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(54) **DOUBLE SIDED ORGANIC LIGHT-EMITTING DISPLAY APPARATUS AND ITS MANUFACTURING METHOD THEREOF**

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(51) **Int. Cl.**

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| ***H01L 51/00*** | (2006.01) |
| ***H01L 51/56*** | (2006.01) |
| *H01L 51/52* | (2006.01) |

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USPC ..... 257/40

See application file for complete search history.

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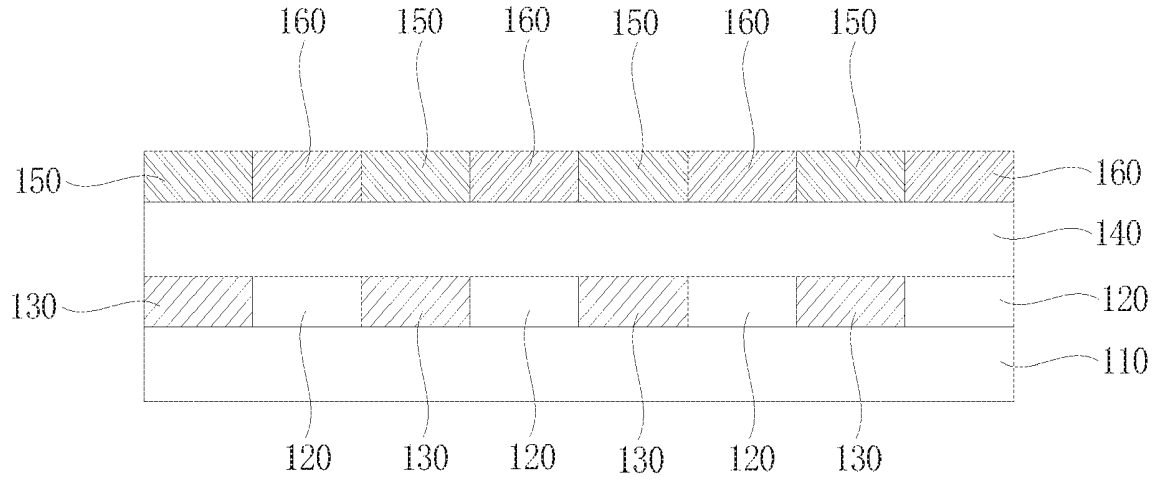
(57) **ABSTRACT**

A double-sided organic light-emitting display apparatus includes: a rigid substrate; a transmission flexible substrate and a reflective flexible substrate formed on the rigid substrate; a display substrate having a plurality of switching elements and formed on the transmission flexible substrate and the reflective flexible substrate; and a top-emission OLED light-emitting layer and a bottom-emission OLED light-emitting layer formed on the display substrate. The top-emission OLED light-emitting layer is corresponding to the reflective flexible substrate and the bottom-emission OLED light-emitting layer is corresponding to the transmission flexible substrate. The OLED display apparatus can serve as a double-sided display, and because of the use of the flexible substrate, it also has the advantage of easy carrying and flexibility.

