費を増加させないで、バックライトの出射光の色調を変換させることができた。しかも、この液晶表示装置によれば、小型化かつ低コスト化を達成することができた。

【図面の簡単な説明】

【図1】本発明の液晶表示装置の概略断面図である。

【図2】従来の液晶表示装置の概略断面図である。

【図3】従来の他の液晶表示装置の概略断面図である。

【図4】本発明の他の液晶表示装置の概略断面図である。

【図5】本発明のさらに他の液晶表示装置の概略断面図である。

【図6】図5に示す装置の要部Aの拡大図である。

【符号の説明】

10：ベゼル

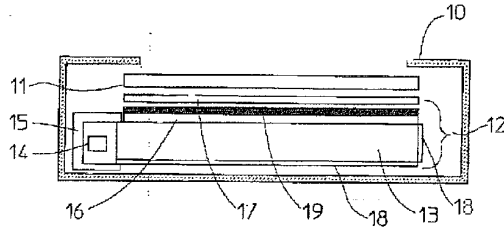
11：液晶表示部

12：LEDバックライト

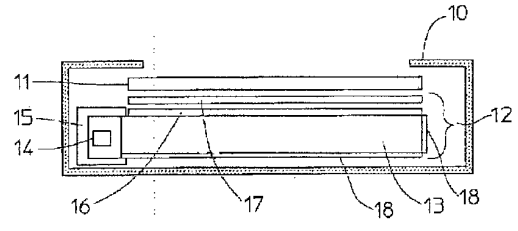
13 : 導光板
14 : LED
15 : リフレクター
16 : 拡散板
17 : レンズシート

18 : 反射シート
19 : 着色層
20 : 着色シート
21 : 顔料

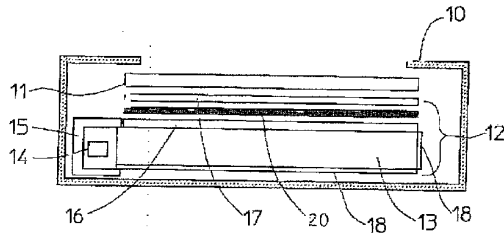
【図1】



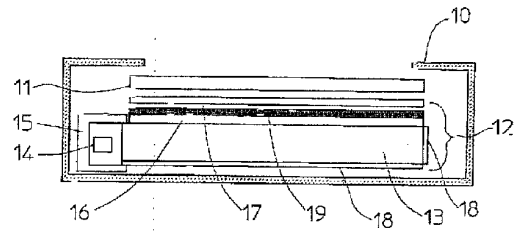
【図2】



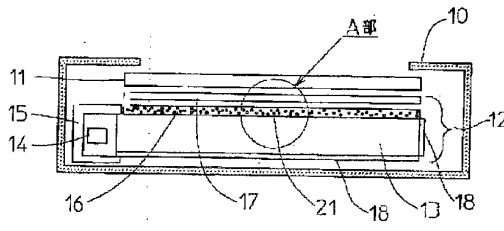
【図3】



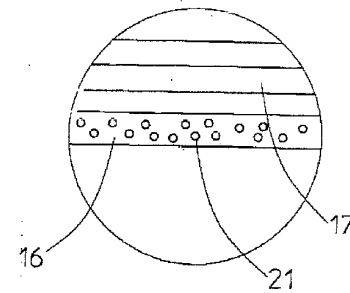
【図4】



【図5】



【図6】



フロントページの続き

(51) Int. Cl.⁷
G 0 2 F 1/1335
// F 2 1 Y 101:02

識別記号
5 2 0

F I
G 0 2 F 1/1335
F 2 1 Y 101:02

(参考)

Electronic Acknowledgement Receipt	
EFS ID:	8823867
Application Number:	12698478
International Application Number:	
Confirmation Number:	4085
Title of Invention:	LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME
First Named Inventor/Applicant Name:	Hyung Hwa PARK
Customer Number:	34610
Filer:	Joanna K. Mason/Lisa Dyer
Filer Authorized By:	Joanna K. Mason
Attorney Docket Number:	HI-0434
Receipt Date:	12-NOV-2010
Filing Date:	02-FEB-2010
Time Stamp:	11:46:58
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		HI-0434IDS.pdf	581177	yes	3
			f95d9412c811e1a5c04abb55095c5d04a02d8293		

	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Filed (SB/08)		3	3	
Warnings:					
Information:					
2	Foreign Reference	HI-0434JP006.pdf	1031294	no	5
			29945579989a0cacf09f21a6af71196aa8fc91e3		
Warnings:					
Information:					
3	Foreign Reference	HI-0434KR685.pdf	373475	no	6
			988651f843052bb5f6fecfd2e898c98c79801456		
Warnings:					
Information:					
4	Foreign Reference	HI-0434WO724.pdf	3547410	no	31
			386bf25b9c905388500ffe9defd7f2c3cdf93249		
Warnings:					
Information:					
5	Foreign Reference	HI-0434JP985.pdf	1269151	no	6
			8ac666f4f0b680bc3add35d8cb3ec44d10837feb		
Warnings:					
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6	NPL Documents	HI-0434_KROA07-30-2010.pdf	312727	no	3
			a889648ccb1be60ce492b68cee81ab35054b872		
Warnings:					
Information:					
7	NPL Documents	HI-0434EPSR08102010.pdf	156354	no	2
			3991262659eef8fcc980af447770546e08b66a3f		
Warnings:					
Information:					
Total Files Size (in bytes):			7271588		

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

Confirmation No.: **4085****Hyung Hwa PARK**Group Art Unit: **2885**Serial No.: **12/698,478**Examiner: **Leah S. Lovell**Filed: **February 2, 2010**Customer No.: **34610**For: **LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME****INFORMATION DISCLOSURE STATEMENT**

U.S. Patent and Trademark Office
Customer Service Window
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Sir:

Pursuant to 37 C.F.R. §1.56, the attention of the Patent and Trademark Office is hereby directed to the references listed on the attached PTO-1449. One copy of each non-U.S. reference is attached. It is respectfully requested that the information be expressly considered during the prosecution of this application, and that the reference(s) be made of record therein and appear among the "References Cited" on any patent to issue therefrom.

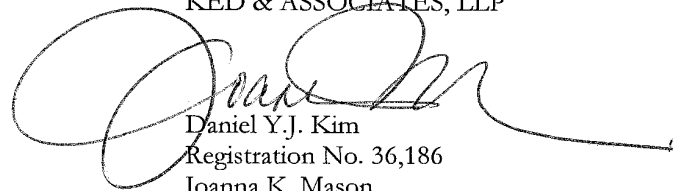
Applicants have listed publication dates on the attached PTO-1449 based on information presently available to the undersigned. However, the listed publication dates should not be construed as an admission that the information was actually published on the indicated date. Applicants reserve the right to establish the patentability of the claimed invention over any of the information provided herewith, and/or to prove that this information may not be prior art, and/or to prove that this information may not be enabling for the teachings purportedly offered. This statement should not be construed as a representation that a search has been made, that information cited in the statement is considered to be and/or is material to patentability, or that information more material to the examination of the present patent application does not exist. The Examiner is specifically requested not to rely solely on the material submitted herewith. It is further understood that the Examiner will consider information that was cited or submitted to the U.S. Patent and Trademark Office in a prior application relied on under 35 U.S.C. §120. 1138 OG 37, 38 (May 19, 1992).

- ☒ 1. This Information Disclosure Statement is being filed (i) within three months of the U.S. filing date of a U.S. application other than a CPA continued prosecution application under §1.53(d) OR (ii) within three months of the date of entry of the national stage as set forth in §1.491 in an international application OR (iii) before the mailing date of a first Office Action on the merits OR (iv) before the mailing of a first Office Action after the filing of a Request for continued examination under §1.114. No certification or fee is required. 37 C.F.R. §1.97(b).
- ☐ 2. This Information Disclosure Statement is being filed more than three months after the U.S. filing date AND after the mailing date of the first Office Action on the merits, but before the mailing date of a Final Rejection OR Notice of Allowance OR an action that otherwise closes prosecution in the application. 37 C.F.R. §1.97(c).
- ☐ a. I hereby state that each item of information contained in this Information Disclosure Statement was first cited in a communication from a foreign patent office in a counterpart foreign application or from the U.S. Patent Office in a related U.S. application, not more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. §1.97(e)(1). No fee is required.
- ☐ b. I hereby state that no item of information in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application and, to

my knowledge after making reasonable inquiry, was known to any individual designated in 37 C.F.R. §1.56(c) more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. §1.97(e)(2).

