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(54) **FLEXIBLE DISPLAY SUBSTRATE AND PREPARATION METHOD THEREFOR, AND FLEXIBLE DISPLAY DEVICE**

(57) The present invention provides a flexible display substrate and a manufacturing method thereof, and a flexible display device, and belongs to the field of flexible display technology. The present invention can solve the problem that the display structure in the existing flexible display substrate is likely to be damaged at the time of laser lift-off. The flexible display substrate of the present invention comprises: a flexible base and a display structure, and a reflective layer provided between the flexible base and the display structure. The manufacturing method

of a flexible display substrate of the present invention comprises: forming a flexible material layer on a base; forming a reflective layer on the flexible material layer; forming a display structure; separating the flexible material layer from the base by means of laser lift-off to obtain the flexible display substrate. The present invention is applicable to flexible display devices, particularly to a top-emitting type organic light emitting diode display device and a flexible array substrate with a low-temperature polysilicon thin film transistor.

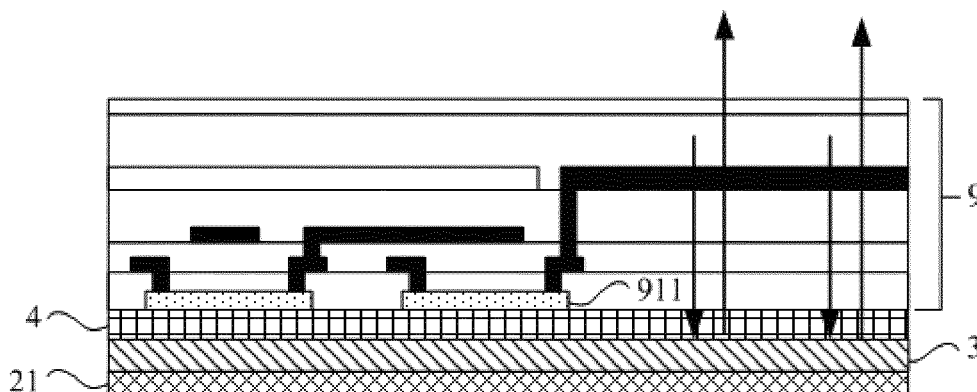


Fig. 3

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## Description

### FIELD OF THE INVENTION

**[0001]** The present invention belongs to the field of flexible display technology, and particularly relates to a flexible display substrate and a manufacturing method thereof, and a flexible display device.

### BACKGROUND OF THE INVENTION

**[0002]** With the development of technology, flexible display devices have been more and more widely applied. The flexible display devices include different types of organic light emitting diode display devices, electrophoretic display devices, and the like. Obviously, a base of a display substrate (for example, a flexible array substrate of a flexible organic light emitting diode display device) of the flexible display device must be a flexible base, and the flexible base is primarily made of organic materials such as polyimide, polyethylene terephthalate, and the like.

**[0003]** As the flexible base is susceptible to deformation, in the manufacturing process of the display substrate, the flexible base is rather difficult to be located, carried, and stored. For this reason, as shown in Figs. 1 and 2, generally, a flexible material layer 2 is first formed on a glass base 1, and a buffer layer 4 and a display structure 9 are then formed successively (taking a flexible organic light emitting diode display device as an example, including a thin film transistor, a data line, a gate line, a capacitor, an anode, a cathode, an organic light emitting layer, a pixel defining layer, and the like, which are not labeled in drawings as they are known structures) on the flexible material layer 2. Then, the flexible material layer 2 is irradiated from a side of the glass base 1 with ultraviolet laser light, causing the adhesive force between the flexible material layer 2 and the glass base 1 to be reduced so that the flexible material layer is separated from the glass base 1 (i.e., laser lift-off) to form a separate flexible display substrate (at this time, the flexible material layer 2 becomes the flexible base 21).

**[0004]** Meanwhile, the flexible array substrate includes multiple display units arranged in an array form. These display units usually include thin film transistors, and low-temperature polysilicon thin film transistor is an important type of the thin film transistors, an active region 911 of which is constituted by polysilicon. A method for manufacturing the active region 911 includes: first, forming an amorphous silicon layer; then, irradiating the amorphous silicon layer from a side away from the glass base 1 with ultraviolet laser light (excimer laser light), allowing the amorphous silicon to be molten, nucleated, and grown by means of excimer laser annealing (ELA) to be transformed into polysilicon; and then, forming the active region 911 with the polysilicon layer.

**[0005]** The inventor has found that there are at least the following problems in the prior art.

**[0006]** First, in the process of laser lift-off, part of laser light may pass through the flexible material layer to be irradiated on the display structure, thereby having an influence on the performance of the display structure; for example, if the laser light is irradiated on the active region of the thin film transistor (particularly metal oxide thin film transistor), defects such as threshold voltage shift and the like will be caused.

**[0007]** Second, for the array substrate having low-temperature polysilicon thin film transistors, in its laser annealing process, the laser light may pass through the amorphous silicon layer to be irradiated on the flexible material layer, thereby degrading the performance of the flexible material layer, for example causing the flexible material layer to be carbonized or separated from an adjacent layer (for example, a buffer layer), and the like.

### SUMMARY OF THE INVENTION

**[0008]** In view of the problem that display structures in the existing flexible display substrates are likely to be damaged at the time of laser lift-off, the present invention provides a flexible display substrate and a manufacturing method thereof, and a flexible display device that can protect the display structures against damage in laser lift-off.

**[0009]** A technical solution employed to solve the technical problem of the present invention is a flexible display substrate, including a flexible base and a display structure, and a reflective layer provided between the flexible base and the display structure.