**8 Claims, 3 Drawing Sheets**



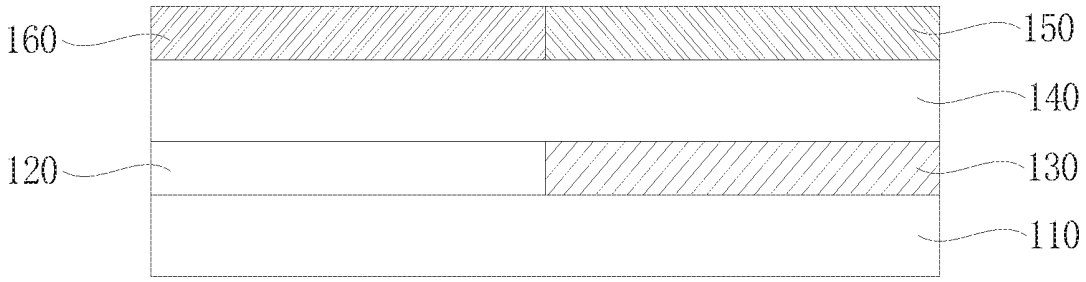

160
150
140
120
130
110

FIG. 1

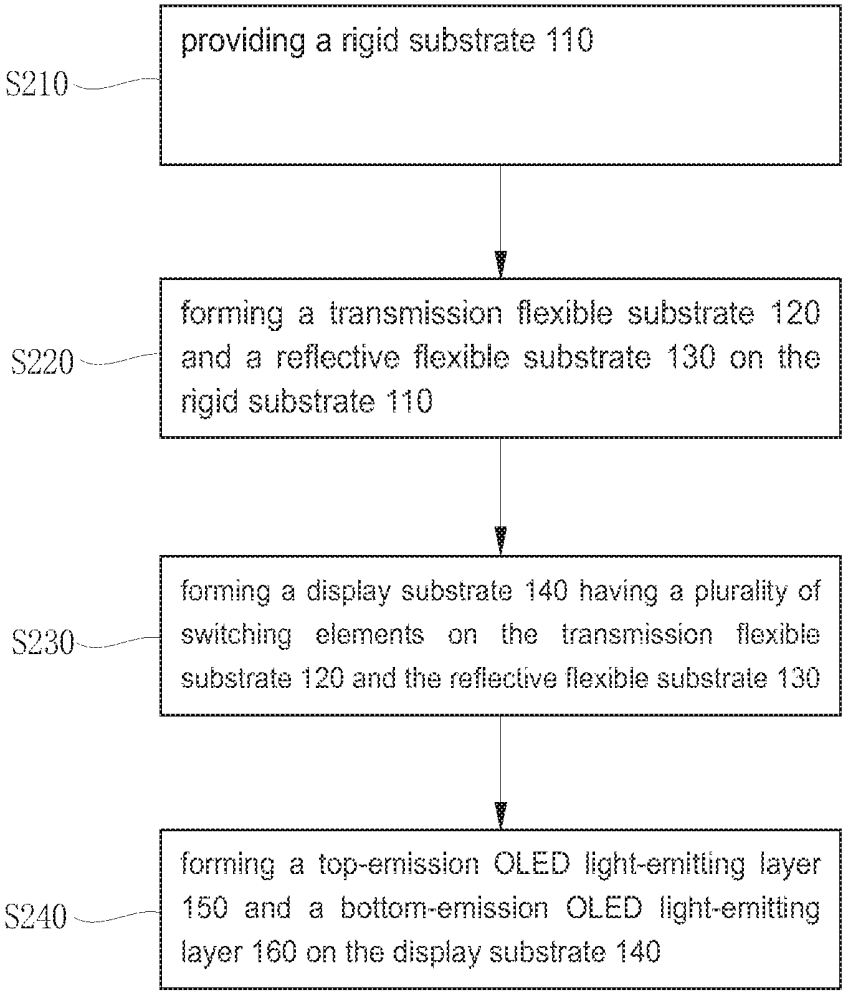

S210
providing a rigid substrate 110
S220
forming a transmission flexible substrate 120 and a reflective flexible substrate 130 on the rigid substrate 110
S230
forming a display substrate 140 having a plurality of switching elements on the transmission flexible substrate 120 and the reflective flexible substrate 130
S240
forming a top-emission OLED light-emitting layer 150 and a bottom-emission OLED light-emitting layer 160 on the display substrate 140