- ☐ c. Please charge our Credit Card in the amount of \$180.00 in payment of the fee under 37 C.F.R. §1.17(p) per the attached PTO 2038 form. Please credit or debit Deposit Account No. 16-0607 as needed to ensure consideration of the disclosed information.
- ☐ 3. This Information Disclosure Statement is being filed after the mailing date of a Final Rejection OR Notice of Allowance OR an action that otherwise closes prosecution in the application, but on or before payment of the Issue Fee. Please charge our Credit Card in the amount of \$180.00 in payment of the fee under 37 C.F.R. §1.17(p) per the attached PTO 2038 form. Please credit or debit Deposit Account No. 16-0607 as needed to ensure consideration of the disclosed information. 37 C.F.R. §1.97(d).
- ☐ a. I hereby state that each item of information contained in this Information Disclosure Statement was first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. §1.97(e)(1).
- ☐ b. I hereby state that no item of information in this Information Disclosure Statement was cited in a communication from a foreign patent office in a counterpart foreign application or, to my knowledge after making reasonable inquiry, was known to any individual designated in 37 C.F.R. §1.56(c) more than three months prior to the filing of this Information Disclosure Statement. 37 C.F.R. §1.97(e)(2).
- ☒ 4. The references were cited in corresponding foreign applications in a Korean Office Action issued in KR Application No. 10-2009-0013161 dated July 30, 2010 and a European Search Report issued in EP Application No. 10153414.7 dated August 10, 2010.
- ☒ 5. To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 16-0607 and please credit any excess fees to such deposit account.

Respectfully Submitted,
KED & ASSOCIATES, LLP



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DYK:JKM:lhd
256647



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/698,478	02/02/2010	Hyung Hwa PARK	HI-0434	4085
34610 7590 04/02/2012 KED & ASSOCIATES, LLP P.O. Box 8638 Reston, VA 20195			EXAMINER MACCHIAROLO, LEAH SIMONE	
			ART UNIT 2885	PAPER NUMBER
			MAIL DATE 04/02/2012	DELIVERY MODE PAPER

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.

Office Action Summary	Application No.		Applicant(s)		
	12/698,478		PARK, HYUNG HWA		
	Examiner		Art Unit		
LEAH S. MACCHIAROLO		2885			

-- 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 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, 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 02 February 2010.

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) 1-27 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) 1-27 is/are rejected.

8) ☐ Claim(s) ____ is/are objected to.

9) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

10) ☐ The specification is objected to by the Examiner.

11) ☒ The drawing(s) filed on 02 February 2010 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).

12) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a) ☐ All b) ☐ Some * c) ☐ None of:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. ____.

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) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date 7/13/10&11/12/10.

4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____.

5) ☐ Notice of Informal Patent Application

6) ☐ Other: ____.

DETAILED ACTION

Priority

Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Information Disclosure Statement

The information disclosure statement (IDS) submitted on 07/13/2010 and 11/12/2010 is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Claim Objections

Claims 19 and 20 are objected to because of the following informalities:

Claims 19 and 20 recite the limitation, “color coordinate conversion assembly.”

However, there is not proper antecedent basis for this claim limitation. The Examiner is interpreting this to refer to the conversion sheet. Appropriate correction is required.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 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 1-3, 8-10 are rejected under 35 U.S.C. 102(b) as being anticipated by Lin et al. (US 2008/0158907; hereinafter “Lin”).

Regarding claim 1, Lin discloses at least in figs. 1 and 3 a light source, comprising: a light guide plate [fig. 1; 110]; at least one light emitting module [130] positioned so as to emit light incident on the light guide plate [110], wherein the at least one light emitting module comprises a plurality of light emitting diodes [see fig. 3, 330]; and a conversion sheet [fig. 1; 120] provided on the light guide plate [110], wherein the conversion sheet [120] converts a color of the light emitted by the at least one light emitting module to a target color [see at least paragraph 20].

Regarding claims 2 and 3, Lin discloses at least in paragraph 20, the conversion sheet [120] includes a fluorescent material having at least one color, the conversion sheet includes at least one of red, green, blue, or yellow fluorescent materials.

Regarding claims 8-10, Lin discloses at least in fig. 4 the at least one light emitting module [430] comprises a first light emitting module positioned at a first side edge [not labeled] of the light guide plate [410], and a second light emitting module [430] positioned at a second side edge of the light guide plate, wherein the second side edge can be interpreted to be both opposite to and adjacent to the first side edge.

Claims 1-7, 11, 14, 17-23 and 27 are rejected under 35 U.S.C. 102(b) as being anticipated by Kurihara et al. (US 2006/0268537; hereinafter “Kurihara”).

Regarding claim 1, Kurihara discloses at least in figs. 1, 2 and 22, a light source, comprising: a light guide plate [fig. 22; 7]; at least one light emitting module [6] positioned so as to emit light incident on the light guide plate [7], wherein the at least one light emitting module comprises a plurality of light emitting diodes [see paragraph 90]; and a conversion sheet [not shown in fig. 22, but described in paragraph 121 and shown in fig. 2, 9] provided on the light guide plate [110], wherein the conversion sheet [9] converts a color of the light emitted by the at least one light emitting module to a target color [see at least ABSTRACT and paragraph 78].

Regarding claims 2 and 3, Kurihara discloses at least in paragraph 78, the conversion sheet [9] includes a fluorescent material having at least one color, the conversion sheet includes at least one of red, green, blue, or yellow fluorescent materials.

Regarding claims 4-6, Kurihara discloses at least in paragraph 77, the conversion sheet [9] comprises a diffusion sheet including a color conversion material and a prism sheet.

Regarding claim 7, Kurihara discloses at least in fig. 22 a reflective plate [8] positioned under the light guide plate.

Regarding claim 11, Kurihara discloses at least in paragraph 78 at least two of the plurality of light emitting diodes have different color coordinate distributions within a same color spectrum.

Regarding claim 14, Kurihara discloses at least in paragraph 78 the conversion sheet is configured to excite a portion of a first light emitted by the plurality of light emitting diodes so as to convert the portion of the first light to a second light, and to mix the first light and the second light so as to provide a third light having the target color.

Regarding claim 17, Kurihara discloses at least in fig. 2 a size of the conversion sheet [9] is substantially equal to a size of the light guide plate [7].

Regarding claim 18, Kurihara discloses at least in fig. 2 the light guide plate [7], the at least one light emitting module [6] and the conversion sheet [9] are configured to be coupled to a cover [27] having a receiving surface [bottom] and side walls [side edges] extending along an outer peripheral edge of the receiving surface, the side walls defining an open face of the cover so as to form a receiving space therein.

Regarding claim 19, Kurihara discloses at least in fig. 2 wherein the at least one light emitting module [6] is positioned adjacent to the light guide plate [7] within the receiving space on the receiving surface of the cover [27], and the conversion sheet [9] is positioned on a distal edge of the cover defined by an exposed surface of the side walls of the cover [27].

Regarding claim 20, Kurihara discloses at least in fig. 2 and 22 the at least one light emitting module [6] is positioned adjacent to the light guide plate [7] within the receiving space on the receiving surface of the cover [27], and the conversion sheet [9] is positioned within the

receiving space of the cover, spaced apart from the light guide plate and at least one light emitting module [6].

Regarding claim 21, Kurihara discloses at least in fig. 22 the side walls [surfaces] of the cover [27] extend at an incline from a first end [bottom] thereof that is adjacent to the receiving surface of the cover [27] to a second end [top] thereof that defines the open face of the cover.

