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DISPLAY DEVICE

Abstract

A display device in one example includes a first connection part penetrating from an upper surface of the substrate to a lower surface of the substrate, and a second connection part protruding from the first connection portion to a side surface of the substrate. The second connection part is electrically connected with a driving unit. In addition, each of a plurality of lines is electrically connected with one of first and second driving units and is not electrically connected with the other one of the first and second driving units by a connection part.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Korean Patent Application No. 10-2024-0025185 filed in the Republic of Korea on Feb. 21, 2024, the entire contents of which is hereby expressly incorporated by reference into the present application.

BACKGROUND

Field

[0002] The present disclosure relates to a display device with improved light efficiency.

Discussion of the Related Art

[0003] A display device is widely used as a display screen of a notebook computer, a tablet computer, a smart phone, a portable display device, and a portable information device in addition to a display screen of a television or a monitor. With the advancement of technology, the display device can provide photographing or various sensing functions in addition to an image display function. Accordingly, the display device can include an electronic device such as a camera or a sensor.

[0004] The display device can be a liquid crystal display device, a plasma display panel, an organic light-emitting display device, and the like.

[0005] The display device includes a display panel for displaying an image and a panel driver for driving the display panel. When the display panel and the panel driver are electrically connected with each other on an upper surface of the display panel, a bezel area of the display device can increase. Accordingly, in order to minimize the bezel area of the display device, research on a structure in which the display panel and the panel driver are electrically connected with each other on a side surface of the display panel has recently been conducted.

SUMMARY OF THE DISCLOSURE

[0006] The present disclosure has been made in view of the above noted issues and needs associated with the related art, and it is an object of the present disclosure to provide a display device including a plurality of connection members disposed in a substrate.

[0007] In accordance with an aspect of the present disclosure, the above and other objects can be accomplished by the provision of a display device comprising a line disposed on an upper surface of a substrate, a driving unit disposed on a side surface of the substrate, and a connection part disposed in the substrate, wherein the connection part includes a first connection part penetrating from the upper surface of the substrate to a lower surface of the substrate, and a second connection part protruding from the first connection part to the side surface of the substrate, and the second connection part is in contact with the driving unit to be electrically connected with the driving unit at the side surface of the substrate.

[0008] In addition, in accordance with an aspect of the present disclosure, the above and other objects can be accomplished by the provision of a display device comprising a plurality of lines disposed on an upper surface of a substrate, a first driving unit disposed on a lower surface of the substrate, a second driving unit disposed on a side surface of the substrate, and a connection part disposed in the substrate, wherein each of the plurality of lines is electrically connected with one of the first and second driving units and is not electrically connected with the other by the connection part.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The present disclosure will become more fully understood from the detailed description

given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present disclosure.

[0010] FIG. **1** is a perspective view of a display device according to a first embodiment of the present disclosure.

[0011] FIG. **2** is a plan view of the display device according to the first embodiment of the present disclosure.

[0012] FIG. **3** is a cross-sectional view of the display device according to the first embodiment of the present disclosure.

[0013] FIG. **4** is a cross-sectional view of a display device according to a second embodiment of the present disclosure.

[0014] FIG. **5** is a perspective view of a display device according to a third embodiment of the present disclosure.

[0015] FIG. **6** is a plan view of the display device according to the third embodiment of the present disclosure.

[0016] FIGS. **7** to **9** are cross-sectional views of the display device according to the third embodiment of the present disclosure.

[0017] FIGS. **10**A to **10**F are cross-sectional views illustrating a process of the display device according to the first and second embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0018] Advantages and features of the present disclosure and implementation methods thereof will be clarified through following embodiments described with reference to the accompanying drawings. The present disclosure may, however, be embodied in different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete and will fully convey the scope of the present disclosure to those skilled in the art.

[0019] A shape, a size, a ratio, an angle and a number disclosed in the drawings for describing embodiments of the present disclosure are merely an example and thus, the present disclosure is not limited to the illustrated details. Like reference numerals refer to like elements throughout the disclosure. In the following description, when the detailed description of the relevant known function or configuration is determined to unnecessarily obscure the important point of the present disclosure, the detailed description will be omitted. In a case where ‘comprise’, ‘have’ and ‘include’ described in the present disclosure are used, another portion can be added unless ‘only’ is used. The terms of a singular form can include plural forms unless referred to the contrary.

[0020] In construing an element, the element is construed as including an error band although there is no explicit description.

[0021] In describing a position relationship, for example, when the position relationship is described as ‘upon’, ‘above’, ‘below’ and ‘next to’, one or more portions can be disposed between two other portions unless ‘just’ or ‘direct’ is used.

[0022] It will be understood that, although the terms “first,” “second,” etc. can be used herein to describe various elements, these elements should not be limited by these terms. These terms are only used to distinguish one element from another and may not define order or sequence. For example, a first element could be termed a second element, and, similarly, a second element could be termed a first element, without departing from the scope of the present disclosure.