**[0010]** The "display structure" refers to all structures formed above the reflective layer and used for displaying. According to the types of flexible display substrates, the display structure may include: a thin film transistor, a gate line, a gate insulating layer, a data line, a planarizing layer (PLN), a passivation layer (PVX), a capacitor, an anode, a cathode, an organic light emitting layer, a pixel defining layer (PDL), a color filter film, and the like.

**[0011]** Preferably, the reflective layer is a metal reflective layer; and a buffer layer is further provided between the reflective layer and the display structure.

**[0012]** Further preferably, the metal reflective layer is made of aluminum.

**[0013]** Further preferably, the thickness of the metal reflective layer is between 150 nm and 300 nm.

**[0014]** Preferably, the reflective layer is provided with an opening at a position corresponding to an alignment mark.

**[0015]** Preferably, the flexible base is made of an organic flexible material.

**[0016]** Preferably, the display structure includes a plurality of display units arranged in an array form; and the display unit includes a low-temperature polysilicon thin film transistor.

**[0017]** Preferably, the display structure includes a plurality of display units arranged in an array form; and the

display units are top-emitting type organic light emitting diode display units.

**[0018]** A technical solution employed to solve the technical problem of the present invention is a flexible display substrate, including the above flexible display substrate.

**[0019]** A technical solution employed to solve the technical problem of the present invention is a manufacturing method of a flexible display substrate, including:

forming a flexible material layer on a base;  
forming a reflective layer on the flexible material layer;  
forming a display structure; and  
separating the flexible material layer from the base by means of laser lift-off to obtain the flexible display substrate.

**[0020]** Preferably, the reflective layer is a metal reflective layer; and between the step of forming the metal reflective layer and the step of forming a display structure, the method further includes: forming a buffer layer on the metal reflective layer.

**[0021]** Preferably, the metal reflective layer is made of aluminum, and formed by a vacuum evaporating process; and parameters for the vacuum evaporating process are as follows: the evaporation rate is greater than or equal to 40 nm/s, the evaporation air pressure is less than or equal to  $1.3 \times 10^{-4}$  Pa, and the thickness to be evaporated is between 150 nm and 300 nm.

**[0022]** Preferably, between the step of forming the reflective layer and the step of forming a display structure, the method further includes: forming an opening in the reflective layer at a position corresponding to an alignment mark.

**[0023]** Preferably, the display structure includes a plurality of display units arranged in an array form, and the display unit includes a low-temperature polysilicon thin film transistor; the step of forming a display structure includes: forming an amorphous silicon layer; and transforming the amorphous silicon layer into a polysilicon layer by laser annealing.

**[0024]** In the flexible display substrate and the manufacturing method thereof, and the flexible display device of the present invention, a reflective layer is provided between the flexible base (the flexible material layer) and the display structure, and thus, during the laser lift-off, the laser light passing through the flexible material layer may be reflected back by the reflective layer, to prevent the laser light from irradiating towards the display structure including the thin film transistor, further to protect the display structure against damage.

**[0025]** At the same time, the reflective layer is preferably a metal material. The metal material layer always has good water and oxygen isolation performance, and it may thus prevent moisture, oxygen, and the like from contacting the display structure, to protect (similar to packaging) the display structure.

**[0026]** In addition, for the flexible array substrate hav-

ing a low-temperature polysilicon thin film transistor, during the laser annealing, the laser light passing through the amorphous layer also may be reflected back by the reflective layer, to protect the flexible material layer against damage.

**[0027]** The present invention is applicable to flexible display devices, particularly to flexible top-emitting type organic light emitting diode display devices and flexible array substrates with low-temperature polysilicon thin film transistors.

## BRIEF DESCRIPTION OF THE DRAWINGS

### **[0028]**

Fig. 1 is a sectional structure diagram of an existing flexible display substrate;

Fig. 2 is a sectional structure diagram of an existing flexible display substrate during laser lift-off in the manufacturing process;

Fig. 3 is a sectional structure diagram of a flexible display substrate according to Embodiment 1 of the present invention;

Fig. 4 is a graph of absorption spectrum and reflection spectrum of aluminum;

Fig. 5 is a top structure diagram of the flexible display substrate with an alignment opening provided on the reflective layer in the manufacturing process according to Embodiment 1 of the present invention;

Fig. 6 is a sectional structure diagram of the flexible display substrate during laser annealing in the manufacturing process according to Embodiment 1 of the present invention;

Fig. 7 is a sectional structure diagram of a flexible display substrate during laser lift-off in the manufacturing process according to Embodiment 1 of the present invention;

in which, reference numerals:

1. glass base;
2. flexible material layer;
21. flexible base;
3. reflective layer;
31. opening;
4. buffer layer;
8. alignment mark;
9. display structure;
91. amorphous silicon layer;
911. active region.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

**[0029]** In order to make a person skilled in the art better understand technical solutions of the present invention, the present invention will be further described in details below in conjunction with the accompanying drawings and specific implementation.

Embodiment 1:

**[0030]** As shown in Figs. 3 to 7, this embodiment provides a flexible display substrate, including:

- a flexible base 21;
- a reflective layer 3 provided on the flexible base 21;
- and
- a display structure 9 provided above the reflective layer 3;

**[0031]** The "display structure 9" refers to all structures formed above the reflective layer 3 and used for displaying. According to types of flexible display substrates, the display structure 9 may include: a thin film transistor, a gate line, a gate insulating layer, a data line, a planarizing layer (PLN), a passivation layer (PVX), a capacitor, an anode, a cathode, an organic light emitting layer, a pixel defining layer (PDL), a color filter film, and the like.

