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(54) **BACKLIGHT UNIT HAVING A LENS WITH REFRACTION AND REFLECTION PORTIONS**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

G02F 1/1333 (2006.01)
G02B 19/00 (2006.01)
G02F 1/1335 (2006.01)
G02F 1/13357 (2006.01)

(52) **U.S. Cl.**

CPC ... ***G02F 1/133606*** (2013.01); ***G02B 19/0028*** (2013.01); ***G02B 19/0061*** (2013.01); ***G02F 1/133603*** (2013.01); ***G02F 1/133605*** (2013.01); *G02F 1/133607* (2021.01)

(58) **Field of Classification Search**

CPC G02F 1/133603

See application file for complete search history.

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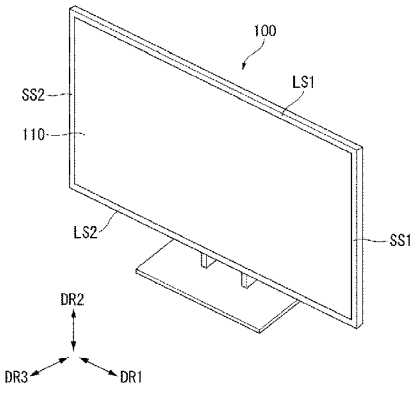
(74) *Attorney, Agent, or Firm* — Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

A display device is provided. The display device includes: a substrate; and at least one light assembly separately located on the substrate, wherein the light assembly includes: a light source; and a lens configured to shield an upper surface and a side surface of the light source, wherein the lens includes: a refraction portion separately located on the upper surface of the light source; and a reflection portion separately located at the side surface of the light source. Thereby, the lens includes a reflection portion located at a side surface of the light source, thereby improving light efficiency of a backlight unit.

19 Claims, 22 Drawing Sheets



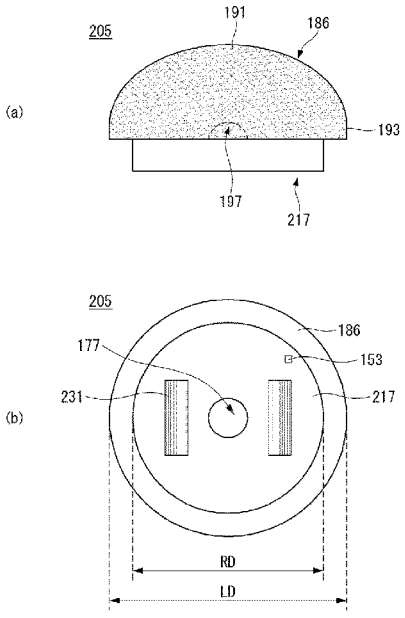


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FIG. 1

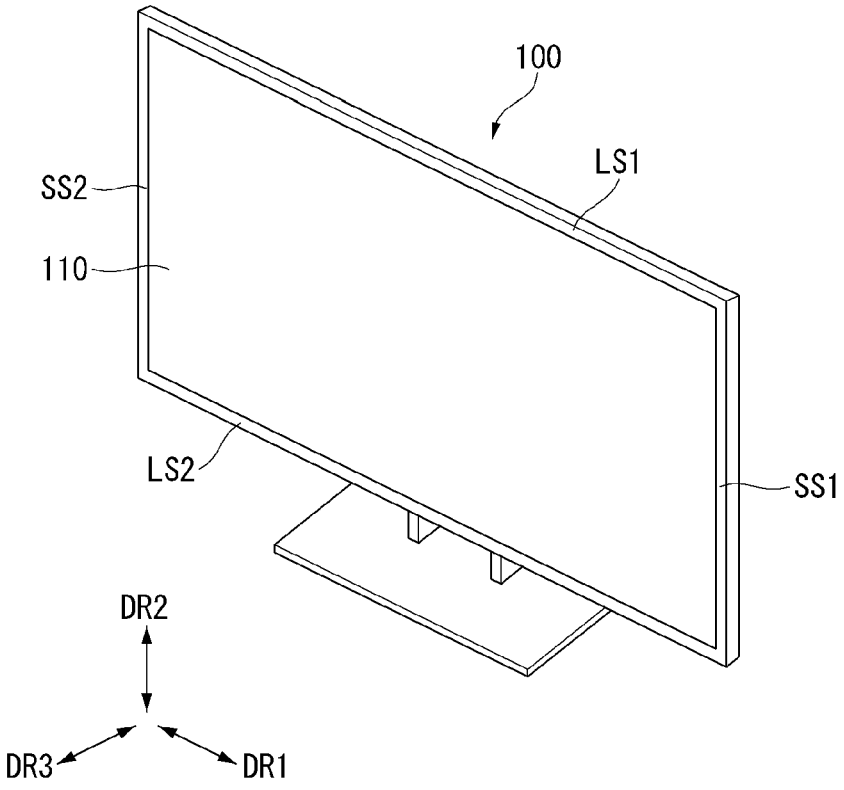


FIG. 2

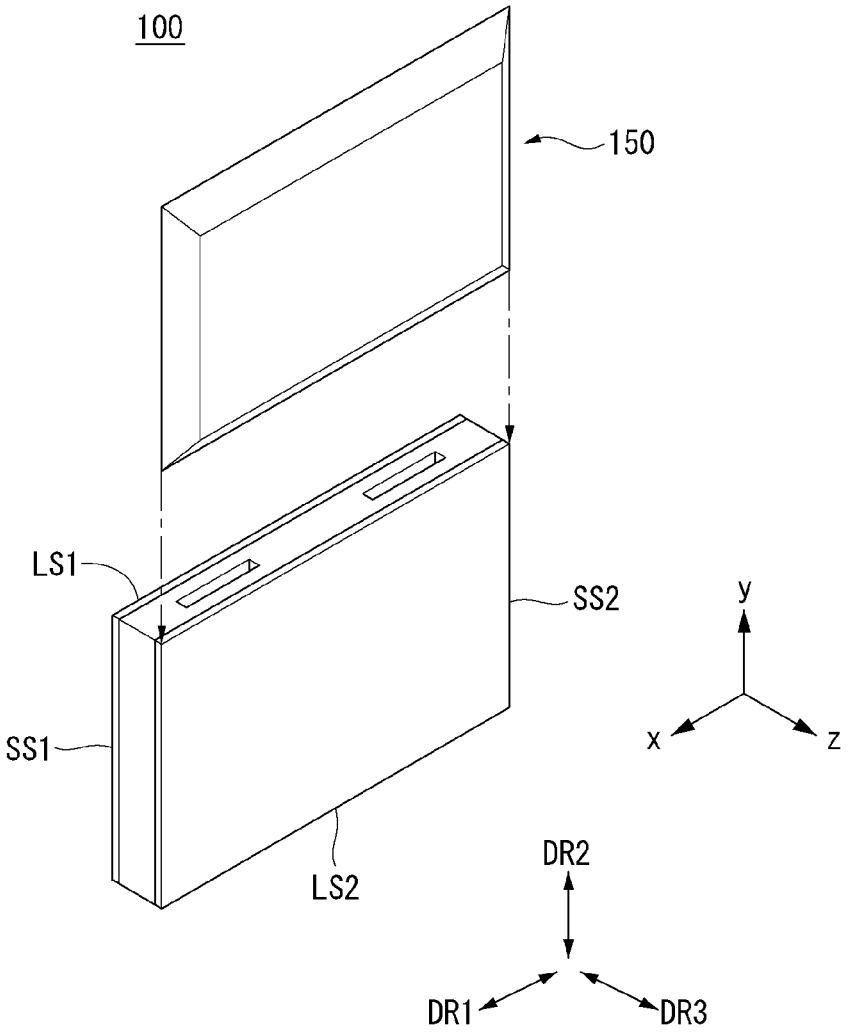


FIG. 3

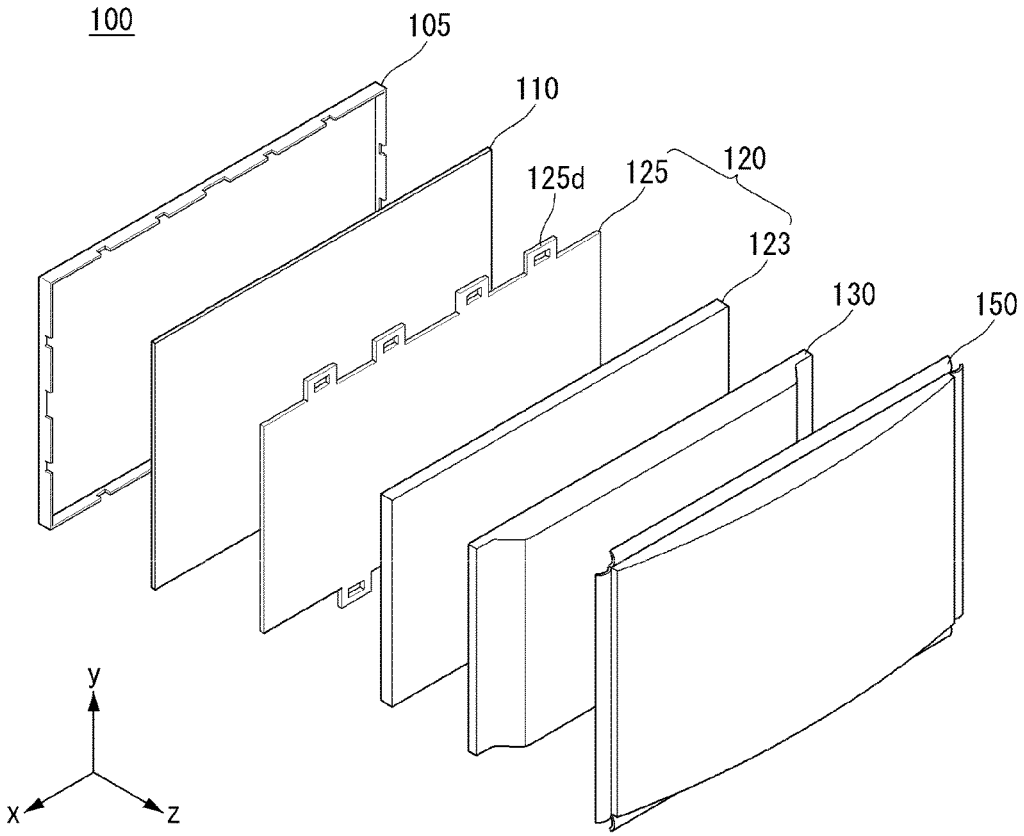
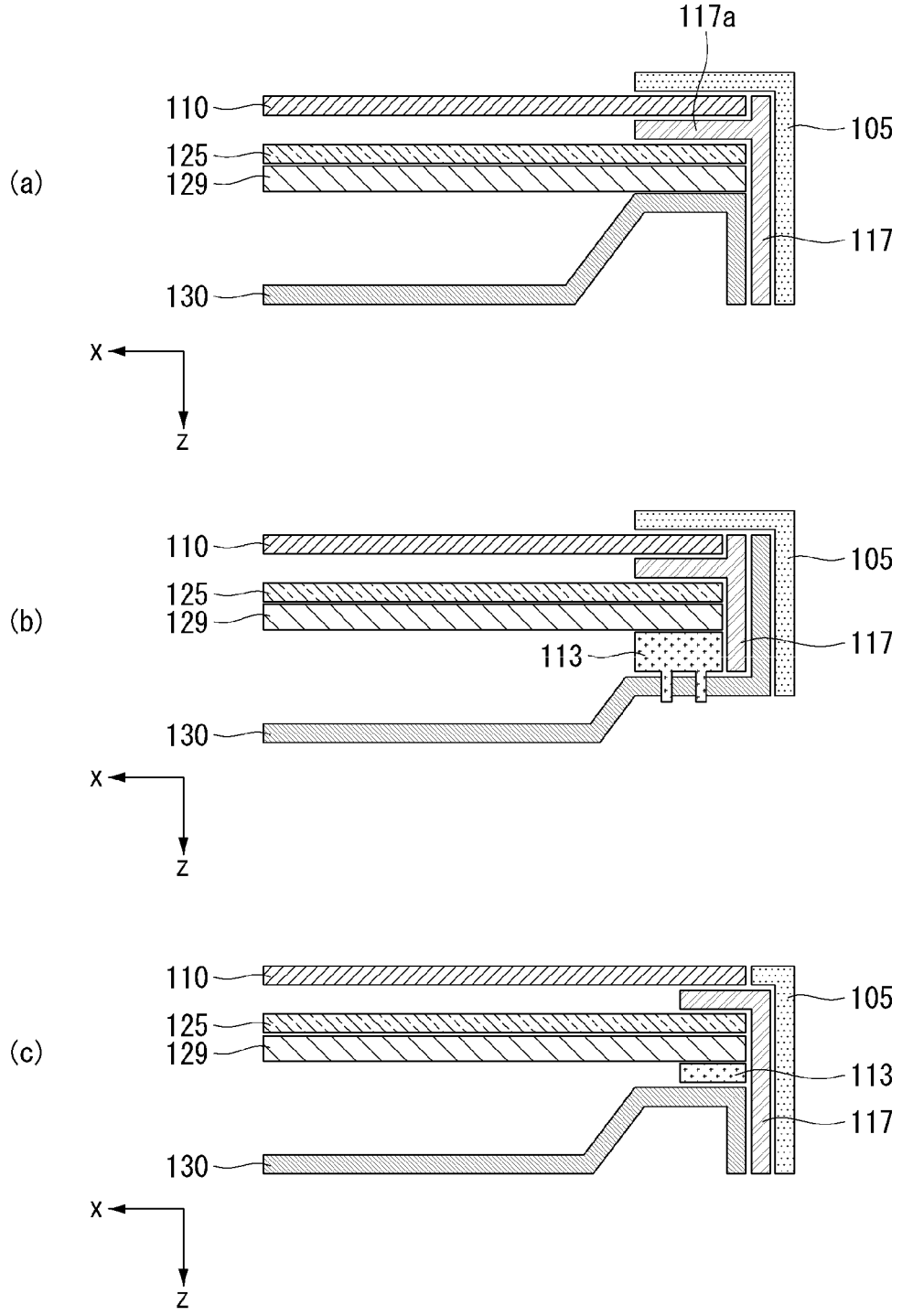


