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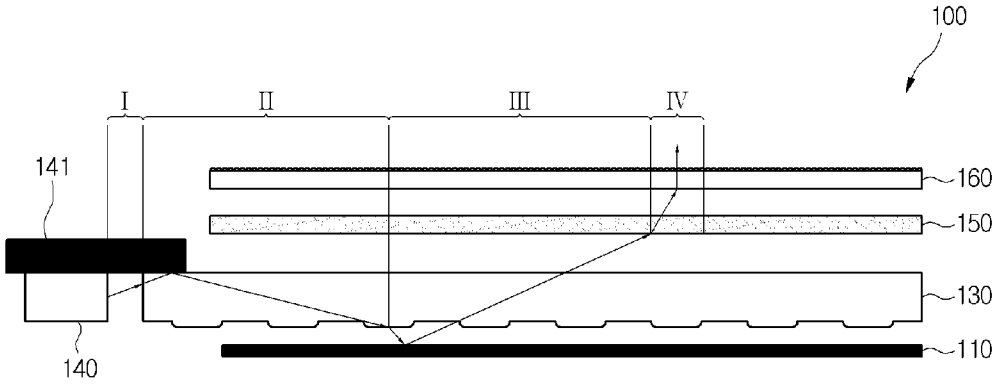
(54) **Title:** BACKLIGHT ASSEMBLY AND LIQUID CRYSTAL DISPLAY DEVICE HAVING THE SAME



(57) **Abstract:** An embodiment of the present invention provides a backlight assembly including at least one LED light source, a light guide panel for guiding light emitted from the LED light source, a reflection sheet formed under the light guide panel, a photo-luminescent diffusion sheet formed on the light guide panel, and a micro lens array film formed on the photo-luminescent diffusion sheet.

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Description

BACKLIGHT ASSEMBLY AND LIQUID CRYSTAL DISPLAY DEVICE HAVING THE SAME

Technical Field

[1] The present invention relates to a backlight assembly and a liquid crystal display device having the same.

Background Art

[2] A liquid crystal display (LCD) device includes a light source for displaying an image on an LCD screen. An LCD device may include a backlight assembly. The backlight assembly generally uses a cold cathode fluorescent lamp (CCFL) as a light source. Light is generated at the CCFL, passes through a light guide panel (LGP), and is incident on a liquid crystal panel from right under the LCD device.

[3] Also, the backlight assembly of the LCD device includes an LGP for guiding light emitted from the CCFL, which is a light source, and a reflection sheet that is disposed under the LGP to reflect light incident from the LGP to the liquid crystal panel. On the LGP, a diffusion panel, a prism panel and a protection panel may be stacked to be assembled in a mold frame in a top down manner. A back cover is disposed in a lowermost portion of the LCD device. Also, the LCD device includes an inverter for receiving alternating current (AC) power and variably controlling light intensity.

[4] However, the CCFL has the following disadvantages. It is subject to environmental regulation, because it contains 2.5 ~ 3.5 mg of mercury per lamp. It needs a wire for a connection to the inverter. Electric current leakage may occur. Its life ranges from 10,000 hours to 50,000 hours, which is too short for a television. The CCFL is vulnerable to a vibration and an impact in an aspect of reliability. Also, the CCFL has poor visibility compared with a related art cathode ray tube (CRT) in an aspect of color reproduction.

[5] Therefore, it is proposed to use a light emitting device (LED) as a light source of a backlight assembly in order to overcome the above-described problems of the CCFL.

[6] Fig. 1 is a schematic view illustrating a related art backlight assembly.

[7] Referring to Fig. 1, the related art backlight assembly includes an LED array 21 having at least one LED for emitting light, and a printed circuit board (PCB) 26 formed under the LED array 21 to switch on the LED. The backlight assembly includes a reflection sheet 22 formed in a portion of the LED array that excludes a portion where the LED is formed, and a diffusion sheet 23 formed on the LED array 21 to reduce non-uniformity of light emitted from the LED array 21. Also, the backlight assembly includes a prism sheet 24 formed on the diffusion sheet 23 to condense light in

directions of top/bottom/left/right and increase brightness, and a protection sheet 25 for protecting the prism sheet 24 and increasing a viewing angle.