[0023] Features of various embodiments of the present disclosure can be partially or overall coupled to or combined with each other and can be variously inter-operated with each other and driven technically as those skilled in the art can sufficiently understand. The embodiments of the present disclosure can be carried out independently from each other or can be carried out together in a co-dependent relationship.

[0024] Hereinafter, various embodiments of the present disclosure will be described in detail with reference to the accompanying drawings. All the components of each display device according to

all embodiments of the present disclosure are operatively coupled and configured.

[0025] FIG. **1** is a perspective view of a display device **1000** according to a first embodiment of the present disclosure. Further, FIG. **2** is a plan view of the display device **1000** according to the first embodiment of the present disclosure. FIGS. **1** and **2** illustrate a partial area of the display device **1000**.

[0026] Referring to FIGS. **1** and **2**, the display device **1000** according to the first embodiment of the present disclosure can include a substrate **100**, a plurality of lines **200**, and a driving unit **400**.

[0027] The substrate **100** can be made of glass or plastic, but is not limited thereto. The display device according to an embodiment of the present disclosure can be configured in a top emission type in which the emitted light is emitted upward. Therefore, as the material of the substrate **100**, not only a transparent material but also an opaque material can be used.

[0028] The plurality of lines **200** can be disposed on an upper surface of the substrate **100**. The plurality of lines **200** can be spaced apart from each other along one direction. Further, the plurality of lines **200** can be signal lines such as a gate line, a data line, or a common voltage line. In this case, the plurality of lines **200** can receive signals from the driving unit **400** and transfer signals to a driving element or a light emitting device.

[0029] The driving unit **400** is electrically connected with the plurality of lines **200**, and can apply various signals to the plurality of lines **200**. Further, the driving unit **400** can include a plurality of first driving units **410** and a plurality of second driving units **420**.

[0030] The plurality of first driving units **410** can be disposed in an edge of a lower surface of the substrate **100**. For example, the substrate **100** can be disposed between the plurality of lines **200** and the plurality of first driving units **410**. The plurality of first driving units **410** can be spaced apart from each other in the same direction as the plurality of lines **200**. Further, the plurality of first driving units **410** can be parallel to the plurality of lines **200**. The plurality of first driving units **410** can overlap the plurality of lines **200**. For example, the single first driving unit **410** can overlap the single line **200**, but is not limited thereto. Further, an entire upper surface of the plurality of first driving units **410** can be in contact with the substrate **100**, but are not limited thereto.

[0031] The plurality of second driving units **420** can be disposed on a side surface of the substrate **100**. Among the four side surfaces of the substrate **100**, the side surface of the substrate **100** on which the plurality of second driving units **420** are disposed can be the closest side surface to the plurality of first driving units **420**. Further, the plurality of second driving units **420** can be disposed in the same direction as the plurality of lines **200**. The plurality of second driving units **420** can be perpendicular to the plurality of lines **200**. Further, some areas of the plurality of second driving units **420** can extend in a direction of the lower surface of the substrate **100**. For example, some areas of the plurality of second driving units **420** can overlap side surfaces of the substrate **100**, and the remaining areas may not overlap side surfaces of the substrate **100**. In this case, the plurality of second driving units **420** can face the plurality of first driving units **410**.

[0032] The plurality of first and second driving units **410** and **420** and the plurality of lines **200** can correspond to each other on a one-to-one basis, and can be electrically connected with each other. For example, one line **200** can be electrically connected with one first driving unit **410** and one second driving unit **420**. Further, the number of the plurality of lines **200**, the plurality of first driving units **410**, and the plurality of second driving units **420** can be the same, but is not limited thereto.

[0033] FIG. **3** is a cross-sectional view of the display device **1000** according to a first embodiment of the present disclosure. Specifically, FIG. **3** is a cross-sectional view taken along line A-A′ of FIG. **2**.

[0034] Referring to FIG. **3**, the display device **1000** according to the first embodiment of the present disclosure can include the substrate **100**, the plurality of lines **200**, a light emitting unit **300**, the driving unit **400**, and a plurality of connection parts **500**.

[0035] The substrate **100** can be formed of glass or plastic, but is not limited thereto. The display

device according to an embodiment of the present disclosure can be configured in a top emission type in which the emitted light is emitted upward. Therefore, as the material of the substrate **100**, not only a transparent material but also an opaque material can be used.

[0036] The plurality of lines **200** can be disposed on an upper surface of the substrate **100**. The plurality of lines **200** can be spaced apart from each other along one direction. Further, the plurality of lines **200** can be signal lines such as a gate line, a data line, or a common voltage line.