FIG. 4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117a
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105
125
129
117
130
x
z
(b)
110
105
125
129
113
117
130
x
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(c)
110
105
125
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113
117
130
x
z

FIG. 5

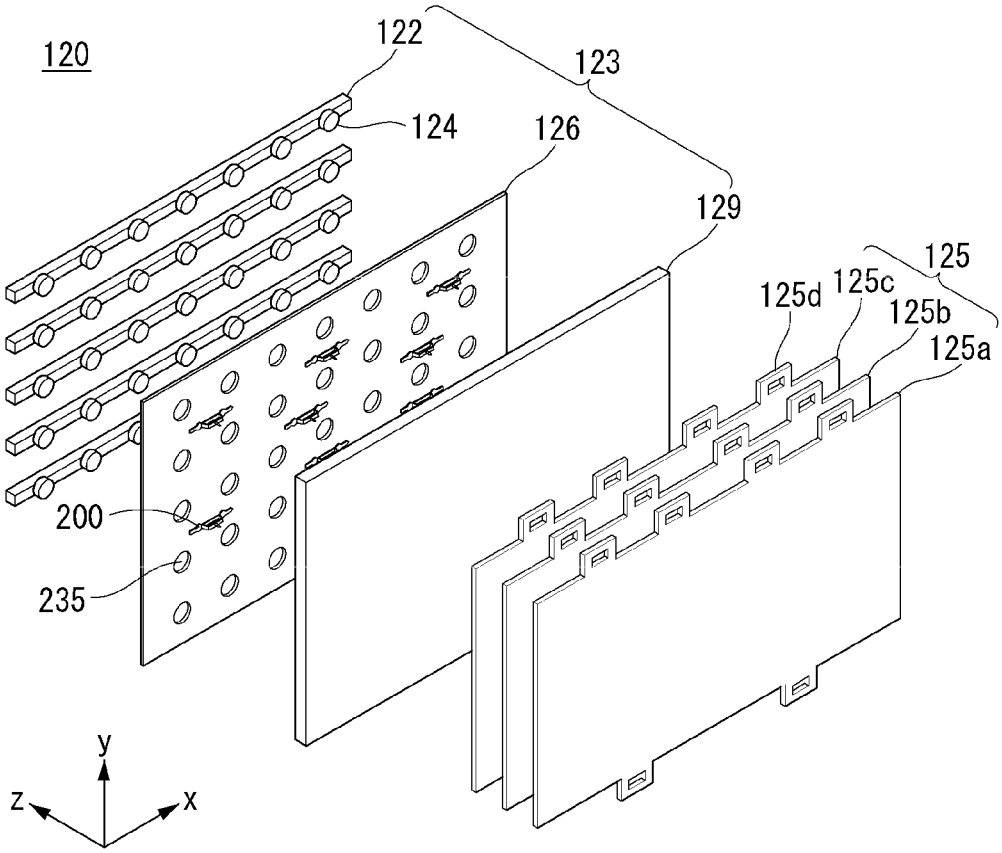
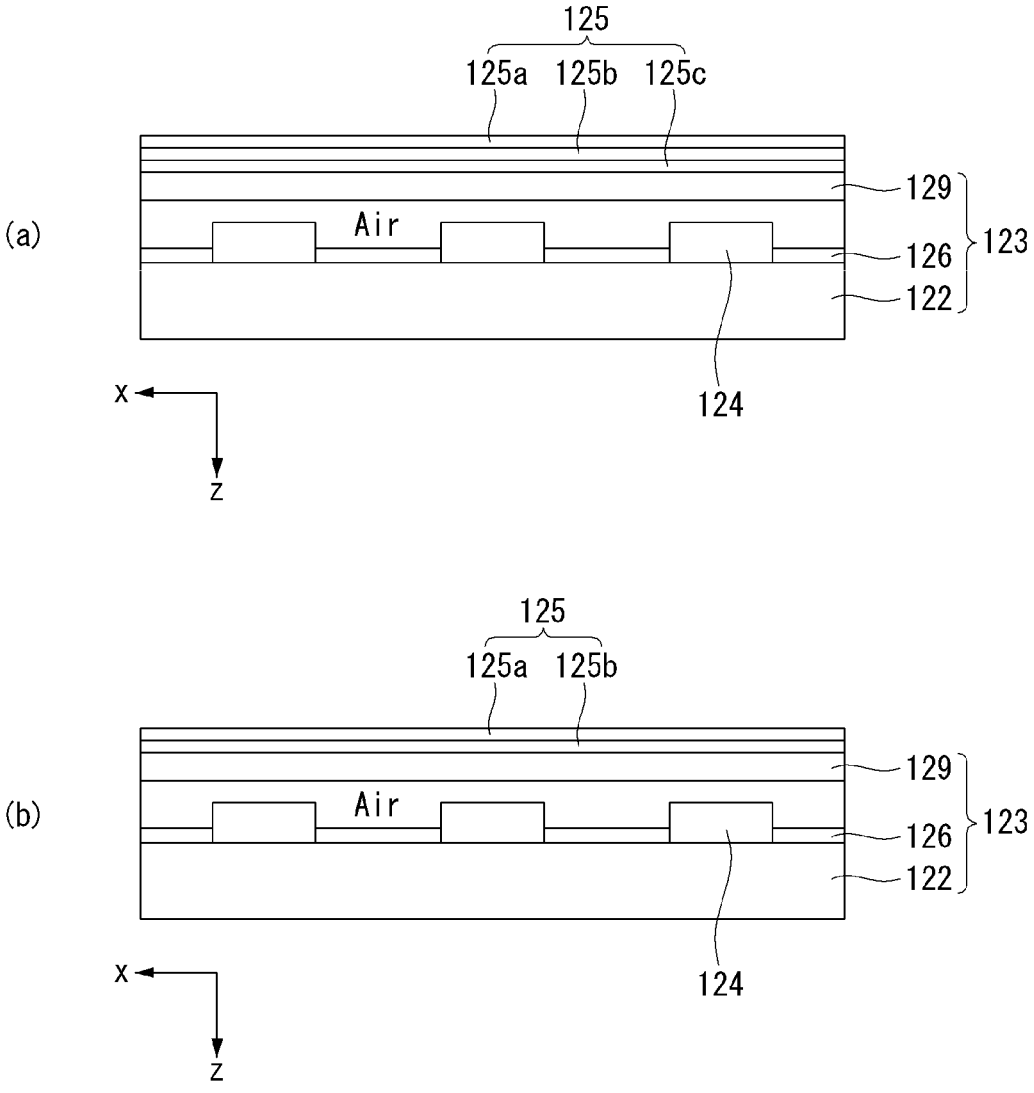


FIG. 6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125b
125c
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(b)
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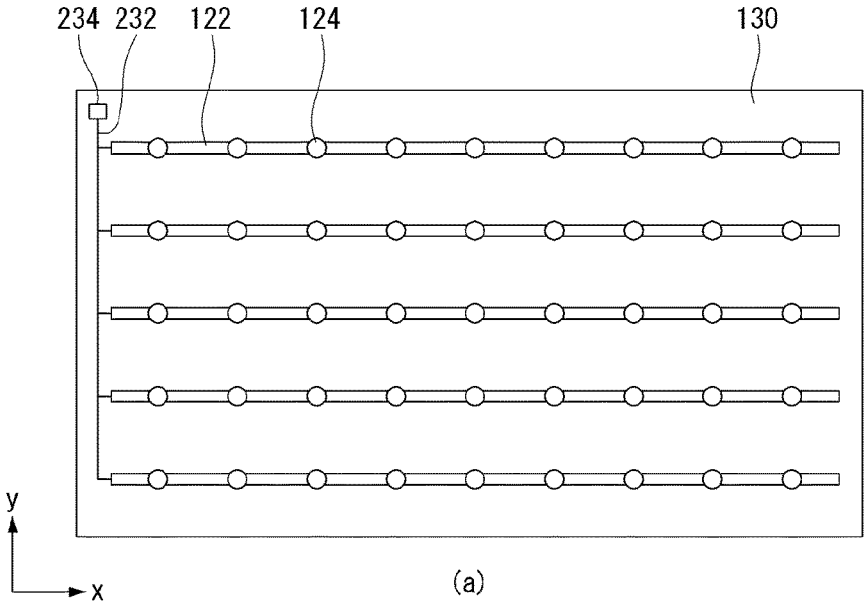
129
123
126
122
124
x
z

FIG. 7



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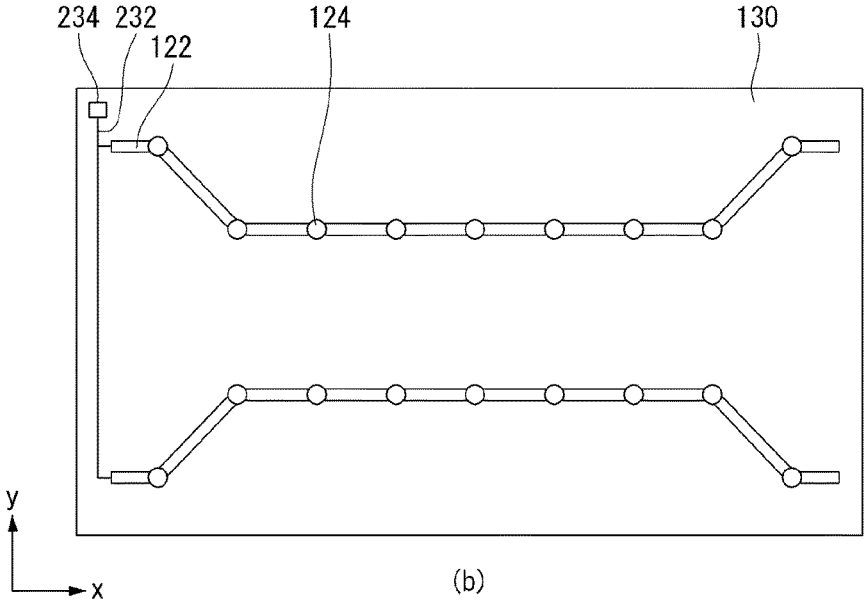
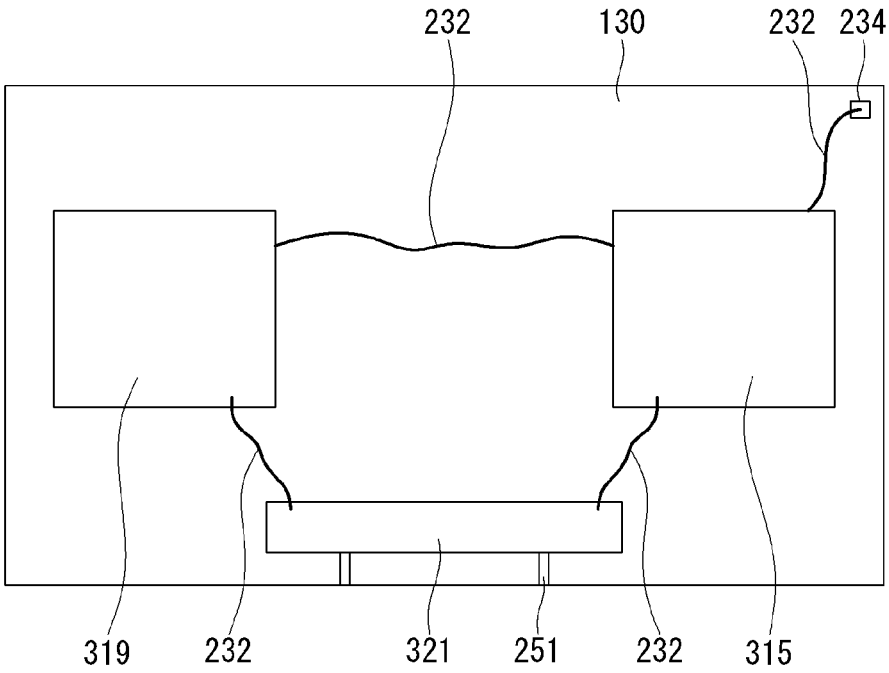


(b)