[8] The backlight assembly further includes a fixing bottom cover 27. LEDs contained in the LED array 21 serve as point light sources emitting red light, green light and blue light, respectively.

[9] The diffusion sheet 23 is disposed with a predetermined distance from the LED array 21 so that light emitted from the LED array 21 could have a uniform distribution. The reflection sheet 22 is formed on the PCB 26 to re-reflect light that has not passed through the diffusion sheet 23 and has been reflected toward the PCB 26.

[10] However, there is a limitation in reducing the thickness of the above-described related art backlight assembly because of the plurality of optical sheets included therein.

[11] Also, a backlight assembly having a slim profile, high emission brightness and wide color gamut is highly required.

Disclosure of Invention

Technical Problem

[12] An embodiment of the present invention provides a backlight assembly having a slim profile, high emission brightness and wide color gamut, and an LCD having the same.

Technical Solution

[13] An embodiment of the present invention provides a backlight assembly including at least one LED light source, a light guide panel for guiding light emitted from the LED light source, a reflection sheet formed under the light guide panel, a photo-luminescent diffusion sheet formed on the light guide panel, and a micro lens array film formed on the photo-luminescent diffusion sheet.

[14] An embodiment of the present invention provides an LCD device including at least one LED light source, a light guide panel for guiding light emitted from the LED light source, a reflection sheet formed under the light guide panel, a photo-luminescent diffusion sheet formed on the light guide panel, a micro lens array film formed on the photo-luminescent diffusion sheet, and a liquid crystal panel for receiving light that has passed through the micro lens array film.

Advantageous Effects

[15] According to an embodiment of the present invention, a backlight assembly and an LCD device having the same can be realized to have a slim profile, uniform white color purity, high emission brightness and wide color gamut.

[16] According to an embodiment of a backlight assembly and an LCD device having the same, it is possible to reduce the defect ratio of the process, increase the reliability,

and decrease manufacturing cost.

Brief Description of the Drawings

[17] Fig. 1 is a schematic view of a related art backlight assembly.

[18] Fig. 2 is a schematic view of a backlight assembly according to an embodiment of the present invention.

[19] Fig. 3 is a cross-sectional view of a backlight assembly according to an embodiment of the present invention.

[20] Fig. 4 is a graph of brightness of a backlight assembly as a function of a horizontal viewing angle according to an embodiment of the present invention.

[21] Fig. 5 is a graph of brightness of a backlight assembly as a function of a vertical viewing angle according to an embodiment of the present invention.

Mode for the Invention

[22] Hereinafter, embodiments of the present invention will be described in detail with reference to accompanying drawings.

[23] 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 preferred embodiments, the term 'on (or under)' has the meaning of both 'directly on (or under)' and 'indectly on (or under)'.

[24] Fig. 2 is a schematic view of a backlight assembly according to an embodiment of the present invention, and Fig. 3 is a cross-sectional view of a backlight assembly according to an embodiment of the present invention.

[25] Referring to Fig. 2, a backlight assembly 100 according to an embodiment of the present invention includes a light source 140 which is formed at one side of the backlight assembly 100 and has at least one blue LED, and an LGP 130 for converting blue light incident from the light source 140 to a surface light to emit the surface light perpendicularly. The backlight assembly 100 includes a PLDS (Photo-Luminescent Diffusion Sheet) 150 which is formed on the LGP 130 to react to the blue light emitted from the LGP 130 and emit white light. The backlight assembly 100 also includes MLAF (Micro Lens Array Film) 160 which is formed on the PLDS 150 to condense the white light, which has passed through the PLDS 150, and emit the condensed white light.