Regarding claim 22, Kurihara discloses at least in fig. 22 the side walls of the cover [27] extend at an incline from a first end [bottom] thereof that is adjacent to the receiving surface of the cover to an intermediate point of the side walls, and wherein the side walls are bent at the intermediate point [corner] so as to extend in a direction [up] that is perpendicular to the receiving surface of the cover from the intermediate point to a second end [top] thereof that defines the open face of the cover [27].

Claims 23 and 27 contain one or more limitations or elements substantially similar to those discussed with respect to rejected claims 1, 18 and 22, respectively, and are therefore also rejected for at least the above corresponding reasons and will not be repeated here.

Claim Rejections - 35 USC § 103

The following is a quotation of 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 negated by the manner in which the invention was made.

Claims 12 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over

Kurihara in view of Yamamoto et al. (US 7,350,937; hereinafter “Yamamoto”).

Regarding claim 12, Kurihara is silent to using different ranked LEDs.

However, Yamamoto teaches in at least column 7, lines 44-50 that using different ranked LED's will lower the overall cost of the device.

Therefore, in view of the above discussion, it would have been obvious to one having ordinary skill in the art at the time the invention was made to construct Kurihara's LED module with different ranked LED's to lower the overall cost of the device.

Regarding claim 13, both Kurihara and Yamamoto disclose the LED chip comprises one of the recited colors.

Claims 15, 16 and 24-26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kurihara.

Regarding claims 15 and 24, it appears Kurihara recites the specific CIE coordinates in at least fig. 20, but it is not explicitly disclosed.

However, the Examiner takes official notice that Applicant's recited CIE coordinates are well-known in the art to be white. Furthermore, one of ordinary skill in the art would be able to suitably select the target color to fall within the recited range since this will allow for good backlighting of an LCD display device.

Therefore, in view of the above discussion, it would have been obvious to one having ordinary skill in the art at the time the invention was made to select Applicant's recited CIE coordinates to will allow for good backlighting of an LCD display device.

Regarding claim 16, Kurihara discloses in at least paragraph 78 the light emitted by the light guide plate will be different than the target color, thus light emitted by the light guide plate has a color coordinate distribution that is outside of that of the target color.

The limitations in claims 25 and 26 have been previously discussed in the rejection of claims 4-6 and are rejected for the same reasons and will not be repeated here.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to LEAH S. MACCHIAROLO whose telephone number is (571)272-2719. The examiner can normally be reached on Monday through Friday 9 a.m. until 5:30 p.m.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jong-Suk (James) Lee can be reached on (571) 272-7044. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Application/Control Number: 12/698,478
Art Unit: 2885

Page 9

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.

Leah Macchiarolo
Examiner, AU 2885
24 March 2012

/LM/

**/JOHN A WARD/
Primary Examiner, Art Unit 2885**

Notice of References Cited	Application/Control No. 12/698,478		Applicant(s)/Patent Under Reexamination PARK, HYUNG HWA	
	Examiner LEAH S. MACCHIAROLO		Art Unit 2885	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2008/0158907	07-2008	LIN et al.	362/606
*	B	US-2006/0268537	11-2006	Kurihara et al.	362/034
*	C	US-7,350,937	04-2008	Yamamoto et al.	362/249.01
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	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.

Receipt date: 11/12/2010

12698438-6AL02885

LIST OF ART CITED BY APPLICANT (PTO-1449) Examiner: Leah Macchiarolo				ATTORNEY, DOCKET NO. HI-0434		APPLICATION SERIAL NO. 12/698,478	
				APPLICANT(S) Hyung Hwa PARK			
				FILING DATE February 2, 2010		GROUP 2885	
U.S. PATENT DOCUMENTS							
EXAMINER'S INITIALS	*PATENT NO.	*ISSUE DATE	*INVENTOR NAME	CLASS	SUBCLASS	FILING DATE	
/LSM/	5,982,092	11-09-1999	Chen				
U.S. PATENT APPLICATION PUBLICATIONS							
EXAMINER'S INITIALS	*APPLICATION PUBLICATION NO.	*PUBLICATION DATE	*INVENTOR	CLASS	SUBCLASS	FILING DATE	
/LSM/	2008/067536	03-20-2008	Komoto et al.				
/LSM/	2007/090383	04-26-2007	Ota et al.				
/LSM/	2008/302977	12-11-2008	Yao et al.				
U.S. PATENT APPLICATIONS							
EXAMINER'S INITIALS	*APPLICATION NO.	*FILING DATE	*INVENTOR	CLASS	SUBCLASS	FILING DATE	
FOREIGN PATENT DOCUMENTS							
EXAMINER'S INITIALS	PATENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	Translation Yes No	
/LSM/	JP 2000-133006	05-12-2000	Japan (full Japanese text and English abstract)			X	
	KR 20-1998-065685	12-05-1998	Korea (full Korean text and English abstract)			X	
	WO 2007/138724	12-06-2007	PCT (full Japanese text and English abstract)			X	
/LSM/	JP 2003-279985	10-02-2003	Japan (full Japanese text and English abstract)			X	
OTHER ART (Including Author, Title, Date, Pertinent Pages, Publisher, Place of Publication, Etc.)							
/LSM/	Korean Office Action issued in KR Application No. 10-2009-0013161 dated July 30, 2010.						
/LSM/	European Search Report issued in EP Application No. 10153414.7 dated August 10, 2010.						
EXAMINER /Leah Macchiarolo/				DATE CONSIDERED 03/24/2012			

EXAMINER: Initial if reference has been 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.
256653

Search Notes 	Application/Control No. 12698478	Applicant(s)/Patent Under Reexamination PARK, HYUNG HWA
	Examiner LEAH S MACCHIAROLO	Art Unit 2885

SEARCHED			
Class	Subclass	Date	Examiner
362	612,606,617-619,627,629	24 MAR 2012	LSM

SEARCH NOTES		
Search Notes	Date	Examiner
See attached EAST search history printout.	24 MAR 2012	LSM
INVENTOR search. See attached EAST search history printout.	24 MAR 2012	LSM
TEXT searching. See attached EAST search history printout.	24 MAR 2012	LSM
FORWARD and BACKWARD citation searches on relevant art. See attached EAST search history printout.	24 MAR 2012	LSM

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

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Receipt date: 07/13/2010

12698478 - GAU: 2885

Examiner: Leah Macchiarolo

SHEET 1 OF 1

LIST OF ART CITED BY APPLICANT (PTO-1449)				ATTY. DOCKET NO. HI-0434		APPLN. SERIAL NO. 12/698,478	
				APPLICANT(S) Hyung Hwa PARK			
				FILING DATE February 2, 2010		GROUP 2885 2844	
U.S. PATENT DOCUMENTS							
EXAMINER'S INITIALS	*PATENT NO.	*ISSUE DATE	*INVENTOR NAME	CLASS	SUBCLASS	FILING DATE	
U.S. PATENT APPLICATION PUBLICATIONS							
	*PATENT APPLN. PUB. NO.	*PUB. DATE	*APPLICANT	CLASS	SUBCLASS		
/LSM/	2004/090161	05-13-2004	Noguchi et al.				
↓	2009/251922	10-08-2009	Ueyama				
↓	2006/001036	01-05-2006	Jacob et al.				
↓	2007/057626	03-15-2007	Kurihara et al.				
/LSM/	2004/207995	10-21-2004	Park et al.				
U.S. PATENT APPLICATIONS							
	*APPLN. NO.	*FILING DATE	*INVENTOR	CLASS	SUBCLASS		
FOREIGN PATENT DOCUMENTS							
EXAMINER'S INITIALS	PATENT NO.	DATE	COUNTRY	CLASS	SUBCLASS	Translation Yes No	
/LSM/	WO 2006/131924	12-14-2006	PCT				
↓	JP 2007-109616	04-26-2007	Japan (full Japanese text and English abstract)			Abstract	
↓	WO 2007/086657	08-02-2007	PCT				
/LSM/	JP 2003-222861	08-08-2003	Japan (full Japanese text and English abstract)			Abstract	
OTHER ART (Including Author, Title, Date, Pertinent Pages, Publisher, Place of Publication, Etc.)							
/LSM/	European Search Report issued in EP Application No. 10153414.7 dated May 31, 2010.						
EXAMINER /Leah Macchiarolo/				DATE CONSIDERED 03/24/2012			