**[0032]** In the flexible display substrate of this embodiment, the reflective layer 3 is provided between the flexible base 21 and the display structure 9. Thus, as shown in Fig. 7, in the laser lift-off, the laser light passing through the flexible material layer 2 may be reflected back by the reflective layer 3, to prevent laser light from irradiating on the display structure 9 including the thin film transistor and the like, thereby preventing the performance of the display structure 9 from being influenced. Meanwhile, metal reflective layer always has good water and oxygen isolation performance, and it may thus prevent moisture, oxygen, and the like from contacting the display structure 9, to play role in protecting the display structure 9.

**[0033]** Preferably, this embodiment takes the array substrate of the flexible top-emitting type organic light emitting diode display device as an example of the flexible display substrate. That is, the display structure in the flexible display substrate includes multiple display units arranged in an array form, and the display units are top-emitting type organic light emitting diode display units which include a driving circuit (a switch thin film transistor, a driving thin film transistor, a capacitor and the like), a gate line, a data line, a cathode, an anode, an organic light emitting layer, a pixel defining layer, and the like, and which emit light from a side away from the flexible base 21.

**[0034]** As shown in Fig. 3, the reflective layer 3 may reflect back light emitted by the organic light emitting layer and irradiated towards the flexible base 21, thus improving the light extraction efficiency of the flexible display substrate. In addition, the flexible display substrate is preferably a flexible array substrate including multiple display units arranged in an array form, and each display unit usually includes a thin film transistor, an active region 911 of which (particularly metal oxide thin film transistor) is a display structure 9 which is most likely to be influenced in the laser lift-off process. Therefore, the reflective layer 3 may protect the array substrate to the largest extent.

**[0035]** Preferably, for the flexible array substrate (not limited to application in organic light emitting diode display devices), a low-temperature polysilicon thin film transistor is preferably used. That is, the active region 911 of the thin film transistor is made of a low-temperature polysilicon material.

**[0036]** For the low-temperature polysilicon thin film transistor, the active region 911 made of polysilicon is formed by: first, forming an amorphous silicon layer 91, and transforming the amorphous silicon layer 91 into a polysilicon layer by laser annealing. During the laser annealing, part of laser light may pass through the amorphous silicon layer 91 to damage the flexible base 21. Here, the reflective layer 3 may also reflect the laser light back, to protect the flexible base 21 against damage during the laser annealing.

**[0037]** Of course, it should be understood that the thin film transistor in the flexible display substrate of the present invention is not limited to the low-temperature polysilicon thin film transistor.

**[0038]** Preferably, the flexible base 21 is made of organic flexible material, more preferably, polyimide or polyethylene terephthalate, because the flexible base 21 made of an organic flexible material is more frequently used due to its mature technology. In addition, the present invention is particularly applicable to a flexible base 21 made of organic flexible material, because the organic flexible material is more likely to be damaged by laser light. Of course, a flexible base 21 made of inorganic materials such as stainless steel is also feasible.

**[0039]** Preferably, the reflective layer 3 is a metal reflective layer, and a buffer layer 4 is also provided between the reflective layer 3 and the display structure 9.

**[0040]** Metal, as a most common reflective material, is low in cost and is not likely to be damaged by laser light; and the process of evaporating metal to form a thin film is very mature, therefore, the reflective layer 3 is preferably made of a metal material.

**[0041]** Furthermore, as the metal material is conductive, a buffer layer 4 is required to be further formed on the metal material when the metal material is used for manufacturing the reflective layer 3, to prevent the metal reflective layer from directly conducting the display structure 9 including the active region 911, the gate line, the data line and the like.

**[0042]** The buffer layer 4 may be made of known inorganic materials such as silicon nitride (SiN<sub>x</sub>) and silicon oxide (SiO<sub>2</sub>) and may have a thickness of preferably 250 nm to 400 nm. In addition to insulating, the buffer layer 4 may also reduce the surface roughness, and improve the bonding between the display structure 9 and the flexible base 21, and the like. A buffer layer 4 exists in the conventional display substrate, and thus will not be described in detail here.

**[0043]** Of course, it should be understood that the reflective layer 3 may also be made of other non-conductive materials (for example, a reflective layer made of a polymer material). In this case, the buffer layer 4 may be

omitted.

**[0044]** Further preferably, the metal reflective layer is made of aluminum.

**[0045]** Ultraviolet laser light having a wavelength of 308 nm is usually used in processes such as laser lift-off, laser annealing. Among the frequently used metal materials, aluminum has a high reflection index to light within the wavelength range of the ultraviolet light (its reflection/absorption curve is as shown in Fig. 4). Therefore, the reflective layer 3 may be made of aluminum preferably. It can be seen from Fig. 4 that aluminum material has a high reflection index (corresponding to the reflection index coordinates on the left side) and a high absorptivity (corresponding to the absorptivity coordinates on the right side) to light within the wavelength range (4 nm to 380 nm) of the ultraviolet light, so that ultraviolet rays may be prevented from passing through to the largest extent.

**[0046]** Of course, it should be understood that it is possible to make the metal reflective layer from other metals or alloys having a high reflection index to the ultraviolet range (ultraviolet light), for example, rhodium (Rh) also has a high reflection index to the ultraviolet range. Furthermore, the use of conventional metals (having a low reflection index to the ultraviolet range) such as copper and silver is possible.

**[0047]** Further preferably, the thickness of the metal reflective layer (aluminum reflective layer as an example) is 150 nm to 300 nm.

**[0048]** Apparently, the larger the thickness of the reflective layer 3 is, the better the reflective effect of the reflective layer 3 is. However, a too large thickness of the reflective layer 3 will cause reduced flexibility, reduced adhesive force and increased cost and the like. It has been proved by studies that, for the metal reflective layer, the above thickness range not only may result in good reflective effect but also will not produce adverse influence on other performances.