[0037] The light emitting unit **300** can be disposed on the plurality of lines **200**. The light emitting unit **300** includes a plurality of sub-pixels SP and can emit light. Each sub-pixel SP**1** to SPn of the plurality of sub-pixels SP can include a light emitting device and a plurality of driving elements for driving the light emitting device, where n is a natural number such as an integer greater than 1. The light emitting device of each of the plurality of sub-pixels SP can emit any one of red, green, and blue light. The plurality of driving elements of each of the plurality of sub-pixels SP can include a switching thin film transistor and a driving thin film transistor. In addition, the light emitting unit **300** can further include an encapsulation layer for protecting the plurality of sub-pixels SP.

[0038] The plurality of lines **200** and the plurality of sub-pixels SP can be electrically connected with each other through contact holes. For example, the plurality of lines **200** can transfer signals to light emitting devices and the plurality of driving elements of the plurality of sub-pixels SP. For example, when the plurality of lines **200** include gate lines, the plurality of lines **200** can transfer signals to gate electrodes of the switching thin film transistor or the driving thin film transistor. Alternatively, when the plurality of lines **200** include the common voltage line, the plurality of lines **200** can transfer signals to electrodes of the light emitting devices.

[0039] The driving unit **400** is electrically connected with the plurality of lines **200**, and can apply various signals to the plurality of lines **200**. As described above, the driving unit **400** can include a plurality of first driving units **410** and a plurality of second driving units **420**.

[0040] The plurality of first driving units **410** can be disposed on an edge of a lower surface of the substrate **100**. The plurality of first driving units **410** can include a first connection electrode **411**, a first adhesive layer **412**, a first flexible circuit film **413**, and a first printed circuit board **414**.

[0041] The first connection electrode **411** is disposed on the edge of the lower surface of the substrate **100** and can be in contact with the lower surface of the substrate **100**. The first connection electrode **411** can include a metallic material such as silver (Ag) or carbon (C), but is not limited thereto.

[0042] The first adhesive layer **412** can be disposed on a lower surface of the first connection electrode **411**. Further, the first adhesive layer **412** can physically fix the first flexible circuit film **413** on the first connection electrode **411**. The first adhesive layer **412** can include an organic material having an adhesiveness. For example, the first adhesive layer **412** can include materials such as vinyl acetate, styrene, ethylene-vinyl acetate, styrene-butadiene, polyester, etc., but is not limited thereto.

[0043] The first adhesive layer **412** can include a conductive ball distributed in the organic material. The first connection electrode **411** and the first flexible circuit film **413** can be electrically connected with each other through the conductive ball. The conductive ball can include a metal material such as silver (Ag), copper (Cu), zinc (Zn), indium (In), or the like, but is not limited thereto.

[0044] The first flexible circuit film **413** can be disposed on a lower surface of the first adhesive layer **412**. For example, the first adhesive layer **412** can be disposed between the first connection electrode **411** and the first flexible circuit film **413**. The first flexible circuit film **413** can include a lead wire. The lead wire can be electrically connected with the first connection electrode **411** through the conductive ball of the first adhesive layer **412**.

[0045] The first printed circuit board **414** can be disposed on a lower surface of the first flexible circuit film **413**. For example, the first flexible circuit film **413** can be disposed between the first adhesive layer **412** and the first printed circuit board **414**. The first printed circuit board **414** can be

electrically connected with the lead wire of the first flexible circuit film **413**. For example, the first printed circuit board **414** can apply a signal for driving the plurality of sub-pixels SP through the lead wire of the first flexible circuit film **413**. Further, the first printed circuit board **414** can include a timing controller, a power circuit, a memory element or the like.

[0046] The plurality of second driving units **420** can be disposed on the side surface of the substrate **100**. The plurality of second driving units **420** can include a second connection electrode **421**, a second adhesive layer **422**, a second flexible circuit film **423**, and a second printed circuit board **424**. The plurality of second driving units **420** include the same configuration as the plurality of first driving units **410**, and thus detailed descriptions thereof will be omitted or may be briefly provided. Further, the plurality of first driving units **410** and the plurality of second driving units **420** can supply the same signal, but are not limited thereto.

[0047] The plurality of connection parts **500** can be disposed in the substrate **100** and on the upper surface of the substrate **100**. The plurality of connection parts **500** can transfer signals supplied from the driving unit **400** to the plurality of lines **200**. Accordingly, the signals supplied from the driving unit **400** can be applied to the plurality of sub-pixels SP. Further, the plurality of connection parts **500** can include a metallic material such as copper (Cu), but are not limited thereto.

[0048] Each of the plurality of connection parts **500** can include a first connection part **510**, a second connection part **520**, and a third connection part **530**.

[0049] The first connection part **510** can have a column shape penetrating from the upper surface of the substrate **100** to the lower surface of the substrate **100**. A first region **510***a* of the first connection part **510** can be located in the same plane as the upper surface of the substrate **100**, and a second region **510***b* of the first connection part **510** can be located in the same plane as the lower surface of the substrate **100**. Further, the first region **510***a* of the first connection part **510** can be in contact with a lower surface of the third connection part **530**, and the second region **510***b* of the first connection part **510** can be in contact with the first connection electrode **411**.