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.
241271

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	1	"12698478"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/03/24 15:48
S2	0	("2010/0208495").URPN.	USPAT	OR	ON	2012/03/24 16:23
S3	6	(PARK near2 Hyung near2 Hwa).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/03/24 16:24
S4	6	("20090251922" "20080302977" "20040090161" "5982092" "20070090383" "20080067536").PN.	US-PGPUB; USPAT	OR	ON	2012/03/24 16:33
S5	1	"2006131924"	US-PGPUB; USPAT	OR	ON	2012/03/24 16:35
S6	1	(12/524385).APP.	US-PGPUB; USOCR	OR	ON	2012/03/24 16:35
S7	0	("2009129115").PN.	US-PGPUB; USPAT	OR	OFF	2012/03/24 16:36
S8	1	("20090129115").PN.	US-PGPUB; USPAT	OR	OFF	2012/03/24 16:36
S9	1	(11/921305).APP.	USPAT; USOCR	OR	ON	2012/03/24 16:38
S10	4	("2009/0129115").URPN.	USPAT	OR	ON	2012/03/24 16:46
S11	12	(US-20100208495-\$ or US- 20110103089-\$ or US-20090251922-\$ or US-20080302977-\$ or US-20080067536- \$ or US-20070090383-\$ or US- 20040090161-\$ or US-20100103695-\$ or US-20090129115-\$).did. or (US- 5982092-\$ or US-8128253-\$ or US- 8128272-\$).did.	US-PGPUB; USPAT	OR	ON	2012/03/24 16:59
S12	9	S11 and fluorescent	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/03/24 16:59
S13	259	backlight with (led diode) with fluorescent with (sheet layer)	US-PGPUB; USPAT;	OR	ON	2012/03/24 17:00

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S14	74	backlight with (led diode) with fluorescent with (sheet layer)	DERWENT	OR	ON	2012/03/24 17:00
S15	1	2012-A05990.NRAN.	DERWENT	OR	ON	2012/03/24 17:01
S16	1	2009-R90060.NRAN.	DERWENT	OR	ON	2012/03/24 17:02
S17	1	2009-R65898.NRAN.	DERWENT	OR	ON	2012/03/24 17:02
S18	1	("20110116005").PN.	US-PGPUB; USPAT	OR	OFF	2012/03/24 17:03
S19	1	2009-F36365.NRAN.	DERWENT	OR	ON	2012/03/24 17:04
S20	1	("20110299008").PN.	US-PGPUB; USPAT	OR	OFF	2012/03/24 17:04
S21	1	("20090206353").PN.	US-PGPUB; USPAT	OR	OFF	2012/03/24 17:05
S22	1	("20060002143").PN.	US-PGPUB; USPAT	OR	OFF	2012/03/24 17:06
S23	114	S13 and ("349" "313" "362").clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/03/24 17:07
S24	30	S13 and ("349" "313" "362").clas. not (fluorescent near2 lamp)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/03/24 17:11
S25	7	S13 and ("349" "313" "362").clas. not (fluorescent near (tube lamp))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/03/24 17:13
S26	0	(11/937343).APP.	USPAT; USOCR	OR	ON	2012/03/24 17:34
S27	2	("2008/0158907").URPN.	USPAT	OR	ON	2012/03/24 17:34
S28	0	("2010/0208495").URPN.	USPAT	OR	ON	2012/03/24 17:39
S29	0	(11/937343).APP.	USPAT; USOCR	OR	ON	2012/03/24 17:43
S30	2	("2008/0158907").URPN.	USPAT	OR	ON	2012/03/24 17:43
S31	1	("20060268537").PN.	US-PGPUB; USPAT	OR	OFF	2012/03/24 17:44
S32	0	backlight same (conversion fluorescent)	US-PGPUB;	OR	ON	2012/03/24

EAST Search History

		and (diode led.u/c.) with rank	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			18:03
S33	5	backlight and (conversion fluroescent) and (diode led.u/c.) with rank	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/03/24 18:03
S34	2563	362/612,606,617-619,627,629.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/03/24 22:16

EAST Search History (Interference)

< This search history is empty >

3/ 24/ 2012 10:41:24 PM**C:\Users\Ilovell\Documents\EAST\Workspaces\126-129\12698478 LED backlight with
fluorescent layer on light guide plate.wsp**

<p align="center"><i>Index of Claims</i></p> 	<p>Application/Control No.</p> <p>12698478</p>	<p>Applicant(s)/Patent Under Reexamination</p> <p>PARK, HYUNG HWA</p>
	<p>Examiner</p> <p>LEAH S MACCHIAROLO</p>	<p>Art Unit</p> <p>2885</p>

✓	Rejected
=	Allowed

-	Cancelled
÷	Restricted

N	Non-Elected
I	Interference

A	Appeal
O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47										
CLAIM		DATE								
Final	Original	03/24/2012								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
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	21	✓								
	22	✓								
	23	✓								
	24	✓								
	25	✓								
	26	✓								
	27	✓								

Docket No.: **HI-0434**

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Confirmation No.: **4085**

Hyung Hwa PARK

Group Art Unit: **2885**

Serial No.: **12/698,478**

Examiner: **Macchiarolo, Leah Simone**

Filed: **February 2, 2010**

Customer No.: **34610**

For: **LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME**

AMENDMENT

U.S. Patent and Trademark Office
Customer Window, Mail Stop Amendment
Randolph Building
401 Dulany Street
Alexandria, Virginia 22314

Sir:

In reply to the Office Action of April 2, 2012, please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims.

Remarks/Arguments begin after the listing of the claims.

Serial No. 12/698,478
Amendment dated July 2, 2012
Reply to Office Action of April 2, 2012

Docket No. **HI-0434**

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A light source, comprising:

a light guide plate;

at least one light emitting module positioned so as to emit light incident on the light guide plate, wherein the at least one light emitting module comprises a plurality of light emitting diodes;

an optical sheet on a top surface of the light guide plate; and

a conversion sheet provided on ~~the light guide plate~~ a top surface of the optical sheet,
wherein the conversion sheet converts a color of the light emitted by the at least one light emitting module to a target color,

wherein the optical sheet includes a diffusion sheet and a prism sheet aligned with the diffusion sheet, and wherein the optical sheet is disposed on the light guide plate and the conversion sheet such that the conversion sheet converts the color of the light passing through the diffusion sheet and the prism sheet.

2. (Original) The light source of claim 1, wherein the conversion sheet includes a fluorescent material having at least one color.

3. (Original) The light source of claim 1, wherein the conversion sheet includes at least one of red, green, blue, or yellow fluorescent materials.

4-6. (Cancelled)

7. (Original) The light source of claim 1, further comprising a reflective plate positioned under the light guide plate.

8. (Original) The light source of claim 1, wherein the at least one light emitting module comprises a first light emitting module positioned at a first side edge of the light guide plate, and a second light emitting module positioned at a second side edge of the light guide plate.

9. (Original) The light source of claim 8, wherein the first and second side edges of the light guide plate are opposite each other.

Serial No. 12/698,478
Amendment dated July 2, 2012
Reply to Office Action of April 2, 2012

Docket No. HI-0434

10. (Original) The light source of claim 8, wherein the first and second side edges of the light guide plate are adjacent to each other.

11. (Original) The light source of claim 1, wherein at least two of the plurality of light emitting diodes have different color coordinate distributions within a same color spectrum.

12. (Currently Amended) The light source of claim 1, wherein at least two of the light emitting diodes comprise a plurality of light emitting diode chips having emitting light of multi ranks with a wavelength difference within a blue color spectrum therein, respectively.

13. (Currently Amended) The light source of claim 12, wherein ~~each of the light plurality of emitting diode chips comprises~~ comprise at least one of a blue light emitting diode chip, a green light emitting diode chip, a yellow light emitting diode chip, an amber light emitting diode chip, or a blue-green light emitting diode chip.