FIG. 8



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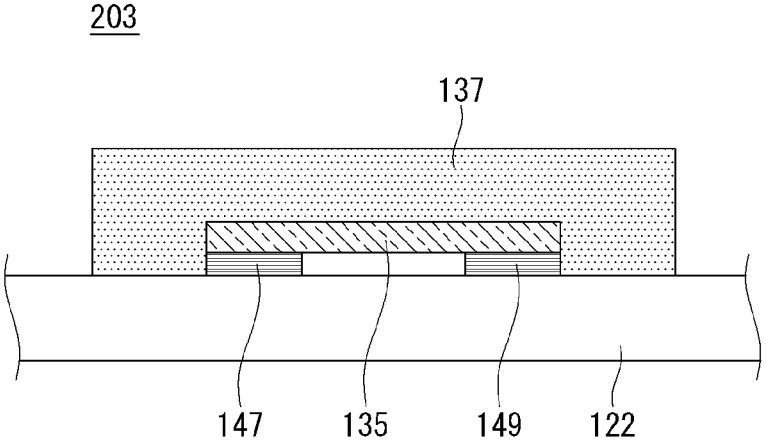
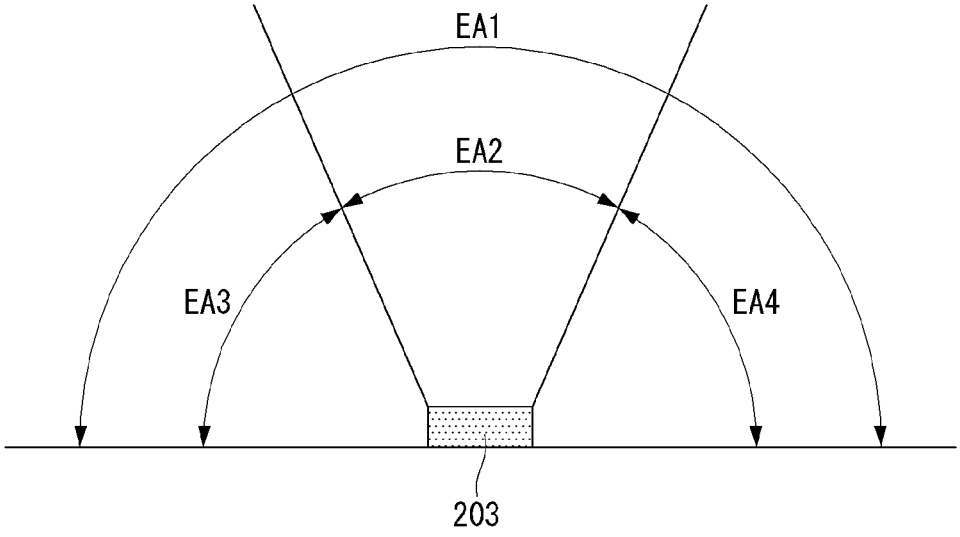


FIG. 10



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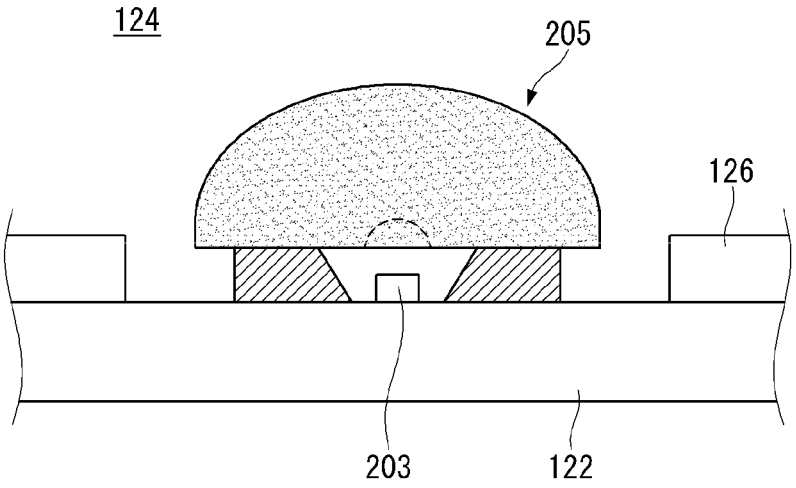
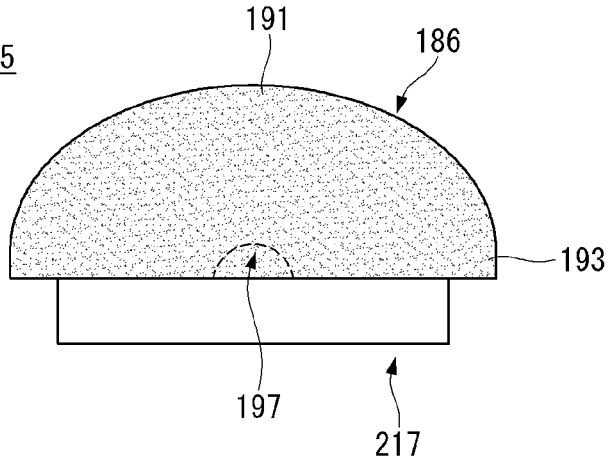


FIG. 12

(a)



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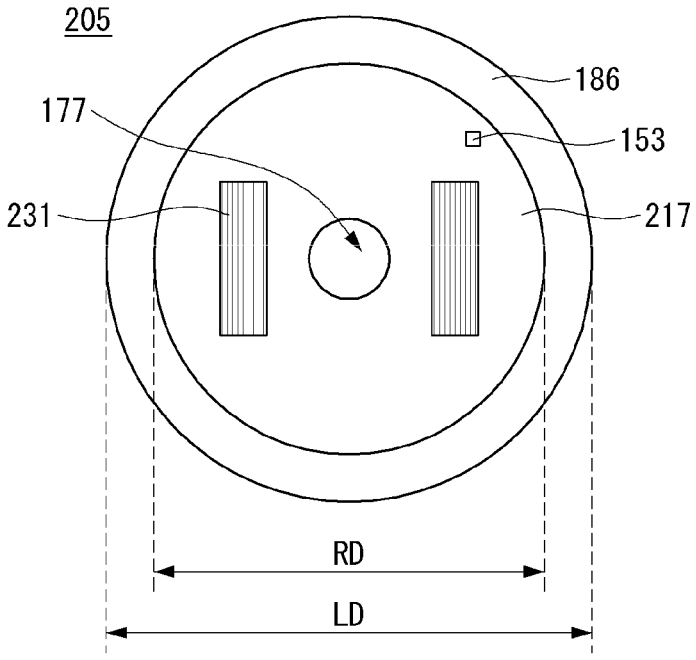
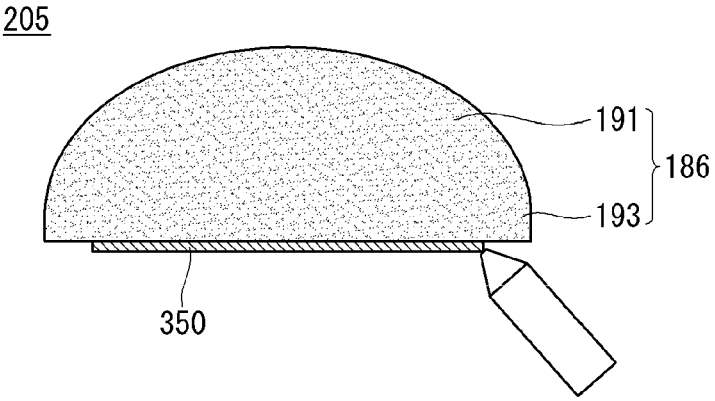


FIG. 13

(a)



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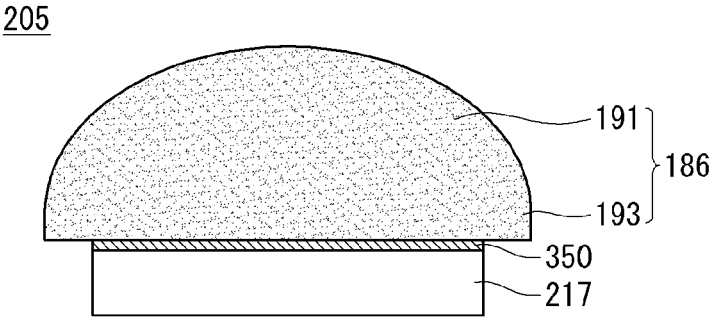

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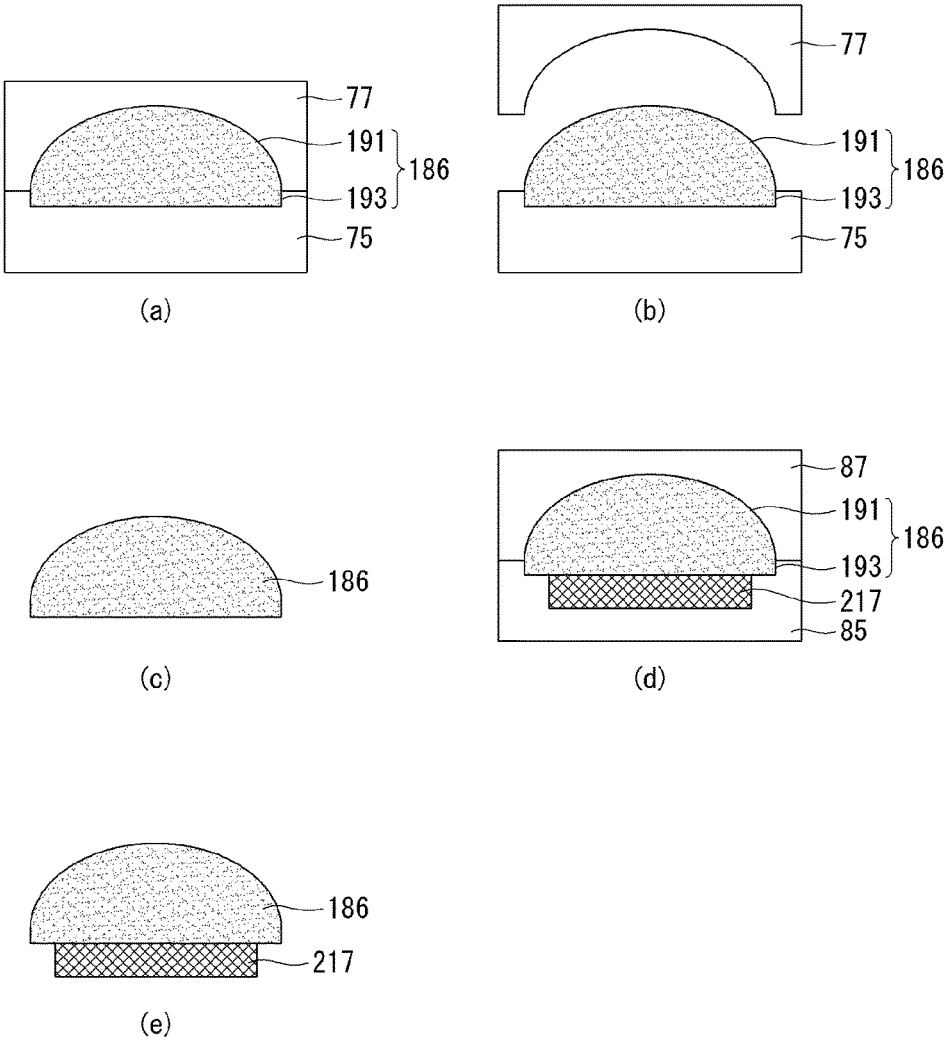
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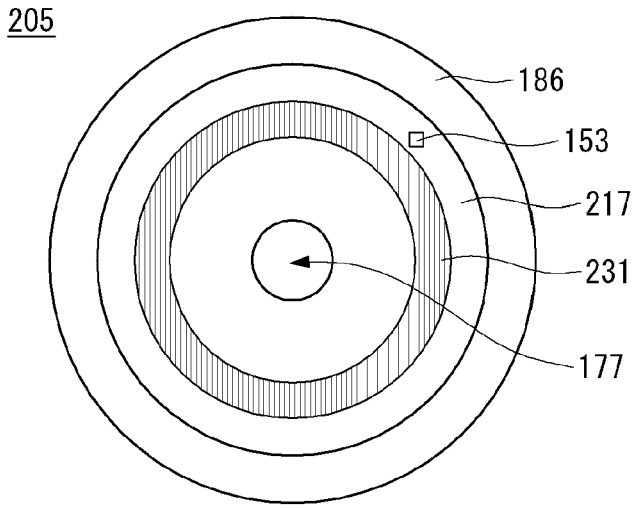
(e)

FIG. 15

(a)