[26] The light source 140 may include an FPCB 141 and a blue LED mounted on the FPCB 141. The light source 140 may be formed at both sides or at one side of a frame 120 including the LGP 130. Blue light emitted from the light source 140 is incident on the LGP 130.

[27] Meanwhile, the light source 140 may be disposed right under the LGP 130 to form a direct light type backlight assembly.

[28] Also, a red LED may be used instead of the blue LED. In that case, a phosphor of the PLDS needs to be changed. That is, a phosphor capable of receiving red light, which is emitted from the red LED, and emitting white light is required.

[29] The PLDS 150 may include a phosphor for reacting to blue light incident from the light source 140 to emit white light. Also, the PLDS 150 may include a sheet coated with phosphors for reacting to blue light to emit white light.

[30] The phosphor may be selected from the group including a YAG based phosphor, such as an yttrium aluminum garnet phosphor {Y3(Al1-rGas)5O12:Ce}(0≤r≤1), a rhenium aluminum garnet based phosphor {(Re1-rSmr)3(Al1-sGas)5O12:Ce}(0≤r≤1, 0≤s≤1), a rhenium aluminum garnet phosphor {Re3Al5O12:Ce}, an yttrium aluminum phosphor {Y1-p-q-rGdpCeqSmr}3(Al1-sGas)5O12}(0≤p≤0.8, 0.003≤q≤0.2, 0.0003≤r≤0.08, 0≤s≤1), an yttrium aluminum phosphor {Y1-p-q-rGdpCeqSmr)3Al5 O12}(0≤p≤0.8, 0.003≤q≤0.2, 0.0003≤r≤0.08), and a rhenium aluminum garnet phosphor {(Re1-rSmr)3(Al1-sGas)5O12}(0≤r≤1, 0≤s≤1), a phosphor having ZnS:Mn or apatite as a major component, and a silicate based phosphor represented by the formula of SrxSiyO:Eu.

[31] The phosphor may be contained in a plastic of a predetermined thickness, such as PC, PCABS, PPA, nylon, PET, PBT, and epoxy resin. Also, a coating layer containing the phosphor may be formed on the plastic.

[32] The phosphor may be a yellow phosphor. The phosphor may be a mixture of a plurality of phosphors, or multiple layers of a plurality of phosphors.

[33] The LGP 130 converts the blue light, which is incident from the light source 140 disposed at a side thereof, to a surface light and emits the surface light perpendicularly. A plurality of scattering patterns may be formed on the lower surface of the LGP 130 in order to scatter and reflect upward the incident blue light. A reflection sheet 110 is formed under the LGP 130. The reflection sheet 110 reflects upward the light incident thereon from the LGP 130. The LGP 130 may be formed of transparent epoxy or silicon.

[34] The MLAF 160 includes a plurality of microlenses for condensing white light that has passed through the PLDS 150. A plurality of microlenses having a lens pitch of about 10 □, a lens thickness of 25 ~ 50 □, a lens height of about 3 □ are arranged in the MLAF 160 with predetermined spaces from one another.

[35] The MLAF 160 has a function of transmitting and condensing light. The MLAF 160 may be formed of polycarbonate or silicon epoxy. The MLAF 160 may be formed to have a lens effect caused by refractive index dispersion by diffusing impurities through the glass substrate in consideration of thermal expansion.

[36] In the LED backlight assembly 100 according to the above described embodiments of the present invention, the PLDS 150 converts blue light emitted from the light

source 110 to white light, and diffuses the white light. Also, the MLAF 160 condenses the white light that has been converted by the PLDS 150. The white light that has been condensed by the MLAF 160 is incident on a liquid crystal panel(not shown) which is disposed on the MLAF 160. Thus, a backlight assembly according to the embodiments of the present invention does not require a related art thick prism sheet, so that the backlight assembly could have a slim profile.