14. (Original) The light source of claim 1, wherein the conversion sheet is configured to excite a portion of a first light emitted by the plurality of light emitting diodes so as to convert

Serial No. 12/698,478
Amendment dated July 2, 2012
Reply to Office Action of April 2, 2012

Docket No. HI-0434

the portion of the first light to a second light, and to mix the first light and the second light so as to provide a third light having the target color.

15. (Original) The light source of claim 14, wherein the target color falls within a range in which x of CIE_x is between approximately 0.293 and 0.333, and y of CIE_y is between approximately 0.309 and 0.349.

16. (Original) The light source of claim 15, wherein light emitted by the light guide plate has a color coordinate distribution that is outside of that of the target color.

17. (Original) The light source of claim 1, wherein a size of the conversion sheet is substantially equal to a size of the light guide plate.

18. (Original) The light source of claim 1, wherein the light guide plate, the at least one light emitting module and the conversion sheet are configured to be coupled to a cover having a receiving surface and side walls extending along an outer peripheral edge of the receiving surface, the side walls defining an open face of the cover so as to form a receiving space therein.

19. (Currently Amended) The light source of claim 18, wherein the at least one light emitting module is positioned adjacent to the light guide plate within the receiving space on the receiving surface of the cover, and the ~~color-coordinate-conversion assembly sheet~~ is positioned on a distal edge of the cover defined by an exposed surface of the side walls of the cover.

20. (Currently Amended) The light source of claim 18, wherein the at least one light emitting module is positioned adjacent to the light guide plate within the receiving space on the receiving surface of the cover, and the ~~color-coordinate-conversion assembly sheet~~ is positioned within the receiving space of the cover, spaced apart from the light guide plate and at least one light emitting module.

21. (Original) The light source of claim 18, wherein the side walls of the cover extend at an incline from a first end thereof that is adjacent to the receiving surface of the cover to a second end thereof that defines the open face of the cover.

22. (Original) The light source of claim 18, wherein the side walls of the cover extend at an incline from a first end thereof that is adjacent to the receiving surface of the cover to an

Serial No. 12/698,478
Amendment dated July 2, 2012
Reply to Office Action of April 2, 2012

Docket No. HI-0434

intermediate point of the side walls, and wherein the side walls are bent at the intermediate point so as to extend in a direction that is perpendicular to the receiving surface of the cover from the intermediate point to a second end thereof that defines the open face of the cover.

23. (Currently Amended) A display device, comprising:

a cover;

a light emitting module provided on the cover, the light emitting module comprising a plurality of light emitting diodes ;

a light guide plate provided at a side of the light emitting module;

an optical sheet provided on the light guide plate, the optical sheet including a diffusion sheet and a prism sheet aligned with the diffusion sheet;

a display panel provided on the optical sheet; and

a conversion layer provided ~~on the light guide plate~~between the optical sheet and the display panel, wherein the conversion layer converts a first color of light emitted by the light guide plate to a target color, and wherein the conversion layer converts the first color of the light passing through the diffusion sheet and the prism sheet.

24. (Original) The display device of claim 23, wherein the conversion layer shifts a

Serial No. 12/698,478
Amendment dated July 2, 2012
Reply to Office Action of April 2, 2012

Docket No. **HI-0434**

color coordinate distribution of the light emitted by the light guide plate to a color coordinate having $CIE_x=0.313$ and $CIE_y=0.329$.

25-26. (Cancelled)

27. (Original) The display device of claim 23, wherein the color coordinate conversion layer comprises a coating of color coordinate conversion material provided on a surface of the diffusion sheet.

28. (New) A light source, comprising:
a light guide plate;
at least one light emitting module positioned so as to emit light incident on the light guide plate, wherein the at least one light emitting module comprises a plurality of light emitting diodes;
an optical sheet on a top surface of the light guide plate;
a conversion sheet provided on a top surface of the optical sheet, wherein the conversion sheet converts a color of the light emitted by the at least one light emitting module to a target color; and

a reflective plate positioned under the light guide plate,
wherein the light emitting module is positioned at a side edge of the light guide plate, and
the optical sheet includes a diffusion sheet and a prism sheet on the diffusion sheet, and the
conversion sheet is coated with a color coordinate material on an upper surface of the diffusion
sheet such that the conversion sheet converts the color of the light diffusing by the diffusion
sheet.

29. (New) The light source of claim 28, wherein at least two of the light emitting
diodes comprise a plurality of light emitting diode chips emitted light of multi ranks with a
wavelength difference from each other within a blue color spectrum therein, respectively.

30. (New) The light source of claim 28, wherein at least two of the plurality of light
emitting diodes have different color coordinate distributions within a same blue color spectrum.

31. (New) The light source of claim 29, wherein the conversion sheet is configured to
excite a portion of a first light emitted by the plurality of light emitting diodes so as to convert
the portion of the first light to a second light, and to mix the first light and the second light so as
to provide a third light having the target color,

Serial No. **12/698,478**
Amendment dated **July 2, 2012**
Reply to Office Action of **April 2, 2012**

Docket No. **HI-0434**

wherein the target color falls within a range in which x of CIE_x is between approximately 0.293 and 0.333, and y of CIE_y is between approximately 0.309 and 0.349.

Serial No. 12/698,478
Amendment dated July 2, 2012
Reply to Office Action of April 2, 2012

Docket No. **HI-0434**

REMARKS/ARGUMENTS

Claims 1-3, 7-24 and 27-31 are pending in this application. By this Amendment, claims 1, 12, 13, 19, 20 and 23 are amended, claims 28-31 are added, and claims 4-6, 25 and 26 are canceled without prejudice or disclaimer. Support for the claims can be found throughout the specification, including the original claims and the drawings. Withdrawal of the rejections in view of the above amendments and the following remarks is respectfully requested.

I. Objection to the Claims

The Office Action objects to claims 19 and 20 due to informalities. It is respectfully submitted that the amendments to claims 19 and 20 are responsive to the Examiner's comments, and thus this objection should be withdrawn.

II. Rejections Under 35 U.S.C. §102(b)

The Office Action rejects claims 1-3 and 8-10 under 35 U.S.C. §102(b) over Lin et al., U.S. Patent Publication No. 2008/0158907 (hereinafter "Lin"). The rejection is respectfully traversed.

Independent claim 1 is directed to a light source, including a light guide plate, at least one light emitting module positioned so as to emit light incident on the light guide plate, wherein the at least one light emitting module comprises a plurality of light emitting diodes, an optical sheet on a top surface of the light guide plate, and a conversion sheet provided on a top surface of the optical sheet. The conversion sheet converts a color of the light emitted by the at least one light emitting module to a target color. The optical sheet includes a diffusion sheet and a prism sheet

aligned with the diffusion sheet, and the optical sheet is disposed on the light guide plate and the conversion sheet such that the conversion sheet converts the color of the light passing through the diffusion sheet and the prism sheet.

Lin neither discloses nor suggests all of the features recited in independent claim 1, or the claimed combination of features.

Lin discloses in Figure 1 a backlight module 100 including a light guide plate 110 positioned on a reflective layer 150 and having a light incident surface 111 and a light emitting surface 112, a fluorescent layer 120 formed on the light emitting surface 111 and a light source 130 positioned facing the light incident surface 111. In the embodiment shown in Figure 2, the backlight module 200 includes the light source 230 positioned facing the fluorescent layer 220. In the embodiment shown in Figure 3, the backlight module 300 includes two light sources 330 positioned on a single support member 340. In the embodiment shown in Figure 4, the backlight module 400 includes two light sources 430 supported on opposite ends of a U-shaped support member 440. In each of the embodiments disclosed by Lin, the fluorescent layer is positioned adjacent to the light guide plate. Lin neither discloses nor suggests an optical sheet on a top surface of the light guide plate, and a conversion sheet provided on a top surface of the optical sheet, wherein the conversion sheet converts a color of the light emitted by the at least one light emitting module to a target color, wherein the optical sheet includes a diffusion sheet and a prism sheet aligned with the diffusion sheet, and wherein the optical sheet is disposed on the light guide plate and the conversion sheet such that the conversion sheet converts the color of

Serial No. **12/698,478**
Amendment dated **July 2, 2012**
Reply to Office Action of **April 2, 2012**

Docket No. **HI-0434**

the light passing through the diffusion sheet and the prism sheet, as recited in independent claim 1.