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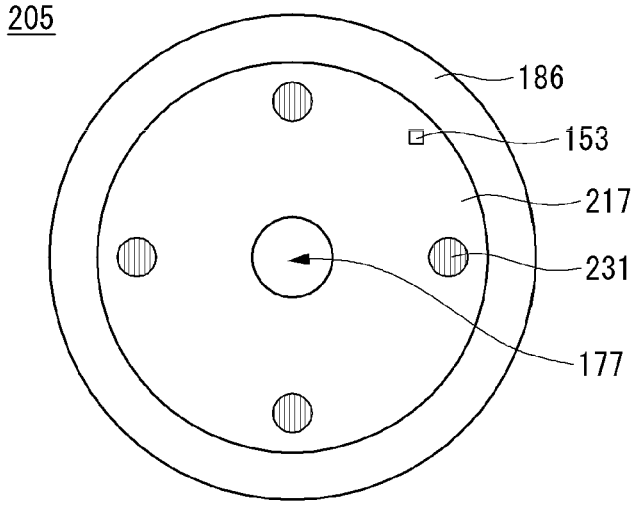
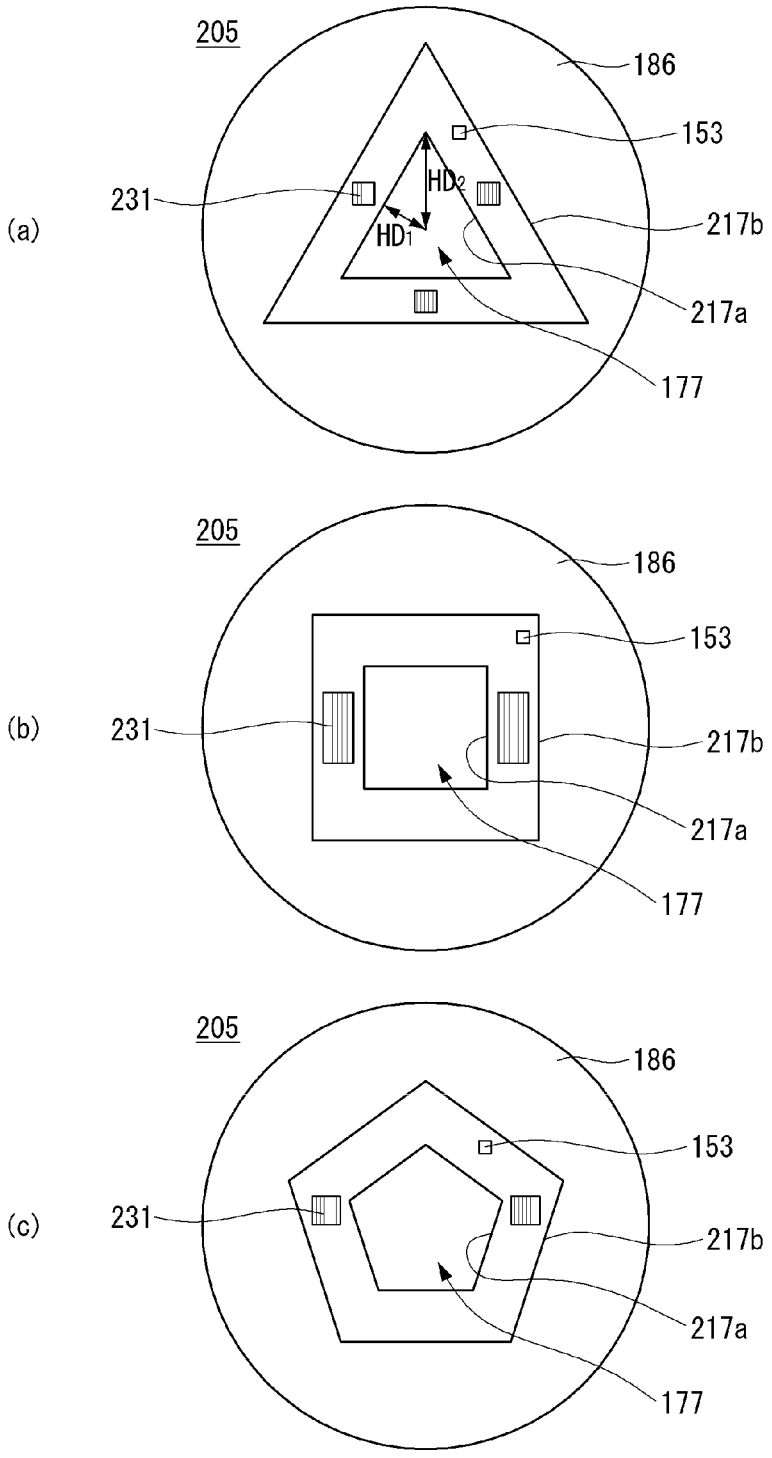


FIG. 16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HD2
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(b)
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(c)
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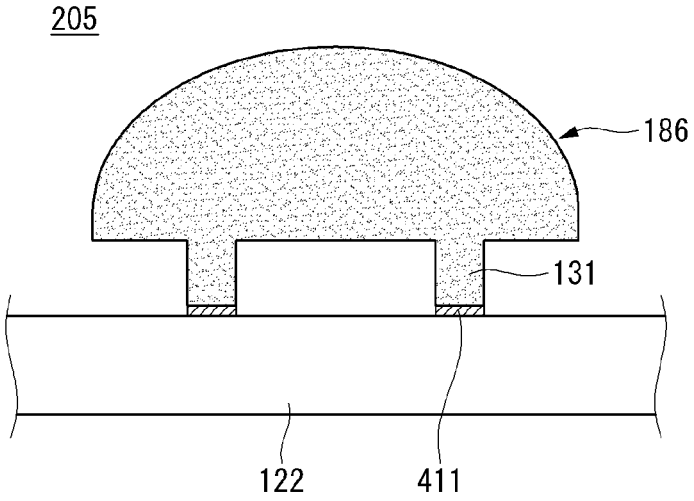
FIG. 17

(a)



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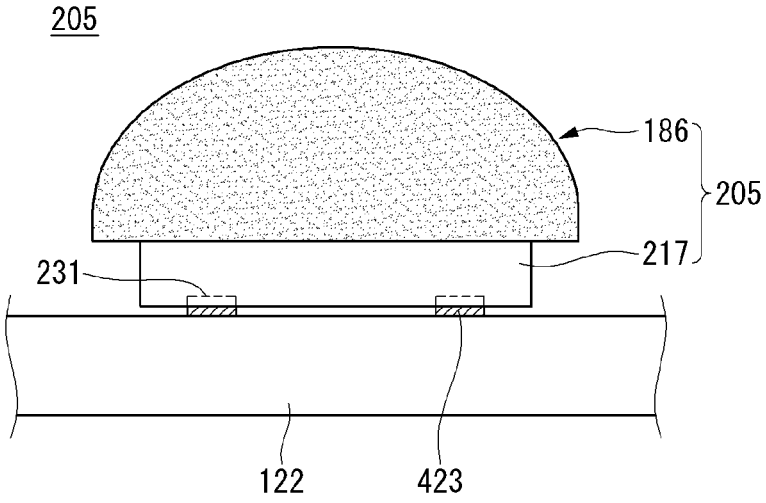

FIG. 18

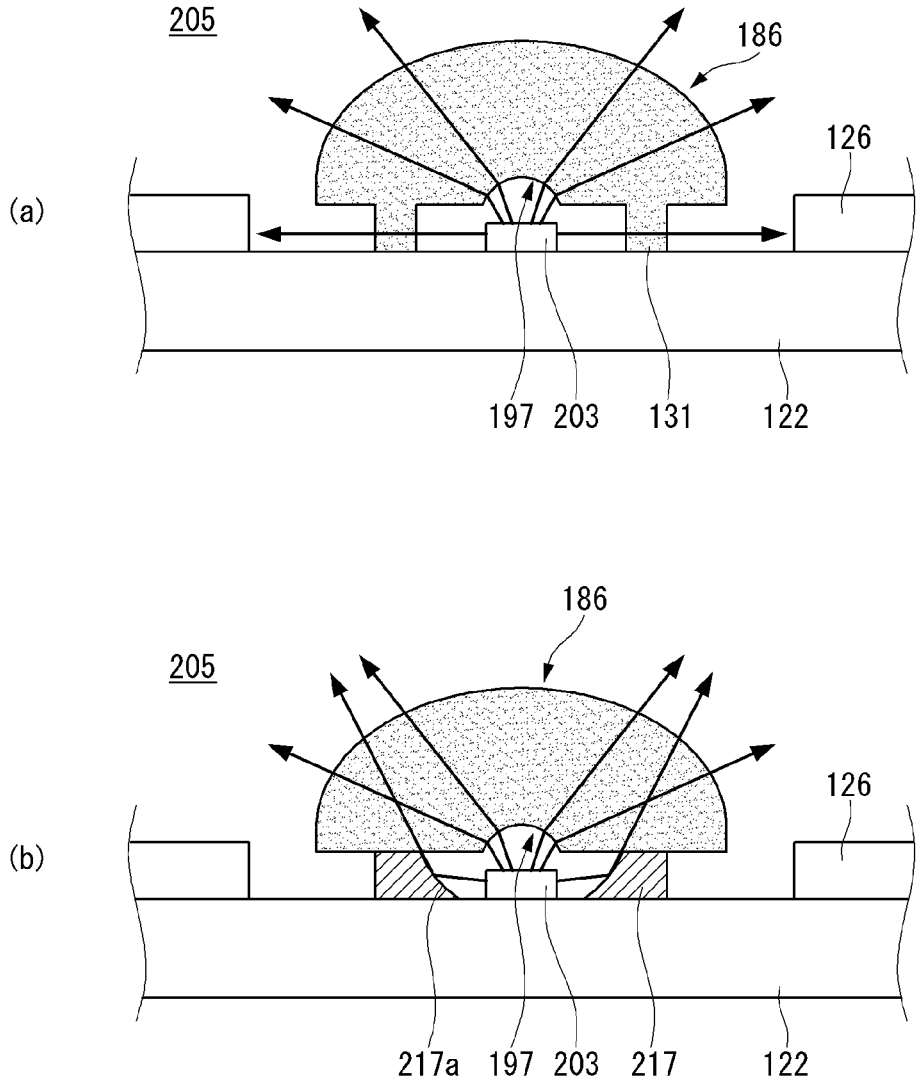

FIG. 19

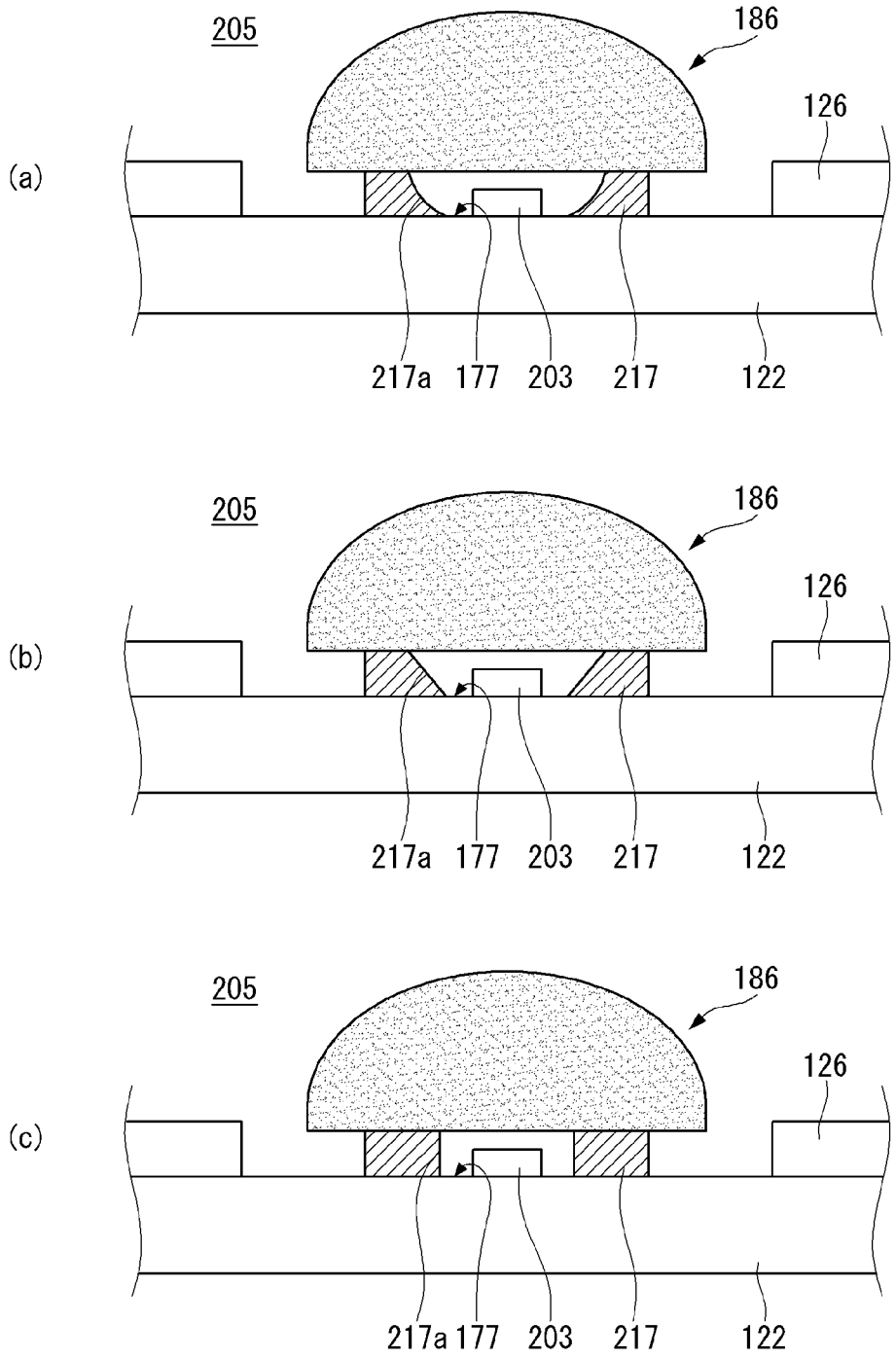
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FIG. 20