[0050] The first and second regions **510***a* and **510***b* of the first connection part **510** can overlap each other, but are not limited thereto. The first connection part **510** is formed in a column shape perpendicular to the upper surface of the substrate **100**, and the first and second regions **510***a* and **510***b* of the first connection part **510** can overlap each other. Alternatively, the first connection part **510** is formed in a column shape forming an acute angle with the upper surface of the substrate **100**, so that the first and second regions **510***a* and **510***b* of the first connection part **510** may not overlap each other.

[0051] The second connection part **520** can have a column shape penetrating a partial region of the substrate **100**. A first region **520***a* of the second connection part **520** can be in contact with a side surface of the first connection part **510**, and a second region **520***b* of the second connection part **520** can be in contact with the second connection electrode **421**. Further, the second region **520***b* of the second connection part **520** can be located in the same plane as the side surface of the substrate **100**. Since the first and second connection parts **510** and **520** are made of the same material, regions in which the first and second connection parts **510** and **520** contact with each other may not be distinguished. For example, the second connection part **520** can have a shape protruding from the side surface of the first connection part **510** to the side surface of the substrate **100**. Also, the first and second connection parts **510** and **520** can be perpendicular to each other.

[0052] The first and second regions **520***a* and **520***b* of the second connection part **520** can overlap each other, but are not limited thereto. The second connection unit **520** can be formed in a column shape perpendicular to the side surface of the substrate **100**, and the first and second regions **520***a* and **520***b* of the second connection unit **520** can overlap each other. Alternatively, the second connection unit **520** can be formed in a column shape forming an acute angle with the side surface of the substrate **100**, and the first and second regions **520***a* and **520***b* of the second connection unit **520** may not overlap each other.

[0053] The third connection part **530** can be disposed on the upper surface of the substrate **100**. An

area of a lower surface of the third connection part **530** can be larger than an area of the first region **510***a* of the first connection part **510**. Further, a portion of the lower surface of the third connection part **530** can be in contact with the first region **510***a* of the first connection part **510**. Since the first and third connection parts **510** and **530** are made of the same material, areas in which the first and third connection parts **510** and **530** contact with each other may not be distinguished. For example, the third connection part **530** can have a shape protruding from the first region **510***a* of the first connection part **510**. Also, the third connection part **530** can cover a partial area of the upper surface of the substrate **100**.

[0054] The plurality of lines **200** can be disposed on the third connection part **530**. The plurality of lines **200** can cover an entire upper surface of the third connection part **530**, but are not limited thereto. The plurality of lines **200** can be in contact with a partial area of the upper surface of the third connection part **530**. Since the plurality of lines **200** and the third connection part **530** are made of a metallic material, the plurality of lines **200** and the third connection part **530** can be electrically connected with each other.

[0055] Accordingly, the signal supplied from the driving unit **400** can be transferred to the plurality of lines **200** through the connection part **500**. Specifically, the signal supplied from the first driving unit **410** can be transferred to the plurality of lines **200** through first and third connection parts **510** and **530**. Further, the signal supplied from the second driving unit **420** can be transferred to the plurality of lines **200** through second and third connection parts **520** and **530**.

[0056] For example, signals supplied from the first and second driving units **410** and **420** can be transferred to the same line **200** through the connection part **500**. In this case, by adjusting the timing of signals supplied from the first and second driving units **410** and **420**, the display device can be driven at a high frequency.

[0057] In addition, when the first and second driving units **410** and **420** supply the same signal, even if any one of the first and second driving units **410** and **420** is not normally driven, the plurality of lines **200** can be normally supplied with the signal. Specifically, even when the first driving unit **410** is not normally driven, the second driving unit **420** can normally supply the signal to the line **200** through the connection part **500**. For example, the signal can be normally supplied to the line **200** even if an additional process such as separating the defective driving unit or connecting the auxiliary driving unit is not performed. Accordingly, the display device can be stably driven.

[0058] FIG. **4** is a cross-sectional view of a display device **1000** according to a second embodiment of the present disclosure.

[0059] Referring to FIG. **4**, the display device **1000** according to the second embodiment of the present disclosure can include the substrate **100**, the plurality of lines **200**, the plurality of light emitting units **300**, the driving unit **400**, and the plurality of connection parts **500**.

[0060] The first embodiment illustrated in FIG. **3** discloses driving by the top emission type, but the second embodiment discloses driving by a double-sided emission type. Specifically, in the structure of the first embodiment illustrated in FIG. **3**, the plurality of lines **200** and the light emitting unit **300** are disposed only on the upper surface of the substrate **100**, but the second embodiment discloses a structure in which the plurality of lines **200** and the light emitting unit **300** are disposed on both the upper surface and the lower surface of the substrate **100**.