[37] For example, when an LGP with a thickness of 0.4 mm, an MLAF with a thickness of 25 ~ 50 □, a PLDS with a thickness of 80 □, and a reflection sheet with a thickness of 65 □ is used, a thickness of a backlight assembly could be 0.570 ~ 0.595 mm.

[38] Hereinafter, processes of emitting white color at a backlight assembly 100 according to an embodiment of the present invention will now be described.

[39] A backlight assembly 100 according to an embodiment of the present invention may have such a structure as shown in Figs. 2 and 3. Also, a backlight assembly according to an embodiment of the present invention may further comprise a PLDS and an MLAF instead of a reflection sheet, so as to emit light to both directions.

[40] A backlight assembly according to an embodiment of the present invention includes a reflection sheet 110 that is disposed under the LGP 130, and a PLDS 150 and an MLAF 160 that is disposed on the LGP 130, so as to obtain a uniform brightness distribution. A liquid crystal panel (not shown) may be disposed on the MLAF 160, so as to form LCD. The backlight assembly may include a light blocking tape 170 to prevent white light from passing through a remaining region except an adhesion region and an emitting region of the liquid crystal panel.

[41] Blue light emitted from the light source 140 is incident on the LGP 130 (process I). The blue light incident on the LGP 130 proceeds upward by a plurality of scattering patterns. Also, light that has been reflected downward by the LGP 130 is re-reflected upward by the reflection sheet 110 (processes II and III). The light that has passed thorough the LGP 130 and has been incident on the PLDS 150 is converted to white light by the PLDS 150. The white light that has been converted by the PLDS 150 passes through the MLAF 160 and is incident on the liquid crystal panel(process IV). The blue light emitted by the light source 140 may be incident directly on the PLDS 150 through the LGP 130 without passing through the reflection sheet 110.

[42] A backlight assembly 100 according to an embodiment of the present invention could have a slim profile because it does not require a plurality of related art prism sheets and diffusion sheets. Also, loss of light transmission efficiency is prevented and uniformity of white color emission is improved. Therefore, a white light source of improved uniformity and increased brightness could be obtained.

[43] In addition, according to an embodiment of a backlight assembly 100 of the present invention, the MLAF 160 that has a plurality of convex lenses corresponding to

respective pixels of the liquid crystal panel condenses light, so that brightness of the LCD device could be increased effectively.

[44] Further, the MLAF 160 includes a plurality of microlenses of the same number as the pixel numbers on the same surface. The microlenses are formed at sites corresponding to respective pixel regions. Thereby, chromaticity coordinate distribution caused by LED deviation may be decreased compared with the related art emitting method using a white LED. That is, as illustrated in Fig. 4, the MLAF 160 condenses light at a range of a horizontal viewing angle and emits uniform light to achieve brightness uniformity at a horizontal viewing angle. Fig. 4 is a graph of brightness of a backlight assembly as a function of a horizontal viewing angle according to an embodiment of the present invention. The dashed curve represents brightness of a backlight assembly using a related art white LED, whereas the dashed dot curve represents brightness of a backlight assembly using only an MLAF. Also, brightness of a backlight assembly using both an MLAF and a PLDS is represented by the solid curve.

[45] Referring to Fig. 5, when only an MLAF 160 is used, brightness curve at a vertical viewing angle shifts to the direction of a negative viewing angle, so that center brightness decreases and light condensing effect is reduced compared with the related art. Fig. 5 is a graph of brightness of a backlight assembly as a function of a vertical viewing angle according to an embodiment of the present invention. The dashed curve represents brightness of a backlight assembly using a related art white LED, whereas the dashed dot curve represents brightness of a backlight assembly using only an MLAF. Also, brightness of a backlight assembly using both an MLAF and a PLDS is represented by the solid curve.

[46] According to an embodiment of the present invention, a PLDS 150 is formed under an MLAF 160. An embodiment of the present invention enable the light emitted from an LGP 130 to proceed at right angles to the MLAF 160, so that uniform brightness distribution may be achieved as shown in Fig. 5.