FIG. 2

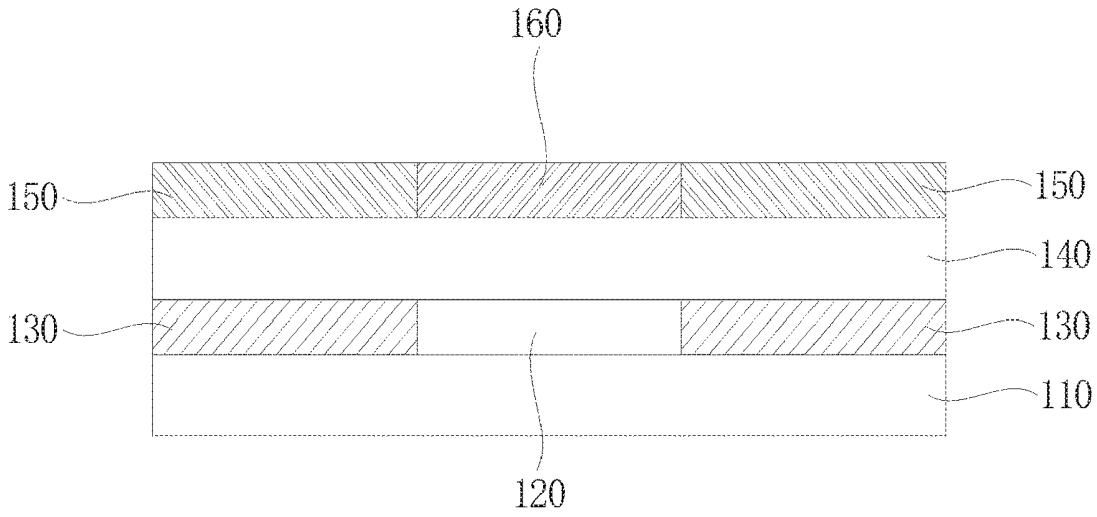

160
150
150
140
130
130
110
120

FIG. 3

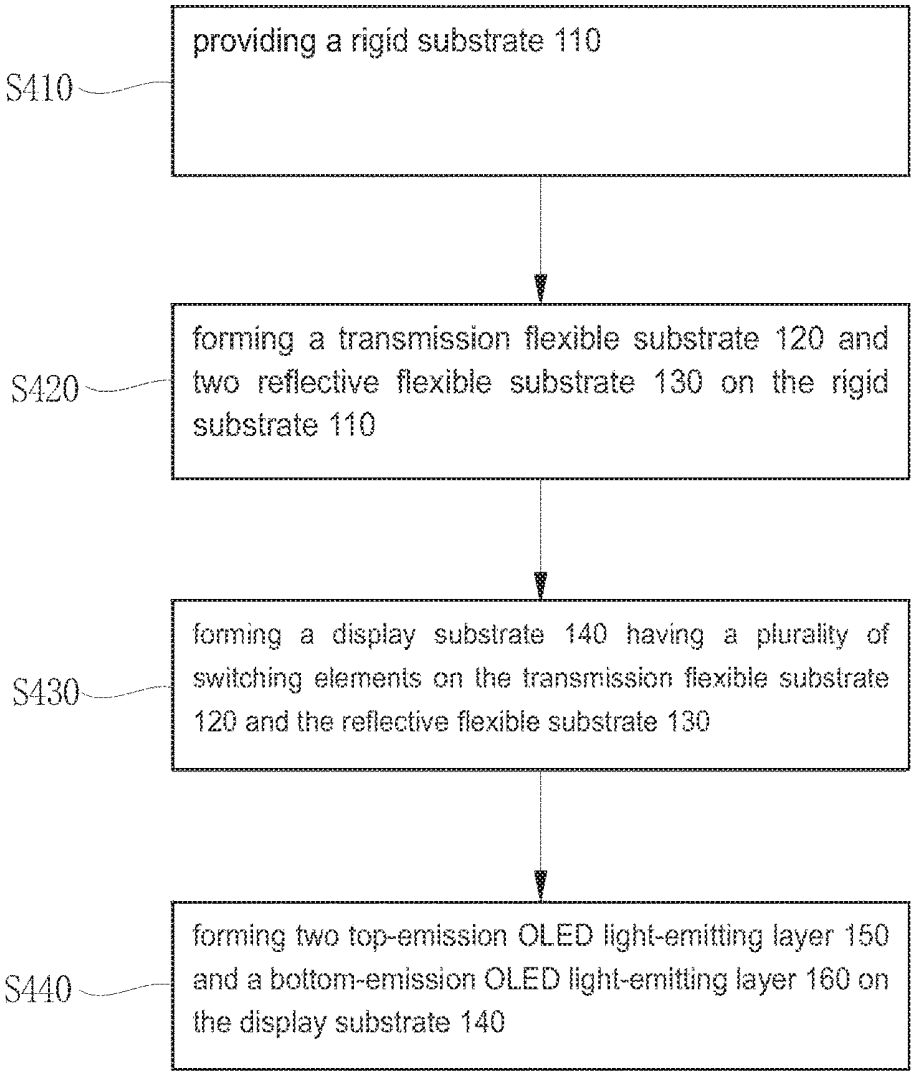

S410
providing a rigid substrate 110
S420
forming a transmission flexible substrate 120 and two reflective flexible substrate 130 on the rigid substrate 110
S430
forming a display substrate 140 having a plurality of switching elements on the transmission flexible substrate 120 and the reflective flexible substrate 130
S440
forming two top-emission OLED light-emitting layer 150 and a bottom-emission OLED light-emitting layer 160 on the display substrate 140