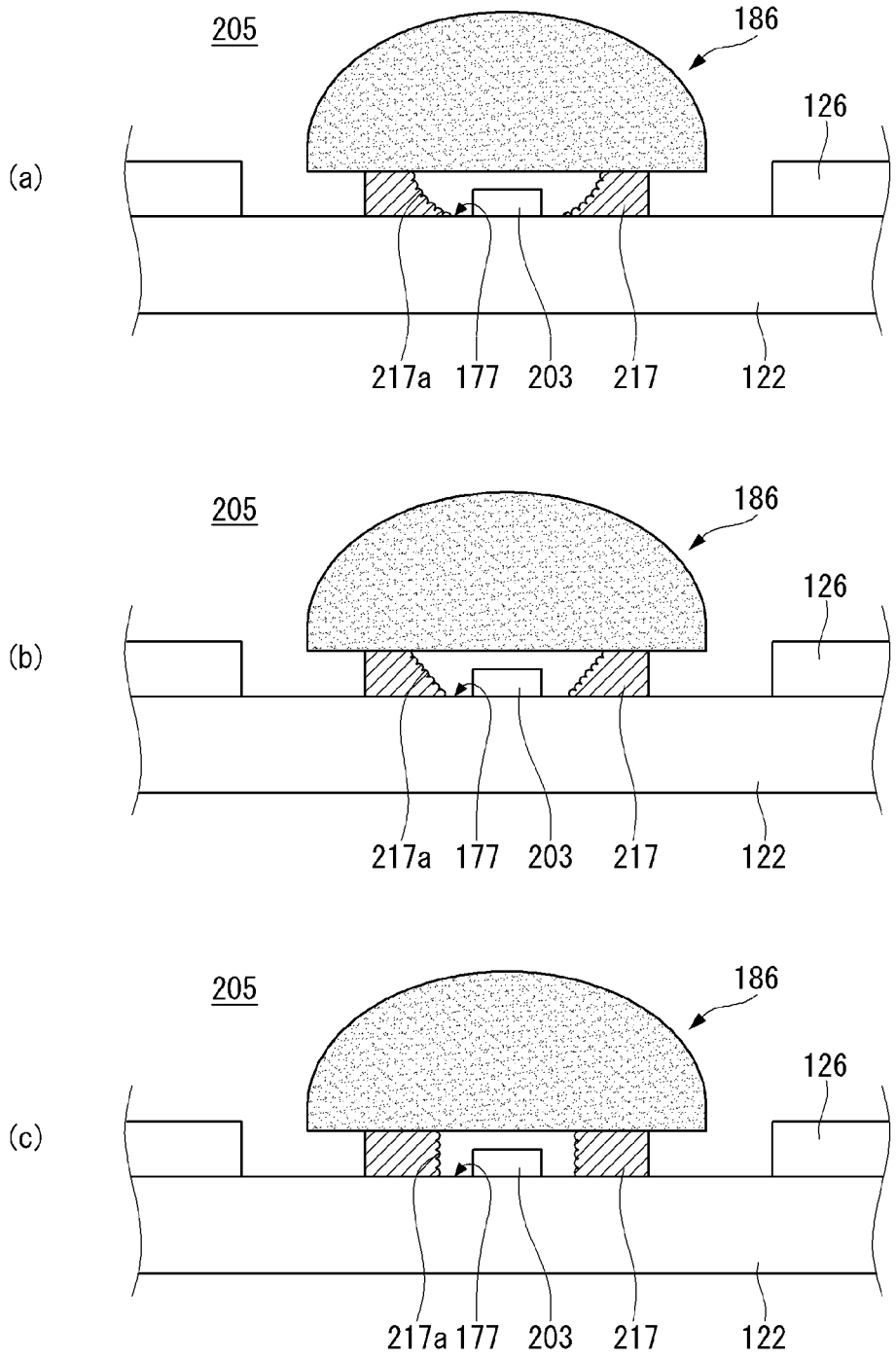
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FIG. 21

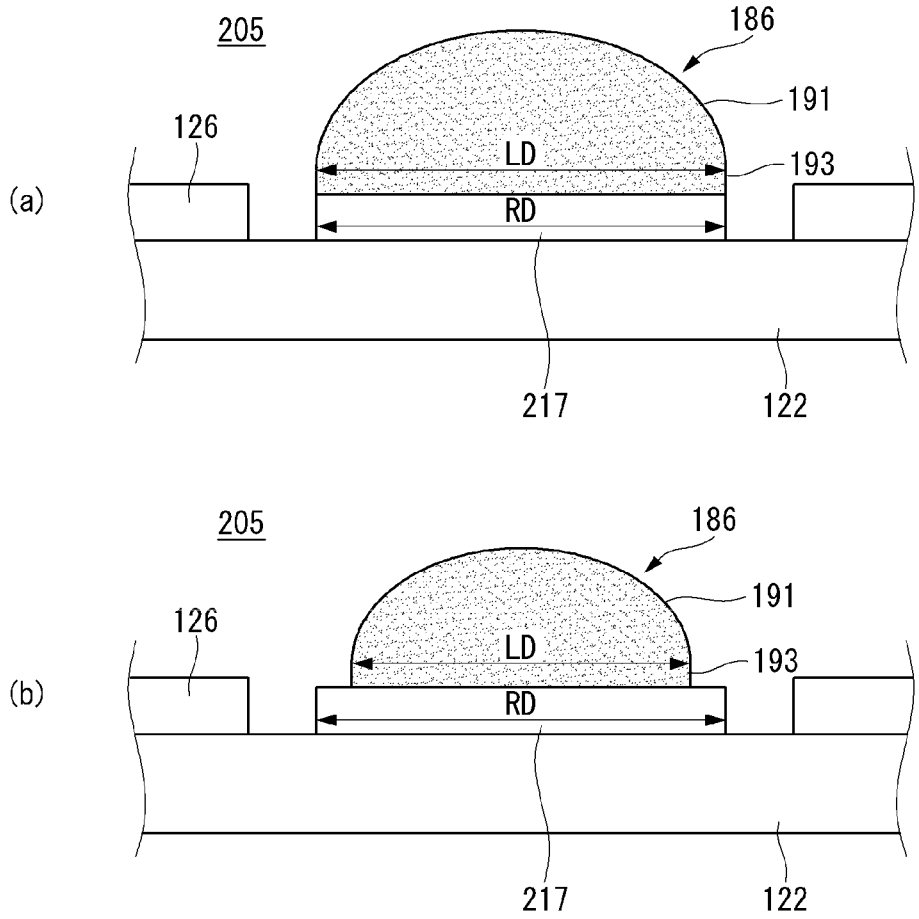
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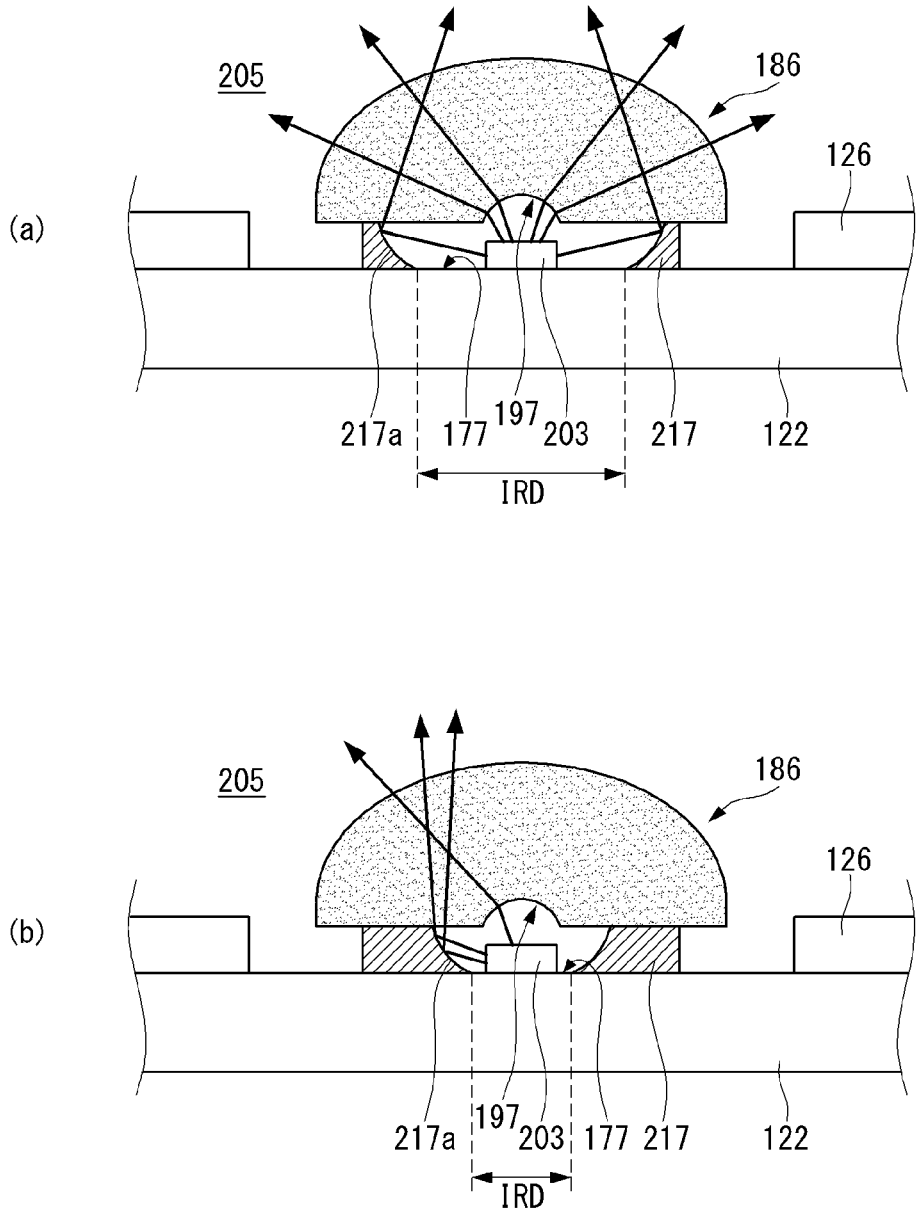
FIG. 22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217
122
IRD

BACKLIGHT UNIT HAVING A LENS WITH REFRACTION AND REFLECTION PORTIONS

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS REFERENCE TO RELATED APPLICATIONS

This application *is a Reissue of U.S. Pat. No. 9,891,471 issued on Feb. 13, 2018, which* claims the benefit of Korean Patent Application No. 10-2015-0153239 filed on Nov. 2, 2015, [the entire contents of which is hereby incorporated by reference in its entirety] *all of which are hereby expressly incorporated by reference into the present application.*

BACKGROUND OF THE DISCLOSURE

Field of the Disclosure

The present invention relates to a backlight unit and a display device including the same.

Background of the Disclosure

With the development of the information society, various demands for display devices have been increasing. In order to meet various demands for the display devices, various display devices, such as a liquid crystal display (LCD), a plasma display panel (PDP), an electroluminescent display (ELD), and a vacuum fluorescent display (VFD), have been recently studied and used.

A liquid crystal panel of the LCD includes a liquid crystal layer and an opposing thin film transistor (TFT) substrate and color filter substrate with the liquid crystal layer interposed therebetween and may display an image using light provided from a backlight unit.

SUMMARY OF THE DISCLOSURE

In accordance with an aspect of the present invention, a backlight unit includes: a substrate; and at least one light assembly separately located on the substrate, wherein the light assembly includes: a light source; and a lens configured to shield an upper surface and a side surface of the light source, wherein the lens includes: a refraction portion separately located on the upper surface of the light source; and a reflection portion separately located at the side surface of the light source.

The refraction portion and the reflection portion may be coupled by an adhesive layer.

The refraction portion and the reflection portion may be coupled by a double injection process.

The refraction portion may include a convex portion having hemisphere shape protruded upward; and a side portion extended from a lower portion of the convex portion and having cylindrical shape.

The reflection portion may have a diameter different from that of the side portion.

The reflection portion may have a diameter smaller than that of the side portion.

The reflection portion may include a central hole configured to penetrate a central portion; a pad located at an outer edge of the central hole; and an electrostatic portion located at the external diameter side of the reflection portion.

The pad may have a shape depressed into the reflection portion.

In the pad, a metal maybe inserted into a depressed portion, and the pad may be formed through an insert injection process of the metal.

The metal and the substrate may be coupled by a Surface Mount Technology (SMT) process.

The pad may be located at both sides of the central hole.

The pad may have a ring shape that encloses the central hole.

The electrostatic portion may have a shape depressed into the reflection portion, and a zener diode may be inserted into a depressed portion.

A low surface of the reflection portion may have any one shape of a triangle, a quadrangle, and a pentagon.

The reflection portion may have a protrusion therein.

The reflection portion may be inclined inward.

In accordance with another aspect of the present invention, a display device includes: a backlight unit; a display panel located at a front surface of the backlight unit; and a back cover located at a rear surface of the backlight unit, wherein the backlight unit includes: a substrate; and at least one light assembly separately located on the substrate, wherein the light assembly includes: a light source; and a lens configured to shield an upper surface and a side surface of the light source, wherein the lens includes: a refraction portion separately located on the upper surface of the light source; and a reflection portion separately located at the side surface of the light source.

The refraction portion and the reflection portion may be coupled by an adhesive layer.

The refraction portion and the reflection portion may be coupled by a double injection process.

The reflection portion may be inclined inward.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention. In the drawings:

FIGS. **1** and **2** are perspective views illustrating a display device according to an exemplary embodiment of the present invention.

FIGS. **3** to **8** are views illustrating a configuration of a display device according to an exemplary embodiment of the present invention.

FIGS. **9** and **10** are diagrams illustrating a light source according to an exemplary embodiment of the present invention.

FIGS. **11** to **22** are diagrams illustrating a light assembly of a display device according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Reference will now be made in detail embodiments of the invention examples of which are illustrated in the accompanying drawings. Since the present invention may be modified in various ways and may have various forms, specific embodiments are illustrated in the drawings and are described in detail in the present specification. However, it

should be understood that the present invention are not limited to specific disclosed embodiments, but include all modifications, equivalents and substitutes included within the spirit and technical scope of the present invention.