[47] As described above, according to an embodiment of a backlight assembly 100 of the present invention, it is possible to increase the white light emitting brightness at a wide viewing angle by uniformly emitting the white light.

Industrial Applicability

[48] According to an embodiment of the present invention, a backlight assembly and an LCD device having the same can be realized to have a slim profile, uniform white color purity, high emission brightness and wide color gamut.

[49] According to an embodiment of a backlight assembly and an LCD device having the same, it is possible to reduce the defect ratio of the process, increase the reliability,

and decrease manufacturing cost.

Claims

[1] A backlight assembly comprising:
at least one LED light source;
a light guide panel for guiding light emitted from the LED light source;
a reflection sheet formed under the light guide panel;
a photo-luminescent diffusion sheet formed on the light guide panel; and
a micro lens array film formed on the photo-luminescent diffusion sheet.

[2] The backlight assembly according to claim 1, comprising a flexible printed circuit board on which the LED light source is mounted.

[3] The backlight assembly according to claim 1, wherein the photo-luminescent diffusion sheet comprises a phosphor for receiving light emitted from the LED light source to emit white light.

[4] The backlight assembly according to claim 1, wherein the photo-luminescent diffusion sheet comprises a phosphor sheet coated with phosphors for receiving light emitted from the LED light source to emit white light.

[5] The backlight assembly according to claim 1, wherein a plurality of microlenses are arranged on a light emitting surface of the micro lens array film in order to condense light incident thereon from the photo-luminescent diffusion sheet.

[6] The backlight assembly according to claim 1, wherein the LED light source is formed at a lateral side of the light guide panel.

[7] The backlight assembly according to claim 1, wherein the LED light source emits one of blue light and red light.

[8] The backlight assembly according to claim 1, wherein the photo-luminescent diffusion sheet comprises a yellow phosphor.

[9] The backlight assembly according to claim 1, wherein the photo-luminescent diffusion sheet comprises one of a single phosphor formed in a single layer, a mixture of a plurality of phosphors formed in a single layer, and a plurality of phosphors formed in multiple layers.

[10] A liquid crystal display device comprising:
at least one LED light source;
a light guide panel for guiding light emitted from the LED light source;
a reflection sheet formed under the light guide panel;
a photo-luminescent diffusion sheet formed on the light guide panel;
a micro lens array film formed on the photo-luminescent diffusion sheet; and
a liquid crystal panel for receiving light that has passed through the micro lens array film.

[11] The liquid crystal display device according to claim 10, comprising a flexible

printed circuit board on which the LED light source is mounted.

[12] The liquid crystal display device according to claim 10, wherein the photo-luminescent diffusion sheet comprises a phosphor for receiving light emitted from the LED light source to emit white light.

[13] The liquid crystal display device according to claim 10, wherein the photo-luminescent diffusion sheet comprises a phosphor sheet coated with phosphors for receiving light emitted from the LED light source to emit white light.

[14] The liquid crystal display device according to claim 10, wherein a plurality of microlenses are arranged on a light emitting surface of the micro lens array film in order to condense light incident thereon from the photo-luminescent diffusion sheet.

[15] The liquid crystal display device according to claim 14, wherein the microlenses on the light emitting surface of the micro lens array film are formed to correspond to respective pixel regions of the liquid crystal panel.