FIG. 4

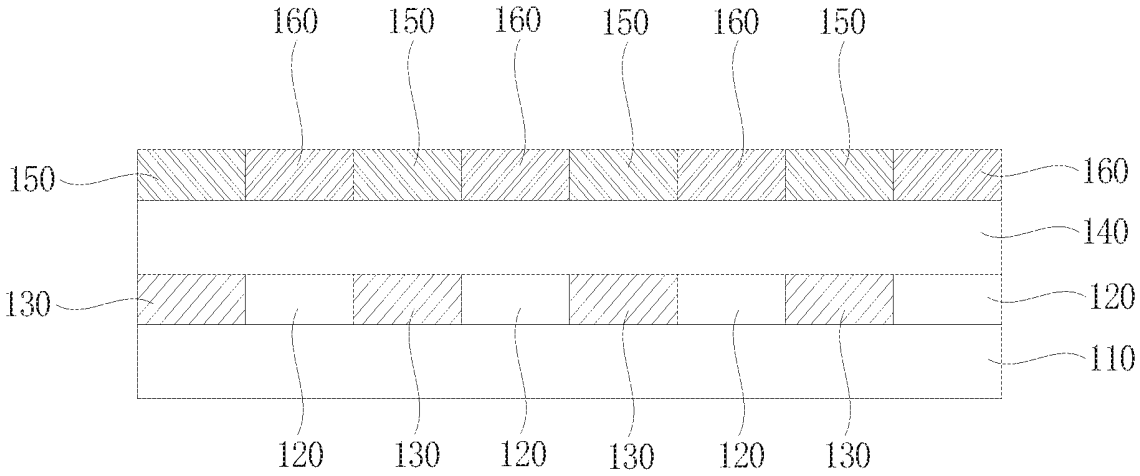

160
150
160
150
160
150
150
160
140
130
120
110
120
130
120
130
120
130

FIG. 5

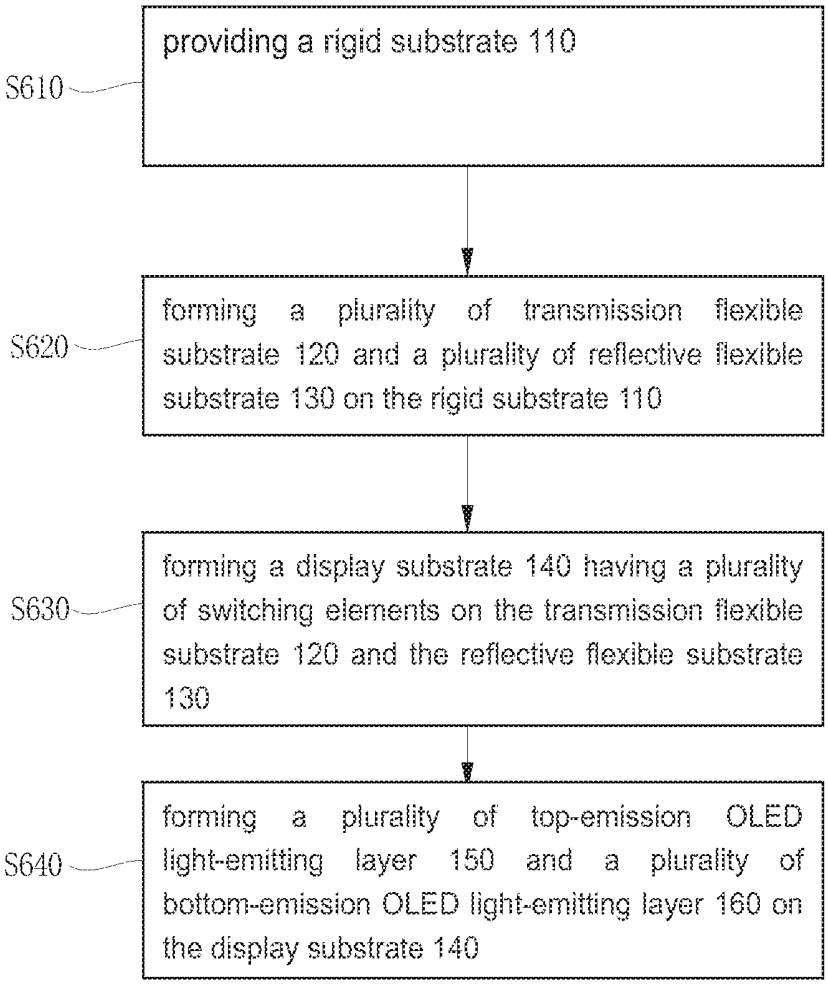

S610
providing a rigid substrate 110
S620
forming a plurality of transmission flexible substrate 120 and a plurality of reflective flexible substrate 130 on the rigid substrate 110
S630
forming a display substrate 140 having a plurality of switching elements on the transmission flexible substrate 120 and the reflective flexible substrate 130
S640
forming a plurality of top-emission OLED light-emitting layer 150 and a plurality of bottom-emission OLED light-emitting layer 160 on the display substrate 140

FIG. 6

# DOUBLE SIDED ORGANIC LIGHT-EMITTING DISPLAY APPARATUS AND ITS MANUFACTURING METHOD THEREOF

## CROSS REFERENCE TO RELATED APPLICATIONS

This is a divisional application of co-pending U.S. patent application Ser. No. 15/111,230, filed on Jul. 13, 2016, which is a national stage of PCT Application No. PCT/CN2016/078264, filed on Apr. 1, 2016, claiming foreign priority of Chinese Patent Application No. 201610151250.4 filed on Mar. 16, 2016.

## FIELD OF THE INVENTION

The present application relates to a display technology field, and more particularly to a double-sided organic light-emitting display apparatus and its manufacturing method thereof.

## BACKGROUND OF THE INVENTION

With the technology develop and the raising of people need to products, the display device is no longer limited to single-sided display but comes with a double-sided display device. The double-sided display device can be applied to mobile phones, handheld computers and other mobile electronic equipment it can also be used in banks, supermarkets and other places for business process.

The organic light-emitting diode (OLED) display technology is different with the traditional LCD display technology, and no need of backlight and it has self-luminous properties. A very thin coating of organic materials and the glass substrate is adopted. When a current is passed, these organic materials will extract light. Besides, the OLED displays can be made lighter and thinner, with larger viewing angle, and can save energy power significantly.

In addition, a flexible display is with light, thin, foldable and portable and other outstanding advantages to achieve double sided display, and has slim and portable features.

Therefore, how to provide a flexible OLED display to enable double sided display is a needed problem to be solved.

## SUMMARY OF THE INVENTION

In order to solve the present technical problem mentioned above, the propose of the present application is to provide a double sided organic light-emitting display apparatus, including a rigid substrate; a transmission flexible substrate and a reflective flexible substrate formed on the rigid substrate; a display substrate having a plurality of switching elements formed on the transmission flexible substrate and the reflective flexible substrate; and a top-emission OLED light-emitting layer and a bottom-emission OLED light-emitting layer formed on the display substrate, wherein the bottom-emission OLED light-emitting layer is corresponding to the transmission flexible substrate and the top-emission OLED light-emitting layer is corresponding to the reflective flexible substrate.