[0061] Referring to FIG. **4**, the plurality of lines **200** can include an upper line **210** and a lower line **220**. The upper line **210** can be disposed on the upper surface of the substrate **100**, and the lower line **220** can be disposed on the lower surface of the substrate **100**. The upper and lower lines **210** and **220** can be spaced apart from each other in the same direction. Further, the upper and lower lines **210** and **220** can overlap each other.

[0062] The plurality of light emitting units **300** can include an upper light emitting unit **310** and a lower light emitting unit **320**. The upper light emitting unit **310** can be disposed on the upper line **210**, and the lower light emitting unit **320** can be disposed on the lower line **220**. The upper light

emitting unit **310** can include an upper sub-pixel group SP**1**, and the lower light emitting unit **320** can include a lower sub-pixel group SP**2**. The number of sub-pixels of the upper sub-pixel group SP**1** can be equal to the number of sub-pixels of the lower sub-pixel group SP**2**.

[0063] Each sub-pixel SP**11** to SP**1***n* of the upper sub-pixel group SP**1** can overlap a corresponding one of the sub-pixel SP**21** to SP**2***n* of the lower sub-pixel group SP**2**. In detail, the first sub-pixel SP**11** of the upper sub-pixel group SP**1** can overlap the first sub-pixel SP**21** of the lower sub-pixel group SP**2**. Likewise, the second sub-pixel SP**12** of the upper sub-pixel group SP**1** can overlap the second sub-pixel SP**22** of the lower sub-pixel group SP**2**, and so on.

[0064] In the upper and lower sub-pixel groups SP**1** and SP**2**, the sub-pixels SP overlapping each other can be driven in the same manner. For example, when the first sub-pixel SP**11** of the upper sub-pixel group SP**1** emits red light, the first sub-pixel SP**21** of the lower sub-pixel group SP**2** can also emit red light. Likewise, when the second sub-pixel SP**12** of the upper sub-pixel group SP**1** emits green light, the second sub-pixel SP**22** of the lower sub-pixel group SP**2** can also emit green light. For example, images displayed by the first and second light emitting units **310** and **320** are the same as each other, and can overlap with each other based on the substrate **100**.

[0065] As described above, the plurality of lines **200** and the plurality of sub-pixels SP can be electrically connected with each other through contact holes. For example, the upper line **210** can be electrically connected with the upper sub-pixel group SP**1**, and the lower line **220** can be electrically connected with the lower sub-pixel group SP**2**.

[0066] The driving unit **400** is electrically connected with the plurality of lines **200**, and various signals can be applied to the plurality of lines **200**. The driving unit **400** can be disposed on the side surface of the substrate **100**. As described above, the driving unit **400** can include a connection electrode **401**, an adhesive layer **402**, a flexible circuit film **403**, and a printed circuit board **404**. Since the driving unit **400** disclosed in FIG. **4** includes the same configuration as the second driving unit **420** disclosed in FIG. **3**, a detailed description thereof will be omitted or may be briefly mentioned.

[0067] The plurality of connection parts **500** can be disposed in the substrate **100** and on the upper surface of the substrate **100**. The plurality of connection parts **500** can transfer signals supplied from the driving part **400** to the plurality of lines **200**. Each of a plurality of connection parts **500** can include a first connection part, a second connection part and a third connection part **510**, **520** and **530**.

[0068] The first connection part **510** can have a column shape penetrating from the upper surface of the substrate **100** to the lower surface of the substrate **100**. A first region **510***a* of the first connection part **510** can be located in the same plane as the upper surface of the substrate **100**, and a second region **510***b* of the first connection part **510** can be located in the same plane as the lower surface of the substrate **100**. Further, the first region **510***a* of the first connection part **510** can be in contact with a lower surface of the third connection part **530**, and the second region **510***b* of the first connection part **510** can be in contact with the lower line **220**.

[0069] The second connection portion **520** can have a column shape penetrating a partial region of the substrate **100**. A first region **520***a* of the second connection portion **520** can be in contact with a side surface of the first connection portion **510**, and a second region **520***b* of the second connection part **520** can be in contact with the connection electrode **401**.

[0070] The third connection part **530** can be disposed on the upper surface of the substrate **100**. A portion of a lower surface of the third connection part **530** can be in contact with the first region **510***a* of the first connection part **510**. Further, the upper line **210** can be in contact with the third connection part **530**.

[0071] Accordingly, the signal supplied from the driving unit **400** can be transferred to the plurality of lines **200** through the connection part **500**. In detail, the signal supplied from the driving unit **400** can be transferred to the upper line **210** through first to third connection parts **510** to **530**. Further, the signal supplied from the driving unit **400** can be transferred to the lower line **220** through the

first and second connection parts **510** and **520**. For example, one driving unit **400** can supply the same signal to the upper and lower lines **210** and **220**. Accordingly, the upper and lower light emitting units **310** and **320** can display the same image.