**[0049]** Preferably, as shown in Fig. 5, the reflective layer 3 is provided with an opening 31 at a position corresponding to an alignment mark 8.

**[0050]** In the manufacturing process of the display substrate, the patterning process, IC bonding process and other steps require accurate alignment. A common alignment method is to perform alignment by providing an alignment mark 8 in an abutment supporting the glass substrate 1 so that this alignment mark 8 may be seen through the flexible material layer 2 and the like (because these layers are transparent). Whereas in this embodiment, the reflective layer 3 is opaque and will thus block the alignment mark 8 so that it cannot be seen. Therefore, it is necessary to provide an opening 31 at a position in the reflective layer 3 corresponding to the alignment mark 8.

**[0051]** This embodiment further provides a flexible display device including the above flexible display substrate.

**[0052]** The flexible display device of this embodiment further comprises, in addition to the above flexible display

substrate, other structures such a packing substrate, the flexible display device is preferably a flexible top-emitting type organic light emitting diode display device. Of course, other types of flexible display devices are possible.

**[0053]** This embodiment further provides a manufacturing method of the above flexible display substrate, including the following steps.

**[0054]** S01: A base is prepared.

10 **[0055]** This base may be a conventional hard base, like a glass base 1.

**[0056]** S02: A flexible material layer 2 is formed on the base.

15 **[0057]** This flexible material layer 2 is preferably an organic flexible material layer 2, for example, a layer made of polyimide or polyethylene terephthalate.

**[0058]** This flexible material layer 2 may be manufactured by conventional methods such as coating, and in the subsequent laser lift-off step, the flexible material layer 2 will be separated from the glass base 1 to become the flexible base 21 of the flexible display substrate.

**[0059]** S03: A reflective layer 3 is formed on the flexible material layer 2.

20 **[0060]** Preferably, this reflective layer 3 is a metal reflective layer, and further preferably an aluminum reflective layer.

**[0061]** For the metal reflective layer, it is preferably manufactured by a vacuum evaporation method.

**[0062]** Specifically, as for the aluminum reflective layer, parameters of its vacuum evaporation process are preferably as follows: the evaporation rate is greater than or equal to 40 nm/s, the evaporation air pressure is less than or equal to  $1.3 \times 10^{-4}$  Pa, and the thickness to be evaporated is between 150 nm and 300 nm.

25 **[0063]** Since aluminum is likely to be oxidized during the evaporation to form aluminum oxide, a high evaporation speed and a low evaporation air pressure are preferred to reduce the oxidization.

**[0064]** Of course, for a reflective layer 3 made of other materials, it may be manufactured by other methods such as affixing.

**[0065]** S04: Preferably, as shown in Fig. 5, an opening 31 is formed at a position of the reflective layer 3 corresponding to an alignment mark 8.

30 **[0066]** That is to say, the opening 31 is formed at the position of the reflective layer 3 corresponding to the alignment mark 8 (which may be formed in an abutment forming the glass base 1) by a patterning process, to expose the alignment mark 8, for the purpose of alignment in the subsequent steps.

**[0067]** S05: Preferably, a buffer layer 4 is formed on the metal reflective layer.

**[0068]** When the reflective layer 3 is a metal reflective layer, to prevent the reflective layer from conducting all parts in the display structure 9, it is necessary to form the buffer layer 4 which has a function of insulating on the reflective layer 3.

**[0069]** The buffer layer 4 is usually an inorganic layer

made of known materials such as silicon nitride and silicon oxide (for example, made of mixed materials of silicon nitride and silicon oxide), and has a thickness of 250 nm to 400 nm. The buffer layer may be manufactured by plasma enhanced chemical vapor deposition (PECVD), and the reaction gas used in the deposition may be a mixed gas of SiH<sub>4</sub>, NH<sub>3</sub> and N<sub>2</sub>, or a mixed gas of SiH<sub>4</sub>, NO<sub>2</sub> and N<sub>2</sub>.

[0070] The material, thickness, manufacturing process and the like of the buffer layer 4 will not be described here since they are well known.

[0071] Of course, if the reflective layer 3 is made of a non-conductive material, the step of forming the buffer layer 4 may be omitted (of course, it may be formed to improve the bonding performance of the display structure 9).

[0072] S06: Preferably, an amorphous silicon layer 91 is formed.

[0073] The amorphous silicon layer 91 may be formed by chemical vapor deposition and may have a thickness of preferably 40 nm to 60 nm.

[0074] S07: Preferably, as shown in Fig. 6, the amorphous silicon layer 91 is transformed to a polysilicon layer by laser annealing (excimer laser annealing).

[0075] The laser light used in the laser annealing is preferably ultraviolet laser light, and most preferably has a wavelength of 308 nm.

[0076] As shown in Fig. 6, in the laser annealing process, due to the presence of the reflective layer 3, laser light passing through the amorphous silicon layer 91 will be reflected back by the reflective layer 3, instead of being irradiated on the flexible material layer 2, so that no damage is produced to the flexible material layer 2.

[0077] The active region 911 of the thin film transistor manufactured according to the method of the embodiment is close to the buffer layer 4. That is, such a thin film transistor belongs to a "top-gate type thin film transistor". However, apparently, bottom-gate type thin film transistors are also applicable to the present invention, the difference is that, during manufacturing the bottom-gate type thin film transistor, it is necessary to form structures such as the gate/gate line and the gate insulating layer first and then manufacture the amorphous silicon layer 91.

[0078] It should be understood that, it is possible to use other types of thin film transistors such as a metal oxide thin film transistor in the flexible array substrate manufactured according to the method of the embodiment. In this case, it is only required to form the metal oxide layer, and no laser annealing is required.

[0079] S08: Other parts of the display structure 9 are formed continuously.