Further, the number of the transmission flexible substrate and the reflective flexible substrate are one, and the number of the top-emission OLED light-emitting layer and a bottom-emission OLED light-emitting layer are one correspondingly.



Further, the number of the transmission flexible substrate is one and the number of the reflective flexible substrate are two, wherein the two reflective flexible substrates are formed separately on the opposite sides of the transmission flexible substrate; and the number of the top-emission OLED light-emitting layer are two and the number of the bottom-emission OLED light-emitting layer are one correspondingly wherein two of the top-emission OLED light-emitting layer are formed corresponding to two of the reflective flexible substrates separately.

Further, both the number of the transmission flexible substrate and the number of the reflective flexible substrate are more than one, wherein the plurality of the reflective flexible substrates and the plurality of the transmission flexible substrate are interlaced formed; and both the number of the top-emission OLED light-emitting layer and the number of the bottom-emission OLED light-emitting layer are more than one correspondingly, wherein the plurality of the top-emission OLED light-emitting layer and the plurality of the bottom-emission OLED light-emitting layer are interlaced formed.

Another purpose of the present application is to provide a manufacturing method for a double-sided organic light-emitting display apparatus, including: providing a rigid substrate; forming a transmission flexible substrate and a reflective flexible substrate on the rigid substrate; forming a display substrate having a plurality of switching elements on the transmission flexible substrate and the reflective flexible substrate; and forming a top-emission OLED light-emitting layer and a bottom-emission OLED light-emitting layer on the display substrate, wherein the top-emission OLED light-emitting layer is corresponding to the reflective flexible substrate and the bottom-emission OLED light-emitting layer is corresponding to the transmission flexible substrate.

Further, a transmission flexible substrate and a reflective flexible substrate are formed on the rigid substrate; and a top-emission OLED light-emitting layer and a bottom-emission OLED light-emitting layer are formed on the display substrate correspondingly.

Further, a transmission flexible substrate is formed on the rigid substrate and two reflective flexible substrate are formed opposite on the two sides of the transmission flexible substrate; a bottom-emission OLED light-emitting layer is formed on the display substrate, and two top-emission OLED light-emitting layer are formed opposite on the two sides of the bottom-emission OLED light-emitting layer correspondingly, wherein the two of the top-emission OLED light-emitting layer are formed corresponding to the two of the reflective flexible substrate separately.

Further, a plurality of the transmission flexible substrate and a plurality of the reflective flexible substrate are interlaced formed on the rigid substrate; and a plurality of the top-emission OLED light-emitting layers and a plurality of the bottom-emission OLED light-emitting layer are interlaced formed on the display substrate, wherein the plurality of the bottom-emission OLED light-emitting layer are formed corresponding to the plurality of the transmission flexible substrate separately and the plurality of the top-emission OLED light-emitting layers are formed corresponding to the plurality of the reflective flexible substrate separately.

Further, the material of the transmission flexible substrate is selected from one or a combination of at least two material of polyimide, polyetherimide, polyphenylene sulfide or polyarylate, and the material of the reflective flexible substrate

is selected from one or a combination of at least two material yellow poly polyimides, polyetherimides, polyphenylene sulfide, or polyarylate.

The advantage of the present application is the OLED display apparatus can achieve the double-sided display, and because of its use of the flexible substrate, it also has the advantage of ease of carrying and flexible property.

## BRIEF DESCRIPTION OF THE DRAWINGS

In order to more clearly illustrate the embodiments of the present application or prior art, the following figures will be described in the embodiments are briefly introduced. It is obvious that the drawings are merely some embodiments of the present application, those of ordinary skill in this field can obtain other figures according to these figures without paying the premise.

FIG. **1** illustrates a schematic structural view of a double-sided organic light-emitting display apparatus according to a first embodiment of the present application;

FIG. **2** illustrates a process flow of manufacturing the double-sided organic light-emitting display apparatus of the first embodiment of the present application;

FIG. **3** illustrates a schematic structural view of a double-sided organic light-emitting display apparatus according to a second embodiment of the present application;

FIG. **4** illustrates a process flow of manufacturing the double-sided organic light-emitting display apparatus of the second embodiment of the present application;

FIG. **5** illustrates a schematic structural view of a double-sided organic light-emitting display apparatus according to a third embodiment of the present application; and

FIG. **6** illustrates a process of manufacturing the double-sided organic light-emitting display apparatus of the third embodiment of the present application.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Embodiments of the present application are described in detail with the technical matters, structural features, achieved objects, and effects with reference to the accompanying drawings as follows. It is clear that the described embodiments are part of embodiments of the present application, but not all embodiments. Based on the embodiments of the present application, all other embodiments to those of ordinary skill in the premise of no creative efforts obtained should he considered within the scope of protection of the present application.

Specifically, the terminologies in the embodiments of the present application are merely for describing the purpose of the certain embodiment, but not to limit the invention. Examples and the appended claims be implemented in the present application requires the use of the singular form of the book "an", "the", and "said" are intended to include most forms unless the context clearly dictates otherwise. It should also he understood that the terminology used herein that "and/or" means and includes any or all possible combinations of one or more of the associated listed items.