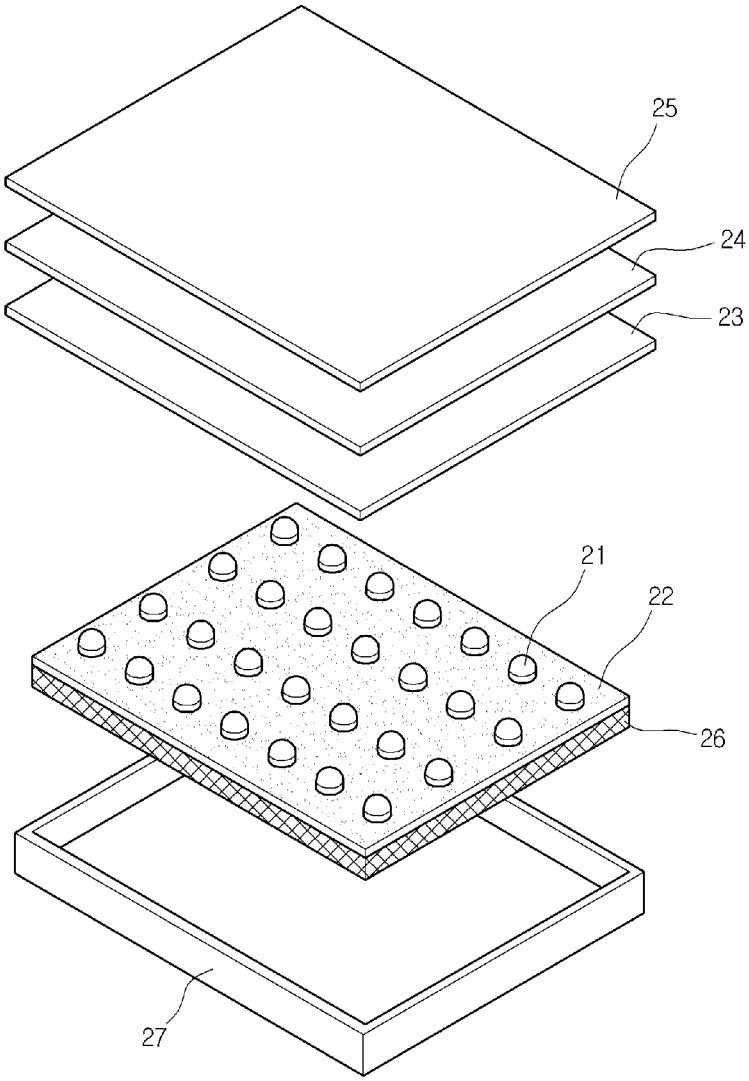
[16] The liquid crystal display device according to claim 10, wherein the LED light source is formed at a lateral side of the light guide panel.

[17] The liquid crystal display device according to claim 10, wherein the LED light source emits one of blue light and red light.

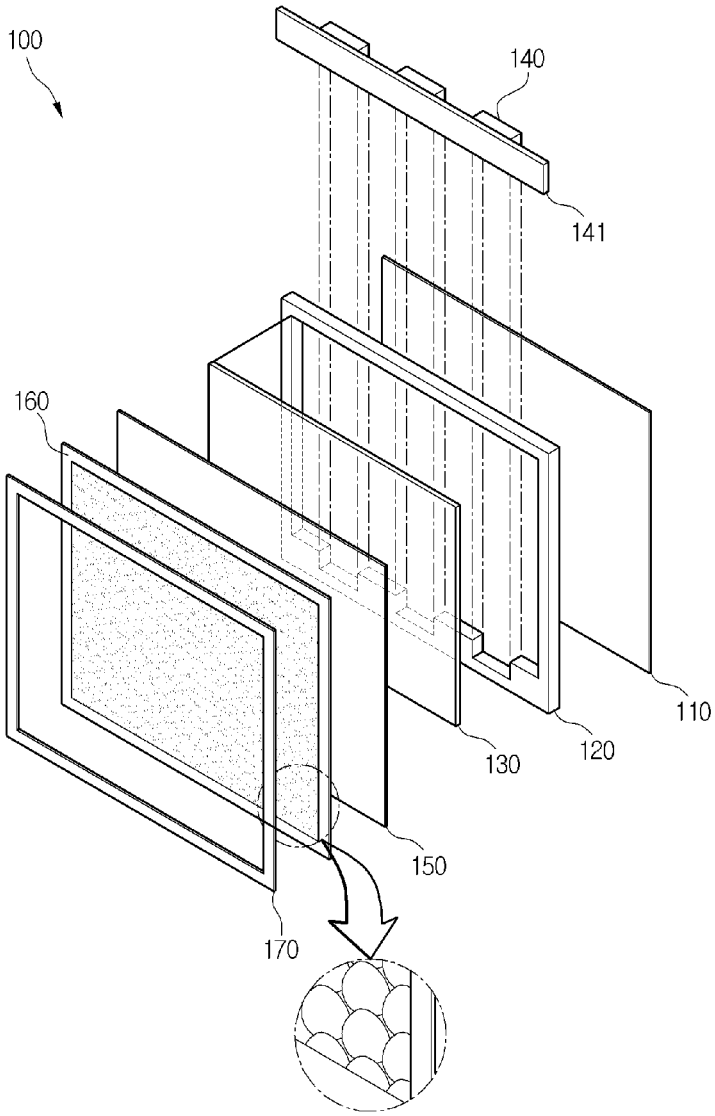
[18] The liquid crystal display device according to claim 10, wherein the photo-luminescent diffusion sheet comprises a yellow phosphor.