[0072] Since a transparent display device simply transmits the image displayed from one side of the transparent display device to the other side through a transparent substrate, distortion can occur in the image displayed from the other side of the transparent display device.

[0073] On the other hand, the double-sided light emitting display device disclosed in FIG. **4** of the present disclosure displays an image by driving both the upper and lower light emitting units **310** and **320**, and thus a stable image can be displayed in both directions of one side and the other side of the display device.

[0074] FIG. **5** is a perspective view of the display device **1000** according to the third embodiment of the present disclosure. Further, FIG. **6** is a plan view of the display device **1000** according to the third embodiment of the present disclosure. FIGS. **5** and **6** illustrate a partial area of the display device **1000**.

[0075] As described above with reference to FIGS. **1** and **2**, the display device **1000** according to the third embodiment of the present disclosure can include a substrate **100**, a plurality of lines **200**, and a driving unit **400**.

[0076] The driving unit **400** is electrically connected with the plurality of lines **200**, and can apply various signals to the plurality of lines **200**. Further, the driving unit **400** can include a plurality of first driving units **410** and a plurality of second driving units **420**.

[0077] In FIGS. **1** and **2**, one line **200** is electrically connected with both one first driving unit **410** and one second driving unit **420**, but in FIGS. **5** and **6**, one line **200** is electrically connected with one of the first driving unit **410** and the second driving unit **420**. For example, some of the plurality of lines **200** are connected with the first driving unit **410**, are not connected with the second driving unit **420**, and the others are connected with the second driving unit **420**, and are not connected with the first driving unit **410**.

[0078] In FIGS. **5** and **6**, the line **200** connected with the first driving unit **410** and the line connected with the second driving unit **420** are alternately arranged, but are not limited thereto. Further, the line **200** disposed at an odd number from an end of the substrate **100** is connected with the first driving unit **410**, and the line **200** disposed at an even number is connected with the second driving unit **420**, but is not limited thereto. Further, the number of the plurality of lines **200** can be equal to the sum of the number of first and second driving units **410** and **420**, but is not limited thereto.

[0079] Recently, ultra-high-resolution display devices for augmented reality (AR) and virtual reality (VR) have been implemented. Accordingly, since the number of lines is increased while the size of the display device is generally maintained, the distance between adjacent lines can be reduced. In this case, as in the structure of the first embodiment, when the first and second driving units **410** and **420** are arranged to correspond to the plurality of lines **200**, the distance between the first driving units **410** and the second driving units **420** adjacent to each other is also reduced.

[0080] Accordingly, a connection failure may occur between the driving units adjacent to each other. To address this issue, a third embodiment is provided, which will now be described as follows.

[0081] FIG. **7** is a cross-sectional view of the display device **1000** according to a third embodiment of the present disclosure. Specifically, FIG. **7** shows a cross-sectional view taken along line B-B′ of FIG. **6**, where a cross-sectional view of the plurality of lines **200**, the driving unit **400**, and the plurality of connection parts **500** viewed from the side surface of the substrate **100** is illustrated. Further, FIG. **8** is a cross-sectional view of the display device **1000** according to the third embodiment of the present disclosure, and illustrates a cross-sectional view taken along line C-C′ of FIG. **6**. Further, FIG. **9** is a cross-sectional view of the display device **1000** according to the third embodiment of the present disclosure, and illustrates a cross-sectional view taken along line D-D′