In the drawings, in order to clarify the device, an exaggerated thickness of layers and regions are shown. The same reference numerals in the drawings refer to like elements throughout.

It can also he understood that when a layer or element is referred to as being formed on another layer or substrate or above or below, or it can be directly formed on the other layer or substrate, or under, or may he intervening layers or elements.

First Embodiment

FIG. **1** illustrates a schematic structural view of a double-sided organic light-emitting display apparatus according to a first embodiment of the present application. FIG. **2** illustrates a process flow of manufacturing the double-sided organic light-emitting display apparatus of the first embodiment of the present application.

Referring to FIGS. **1** and **2**, in Step S**210**, a rigid substrate **110** is provided. In the present embodiment, the rigid substrate **110** may be formed of glass or transparent material such as quartz, but the present application is not limited thereto.

In Step S**220**, a transmission flexible substrate **120** and a reflective flexible substrate **130** is formed on the rigid substrate **110**. In the present embodiment, the number of the transmission flexible substrate **120** and the reflective flexible substrate **130** is one, but the present application is not limited thereto.

Further, the material of the transmission flexible substrate **120** is selected from one or a combination of at least two materials of polyimide, polyetherimide, polyphenylene sulfide or polyarylate. The material of the reflective flexible substrate **130** is selected from one or a combination of at least two materials of yellow poly polyimides, polyetherimides, polyphenylene sulfide, or polyarylate.

Besides, it is noted that the transmission flexible substrate **120** and the reflective flexible substrate **130** can be made sequentially or can be made simultaneously. The thickness of the transmission flexible substrate **120** and the reflective flexible substrate **130** are the same, but the occupied area (i.e., a plan view area) of the transmission flexible substrate **120** and the reflective flexible substrate **130** can be the same or different.

In Step S**230**, a display substrate **140** with a plurality of switching elements formed on it is formed on the transmission flexible substrate **120** and the reflective flexible substrate **130**. In the present embodiment, the switching element can be, for example, a thin film transistor (TFT). Further, the material of the active layer in the thin film transistor described herein can be amorphous silicon (a-Si), low temperature polysilicon (LTPS), oxide semiconductor; carbon nanotube (CNT), graphene or the other.

In Step S**240**, a top-emission OLED light-emitting layer **150** and a bottom-emission OLED light-emitting layer **160** are formed on the display substrate **140**. In this embodiment, number of the top-emission OLED light-emitting layer **150** and the bottom-emission OLED light-emitting layer **160** are one, but the present application is not limited thereto.

Further, the bottom-emission OLED light-emitting layer **160** is formed corresponding to the transmission flexible substrate **120** to achieve the transmission display; the top-emission OLED light-emitting layer **150** is formed corresponding to the reflective flexible substrate **130** to achieve the reflective display.

Therefore, the OLED display apparatus of the present application can achieve the double-sided display, and the OLED display apparatus of the present application can be bended in the contact area of the transmission flexible substrate **120** and the reflective flexible substrate **130** to form a specific angle double sided display.

Second Embodiment

FIG. **3** illustrates a schematic structural view of a double-sided organic light-emitting display apparatus according to the second embodiment of the present application. FIG. **4**

illustrates a process flow of manufacturing the double-sided organic light-emitting display apparatus of the second embodiment of the present application.

Referring to FIGS. **3** and **4**, in Step S**410**, a rigid substrate **110** is provided. In the present embodiment, the rigid substrate **110** may be formed of glass or transparent material such as quartz, but the present application is not limited thereto.

In Step S**420**, one transmission flexible substrate **120** and two reflective flexible substrates **130** is formed on the rigid substrate **110**. The two reflective flexible substrates **130** are formed separately on the opposite sides of the transmission flexible substrate **120**. In the present embodiment, the number of the transmission flexible substrate **120** and the reflective flexible substrate **130** is two, but the present application is not limited thereto.

Further, the material of the transmission flexible substrate **120** is selected from one or a combination of at least two materials of polyimide, polyetherimide, polyphenylene sulfide or polyarylate. The material of the reflective flexible substrate **130** is selected from one or a combination of at least two materials of yellow poly polyimides, polyetherimides, polyphenylene sulfide, or polyarylate.

Besides, it is noted that the transmission flexible substrate **120** and the reflective flexible substrate **130** can be made sequentially or can be made simultaneously. The thickness of the transmission flexible substrate **120** and the reflective flexible substrate **130** are the same, but the occupied area (i.e., a plan view area) of the transmission flexible substrate **120** and the reflective flexible substrate **130** can be the same or different.

In Step S**430**, a display substrate **140** with a plurality of switching element formed on it is formed on the transmission flexible substrate **120** and the reflective flexible substrate **130**. In the present embodiment, the switching element can be, for example, a thin film transistor (TFT). Further, the material of the active layer in the thin film transistor described herein can be amorphous silicon (a-Si), low temperature polysilicon (LTPS), oxide semiconductor, carbon nanotube (CNT), graphene or the other.