[0080] Specifically, this step may include: forming an active region 911 from a polysilicon layer by a patterning process, and continuously forming a gate insulating layer, a gate/gate line, a source/a drain, a passivation layer, a data line, a planarizing layer, an anode, a pixel defining layer, an organic light emitting layer, a cathode, a color

filter film and the like.

[0081] Apparently, the specific type, structure and position of the display structure 9 formed in this step, and the processes, order and parameters and the like used for forming the various display structure 9 are different according to types of the flexible display substrates. Those belong to the known technologies and will not be described in detail here.

[0082] S09: As shown in Fig. 7, the flexible material layer 2 is laser lifted-off to obtain the flexible display substrate.

[0083] That is to say, the flexible material layer 2 is irradiated with ultraviolet laser light (preferably, with a wavelength of 308 nm) from one side of the glass base 1, so that the flexible material layer 2 and the display structure on the same fall off the glass base 1 to form a separated flexible display substrate. In this case, the flexible material layer 2 is the flexible base 21 of the flexible display substrate.

[0084] As shown in Fig. 7, in the laser lift-off process, due to the presence of the reflective layer 3, laser light passing through the flexible material layer 2 will be reflected back by the reflective layer 3, instead of being irradiated on the display structure 9 including a thin film transistor and the like, so that no damage is produced to the display structure 9.

[0085] In the flexible display substrate manufactured according to the method of this embodiment, the metal reflective layer has good oxygen and water isolation performance and thus may protect the display structure 9. Meanwhile, if what is manufactured is an array substrate of a flexible top-emitting type organic light emitting diode display device, as shown in Fig. 3, the reflective layer 3 may reflect light irradiated towards the flexible base 21 back, thus improving the light extraction efficiency.

[0086] It may be understood that, the implementations as described above are exemplary implementation manners merely used for describing the principle of the present invention, and the present invention is not limited thereto. For a person of ordinary skill in the art, various variations and improvements may be done without departing from the spirit and essence of the present invention, and those variations and improvements shall also be regarded as falling into the protection scope of the present invention.

## Claims

1. A flexible display substrate, comprising a flexible base and a display structure, wherein the flexible display substrate further comprises:
  - a reflective layer provided between the flexible base and the display structure.
2. The flexible display substrate according to claim 1, wherein

the reflective layer is a metal reflective layer; and a buffer layer is further provided between the reflective layer and the display structure.

3. The flexible display substrate according to claim 2, wherein the metal reflective layer is made of aluminum. 5
4. The flexible display substrate according to claim 3, wherein the thickness of the metal reflective layer is between 150 nm and 300 nm. 10
5. The flexible display substrate according to claim 1, wherein the reflective layer is provided with an opening at a position corresponding to an alignment mark. 15
6. The flexible display substrate according to any one of claims 1 to 5, wherein the flexible base is made of an organic flexible material. 20
7. The flexible display substrate according to any one of claims 1 to 5, wherein the display structure includes a plurality of display units arranged in an array form; and the display unit includes a low-temperature polysilicon thin film transistor. 25
8. The flexible display substrate according to any one of claims 1 to 5, wherein the display structure includes a plurality of display units arranged in an array form; and the display units are top-emitting type organic light emitting diode display units. 30
9. A flexible display device, comprising: 35
- the flexible display substrate according to any one of claims 1 to 8. 40
10. A manufacturing method of a flexible display substrate, comprising: 45
- forming a flexible material layer on a base; forming a reflective layer on the flexible material layer; forming a display structure; and separating the flexible material layer from the base by means of laser lift-off to obtain the flexible display substrate. 50
11. The manufacturing method of a flexible display substrate according to claim 10, wherein the reflective layer is a metal reflective layer; and between the step of forming the metal reflective layer and the step of forming a display structure, the meth-

od further comprises: forming a buffer layer on the metal reflective layer.

12. The manufacturing method of a flexible display substrate according to claim 11, wherein the metal reflective layer is made of aluminum, and formed by a vacuum evaporating process; and parameters for the vacuum evaporating process are as follows: the evaporation rate is greater than or equal to 40 nm/s, the evaporation air pressure is less than or equal to  $1.3 \times 10^{-4}$  Pa, and the thickness to be evaporated is between 150 nm and 300 nm.
13. The manufacturing method of a flexible display substrate according to claim 10, wherein between the step of forming the reflective layer and the step of forming a display structure, the method further comprises: 55
- forming an opening in the reflective layer at a position corresponding to an alignment mark.
14. The manufacturing method of a flexible display substrate according to claim 10, wherein the display structure includes a plurality of display units arranged in an array form, and the display unit includes a low-temperature polysilicon thin film transistor; the step of forming a display structure comprises: 60
- forming an amorphous silicon layer; and transforming the amorphous silicon layer into a polysilicon layer by laser annealing. 65