of FIG. **6**.
[0082] Referring to FIGS. **7** to **9**, structures of the plurality of connecting parts **500** can be different depending on the connection relationship between the plurality of lines **200** and the driving unit **400**. Accordingly, the plurality of connecting parts **500** can be divided into a first group **500***a* and a second group **500***b*.
[0083] Referring to FIGS. **7** and **8**, the first group **500***a* can electrically connect the plurality of lines **200** with the first driving unit **410**. Each of the first group **500***a* can include a first connection part **510** and a third connection part **530**.
[0084] A first region **510***a* of the first connection part **510** can be located in the same plane as the upper surface of the substrate **100**, and a second region **510***b* of the first connection part **510** can be located in the same plane as the lower surface of the substrate **100**. Further, the first region **510***a* of the first connection part **510** can be in contact with a lower surface of the third connection part **530**, and the second region **510***b* of the first connection part **510** can be in contact with the first connection electrode **411**. Accordingly, some of the plurality of lines **200** can be electrically connected with the first driving unit **410**.
[0085] Referring to FIGS. **7** and **9**, the second group **500***b* can electrically connect the plurality of lines **200** with the second driving unit **420**. Each of the second group **500***b* can include first to third connection parts **510** to **530**.
[0086] The first region **510***a* of the first connection part **510** can be located in the same plane as the upper surface of the substrate **100**, and the second region **510***b* of the first connection part **510** can be located inside the substrate **100**. For example, the second region **510***b* of the first connection part **510** may not be exposed to the outside. Further, the first region **510***a* of the first connection part **510** can be in contact with a lower surface of the third connection part **530**.
[0087] The second connection portion **520** can have a column shape penetrating a partial area of the substrate **100**. A first region **520***a* of the second connection portion **520** can be in contact with a side surface of the first connection portion **510**, and a second region **520***b* of the second connection portion **520** can be in contact with the second connection electrode **421**. Accordingly, some of the plurality of lines **200** can be electrically connected with the second driving unit **420**.
[0088] FIGS. **7** and **9** show that the second connection part **520** is disposed at a position adjacent to the second region **510***b* of the first connection part **510**, but the present disclosure is not limited thereto.
[0089] As a result, the signal supplied from the first driving unit **410** through the first group **500***a* of the plurality of connection parts **500** can be transferred to some of the plurality of lines **200**. Further, the signal supplied from the second driving unit **420** through the second group **500***b* of the plurality of connection parts **500** can be transferred to some of the plurality of lines **200**.
[0090] Accordingly, even if the distance between adjacent lines decreases, it is possible to prevent (or minimize) a connection failure between adjacent driving units **400**, and stably connect the plurality of lines **200** with the first and second driving units **410** and **420**.
[0091] FIGS. **10**A to **10**F are cross-sectional views illustrating a process of the display device according to the first and second embodiments of the present disclosure. In particular, a process of the plurality of connection parts **500** according to the first and second embodiments of the present disclosure is illustrated.
[0092] Referring to FIG. **10**A, a first hole H**1** and a second hole H**2** can be formed in a substrate **100** using a laser. The first hole H**1** can be formed to penetrate from an upper surface of the substrate **100** to a lower surface of the substrate **100**. Further, the second hole H**2** can be formed to reach an area in which the first hole H**1** is formed from a side surface of the substrate **100**. For example, the first and second holes H**1** and H**2** can be connected with each other in the substrate **100**. A diameter of the cross-sections of the first and second holes H**1** and H**2** can be a first width W**1**. Further, in FIG. **10**A, the cross-sections of the first and second holes H**1** and H**2** are circular, but are not limited thereto.

[0093] FIG. **10**B is a cross-sectional view taken along line E-E′ of FIG. **10**A. Referring to FIG. **10**B, a size of the first and second holes H**1** and H**2** can be increased through an etching process. Accordingly, the diameter of the cross-sections of the first and second holes H**1** and H**2** can be a second width W**2** greater than the first width W**1**.
[0094] Referring to FIG. **10**C, a metal material M can be plated on the substrate **100** to fill the first and second holes H**1** and H**2** of the substrate **100**. The metal material M can be copper (Cu), but is not limited thereto. The metal material M can cover both an upper surface and a side surface of the substrate **100**. Further, an inside of the first and second holes H**1** and H**2** can be filled with the metal material M. Also, the metal material M can have fluidity so that the metal material M can be filled in the first and second holes H**1** and H**2** of the substrate **100**.
[0095] Referring to FIG. **10**D, after a photoresist PR is formed on the metal material M plated on the upper surface of the substrate **100**, an etching process can be performed. The photoresist PR can be disposed at a position overlapping the first hole H**1**. Further, an area of a lower surface of the photoresist PR can be larger than an area of the cross section of the first hole H**1**. For example, the metal material M plated in the first hole H**1** may not be etched by the photoresist PR.
[0096] By the etching process, the metal material M plated on the upper surface of the substrate **100** can be removed as illustrated in FIG. **10**E. Further, the metal material M plated on the area overlapping the photoresist PR can remain plated. For example, the metal material M plated on a partial region of the upper surface of the substrate **100** remains and can cover the upper surface of the first hole H**1**. Also, since the area of the lower surface of the photoresist PR is larger than the area of the cross section of the first hole H**1**, an area of a lower surface of a remaining metal material M can also be larger than the area of the cross section of the first hole H**1**. In this case, the remaining metal material M can function as a third connection part **530** later, and the metal material M filling the inside of the first hole H**1** can function as a first connection part **510**. For example, an area of a lower surface of the third connection part **530** can be larger than an area of an upper surface of the first connection part **510**.
[0097] Referring to FIG. **10**E, a scribing process can be performed. Specifically, a partial area of the substrate **100** can be removed along a trimming line Trim. Accordingly, the metal material M plated on the side surface of the substrate **100** and an edge area of the substrate **100** can be removed.
[0098] Referring to FIG. **10**F, the side surface of the substrate **100** can be non-uniform due to the scribing process, and thus a grinding process can be performed. Accordingly, since the side surface of the substrate **100** in which the second hole H**2** formed has a uniform surface, a driving unit to be disposed on the side surface of the substrate **100** later can be stably attached. In conclusion, a connection part **500** including first to third connection parts **510** to **530** can be formed.
[0099] As mentioned above, FIGS. **10**A to **10**F illustrate the process of the display device according to the first and second embodiments of the present disclosure, but referring to this, a process of the display device according to the third embodiment can be started. Specifically, the first hole H**1** can be formed from the upper surface of the substrate **100** to a specific point of the inside of the substrate **100**, and the second hole H**2** can be formed from the side surface of the substrate **100** to the area in which the first hole H**1** is formed. Thereafter, the metal material M can be plated to fill the first and second holes H**1** and H**2** of the substrate **100**.
[0100] According to the present disclosure, the following advantageous effects can be obtained.
[0101] According to the present disclosure, the plurality of light conversion layers can be formed so that light efficiency can be improved, and reflectance due to external light can be reduced.
[0102] It will be apparent to those skilled in the art that the present disclosure described above is not limited by the above-described embodiments and the accompanying drawings and that various substitutions, modifications and variations can be made in the present disclosure without departing from the spirit or scope of the disclosures. Consequently, the scope of the present disclosure is defined by the accompanying claims and it is intended that all variations or modifications derived