In Step S**440**, two top-emission OLED light-emitting layers **150** and one bottom-emission OLED light-emitting layer **160** are formed on the display substrate **140**. In this embodiment, the number of the top-emission OLED light-emitting layer **150** is two and the number of the bottom-emission OLED light-emitting layer **160** is one, but the present application is not limited thereto.

Further, one of the bottom-emission OLED light-emitting layers **160** is formed corresponding to the transmission flexible substrate **120** to achieve the transmission display; the two of the top-emission OLED light-emitting layer **150** is formed corresponding to two of the reflective flexible substrate **130** accordingly to achieve the reflective display separately.

Therefore, the OLED display apparatus of the present application can achieve the double-sided display, and the OLED display apparatus of the present application can be bended in the contact area of the transmission flexible substrate **120** and the reflective flexible substrate **130** to form a specific angle double sided display.

Third Embodiment

FIG. **5** illustrates a schematic structural view of a double-sided organic light-emitting display apparatus according to the second embodiment of the present application. FIG. **6** illustrates a process flow of manufacturing the double-sided organic light-emitting display apparatus of the second embodiment of the present application.

Referring to FIGS. **5** and **6**, in Step S**610**, a rigid substrate **110** is provided in the present embodiment, the rigid substrate **110** may be formed of glass or transparent material such as quartz, but the present application is not limited thereto.

In Step S**620**, a plurality of the transmission flexible substrates **120** and a plurality of the reflective flexible substrates **130** are formed on the rigid substrate **110**. The plurality of the transmission flexible substrates **120** and the plurality of the reflective flexible substrates **130** are interlaced formed to each other.

Further, the material of the transmission flexible substrate **120** is selected from one or a combination of at least two materials of polyimide, polyetherimide, polyphenylene sulfide or polyarylate. The material of the reflective flexible substrate **130** is selected from one or a combination of at least two materials of yellow poly polyimides, polyetherimides, polyphenylene sulfide, or polyarylate.

Besides, it is noted that the transmission flexible substrate **120** and the reflective flexible substrate **130** can be made sequentially or can be made simultaneously. The thickness of the transmission flexible substrate **120** and the reflective flexible substrate **130** are the same, but the occupied area (i.e., a plan view area) of the transmission flexible substrate **120** and the reflective flexible substrate **130** can be the same or different.

In step S**630**, a display substrate **140** with a plurality of switching elements formed on it is formed on the transmission flexible substrate **120** and the reflective flexible substrate **130**. In the present embodiment, the switching element can be, for example, a thin film transistor (TFT). Further, the material of the active layer in the thin film transistor described herein can be amorphous silicon (a-Si), low temperature polysilicon (LTPS), oxide semiconductor, carbon nanotube (CNT), graphene or the other.

In Step S**640**, a plurality of the top-emission OLED light-emitting layers **150** and a plurality of the bottom-emission OLED light-emitting layer **160** are formed on the display substrate **140**. The plurality of the top-emission OLED light-emitting layers **150** and the plurality of the bottom-emission OLED light-emitting layer **160** are interlaced formed to each other.

Further, each of the plurality of the bottom-emission OLED light-emitting layer **160** is formed corresponding to each of the plurality of the transmission flexible substrate **120** accordingly to achieve the transmission display; each of the plurality of the top-emission OLED light-emitting layer **150** is formed corresponding to each of the plurality of the reflective flexible substrate **130** accordingly to achieve the reflective display separately. It should be noted that when the line width of the transmission flexible substrate **120** and the reflective flexible substrate **130** is thinned to a sufficiently level, for example, to the level that the naked eye cannot distinguish, the OLED display apparatus according to the embodiment of the present application can totally achieve the back to back double-sided display.

Therefore, the OLED display apparatus of the present application can achieve the double-sided display, and the OLED display apparatus of the present application can be bended in the contact area of the transmission flexible substrate **120** and the reflective flexible substrate **130** to form a specific angle double sided display.

The above provides embodiments of the present application, which are not intended to limit the scope of the present application. Any modifications, equivalent replacements or

improvements within the spirit and principles of the embodiment described above should be covered by the protected scope of the invention.

What is claimed is:

**1**. A double-sided organic light-emitting display apparatus, comprising:

a rigid substrate;

at least one transmission flexible substrate and at least one reflective flexible substrate formed on the rigid substrate;

a display substrate having a plurality of switching elements formed on the at least one transmission flexible substrate and the at least one reflective flexible substrate; and

at least one top-emission organic light emitting diode (OLED) light-emitting layer and at least one bottom-emission OLED light-emitting layer formed on the display substrate, wherein the at least one top-emission OLED light-emitting layer is corresponding to the at least one reflective flexible substrate and the at least one bottom-emission OLED light-emitting layer is corresponding to the at least one transmission flexible substrate;

wherein the at least one transmission flexible substrate and the at least one reflective flexible substrate are formed on a surface of the rigid substrate and are spaced from and corresponding to the at least one bottom-emission OLED light-emitting layer and the at least one top-emission OLED light-emitting layer, such that the at least one top-emission OLED light-emitting layer is separated by the display substrate from the at least one reflective flexible substrate.