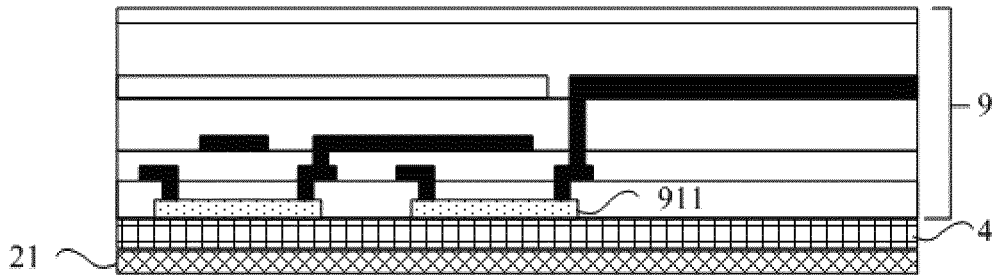


Fig. 1

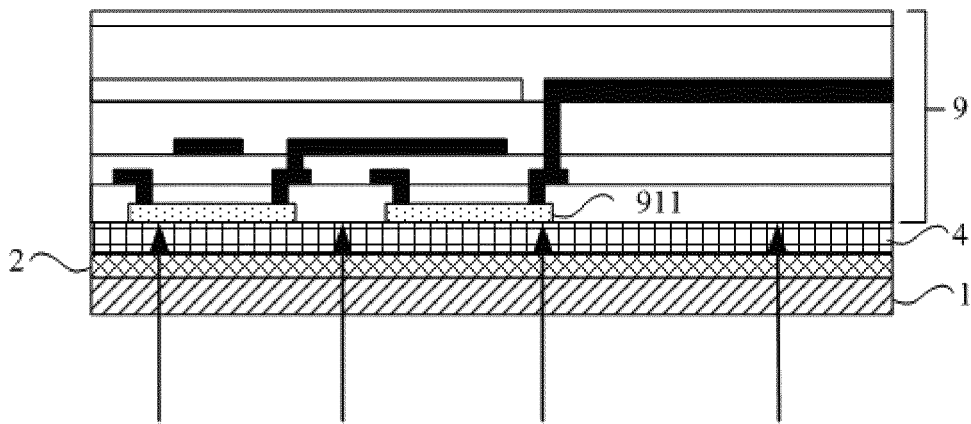


Fig. 2

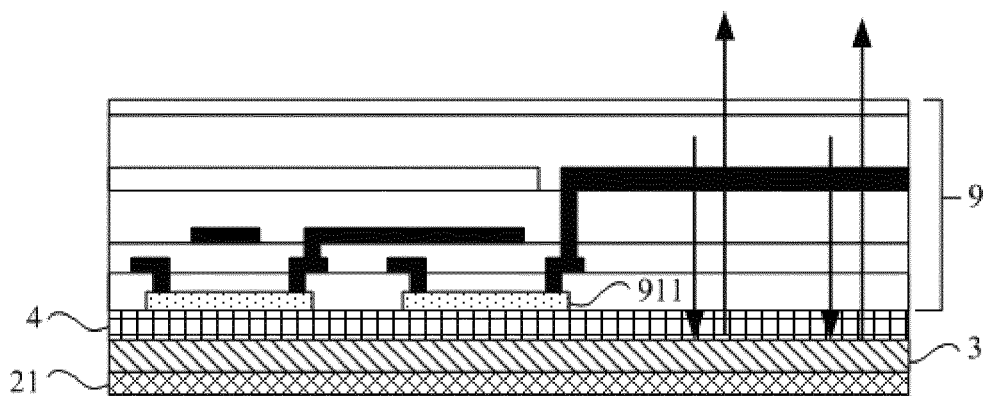


Fig. 3

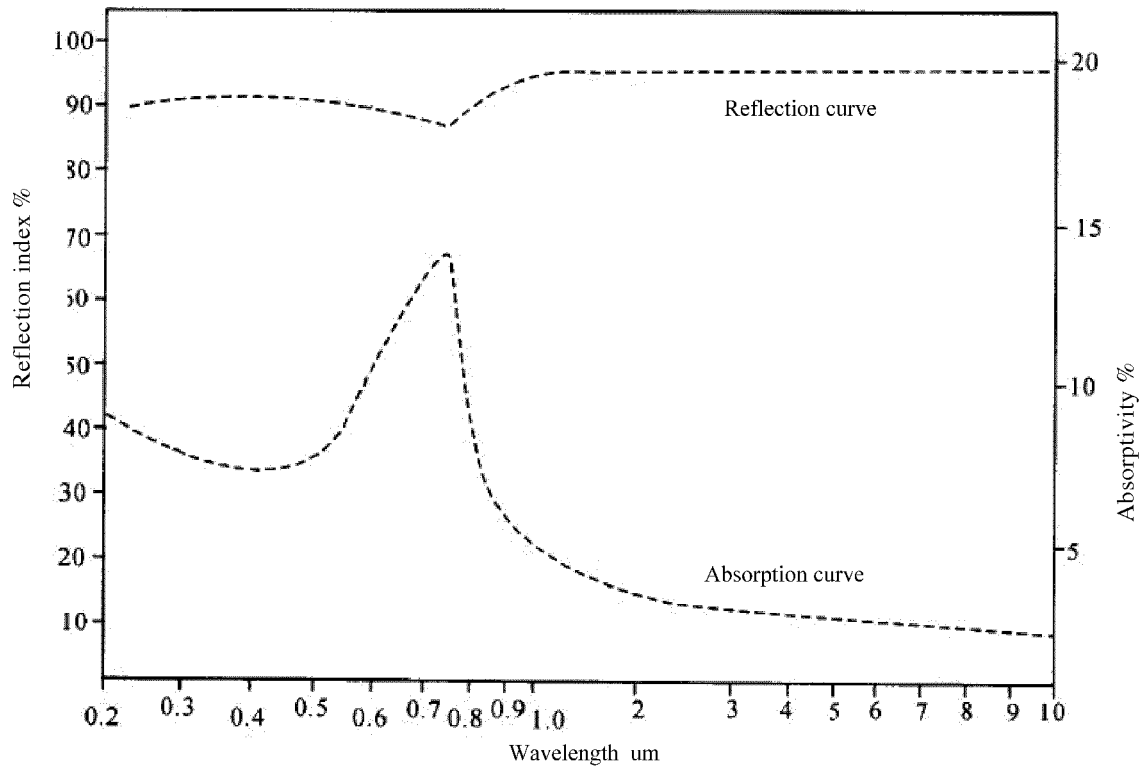


Fig. 4

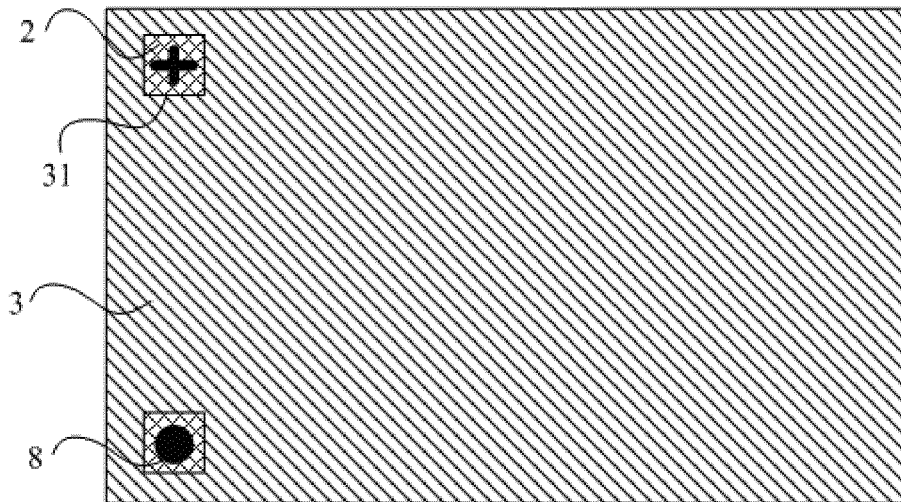


Fig. 5

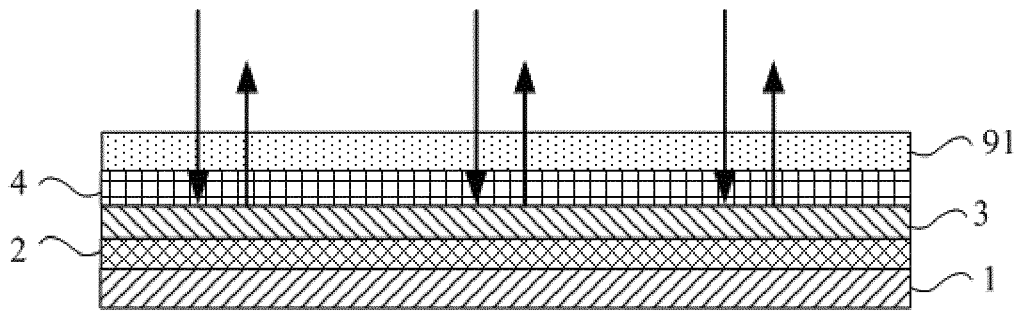


Fig. 6

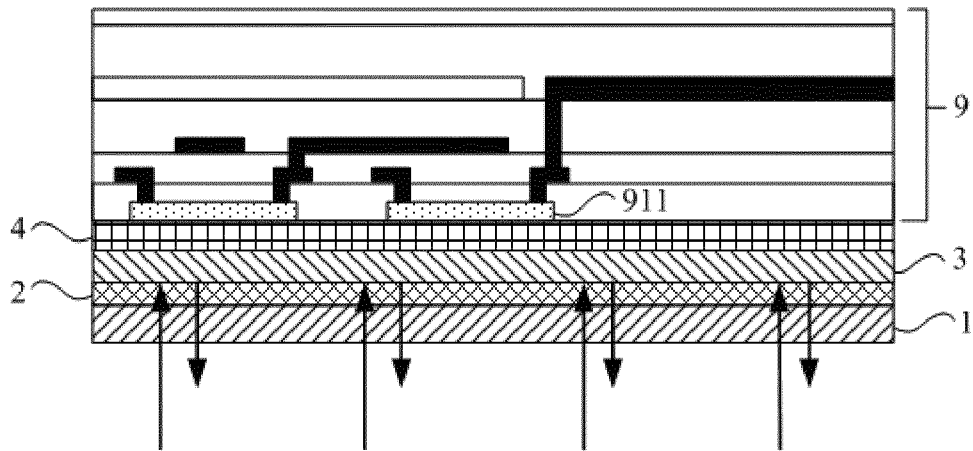


Fig. 7

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2014/075811

|   |  |  |
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| 5<br><b>A. CLASSIFICATION OF SUBJECT MATTER</b>   |  |  |
| H01L 51/50 (2006.01) i; H01L 51/52 (2006.01) i; H01L 51/56 (2006.01) i<br>According to International Patent Classification (IPC) or to both national classification and IPC   |  |  |
| 10<br><b>B. FIELDS SEARCHED</b>   |  |  |
| Minimum documentation searched (classification system followed by classification symbols)<br><br>H01L/-   |  |  |
| 15<br>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched   |  |  |
| Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)<br><br>CNPAT, CNTXT, CNKI, WPI, EPODOC: flexible w display, scroll w display, reflect+, metal, aluminium, laser, UV, substrate |  |  |
| 20<br><b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>   |  |  |
| Category*   | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No.  |
| 25<br>X   | CN 101785086 A (SHARP KK) 21 July 2010 (21.07.2010) description, page 6, paragraph [0090], page 7, paragraph [0094], page 8, paragraphs [0103], [0105], [0107] and [0111]-[0113] | 1-14   |
| X   | CN 101179111 A (SAMSUNG SDI CO LTD) 14 May 2008 (14.05.2008) description, page 4, the sixth paragraph to page 10, the last paragraph   | 1-14   |