from the meaning, scope and equivalent concept of the claims fall within the scope of the present disclosure.

Claims

1. A display device comprising: a line disposed on an upper surface of a substrate; a driving unit disposed on a side surface of the substrate; and a connection part disposed in the substrate, wherein the connection part includes a first connection part penetrating from the upper surface of the substrate to a lower surface of the substrate, and a second connection part protruding from the first connection part to the side surface of the substrate, and the second connection part is in contact with the driving unit to be electrically connected with the driving unit at the side surface of the substrate.
2. The display device of claim 1, wherein the first connection part includes: a first region located in a same plane as the upper surface of the substrate, and a second region located in a same plane as the lower surface of the substrate.
3. The display device of claim 2, wherein the connection part includes a third connection part disposed on the upper surface of the substrate, the third connection part is in contact with the first region of the first connection part, and the line is in contact with the third connection part.
4. The display device of claim 3, wherein an area of a lower surface of the third connection part is larger than an area of the first region of the first connection part.
5. The display device of claim 2, wherein the driving unit includes a first driving unit disposed on the lower surface of the substrate and a second driving unit disposed on the side surface of the substrate, the first connection part is in contact with the first driving unit, and the second connection part is in contact with the second driving unit.
6. The display device of claim 5, wherein the line is electrically connected with both the first and second driving units.
7. The display device of claim 3, wherein the line includes an upper line disposed on the upper surface of the substrate and a lower line disposed on the lower surface of the substrate, the upper line is in contact with the third connection part, and the lower line is in contact with the second region of the first connection part.
8. The display device of claim 7, wherein the driving unit is electrically connected with both the upper line and the lower line.
9. The display device of claim 7, further comprising: an upper sub-pixel group composed of sub-pixels and disposed on the upper line; and a lower sub-pixel group composed of sub-pixels and disposed on the lower line, wherein each sub-pixel of the upper sub-pixel group and one sub-pixel of the lower sub-pixel group overlap each other.
10. The display device of claim 9, wherein when a first sub-pixel of the upper sub-pixel group and a second sub-pixel of the lower sub-pixel group overlap each other, and the first and second sub-pixels emit lights with a same color.
11. A display device comprising: a plurality of lines disposed on an upper surface of a substrate; a first driving unit disposed on a lower surface of the substrate; a second driving unit disposed on a side surface of the substrate; and a connection part disposed in the substrate, wherein each of the plurality of lines is electrically connected with one of the first and second driving units and is not electrically connected with the other of the first and second driving units by the connection part.
12. The display device of claim 11, wherein the connection part includes a first group and a second group, the first group and the second group having different shapes from each other, and some of the plurality of lines are electrically connected with the first driving unit through the first group, and the others of the plurality of lines are electrically connected with the second driving unit through the second group.
13. The display device of claim 12, wherein the first group includes a first connection part

penetrating from an upper surface of the substrate to the lower surface of the substrate, and at the lower surface of the substrate, the first connection part and the first driving unit are in contact with each other.

14. The display device of claim 12, wherein the second group includes a first connection part and a second connection part, both the first and second connection parts penetrating a partial area of the substrate, the first connection part includes a first region located in a same plane as the upper surface of the substrate and a second region disposed in the substrate, the second connection part protrudes from the first connection part to the side surface of the substrate, and on the side surface of the substrate, the second connection part and the second driving unit are in contact with each other.

15. The display device of claim 12, wherein the line electrically connected with the first driving unit and the line electrically connected with the second driving unit are alternately arranged.

16. The display device of claim 12, wherein the line electrically connected with the first driving unit overlaps the first driving unit, and the line electrically connected with the second driving unit does not overlap the first driving unit.