Accordingly, it is respectfully submitted that independent claim 1 is not anticipated by Lin, and thus the rejection of independent claim 1 under 35 U.S.C. §102(b) over Lin should be withdrawn. Dependent claims 2, 3 and 8-10 are allowable over Lin at least for the reasons set forth above with respect to independent claim 1, from which they depend, as well as for their added features.

The Office Action rejects claims 1-7, 11, 17-24 and 27 under 35 U.S.C. §102(b) over Kurihara et al., U.S. Patent Publication No. 2006/0268537 (hereinafter “Kurihara”). Claims 4-6 have been cancelled. The rejection, in so far as it applies to claims 1-3, 7, 11, 17-24 and 27, is respectfully traversed.

The features of independent claim 1 are set forth above.

Independent claim 23 is directed to a display device, including a cover, a light emitting module provided on the cover, the light emitting module comprising a plurality of light emitting diodes, a light guide plate provided at a side of the light emitting module, an optical sheet provided on the light guide plate, the optical sheet including a diffusion sheet and a prism sheet aligned with the diffusion sheet, a display panel provided on the optical sheet, and a conversion layer provided between the optical sheet and the display panel, wherein the conversion layer converts a first color of light emitted by the light guide plate to a target color, and wherein the conversion layer converts the first color of the light passing through the diffusion sheet and the

prism sheet.

Kurihara neither discloses nor suggests all of the features recited in independent claims 1 and 23, or the respective claimed combinations of features.

Kurihara discloses a phosphor film 9 including particles 4 mixed in a binder 2 and applied on a transparent film 1, and a non-permeable layer 3. In the embodiment shown in Figures 2 and 4, light emitted by a light source 6 passes through the phosphor film 9 for conversion to a desired wavelength and guided by a reflection plate 8 and prism sheet 5 for emission by a light guide 7. Alternatively, the phosphor film 9 may be positioned between the light guide 7 and the prism sheet 5, as shown in Figures 3 and 5. The embodiment shown in Figure 11 includes a first phosphor film 9 between the light source 6 and the light guide 7 and a second phosphor film 18 between the reflection plate 8 and the light guide 7. Figures 12, 13 and 14 illustrate various other positions of the first and second phosphor films 9 and 18.

In each of the embodiments disclosed by Kurihara, the phosphor film is positioned between the light source and light guide, or between the light guide and the prism sheet, or between the light guide and the reflection plate. Kurihara neither discloses nor suggests an optical sheet on a top surface of the light guide plate, and a conversion sheet provided on a top surface of the optical sheet, wherein the conversion sheet converts a color of the light emitted by the at least one light emitting module to a target color, wherein the optical sheet includes a diffusion sheet and a prism sheet aligned with the diffusion sheet, and wherein the optical sheet is disposed on the light guide plate and the conversion sheet such that the conversion sheet

Serial No. 12/698,478

Docket No. HI-0434

Amendment dated July 2, 2012

Reply to Office Action of April 2, 2012

converts the color of the light passing through the diffusion sheet and the prism sheet, as recited in independent claim 1; nor an optical sheet provided on the light guide plate, the optical sheet including a diffusion sheet and a prism sheet aligned with the diffusion sheet, a display panel provided on the optical sheet, and a conversion layer provided between the optical sheet and the display panel, wherein the conversion layer converts a first color of light emitted by the light guide plate to a target color, and wherein the conversion layer converts the first color of the light passing through the diffusion sheet and the prism sheet, as recited in independent claim 23.

Accordingly, it is respectfully submitted that independent claims 1 and 12 are not anticipated by Kurihara, and thus the rejection of independent claims 1 and 23 under 35 U.S.C. §102(b) over Kurihara should be withdrawn. Dependent claims 2, 3, 7, 11, 17-19, 21, 22, 24 and 27 are allowable over Kurihara at least for the reasons set forth above with respect to independent claims 1 and 23, from which they respectively depend, as well as for their added features.

III. Rejections Under 35 U.S.C. §103(a)

The Office Action rejects claims 12 and 13 under 35 U.S.C. §103(a) over Kurihara in view of U.S. Patent No. 7,350,937 to Yamamoto (hereinafter “Yamamoto”); and rejects claims 15, 16 and 24-26 under 35 U.S.C. §103(a) over Kurihara. Claims 25 and 26 have been cancelled. These rejections, in so far as they apply to claims 12, 13, 15, 16 and 24, are respectfully traversed.

Dependent claims 12, 13, 15, 16 and 24 are allowable over Kurihara at least for the reasons set forth above with respect to independent claims 1 and 23, from which they

Serial No. 12/698,478

Docket No. HI-0434

Amendment dated July 2, 2012

Reply to Office Action of April 2, 2012

respectively depend, as well as for their added features. Further, Yamamoto is merely cited as allegedly teaching the use of ranked LEDs, and for at least this reason fails to overcome the deficiencies of Kurihara. Accordingly, it is respectfully submitted that claims 12, 13, 15, 16 and 24 are allowable over the respective applied combinations, and thus these rejections should be withdrawn.

IV. New Claims

New claims 28-31 are added to the application. It is respectfully submitted that new claims 28-31 meet the requirements of 35 U.S.C. §112, and are allowable over the applied prior art. More specifically, new independent claim 28 recites, *inter alia*, an optical sheet on a top surface of the light guide plate, a conversion sheet provided on a top surface of the optical sheet, wherein the conversion sheet converts a color of the light emitted by the at least one light emitting module to a target color, and a reflective plate positioned under the light guide plate, wherein the light emitting module is positioned at a side edge of the light guide plate, and the optical sheet includes a diffusion sheet and a prism sheet on the diffusion sheet, and the conversion sheet is coated with a color coordinate material on an upper surface of the diffusion sheet such that the conversion sheet converts the color of the light diffusing by the diffusion sheet.

As set forth above, Lin, Kurihara and Yamamoto, either alone or in combination, neither disclose nor suggest such features. New dependent claims 29-31 are allowable at least in view of

Serial No. 12/698,478

Docket No. HI-0434

Amendment dated July 2, 2012

Reply to Office Action of April 2, 2012

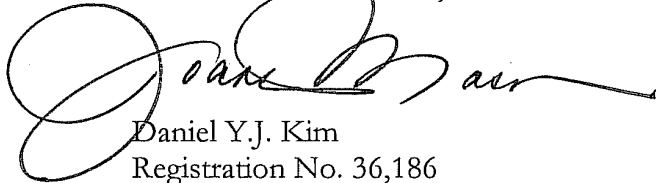
their dependency from new independent claim 28, from which they depend, as well as for their added features.

V. Conclusion

In view of the foregoing amendments and remarks, it is respectfully submitted that the application is in condition for allowance. If the Examiner believes that any additional changes would place the application in better condition for allowance, the Examiner is invited to contact the undersigned, Joanna K. Mason, at the telephone number listed below.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this, concurrent and future replies, including extension of time fees, to Deposit Account 16-0607 and please credit any excess fees to such deposit account.