| PX  | CN 103474583 A (BOE TECHNOLOGY GROUP CO LTD) 25 December 2013 (25.12.2013) claims 1-14   | 1-14   |
| 30<br>PX  | CN 203503661 U (BOE TECHNOLOGY GROUP CO LTD) 26 March 2014 (26.03.2014) description, page 2, paragraph [0031] to page 6, paragraph [0090]  | 1-14   |
| PX  | CN 203503658 U (BOE TECHNOLOGY GROUP CO LTD) 26 March 2014 (26.03.2014) description, page 3, paragraph [0039] to page 7, paragraph [0101]  | 1-14   |
| 35<br><input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.   |  |  |
| * Special categories of cited documents:  |  |  |
| 40<br>"A"   | document defining the general state of the art which is not considered to be of particular relevance   | "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention  |
| "E"   | earlier application or patent but published on or after the international filing date  | "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone   |
| "L"   | document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)              | "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| 45<br>"O"   | document referring to an oral disclosure, use, exhibition or other means   | "&" document member of the same patent family  |
| "P"   | document published prior to the international filing date but later than the priority date claimed   |  |
| Date of the actual completion of the international search<br>15 May 2014  |  | Date of mailing of the international search report<br>30 May 2014  |
| Name and mailing address of the ISA<br>State Intellectual Property Office of the P. R. China<br>No. 6, Xitucheng Road, Jimenqiao<br>Haidian District, Beijing 100088, China<br>Facsimile No. (86-10) 62019451   |  | Authorized officer<br><br>DAN, Meijun<br><br>Telephone No. (86-10) 01061648471   |