The terms 'first', 'second', etc., may be used to describe various components, but the components are not limited by such terms. The terms are used only for the purpose of distinguishing one component from other components. For example, a first component may be designated as a second component without departing from the scope of the present invention. In the same manner, the second component may be designated as the first component.

The term "and/or" encompasses both combinations of the plurality of related items disclosed and any item from among the plurality of related items disclosed.

When an arbitrary component is described as "being connected to"or "being linked to" another component, this should be understood to mean that still another component(s) may exist between them, although the arbitrary component may be directly connected to, or linked to, the second component. In contrast, when an arbitrary component is described as "being directly connected to" or "being directly linked to" another component, this should be understood to mean that no component exists between them.

The terms used in the present application are used to describe only specific embodiments or examples, and are not intended to limit the present invention. A singular expression can include a plural expression as long as it does not have an apparently different meaning in context.

In the present application, the terms "include" and "have" should be understood to be intended to designate that illustrated features, numbers, steps, operations, components, parts or combinations thereof exist and not to preclude the existence of one or more different features, numbers, steps, operations, components, parts or combinations thereof, or the possibility of the addition thereof.

Unless otherwise specified, all of the terms which are used herein, including the technical or scientific terms, have the same meanings as those that are generally understood by a person having ordinary knowledge in the art to which the present invention pertains. The terms defined in a generally used dictionary must be understood to have meanings identical to those used in the context of a related art, and are not to be construed to have ideal or excessively formal meanings unless they are obviously specified in the present application.

The following exemplary embodiments of the present invention are provided to those skilled in the art in order to describe the present invention more completely. Accordingly, shapes and sizes of elements shown in the drawings may be exaggerated for clarity.

Hereinafter, as a display panel, a Liquid Crystal Display Device (LCD) is exemplified, but a display panel that can apply to a display device according to the present invention is not limited to the LCD and may be a Plasma Display Panel (PDP), a Field Emission Display (FED), and an Organic Light Emitting Display (OLED).

FIGS. **1** and **2** are perspective views illustrating a display device according to an exemplary embodiment of the present invention.

As shown in FIG. **1**, a display panel **110** may include a First Long Side (LS**1**), a Second Long Side (LS**2**) opposite to the LS**1**, a First Short Side (SS**1**) adjacent to the LS**1** and the LS**2**, and a Second Short Side (SS**2**) opposite to the SS**1**.

Here, an area of the SS**1** may be referred to as a first side area, an area of the SS**2** may be referred to as a second side area opposite to the first side area, an area of the LS**1** may be referred to as a third side area adjacent to the first side area and the second side area and located between the first side area and the second side area, and an area of the LS**2** may be referred to as a fourth side area adjacent to the first side area and the second side area, located between the first side area and the second side area, and opposite to the third side area.

Further, for convenience of description, it is described that a length of the LS**1** and LS**2** is longer than that of the SS**1** and SS**2**, but a length of the LS**1** and LS**2** may be approximately the same as that of the SS**1** and SS**2**.

Hereinafter, a First Direction (DR**1**) may be a direction parallel to the LS**1** and LS**2** of the display panel **100**, and a Second Direction (DR**2**) may be a direction parallel to the SS**1** and SS**2** of the display panel **100**.

A Third Direction (DR**3**) may be a direction vertical to the DR**1** and/or the DR**2**.

The DR**1** and the DR**2** may be referred to as a horizontal direction.

Further, the DR**3** may be referred to as a vertical direction.

As shown in FIG. **2**, a display device **100** according to an exemplary embodiment of the present invention may include a display panel **110** and a back cover **150** of the rear side of the display panel **110**.

The back cover **150** may be connected to the display panel **110** with a sliding method in a direction toward the LS**2** from the LS**1**, i.e., in the DR**2**. In other words, the back cover **150** may be inserted with a sliding method from the SS**1** of the display panel **110**, the SS**2** corresponding to the SS**1**, and the LS**1** adjacent to the SS**1** and the SS**2** and located between the SS**1** and the SS**2**.

In order to connect the back cover **150** to the display panel **110** with a sliding method, in the back cover **150** and/or other structures adjacent thereto, a protruding portion, a sliding portion, and a coupler may be included.

FIGS. **3** to **8** are views illustrating a configuration of a display device according to an exemplary embodiment of the present invention.

As shown in FIG. **3**, the display device **100** according to an exemplary embodiment of the present invention may include a front cover **105**, a display panel **110**, a backlight unit **120**, a frame **130**, and a back cover **150**.

The front cover **105** may cover at least a partial area of a front surface and a side surface of the display panel **110**. The front cover **105** may have a quadrangular frame shape whose center is hollow. Because the center of the front cover **105** is hollow, an image of the display panel **110** may be displayed to the outside.

The front cover **105** may be divided into a front surface cover and a side surface cover. That is, the front cover **105** may be divided into a front surface cover located at the front surface side of the display panel **110** and a side surface cover located at the side surface side of the display panel **110**. The front surface cover and the side surface cover may be separately formed. Any one of the front surface cover and the side surface cover may be omitted. For example, for an enhanced design, the front surface cover may not exist and only the side surface cover may exist.

The display panel **110** may be provided at a front surface of the display device **100** to display an image. The display panel **110** may divide an image into a plurality of pixels to output the image to correspond to a color, brightness, and chroma per pixel. The display panel **110** may be divided into an active area that displays an image and an inactive area that does not display an image. The display panel **110** may include an opposing front substrate and rear substrate with a liquid crystal layer interposed therebetween.

The front substrate may include a plurality of pixels formed with red R, green G, and blue B sub pixels. The front substrate may generate an image corresponding to a color of red, green, or blue according to a control signal.

The rear substrate may include switching elements. The rear substrate may switch a pixel electrode. For example, the pixel electrode may change molecule arrangement of the liquid crystal layer according to a control signal applied from the outside. The liquid crystal layer may include a plurality of liquid crystal molecules. The liquid crystal molecules may change arrangement to correspond to a voltage difference that has occurred between a pixel electrode and a common electrode. The liquid crystal layer may transfer light provided from the backlight unit **120** to the front substrate.

The backlight unit **120** may be located at the rear surface side of the display panel **110**. The backlight unit **120** may include a plurality of light sources. A light source of the backlight unit **120** may be disposed in a direct type or an edge type. When the backlight unit **120** is an edge type backlight unit **120**, the edge type backlight unit **120** may further include a light guide panel.

The backlight unit **120** may be coupled to the front side of the frame **130**. For example, a plurality of light sources may be disposed at the front side of the frame **130**, and this backlight unit may be referred to as an edge type backlight unit.

The backlight unit **120** maybe driven with an entire driving method or a partial driving method such as local dimming and impulsive. The backlight unit **120** may include an optical sheet **125** and an optical layer **123**.

The optical sheet **125** may enable light of a light source to uniformly transfer to the display panel **110**. The optical sheet **125** may be formed with a plurality of layers. For example, the optical sheet **125** may include at least one prism sheet and/or at least one diffusion sheet.

In the optical sheet **125**, at least one coupler **125**d may exist. The coupler **125**d may be coupled to the front cover **105** and/or the back cover **150**. That is, the coupler **125**d may be directly coupled to the front cover **105** and/or the back cover **150**. Alternatively, the coupler **125**d may be coupled to a structure coupled on the front cover **105** and/or the back cover **150**. That is, the coupler **125**d may be indirectly coupled to the front cover **105** and/or the back cover **150**.

The optical layer **123** may include a light source. A detailed configuration of the optical layer **123** will be described in a corresponding portion.

The frame **130** may perform a function of supporting constituent elements of the display device **100**. For example, constituent elements of the backlight unit **120** may be coupled to the frame **130**. The frame **130** may be made of a metal material such as an aluminum alloy.

The back cover **150** may be located at a rear surface of the display device **100**. The back cover **150** may protect internal constituent elements from an external impact. At least a portion of the back cover **150** may be coupled to the frame **130** and/or the front cover **105**. The back cover **150** may be an injection material made of a resin material.

FIG. **4** is a cross-sectional view illustrating a configuration of the optical sheet **125**.

As shown in FIG. **4**A, in an upper portion of the frame **130**, the optical sheet **125** and/or a diffusion plate **129** may be located. The optical sheet **125** and/or the diffusion plate **129** may be coupled to the frame **130** at an edge of the frame **130**. The optical sheet **125** and/or the diffusion plate **129** may be directly received at the edge of the frame **130**. That is, an outer circumference of the optical sheet **125** and/or the diffusion plate **129** may be supported by the frame **130**. An upper surface of an edge of the optical sheet **125** and/or the diffusion plate **129** may be enclosed by a first guide panel **117**. For example, the optical sheet **125** and/or the diffusion plate **129** maybe located between an edge of the frame **130** and a flange **117**a of the first guide panel **117**.

At the front surface side of the optical sheet **125**, the display panel **110** may be located. An edge of the display panel **110** may be coupled to the first guide panel **117**. That is, the display panel **110** may be supported by the first guide panel **117**.

An edge area of the front surface of the display panel **110** may be enclosed by the front cover **105**. For example, the display panel **110** may be located between the first guide panel **117** and the front cover **105**.

As shown in FIG. **4**B, the display device **100** according to an exemplary embodiment of the present invention may further include a second guide panel **113**. The optical sheet **125** and/or the diffusion plate **129** may be coupled to the second guide panel **113**. That is, the second guide panel **113** may be coupled to the frame **130**, and the optical sheet **125** and/or the diffusion plate **129** may be coupled to the second guide panel **113**. The second guide panel **113** may be made of a material different from that of the frame **130**. The frame **130** may have a form that encloses the first and second guide panels **117** and **113**.

As shown in FIG. **4**C, in the display device **100** according to an exemplary embodiment of the present invention, the front cover **105** may not cover a front surface of the display panel **110**. That is, one end portion of the front cover **105** may be located at a side surface of the display panel **110**.

Referring to FIGS. **5** and **6**, the backlight unit **120** may include a substrate **122**, at least one light assembly **124**, an optical layer **123** including a reflection sheet **126** and a diffusion plate **129**, and an optical sheet **125** located at the front surface side of the optical layer **123**.

The substrate **122** may be formed in a plurality of strap forms extended in a first direction and separated by a predetermined gap in a second direction orthogonal to the first direction.

In the substrate **122**, at least one light assembly **124** may be mounted. In the substrate **122**, an electrode pattern for connecting an adaptor and the light assembly **124** may be formed. For example, in the substrate **122**, a carbon nanotube electrode pattern for connecting the light assembly **124** and the adaptor may be formed.

The substrate **122** may be made of at least one of polyethyleneterephthalate (PET), glass, polycarbonate (PC), and silicon. The substrate **122** may be a Printed Circuit Board (PCB) that mounts at least one light assembly **124**.

In the substrate **122**, the light assemblies **124** may be disposed at a predetermined gap in a first direction. A diameter of the light assembly **124** may be larger than a width of the substrate **122**. That is, a diameter of the light assembly **124** may be larger than a second direction length of the substrate **122**.

The light assembly **124** may be a light emitting diode package including a Light Emitting Diode (LED) chip or at least one light emitting diode chip.

The light assembly **124** may be formed with a color LED that emits at least one of colors such as red, blue, and green or a white LED. The color LED may include at least one of red LED, blue LED, and green LED.

A light source included in the light assembly **124** may be a Chip On Board (COB) type light source. The COB type light source may have a form that directly couples an LED

chip, which is a light source to the substrate **122**. Therefore, a process can be simplified. Further, resistance can be lowered and thus energy to be lost due to a heat can be reduced. That is, power efficiency of the light assembly **124** can be enhanced. The COB type light source can provide more bright lighting. The COB type light source maybe implemented in a smaller thickness and a lighter weight than a conventional light source.

At the front surface side of the substrate **122**, the reflection sheet **126** maybe located. The reflection sheet **126** maybe located on an area, except for an area in which the light assembly **124** of the substrate **122** is formed. That is, in the reflection sheet **126**, a plurality of through-holes **235** may be formed.

The reflection sheet **126** may reflect light emitted from the light assembly **124** to the front surface side. Further, the reflection sheet **126** may again reflect light reflected from the diffusion plate **129**.

The reflection sheet **126** may include at least one of a metal and metal oxide, which is a reflection material. For example, the reflection sheet **126** may include a metal and/or metal oxide having high reflectivity, such as at least one of aluminum (Al), silver (Ag), gold (Au), and titanium dioxide (TiO2).

The reflection sheet **126** maybe formed by depositing and/or coating a metal or metal oxide on the substrate **122**. In the reflection sheet **126**, ink including a metal material may be printed. In the reflection sheet **126**, a deposition layer may be formed using a vacuum deposition method such as a heat deposition method, an evaporation method, or a sputtering method. In the reflection sheet **126**, a coating layer and/or a print layer may be formed using a printing method, a gravure coating method, or a silk screen method.

An air gap may be formed between the reflection sheet **126** and the diffusion plate **129**. The air gap may perform a buffer function of widely spreading light emitted from the light assembly **124**. In order to maintain the air gap, a support **200** may be located between the reflection sheet **126** and the diffusion plate **129**.

A resin may be deposited on the light assembly **124** and/or the reflection sheet **126**. The resin may perform a function of diffusing light emitted from the light assembly **124**.

The diffusion plate **129** may diffuse light emitted from the light assembly **124** upward.

The optical sheet **125** may be located at the front surface side of the diffusion plate **129**. A rear surface of the optical sheet **125** may close contact with the diffusion plate **129**, and a front surface of the optical sheet **125** may close contact with a rear surface of the display panel **110**.