Respectfully submitted,
KED & ASSOCIATES, LLP



Daniel Y.J. Kim
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Joanna K. Mason
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Correspondence Address:

P.O. Box 8638

Reston, VA 20195

703 766-3777 DYK:JKM:ilhd

Date: July 2, 2012

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Electronic Acknowledgement Receipt	
EFS ID:	13158485
Application Number:	12698478
International Application Number:	
Confirmation Number:	4085
Title of Invention:	LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME
First Named Inventor/Applicant Name:	Hyung Hwa PARK
Customer Number:	34610
Filer:	Joanna K. Mason/Lisa Dyer
Filer Authorized By:	Joanna K. Mason
Attorney Docket Number:	HI-0434
Receipt Date:	02-JUL-2012
Filing Date:	02-FEB-2010
Time Stamp:	14:59:02
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		HI-0434Amendment.pdf	609008	yes	18
			68381d7d01359c2446bcd768d37f821db060f3d		

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Transmittal Letter	1	1
	Amendment/Req. Reconsideration-After Non-Final Reject	2	2
	Claims	3	11
	Applicant Arguments/Remarks Made in an Amendment	12	18
Warnings:			
Information:			
Total Files Size (in bytes):		609008	
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Docket No.: HI-0434

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Confirmation No.: 4085

Hyung Hwa PARK

Group Art Unit: 2885

Serial No: 12/698,478

Examiner: MACCHIAROLO, LEAH SIMONE

Filed: February 2, 2010

Customer No.: 34610

For: LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME

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☐ Also attached:

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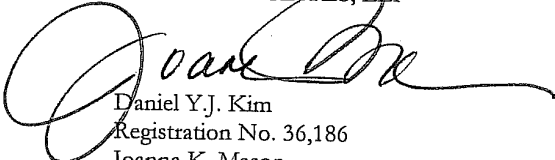
	NO. OF CLAIMS	HIGHEST PREVIOUSLY PAID FOR	EXTRA CLAIMS	RATE	FEE
Total Claims	26	27	0	x \$60.00 =	\$0.00
Independent Claims	3	3	0	x 250.00=	\$0.00
If multiple claims newly presented, add \$450.00					\$0.00
Fee for extension of time					\$0.00
TOTAL FEE DUE					\$0.00

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Respectfully submitted,
KED & ASSOCIATES, LLP


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P.O. Box 8638
Reston, VA 20195
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Date: July 2, 2012

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NOTICE OF ALLOWANCE AND FEE(S) DUE

34610 7590 12/06/2012
KED & ASSOCIATES, LLP
P.O. Box 8638
Reston, VA 20195

EXAMINER

MACCHIAROLO, LEAH SIMONE

ART UNIT

PAPER NUMBER

2885

DATE MAILED: 12/06/2012

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/698,478	02/02/2010	Hyung Hwa PARK	HI-0434	4085
TITLE OF INVENTION: LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME				

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1770	\$300	\$0	\$2070	03/06/2013

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

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IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

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(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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12/698,478	02/02/2010	Hyung Hwa PARK	HI-0434	4085
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TITLE OF INVENTION: LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1770	\$300	\$0	\$2070	03/06/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
MACCHIAROLO, LEAH SIMONE	2885	362-618000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

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- (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
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3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

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☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/698,478	02/02/2010	Hyung Hwa PARK	HI-0434	4085
34610	7590	12/06/2012	EXAMINER	
KED & ASSOCIATES, LLP			MACCHIAROLO, LEAH SIMONE	
P.O. Box 8638			ART UNIT	PAPER NUMBER
Reston, VA 20195			2885	

DATE MAILED: 12/06/2012

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 400 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 400 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No.	Applicant(s)	
	12/698,478	PARK, HYUNG HWA	
	Examiner	Art Unit	
	LEAH S. MACCHIAROLO	2885	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to the amendment filed 2 July 2012.
2. ☐ 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.
3. ☒ The allowed claim(s) is/are 1-3, 7-24 and 27-31. As a result of the allowed claim(s), 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.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - 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. ____.
 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)).

* Certified copies not received: ____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.

☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892) 2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date ____ 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____.	5. ☐ Examiner's Amendment/Comment 6. ☒ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____.
--	--

ALLOWANCE

The amendment submitted 2 July 2012 consists of changes to the claims and a response to the previous amendment.

The amendment submitted 2 July 2012 has been considered and entered.

Allowable Subject Matter

Claims 1-3, 7-24, and 27-31 are allowed.

The following is an examiner's statement of reasons for allowance: prior art, whether taken alone or in combination, fails to disclose, teach, or render obvious the specifically called for structural arrangements of:

An optical sheet on a top surface of the light guide plate, a conversion sheet provided on a top surface of the optical sheet, wherein the optical sheet includes a diffusion sheet and a prism sheet aligned with the diffusion sheet, and wherein the optical sheet is disposed on the light guide plate and the conversion sheet such that the conversion sheet converts the color of the light passing through the diffusion sheet and the prism sheet (claim 1).

An optical sheet provided on the light guide plate, the optical sheet including a diffusion sheet and a prism sheet aligned with the diffusion sheet; a display panel provided on the optical sheet; and a conversion layer provided between the optical sheet and the display panel, wherein the

conversion layer converts a first color of light emitted by the light guide plate to a target color, and wherein the conversion layer converts the first color of the light passing through the diffusion sheet and the prism sheet (claim 23).

An optical sheet on a top surface of the light guide plate; a conversion sheet provided on a top surface of the optical sheet; and a reflective plate positioned under the light guide plate, wherein the light emitting module is positioned at a side edge of the light guide plate, and the optical sheet includes a diffusion sheet and a prism sheet on the diffusion sheet, and the conversion sheet is coated with a color coordinate material on an upper surface of the diffusion sheet such that the conversion sheet converts the color of the light diffusing by the diffusion sheet (claim 28).

The remaining claims are allowable due to their dependency.

Furthermore, regarding independent claims 1, 23, and 28, the prosecution history, especially at the previous Remarks by Applicant (2 July 2012, pp. 12-16) clearly indicates the reasons for allowance.

Finally, the closest prior art, Choi (US 2007/0147081), fails to disclose teach or render obvious an optical sheet on a light guide plate in combination with the claimed structural arrangement of the optical sheets and conversion sheets. Choi specifically lacks a light guide plate. It would not have been obvious to include a light guide plate as it would detract from the

purpose of Choi's invention to have a thick backlight by having a thicker diffusion plate [123] serve as both a diffuser and light guide plate.

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

Any inquiry concerning this communication or earlier communications from the examiner should be directed to LEAH S. MACCHIAROLO whose telephone number is (571)272-2719. The examiner can normally be reached on Monday through Friday 9 a.m. until 5:30 p.m.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jong-Suk (James) Lee can be reached on (571) 272-7044. 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

Application/Control Number: 12/698,478

Page 5

Art Unit: 2885

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.

Leah Macchiarolo
Examiner, AU 2885
30 November 2012
/LSM/

/Jong-Suk (James) Lee/
Supervisory Patent Examiner, Art Unit 2885

Notice of References Cited	Application/Control No. 12/698,478		Applicant(s)/Patent Under Reexamination PARK, HYUNG HWA	
	Examiner LEAH S. MACCHIAROLO		Art Unit 2885	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2007/0147081	06-2007	Choi, Jong-Hyun	362/612
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	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.

Search Notes 	Application/Control No. 12698478	Applicant(s)/Patent Under Reexamination PARK, HYUNG HWA
	Examiner LEAH S MACCHIAROLO	Art Unit 2885

SEARCHED			
Class	Subclass	Date	Examiner
362	612,606,617-619,627,629,84,561,97.2,97.3,97.1	30 NOV 2012	LSM

SEARCH NOTES		
Search Notes	Date	Examiner
See attached EAST search history printout.	24 MAR 2012	LSM
INVENTOR search. See attached EAST search history printout.	24 MAR 2012	LSM
TEXT searching. See attached EAST search history printout.	24 MAR 2012	LSM
FORWARD and BACKWARD citation searches on relevant art. See attached EAST search history printout.	24 MAR 2012	LSM
UPDATED previous searches. See attached EAST search history printout.	30 NOV 2012	LSM
CONSULTED with Sharon Payne on allowability. She suggested a further search in 362/84,561,97.2,97.3,97.1 but had no further suggestions.	23 NOV 2012	LSM

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner
	See attached interference search history printout.	30 NOV 2012	LSM

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EAST Search History**EAST Search History (Prior Art)**

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S42	307	(S35 S36 S37 S38 S39 S40 S41) and @pd> "20120315"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/10/24 13:43
S41	2828	362/612,606,617-619,627,629.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/10/24 13:43
S40	6	backlight and (conversion fluoroescnt) and (diode led.u/c.) with rank	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/10/24 13:43
S39	10	S35 and ("349" "313" "362").clas. not (fluorescent near (tube lamp))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/10/24 13:43
S38	33	S35 and ("349" "313" "362").clas. not (fluorescent near2 lamp)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/10/24 13:43
S37	129	S35 and ("349" "313" "362").clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/10/24 13:43
S36	78	backlight with (led diode) with fluorescent with (sheet layer)	DERWENT	OR	ON	2012/10/24 13:43
S35	290	backlight with (led diode) with fluorescent with (sheet layer)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2012/10/24 13:43