[19] The liquid crystal display device according to claim 10, wherein the photo-luminescent diffusion sheet comprises one of a single phosphor formed in a single layer, a mixture of a plurality of phosphors formed in a single layer, and a plurality of phosphors formed in multiple layers.

[Fig. 1]



[Fig. 2]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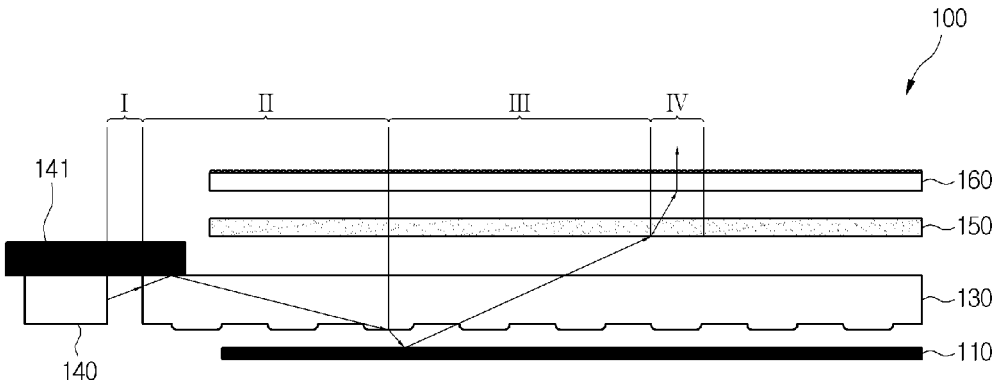
[Fig. 3]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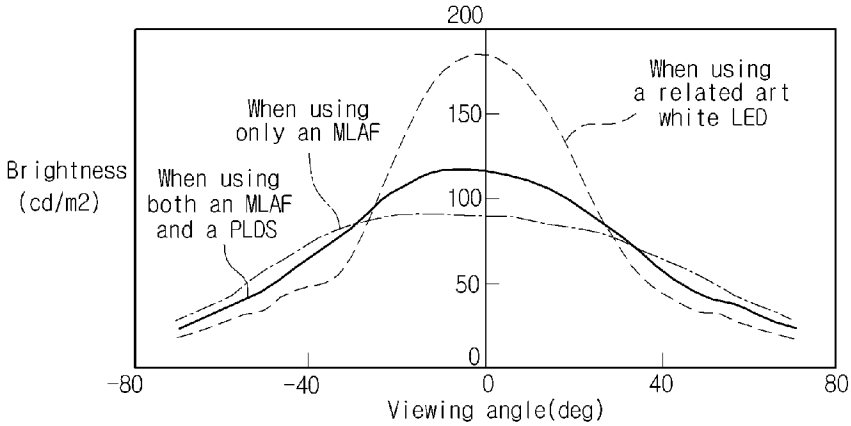
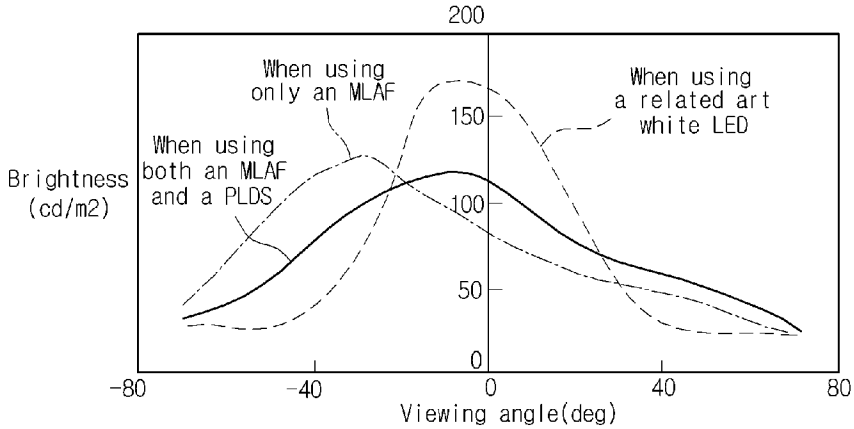
140