The optical sheet **125** may include at least one sheet. Specifically, the optical sheet **125** may include at least one prism sheet and/or at least one diffusion sheet. A plurality of sheets included in the optical sheet **125** may be in a bonding state and/or a close contact state.

The optical sheet **125** may be formed with a plurality of sheets having different functions. For example, the optical sheet **125** may include first to three optical sheets **125**a to **125**c. The first optical sheet **125**a may have a function of a diffusion sheet, and the second and third optical sheets **125**b and **125**c may have a function of a prism sheet. The number and/or a location of diffusion sheets and prism sheets maybe changed. For example, the optical sheet **125** may include the first optical sheet **125**a, which is a diffusion sheet and the second optical sheet **125**b, which is a prism sheet.

The diffusion sheet prevents light emitted from the diffusion plate **129** from partially concentrating, thereby enabling more uniform luminance of light. The prism sheet concentrates light emitted from the diffusion sheet to enable vertical incidence of light to the display panel **110**.

The coupler **125**d may be formed in at least one of corners of the optical sheet **125**. The coupler **125**d may be formed in at least one of the first to third optical sheets **125**a to **125**c.

The coupler **125**d may be formed at a corner of the long side of the optical sheet **125**. The coupler **125**d formed at the first long side and the coupler **125**d formed at the second long side may be asymmetric. For example, a location and/or the number of the coupler **125**d formed at the first long side and the coupler **125**d formed at the second long side may be different.

Referring to FIG. **7**A, on the frame **130**, the substrate **122** formed with a plurality of straps extended in a first direction and separated by a predetermined gap in a second direction orthogonal to the first direction may be provided. One side end of a plurality of substrates **122** may be connected to a wiring electrode **232**.

The wiring electrode **232** may be extended in a second direction. The wiring electrode **232** may be connected to one side end of the substrate **122** at a constant gap in a second direction.

At one side end of the wiring electrode **232**, a wiring hole **234** may be formed. The wiring hole **234** may be a micro hole that penetrates the frame **130**. The wiring electrode **232** may be extended to a rear surface of the frame **130** through the wiring hole **234**. The wiring electrode **232** maybe electrically connected to an adaptor (not shown) located at a rear surface of the frame **130** through the wiring hole **234**.

On the substrate **122**, the light assemblies **124** may be disposed at a predetermined gap in the front direction. A diameter of the light assembly **124** may be larger than a width of a second direction of the substrate **122**. Accordingly, an external area of the light assembly **124** may extended to an area in which the substrate **122** is not provided.

Referring to FIG. **7**B, the substrate **122** formed with a plurality of straps may be extended in other directions other than a first direction at both end portions. That is, both end portions of the substrate **122** may be extended to a corner area such that the light assemblies **124** are located at a corner area.

The substrate **122** that mounts the light assemblies **124** is located at a corner area, thereby compensating a dark portion of the corner area. That is, in an entire area of the display device, light may be uniformly emitted.

One side end of the substrate **122** located at a corner area may be connected to the wiring electrode **232**. The wiring electrode **232** may be extended in a second direction and may be electrically connected to an adaptor located at a rear surface of the frame **130** through the wiring hole **234** formed at one side end.

Referring to FIG. **8**, the wiring electrode **232** extended at a front surface of the frame **130** through the wiring hole **234** may be connected to one side of a power supply **315**. The power supply **315** may be a printed circuit board that supplies power to the display device **100**. The power supply **315** may change an AC frequency to a DC frequency. That is, the power supply **315** changes a low frequency to a high frequency, thereby enhancing electricity efficiency.

The power supply **315** may enable the light assembly **124** located at a front surface of the frame **130** to emit light through the wiring electrode **232**.

The power supply **315** may be connected to a main board **321** through the wiring electrode **232** at the other side. The main board **321** may be separated by a predetermined gap from the power supply **315**. For example, the main board

321 may be located opposite to the power supply 315 in a second direction based on a central portion of the frame 130.

The main board 321 may be a printed circuit board that provides an interface that enables the display device 100 to operate. Further, the main board 321 may check and manage an operation state of each component of the display device 100.

The main board 321 and the power supply 315 maybe connected to a T-CON board 319 through the wiring electrode 232. The T-CON board 319 may be a printed circuit board that transfers a signal input to the main board 321 or the power supply 315 to the display panel 110. The T-CON board 319 may be electrically connected to the display panel 110 of a front surface of the frame 130 through a Flat Flex Cable (FFC cable) 251.

Respective printed circuit boards are connected, but the present invention is not limited thereto and only at least a portion of the respective printed circuit boards may be connected.

FIGS. 9 and 10 are diagrams illustrating a light source according to an exemplary embodiment of the present invention.

As shown in FIG. 9, a light source 203 may be a COB type light source. The COB type light source 203 may include at least one of a light emitting layer 135, first and second electrodes 147 and 149, and a fluorescent layer 137.

The light emitting layer 135 may be located on the substrate 122. The light emitting layer 135 may emit light of any one color of blue, red, and green. The light emitting layer 135 may include any one of Firpic, (CF3ppy)2Ir(pic), 9, 10-di (2-naphthyl) anthracene (AND), Perylene, distyrybiphenyl, PVK, OXD-7, and UGH-3 (Blue) and a combination thereof.

The first and second electrodes 147 and 149 may be located at both sides of a low surface of the light emitting layer 135. The first and second electrodes 147 and 149 may transfer an external driving signal to the light emitting layer 135.

The fluorescent layer 137 may cover the light emitting layer 135 and the first and second electrodes 147 and 149. The fluorescent layer 137 may include a fluorescent material that converts light of spectrum generated in the light emitting layer 135 to white light. In a lower portion of the fluorescent layer 137, the light emitting layer 135 may have a uniform thickness. The fluorescent layer 137 may have a refractive index of 1.4 to 2.0.

The COB type light source 203 according to an exemplary embodiment of the present invention may be directly mounted on the substrate 122. Therefore, a size of the light assembly 124 may reduce.

As the light source 203 is located on the substrate 122, a heat releasing property is excellent and thus the light source 203 may be driven with a high current. Accordingly, the number of the light sources 203 necessary for securing the same light quantity may be reduced.

As the light source 203 is mounted on the substrate 122, a wire bonding process may be not required. Accordingly, a cost can be reduced with simplification of a process.

As shown in FIG. 10, light emission of the light source 203 according to an exemplary embodiment of the present invention may be performed over a first light emitting range EA1. That is, light emission may be performed over an area including a second light emitting range EA2, which is the front surface side and third and fourth light emitting ranges EA3 and EA4, which are the side surface side. This is different in that a conventional light source including a POB type light source emits light in the second light emitting range EA2. That is, it means that the light source 203 according to an exemplary embodiment of the present invention may emit light to a wide range including a side surface of the light source 203.

FIGS. 11 to 22 are diagrams illustrating a light assembly of a display device according to an exemplary embodiment of the present invention.

Referring to FIG. 11, the light assembly 124 may include a light source 203 and a lens 205.

The light source 203 may be located at a central portion of the light assembly 124. The light source 203 is not limited thereto and may be located at a portion other than a central portion of the light assembly 124.

The light source 203 may emit light by an electric signal. For example, the light source 203 may emit light in a third direction by an electric signal. A direction of the light source 203 is not limited thereto and the light source 203 may emit light in a direction inclined by a predetermined angle from a third direction by an electric signal.

The lens 205 may be located at an upper portion of the light source 203. The lens 205 may have a diameter larger than that of the light source 203. In order words, the lens 205 may have a shape that encloses the light source 203. The lens 205 may change an advancing direction of light emitted from the light source 203 to send light to the display panel. A detailed structure of the lens 205 will be described later.

The lens 205 may be enclosed by the reflection sheet 126. A diameter of an area in which the reflection sheet 126 is not provided on the substrate 122 may be larger than that of the lens 205.

The lens 205 may include a material having a refractive index of 1 to 1.5. For example, the lens 205 may include any one of Poly Methyl Mata Acrylate (PMMA), Cylic Olefin Copolymer (COC), and a combination thereof.

In the light assembly 124 according to the present exemplary embodiment, the light source 203 may be directly located on a printed circuit board 122. Accordingly, the light assembly 124 can have a small size and a light weight.

Referring to FIG. 12, the lens 205 may include a refraction portion 186 and a reflection portion 217. The refraction portion 186 may change an advancing direction of light emitted from a light source to send light to the display panel. The refraction portion 186 may include a convex portion 191 and a side portion 193.

The convex portion 191 may have a hemisphere shape protruded upward. The convex portion 191 may have a convex shape upward. That is, the convex portion 191 may have a diameter reducing as advancing upward. An advancing direction of light may be widely spread while passing through the convex portion 191. Accordingly, light may be uniformly emitted to the display panel while passing through the convex portion 191.

The side portion 193 may be extended in a lower portion of the convex portion 191. The side portion 193 may have the same diameter in an entire portion. That is, the side portion 193 may have a cylindrical shape. Accordingly, it may more conveniently attach the reflection portion 217 to be described later to a lower portion of the side portion 193.

In a central portion of a low surface of the side portion 193, a hemispherical groove 197 may be located. The hemispherical groove 197 may have a shape advancing upward from a central portion of a low surface. The hemispherical groove 197 may have a hemisphere shape that encloses a light source. The hemispherical groove 197 may transfer light applied from the light source to a side surface or an upper surface of the lens 205.

The reflection portion **217** may be extended from a low surface of the side portion **193**. The reflection portion **217** and the refraction portion **186** may be integrally formed. A coupling method of the reflection portion **217** and the refraction portion **186** will be described later.

The reflection portion **217** may have a cylindrical shape extended in the same direction as that of the side portion **193**. A diameter RD of the reflection portion **217** may be smaller than a diameter LD of the side portion **193** of the refraction portion **186**. Accordingly, when a user views the lens **205** attached to the substrate, the reflection portion **217** may not be viewed. Accordingly, the user may feel that the lens **205** has an enhanced external appearance.

The reflection portion **217** may reflect light emitted from the light source to send the reflected light to the refraction portion **186**. Accordingly, the reflection portion **217** may include a material having high reflectivity. In order to improve reflectivity, the reflection portion **217** may have a white surface.

The reflection portion **217** may include a central hole **177**, a pad **231**, and an electrostatic portion **153**. The central hole **177** may have a shape that penetrates a central portion of the reflection portion **217**. Accordingly, due to the central hole **177**, a low surface of the refraction portion **186** may be exposed.

The central hole **177** may be a portion that inserts a light source. Accordingly, a diameter of the central hole **177** may be larger than a width of the light source. A size and location relationship of the central hole **177** will be described later.

The central hole **177** may be a passage that discharges a heat generated in the light source to the outside. When a heat is not discharged by the central hole **177**, a temperature of the light source excessively rises and thus the light source may be deteriorated, light emitting efficiency may be deteriorated, and a life-span of the light source may be reduced.

At an outer edge of the central hole **177**, the pad **231** may be located. For example, at both sides of the central hole **177**, the pads **231** may be located. The pad **231** may have a shape in which a metal is inserted at a low surface of the reflection portion **217**. That is, the pad **231** may have a shape depressed into the reflection portion **217**, and in a depressed portion, a metal may be inserted. In order to use a Surface Mount Technology (SMT) process to be described later, the metal inserted into the pad **231** may include a material having a high melting point. For example, a melting point of the pad **231** may be higher than that of solder cream necessary for a SMT process. The pad **231** may be formed through an insert injection process of the metal.

At one side of a low surface of the reflection portion **217**, the electrostatic portion **153** may be located. For example, the electrostatic portion **153** may be located at the external diameter side of the reflection portion **217**. The electrostatic portion **153** may be a portion that inserts a zener diode. That is, the electrostatic portion **153** is depressed into the reflection portion **217**, and in a depressed portion, the zener diode may be inserted. Accordingly, the electrostatic portion **153** can prevent static electricity from occurring in the light source. That is, the electrostatic portion **153** can prevent Electrostatic Discharge (ESD). As the zener diode is inserted into the reflection portion **217**, each lens **205** may include the zener diode. Accordingly, ESD can be more effectively prevented.

Referring to FIG. **13**, by forming an adhesive layer **350** at a low surface of the side portion **193**, the refraction portion **186** and the reflection portion **217** may be coupled. The adhesive layer **350** may be formed in a portion corresponding to a coupling location of the reflection portion **217**.

The adhesive layer **350** may have a separate thickness. Accordingly, a foreign substance or dust may enter between the refraction portion **186** and the reflection portion **217**. In order to prevent this, the adhesive layer **350** may be protruded further than an outer circumference portion of the reflection portion **217**.

In a display device according to an exemplary embodiment of the present invention, the refraction portion **186** and the reflection portion **217** of the lens **205** may be attached by an adhesive to be integrally formed. Accordingly, luminous efficiency when the refraction portion **186** and the reflection portion **217** are integrally formed may be better than that when the refraction portion **186** and the reflection portion **217** are separately formed.

Referring to FIG. **14**, the lens **205** may be formed by double injection. As shown in FIG. **14**A, by inserting a raw material of the refraction portion **186** between a first upper mold **77** and a first lower mold **75**, the refraction portion **186** may be injection molded. In the first upper mold **77**, a shape of the convex portion **191** may be provided, and in the first lower mold **75**, a shape of the side portion **193** may be provided.

Thereafter, as shown in FIGS. **14**B and **14**C, by separating the first upper mold **77** from the first lower mold **75**, the refraction portion **186** may be formed.