			IBM_TDB			
S43	13	("20020071288" "20030052594" "20040061814" "20050259195" "4948214" "6439731" "6636363" "6747710" "6770498" "7063430" "7144131" "7322731" "7385653").PN. OR ("8203665").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2012/10/24 14:36
S44	1	(11/475942).APP.	US-PGPUB; USOCR	OR	ON	2012/10/25 10:41
S45	1	("2007/0147081").URPN.	USPAT	OR	ON	2012/10/25 14:26
S47	3	S46 and prism and diffusion and (light\$1guide LGP) and (color near2 (chang\$3 conversion convert\$3))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/19 13:47
S46	5272	362/84,561,97.2,97.3,97.1.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/19 13:47
S48	1091	S46 and ((color near2 (chang\$3 conversion convert\$3)) (fluorescent with (sheet layer)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/19 14:12
S50	881	S49 and ((color near2 (chang\$3 conversion convert\$3)) (fluorescent with (sheet layer))) not (fluorescent adj tube)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/20 12:51
S49	5276	362/84,561,97.2,97.3,97.1.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/20 12:51
L9	86	(L2 L3 L4 L5 L6 L7 L8) and @pd> "20121015"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/30 15:29
L8	2893	362/612,606,617-619,627,629.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/30 15:29

EAST Search History

L7	6	backlight and (conversion fluroescent) and (diode led.u/c.) with rank	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/30 15:29
L6	10	L2 and ("349" "313" "362").clas. not (fluorescent near (tube lamp))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/30 15:29
L5	33	L2 and ("349" "313" "362").clas. not (fluorescent near2 lamp)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/30 15:29
L4	130	L2 and ("349" "313" "362").clas.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/30 15:29
L3	79	backlight with (led diode) with fluorescent with (sheet layer)	DERWENT	OR	ON	2012/11/30 15:29
L2	293	backlight with (led diode) with fluorescent with (sheet layer)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2012/11/30 15:29

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2	(optical with sheet with conversion with diffusion with prism).clm.	US-PGPUB; USPAT; UPAD	OR	ON	2012/11/30 15:17

11/ 30/ 2012 3:45:34 PM

C:\Users\Iloveli\Documents\EAST\Workspaces\126-129\12698478 LED backlight with fluorescent layer on light guide plate.wsp

Issue Classification 	Application/Control No. 12698478	Applicant(s)/Patent Under Reexamination PARK, HYUNG HWA
	Examiner LEAH S MACCHIAROLO	Art Unit 2885

ORIGINAL						INTERNATIONAL CLASSIFICATION												
CLASS		SUBCLASS				CLAIMED					NON-CLAIMED							
362		618				G	0	2	B	6 / 10 (2006.01.01)								
CROSS REFERENCE(S)																		
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)																	
362	612	627	97.3															

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	14	17												
2	2	15	18												
3	3	16	19												
-	4	17	20												
-	5	18	21												
-	6	19	22												
4	7	20	23												
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6	9	-	25												
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8	11	22	27												
9	12	23	28												
10	13	24	29												
11	14	26	30												
12	15	25	31												
13	16														

/LEAH S MACCHIAROLO/ Examiner.Art Unit 2885 (Assistant Examiner)	30 NOV '12 (Date)	Total Claims Allowed: 26	
/JONG-SUK (JAMES) LEE/ Supervisory Patent Examiner.Art Unit 2885 (Primary Examiner)	11/30/2012 (Date)	O.G. Print Claim(s) 20	O.G. Print Figure 8



UNITED STATES PATENT AND TRADEMARK OFFICE

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 United States Patent and Trademark Office
 Address: COMMISSIONER FOR PATENTS
 P.O. Box 1450
 Alexandria, Virginia 22313-1450
 www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 4085

SERIAL NUMBER 12/698,478	FILING or 371(c) DATE 02/02/2010 RULE	CLASS 362	GROUP ART UNIT 2885	ATTORNEY DOCKET NO. HI-0434		
APPLICANTS Hyung Hwa PARK, Namdong-gu, KOREA, REPUBLIC OF; ** CONTINUING DATA ***** ** FOREIGN APPLICATIONS ***** REPUBLIC OF KOREA 10-2009-0013161 02/17/2009 ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** 02/18/2010						
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☐ No Verified and /LEAH SIMONE Acknowledged MACCHIAROLO/ Examiner's Signature		☐ Met after Allowance Initials	STATE OR COUNTRY KOREA, REPUBLIC OF	SHEETS DRAWINGS 6	TOTAL CLAIMS 27 26	INDEPENDENT CLAIMS 2 3
ADDRESS KED & ASSOCIATES, LLP P.O. Box 8638 Reston, VA 20195 UNITED STATES						
TITLE LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME						
FILING FEE RECEIVED 1454	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit			

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

34610 7590 12/06/2012
KED & ASSOCIATES, LLP
P.O. Box 8638
Reston, VA 20195

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/698,478	02/02/2010	Hyung Hwa PARK	HI-0434	4085

TITLE OF INVENTION: LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1770	\$300	\$0	\$2070	03/06/2013

EXAMINER	ART UNIT	CLASS-SUBCLASS
MACCHIAROLO, LEAH SIMONE	2885	362-618000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. Use of a Customer Number is required.

2. For printing on the patent front page, list
 (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, **KED & ASSOCIATES, LLP**
 (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

LG Innotek Co., Ltd.

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Seoul, Republic of Korea

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

- ☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): (Please first reapply any previously paid issue fee shown above)

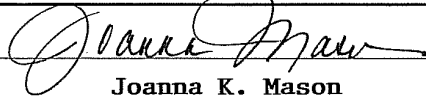
- ☐ A check is enclosed.
☒ Payment by credit card. Form PTO-2038 is attached.
☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number **16-0607** (enclose an extra copy of this form).

5. Change in Entity Status (from status indicated above)

- ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature


Joanna K. Mason

Date

March 4, 2013

Typed or printed name

Registration No.

56,408

This collection of information is required by 37 CFR 1.311. 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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.

Electronic Patent Application Fee Transmittal				
Application Number:		12698478		
Filing Date:		02-Feb-2010		
Title of Invention:		LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME		
First Named Inventor/Applicant Name:		Hyung Hwa PARK		
Filer:		Carol Lynn Druzblck/Tracy Green		
Attorney Docket Number:		HI-0434		
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
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:				
Utility Appl Issue Fee	1501	1	1770	1770
Publ. Fee- Early, Voluntary, or Normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				2070

Electronic Acknowledgement Receipt	
EFS ID:	15104372
Application Number:	12698478
International Application Number:	
Confirmation Number:	4085
Title of Invention:	LIGHT SOURCE AND DISPLAY DEVICE HAVING THE SAME
First Named Inventor/Applicant Name:	Hyung Hwa PARK
Customer Number:	34610
Filer:	Carol Lynn Druzblck/Tracy Green
Filer Authorized By:	Carol Lynn Druzblck
Attorney Docket Number:	HI-0434
Receipt Date:	04-MAR-2013
Filing Date:	02-FEB-2010
Time Stamp:	12:49:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	\$2070
RAM confirmation Number	12707
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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1	Issue Fee Payment (PTO-85B)	HI0434IssueFeeTrans.pdf	95691 5fc4aa089093d9c5ad8624b4d697dafa19c65a5	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	32084 91d8df32a344ae877acec1bcef48dc16bbeac937	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			127775		
<p>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.</p> <p><u>New Applications Under 35 U.S.C. 111</u> 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.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> 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.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> 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.</p>					



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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/698,478	04/02/2013	8408778	HI-0434	4085

34610 7590 03/13/2013
KED & ASSOCIATES, LLP
P.O. Box 8638
Reston, VA 20195

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 459 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Hyung Hwa PARK, Namdong-gu, KOREA, REPUBLIC OF;

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