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**INTERNATIONAL SEARCH REPORT**

International application No.  
PCT/CN2014/075811

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| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |   |                       |
|---|---|-----------------------|
| Category*   | Citation of document, with indication, where appropriate, of the relevant passages  | Relevant to claim No. |
| PX  | CN 103500745 A (BOE TECHNOLOGY GROUP CO LTD) 08 January 2014 (08.01.2014) description, page 3, paragraph [0045] to page 8, paragraph [0107] | 1-14                  |

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.  
PCT/CN2014/075811

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| Patent Documents referred in the Report | Publication Date | Patent Family      | Publication Date |
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| CN 101785086 A                          | 21 July 2010     | US 2011/0204361 A1 | 25 August 2011   |
|   |                  | WO 2009/037797 A1  | 26 March 2009    |
| CN 101179111 A                          | 14 May 2008      | US 2008/0111477 A1 | 15 May 2008      |
|   |                  | JP 2008-124419 A   | 29 May 2008      |
|   |                  | EP 1921679 A2      | 15 May 2008      |
|   |                  | KR 10-0824880 B1   | 23 April 2008    |
| CN 103474583 A                          | 25 December 2013 | None               |                  |
| CN 203503661 U                          | 26 March 2014    | None               |                  |
| CN 203503658 U                          | 26 March 2014    | None               |                  |
| CN 103500745 A                          | 08 January 2014  | None               |                  |

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| 专利名称(译)        | 柔性显示基板及其制备方法，以及柔性显示装置  |         |            |
| 公开(公告)号        | <a href="#">EP3051601A1</a>  | 公开(公告)日 | 2016-08-03 |
| 申请号            | EP2014849872   | 申请日     | 2014-04-21 |
| [标]申请(专利权)人(译) | 京东方科技集团股份有限公司  |         |            |
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| [标]发明人         | CHEN LIQIANG<br>GAO TAO  |         |            |
| 发明人            | CHEN, LIQIANG<br>GAO, TAO  |         |            |
| IPC分类号         | H01L51/50 H01L51/52 H01L51/56 H01L27/12 H01L27/32  |         |            |
| CPC分类号         | H01L51/003 H01L51/0097 H01L51/5271 H01L2251/5315 H01L2251/5338 H01L27/1218 H01L27/1266<br>Y02E10/549 Y02P70/521 H01L21/02354 H01L27/1222 H01L27/1274 H01L27/3244 H01L51/56<br>H01L2227/323 H01L2251/301 H01L2251/558 |         |            |
| 代理机构(译)        | COHAUSZ & FLORACK  |         |            |
| 优先权            | 201310439383.8 2013-09-24 CN   |         |            |
| 其他公开文献         | EP3051601A4  |         |            |
| 外部链接           | <a href="#">Espacenet</a>  |         |            |

摘要(译)

本发明提供一种柔性显示基板及其制造方法，以及柔性显示装置，属于柔性显示技术领域。本发明可以解决现有柔性显示基板中的显示结构在激光剥离时可能被损坏的问题。本发明的柔性显示基板包括：柔性基底和显示结构，以及设置在柔性基底和显示结构之间的反射层。本发明的柔性显示基板的制造方法包括：在基底上形成柔性材料层；在柔性材料层上形成反射层；形成显示结构；通过激光剥离将柔性材料层与基底分离，得到柔性显示基板。本发明适用于柔性显示器件，特别是顶发射型有机发光二极管显示器件和具有低温多晶硅薄膜晶体管的柔性阵列基板。

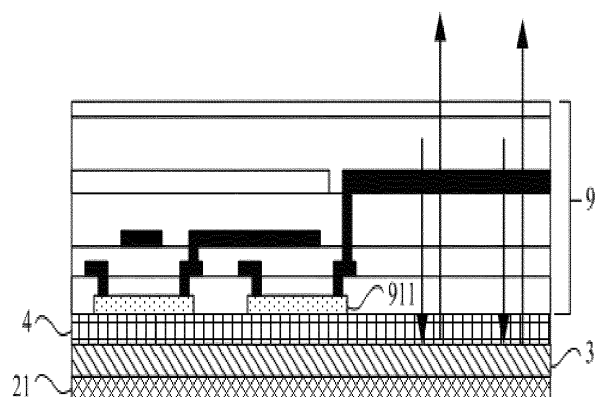


Fig. 3