Thereafter, as shown in FIG. **14**D, by inserting the formed refraction portion **186** into a second upper mold **87** and a second lower mold **85**, the reflection portion **217** maybe injection molded. In this case, in the second lower mold **85**, in addition to a shape of the side portion **193**, a shape of the reflection portion **217** having a diameter smaller than that of the side portion **193** may be provided. Accordingly, at a low surface of the side portion **193**, the reflection portion **217** may be formed by an injection process.

In a display device according to an exemplary embodiment of the present invention, the refraction portion **186** and the reflection portion **217** of the lens **205** are integrally formed, thereby having good luminous efficiency. Further, as the lens **205** is formed by a double injection process, a separate thickness may not exist due to an adhesive layer between the refraction portion **186** and the reflection portion **217**. Accordingly, light that gets out to the adhesive layer reduces and thus light emitting efficiency can be further improved.

Referring to FIG. **15**, the pad **231** maybe provided in various shapes at a low surface of the reflection portion **217**.

For example, as shown in FIG. **15**A, the pad **231** may have a circular shape whose central portion is hollow. That is, the pad **231** may have a ring shape that encloses a central hole **177**. In this case, because the pad **231** is located in an entire diameter direction of a low surface of the reflection portion **217**, the lens **205** and the substrate may be more strongly coupled.

For another example, as shown in FIG. **15**B, the pads **231** may be located at both ends of first and second directions of the reflection portion **217**. In this case, the respective pads **231** may couple the lens **205** and the substrate at different locations. Further, a location of the pads **231** maybe distributed. Accordingly, even if one pad **231** is separated, coupling of the lens **205** and the substrate may be maintained.

In the display device according to an exemplary embodiment of the present invention, due to a location change of the pad **231**, a coupling force of the lens **205** and the substrate can be improved.

Referring to FIG. **16**, the reflection portion **217** may have various shapes. For example, a low surface of the reflection

portion **217** may have any one shape of a triangle, quadrangle, and pentagon whose central portion is hollow.

Both an inner portion **217**a and an outer portion **217**b of the reflection portion **217** may have any one shape of a triangle, a quadrangle, and a pentagon. Unlike a case in which a low surface of the reflection portion **217** is a circle, a distance from the center of the reflection portion **217** to the inner portion **217**a of the reflection portion **217** may be different. For example, as shown in FIG. **16**A, a distance HD**1** from the center of the reflection portion **217** to one side of the inner portion **217**a of the reflection portion **217** may be shorter than a distance HD**2** from the center of the reflection portion **217** to an apex of the inner portion **217**a of the reflection portion **217**. In this case, as a distance HD**1** from the center of the reflection portion **217** to the inner portion **217**a of the reflection portion **217** becomes short, light may be further concentrated.

Accordingly, by changing a shape of the reflection portion **217**, in a portion in which a bright point defect occurs, a user may increase a distance from the center of the reflection portion **217** to the inner portion **217**a of the reflection portion **217**. Accordingly, light may be uniformly distributed to the display panel.

Referring to FIG. **17**, as shown in FIG. **17**A, in a display device of the conventional art, the lens **205** may be formed with only the refraction portion **186**. Specifically, in the lens **205**, a support **131** protruded from a low surface of the refraction portion **186** to the outside may be coupled to the substrate **122**. In this case, the support **131** and the substrate **122** are coupled using epoxy **411**. When coupling using the epoxy **411**, a process time may be extended to a long period. Further, because the lens **205** and the substrate **122** are coupled in a short area, there is a problem of a high probability in which the lens **205** may be separated from the substrate **122**.

Alternatively, as shown in FIG. **17**B, in the display device according to an exemplary embodiment of the present invention, the substrate **122** and a metal inserted into the pad **231** may be coupled by an SMT process. That is, a metal inserted into the pad **231** may be coupled to the substrate **122** using solder cream **423**. After the solder cream **423** is injected between the metal inserted into the pad **231** and the substrate **122**, by heating the solder cream **423**, the metal inserted into the pad **231** and the substrate **122** may be coupled.

In the display device according to an exemplary embodiment of the present invention, the lens **205** and the substrate **122** may be coupled using an SMT process. Accordingly, a process time can be reduced, and a coupling force of the lens **205** and the substrate **122** can be strong.

Referring to FIG. **18**, as shown in FIG. **18**A, in a display device at the convention art, at least a portion of light emitted from the light source **203** may pass through without the refraction portion **186**. For example, light emitted from a side surface of the light source **203** may pass through without the refraction portion **186**. The passed light may be absorbed into the substrate **122** or the reflection sheet **126**. Accordingly, a light quantity arriving toward the display panel may be reduced. That is, light efficiency of a backlight unit may be reduced.

Alternatively, as shown in FIG. **18**B, in the display device according to an exemplary embodiment of the present invention, the reflection portion **217** may be located separately from a side surface of the light source **203**, and the refraction portion **186** may be located separately from an upper surface. Accordingly, light emitted to a side surface of the light source **203** is reflected by the reflection portion **217** to advance toward an upper portion of the refraction portion **186**. Accordingly, light of a quantity larger than that of the convention art may advance toward an upper portion of the refraction portion **186**. That is, light efficiency of the backlight unit can be improved.

Referring to FIG. **19**, in the display device according to an exemplary embodiment of the present invention, the inner portion **217**a of the reflection portion **217** may have various shapes.

For example, as shown in FIG. **19**A, the inner portion **217**a of the reflection portion **217** may be concavely inclined. That is, an angle of the inner portion **217**a of the reflection portion **217** from the ground may gradually increase from 0° of a lower surface to 90° of an upper surface. In this case, when an angle of the inner portion **217**a of the reflection portion **217** from the ground gradually increases from 0° of a lower surface to 90° of an upper surface, light advancing toward an upper surface may increase greater than that when an angle of the inner portion **217**a of the reflection portion **217** from the ground is constant. Accordingly, light efficiency of the display device can be further improved.

For another example, as shown in FIG. **19**B, the inner portion **217**a of the reflection portion **217** may be inclined by a constant angle from the ground. In this case, light emitted to a lower portion of a side surface of the light source **203** may be reflected to a central portion of the lens **205** further than light emitted to an upper portion of a side surface of the light source **203**. Light emitted from a side surface of the light source **203** may have a light quantity larger than that of light applied from a side surface of a lower portion as advancing upward. Accordingly, a light quantity of a central portion further increases and thus light efficiency can be enhanced.

For another example, as shown in FIG. **19**C, the inner portion **217**a of the reflection portion **217** may be orthogonal to the ground. In this case, a central hole **177** may have a circular shape. Accordingly, the reflection portion **217** may be more easily produced.

Referring to FIG. **20**, in the display device according to an exemplary embodiment of the present invention, at the inner portion **217**a of the reflection portion **217**, a plurality of protrusions may be located. The protrusions may be convexly protruded toward the central hole **177**.

In the display device according to an exemplary embodiment of the present invention, due to protrusions, light emitted to a side surface of the light source **203** may be irregularly distributed in several directions. Accordingly, because of less light that gets out to the side, while light efficiency is improved, light can be uniformly distributed.

In the present exemplary embodiment, it is shown that protrusions are convexly protruded to the inner portion **217**a of the reflection portion **217**, but the present invention is not limited thereto and the protrusions may be concavely protruded to the inner portion **217**a of the reflection portion **217**.

Referring to FIG. **21**, in the display device according to an exemplary embodiment of the present invention, a relationship between a diameter RD of the reflection portion **217** and a diameter LD of the side portion **193** of the refraction portion **186** may variously change.

For example, as shown in FIG. **21**A, the diameter RD of the reflection portion **217** may be the same as the diameter LD of the side portion **193**. In this case, when a user views the lens **205** attached to the substrate **122**, the reflection portion **217** may not be viewed. Further, because the outside of the reflection portion **217** is extended in a straight line to

the side portion **193**, upon double injection, a mold shape can be simplified. Accordingly, a production process can be more simplified.

For another example, as shown in FIG. **21**B, the diameter RD of the reflection portion **217** may be larger than the diameter LD of the side portion **193**. In this case, a contact area of the lens **205** and the substrate **122** may further increase. Accordingly, the lens **205** and the substrate **122** may be more stably coupled. Further, as the diameter RD of the reflection portion **217** increases, a diameter of the central hole to be described later may be more freely changed.

Referring to FIG. **22**, in the display device according to an exemplary embodiment of the present invention, a diameter IRD of a low surface of the central hole **177** may be variously changed.

For example, as shown in FIG. **22**A, the diameter IRD of a low surface of the central hole **177** may increase much larger than a width of the light source **203**. In this case, in the inner portion **217**a of the reflection portion **217**, only light emitted to a lower end portion of a side surface of the light source **203** may be reflected. Light emitted to an upper portion or an upper end portion of a side surface of the light source **203** may advance to the refraction portion **186**. Light directly advancing to the refraction portion **186** may be widely distributed.

For another example, as shown in FIG. **22**B, the diameter IRD of a low surface of the central hole **177** may be a little larger than a width of the light source **203**. In this case, in the inner portion **217**a of the reflection portion **217**, light emitted from a lower end portion and an upper end portion of a side surface of the light source **203** maybe reflected. Compared with a case in which the diameter IRD of a low surface of the central hole **177** is much larger than a width of the light source **203**, light may be concentrated to an upper portion of the lens **205**.

In the display device according to an exemplary embodiment of the present invention, by adjusting the diameter IRD of a low surface of the central hole **177**, light efficiency may be adjusted. When increasing light efficiency by increasing the diameter IRD of a low surface of the central hole **177** to be a little larger than a width of the light source **203**, even if the number of the lenses **205** located on the substrate **122** is reduced, the same light efficiency can be obtained. Accordingly, a production cost of the display device can be reduced.

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 scope of the principles of this disclosure. More particularly, various 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 backlight unit, comprising:

a substrate; and

at least one light assembly separately located on the substrate,

wherein the light assembly comprises:

a light source; and

a lens configured to shield an upper surface and a side surface of the light source,

wherein the lens comprises:

a **[**refraction**]** *first* portion separately located on the upper surface of the light source, *wherein the first portion refracts light emitted from the light source*; and

a **[**reflection**]** *second* portion separately located at the side surface of the light source, *wherein the second portion changes an advancing direction of light emitted from the light source, and*

wherein the **[**refraction**]** *first* portion comprises:

a convex portion having a hemisphere shape protruded upward; and

a side portion extended from a lower portion of the convex portion, **[**and**]**

wherein a diameter of the **[**reflection**]** *second* portion is smaller than a diameter of the side portion, *and*

wherein the second portion includes an electrostatic portion located at an external side diameter of the second portion.

2. The backlight unit of claim **1**, wherein the **[**refraction**]** *first* portion and the **[**reflection**]** *second* portion are coupled by an adhesive layer.

3. The backlight unit of claim **1**, wherein the **[**refraction**]** *first* portion and the **[**reflection**]** *second* portion are coupled by a double injection process.

4. The backlight unit of claim **1**, wherein the side portion has a cylindrical shape.

5. The backlight unit of claim **4**, wherein the **[**reflection**]** *second* portion has a cylindrical shape.

6. The backlight unit of claim **5**, wherein the side portion includes an annular bottom surface,

wherein the annular bottom surface faces the substrate, and

wherein the annular bottom surface surrounds an upper side of the reflection portion.

7. The backlight unit of claim **1**, wherein the **[**reflection**]** *second* portion *further* comprises:

a central hole configured to penetrate a central portion; *and*

a pad located at an outer edge of the central hole**[**; and

an electrostatic portion located at an external side diameter of the reflection portion**]**.

8. The backlight unit of claim **7**, wherein the pad has a shape depressed into the **[**reflection**]** *second* portion.

9. The backlight unit of claim **8**, wherein in the pad, a metal is inserted into a depressed portion, and

the pad is formed through an insert injection process of the metal.

10. The backlight unit of claim **9**, wherein the metal and the substrate are coupled by a Surface Mount Technology (SMT) process.

11. The backlight unit of claim **7**, wherein the pads are located at both sides of the central hole.

12. The backlight unit of claim **7**, wherein the pad has a ring shape that encloses the central hole.

13. The backlight unit of claim **7**, wherein the electrostatic portion has a shape depressed into the reflection portion, and

a zener diode is inserted into a depressed portion.

14. The backlight unit of claim **7**, wherein the **[**reflection**]** *second* portion has a protrusion therein.

15. The backlight unit of claim **7**, wherein the reflection portion is inclined inward.

16. A display device, comprising:

[the backlight unit of claim **1**;**]**

a display panel located at a front surface of **[**the**]** *a* backlight unit; and

a back cover located at a rear surface of the backlight unit,

wherein the backlight unit comprises:

a substrate; and

at least one light assembly separately located on the substrate,

wherein the light assembly comprises:

a light source; and

a lens configured to shield an upper surface and a side surface of the light source,

wherein the lens comprises:

a first portion separately located on the upper surface of the light source; and

a second portion separately located at the side surface of the light source,

wherein the first portion comprises:

a convex portion having a hemisphere shape protruded upward; and

a side portion extended from a lower portion of the convex portion,

wherein a diameter of the second portion is smaller than a diameter of the side portion, and

wherein the second portion includes an electrostatic portion located at an external side diameter of the second portion.

17. The display device of claim **16**, wherein the **[**refraction**]** *first* portion and the **[**reflection**]** *second* portion are coupled by an adhesive layer.

18. The display device of claim **16**, wherein the **[**refraction**]** *first* portion and the **[**reflection**]** *second* portion are coupled by a double injection process.

19. The display device of claim **16**, wherein the reflection portion is inclined inward.

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