[Fig. 4]


200
150
100
50
0
Brightness
(cd/m2)
When using
only an MLAF
When using
both an MLAF
and a PLDS
When using
a related art
white LED
-80
-40
0
40
80
Viewing angle(deg)

[Fig. 5]


200
150
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50
0
Brightness
(cd/m2)
When using
only an MLAF
When using
both an MLAF
and a PLDS
When using
a related art
white LED
-80
-40
0
40
80
Viewing angle(deg)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2006/004662

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, H01L, F21V

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Patents and application for inventions since 1975
Korean Utility models and application for Utility models since 1975
Japanese Utility models and application for Utility models since 1975

Electronic data base consulted during the internationl search (name of data base and, where practicable, search terms used)
eKIPASS (KIPO internal) & keywords: "blue", "white", and "led, light emitting diode"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2005-0093047 A (ADT CORP.) 23 September 2005 abstract; figures 4, 6, and 7, and their corresponding descriptions	1-19
Y	KR 10-2005-0022820 A (CYBERBANK CO.) 08 March 2005 abstract; figures 1-4 and their corresponding descriptions	1-19
Y	KR 10-2004-0028873 A (PARK, SANG HOE) 03 April 2004 abstract; figure 3 and its corresponding description	1-19
Y	US 2005-0185115 A1 (YEE, YPUNG-JOO et al.) 25 August 2005 abstract; figures 4-12 and their corresponding descriptions; paragraph [0080]	1-19
A	US 2005-0073495 A1 (HARBERS, GERARD et al.) 30 May 2006 abstract; figures 12-13 and their corresponding descriptions	1-19
A	KR 10-2002-0014130 A (LS TECH CO., LTD.) 25 February 2002 abstract; figures 3-7 and their corresponding descriptions	1-19
A	JP 08-007614 A (NICHIA CHEM. IND. LTD.) 12 January 1996 abstract; figures 1-2 and their corresponding descriptions	1-19

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

* Special categories of cited documents:
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 FEBRUARY 2007 (13.02.2007)	**13 FEBRUARY 2007 (13.02.2007)**
Name and mailing address of the ISA/KR Korean Intellectual Property Office 920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea Facsimile No. 82-42-472-7140	Authorized officer YOON, Seong Ju Telephone No. 82-42-481-5987

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

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2006/004662

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 1533851 A2 (SUMITOMO ELECTRIC INDUSTRIES, LTD.) 25 May 2005 abstract; figures 1-13	1-19
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Form PCT/ISA/210 (continuation of second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

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