**2**. The double-sided organic light-emitting display apparatus according to claim **1**, wherein the at least one transmission flexible substrate comprises one transmission flexible substrate and the at least one reflective flexible substrate comprises one reflective flexible substrate, and the at least one top-emission OLED light-emitting layer comprises one top-emission OLED light-emitting layer corresponding to the one reflective flexible substrate and the at least one bottom-emission OLED light-emitting layer comprises one bottom-emission OLED light-emitting layer corresponding to the one transmission flexible substrate.

**3**. The double-sided organic light-emitting display apparatus according to claim **1**, wherein the at least one transmission flexible substrate comprises one transmission flexible substrate and the at least one reflective flexible substrate comprises two reflective flexible substrates, wherein the two reflective flexible substrates are respectively located at two opposite sides of the one transmission flexible substrate; and the number of the at least one top-emission OLED light-emitting layer comprises two top-emission OLED light-emitting layers respectively corresponding to the two reflective flexible substrates and the at least one bottom-emission OLED light-emitting layer comprises one bottom-emission OLED light-emitting layer corresponding to the one transmission flexible substrate.

**4**. The double-sided organic light-emitting display apparatus according to claim **1**, wherein the at least one transmission flexible substrate comprises a plurality of transmission flexible substrates and the at least one reflective flexible substrate comprises a plurality of reflective flexible substrates, wherein the plurality of the reflective flexible substrates and the plurality of the transmission flexible substrate are interlaced formed; and the at least one top-emission OLED light-emitting layer comprises a plurality of top-emission OLED light-emitting layers respectively corresponding to the plurality of reflective flexible substrates and the at least one bottom-emission OLED light-emitting layer comprises a plurality of bottom-emission OLED light-emitting layers respectively corresponding to the plurality of transmission flexible substrates, wherein the plurality of top-emission OLED light-emitting layers and the plurality of bottom-emission OLED light-emitting layers are interlaced formed.

**5**. The double-sided organic light-emitting display apparatus according to claim **1**, wherein a material of the at least one transmission flexible substrate is selected from one or a combination of at least two of polyimide, polyetherimide, polyphenylene sulfide, and polyarylate, and a material of the at least one reflective flexible substrate is selected from one or a combination of at least two of yellow poly polyimides, polyetherimides, polyphenylene sulfide, and polyarylate.

**6**. The double-sided organic light-emitting display apparatus according to claim **2**, wherein a material of the at least one transmission flexible substrate is selected from one or a combination of at least two of polyimide, polyetherimide, polyphenylene sulfide, and polyarylate, and a material of the at least one reflective flexible substrate is selected from one or a combination of at least two of yellow poly polyimides, polyetherimides, polyphenylene sulfide, and polyarylate.

**7**. The double-sided organic light-emitting display apparatus according to claim **3**, wherein a material of the at least one transmission flexible substrate is selected from one or a combination of at least two of polyimide, polyetherimide, polyphenylene sulfide, and polyarylate, and a material of the at least one reflective flexible substrate is selected from one or a combination of at least two of yellow poly polyimides, polyetherimides, polyphenylene sulfide, and polyarylate.

**8**. The double-sided organic light-emitting display apparatus according to claim **4**, wherein a material of the at least one transmission flexible substrate is selected from one or a combination of at least two of polyimide, polyetherimide, polyphenylene sulfide, and polyarylate, and a material of the at least one reflective flexible substrate is selected from one or a combination of at least two of yellow poly polyimides, polyetherimides, polyphenylene sulfide, and polyarylate.

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| 专利名称(译) | 双面有机发光显示装置及其制造方法 | | |
| 公开(公告)号 | US10586835 | 公开(公告)日 | 2020-03-10 |
| 申请号 | US16/258768 | 申请日 | 2016-04-01 |
| [标]申请(专利权)人(译) | 武汉华星光电技术有限公司 | | |
| 申请(专利权)人(译) | 中国武汉恒星光电科技有限公司. | | |
| 当前申请(专利权)人(译) | 中国武汉恒星光电科技有限公司. | | |
| [标]发明人 | HUANG JHIH JIE<br>LIANG BO<br>WANG WEI | | |
| 发明人 | HUANG, JHIH-JIE<br>LIANG, BO<br>WANG, WEI | | |
| IPC分类号 | H01L27/32 H01L51/00 H01L51/56 H01L51/52 | | |
| CPC分类号 | H01L51/0035 H01L51/0097 H01L51/56 H01L27/3244 Y02E10/549 H01L2227/323 H01L2251/5338 H01L51/5271 H01L2251/5323 H01L27/3267 | | |
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| 其他公开文献 | US20190172879A1 | | |
| 外部链接 | Espacenet | | |


摘要(译)

双面有机发光显示装置包括：刚性基板；和 透射柔性基板和形成在刚性基板上的反射柔性基板； 显示基板，其具有多个开关元件并且形成在透射柔性基板和反射柔性基板上； 形成在显示基板上的顶部发光OLED发光层和底部发光OLED发光层。 顶部发光的OLED发光层对应于反射柔性基板，而底部发光的OLED发光层对应于透射柔性基板。 OLED显示装置可以用作双面显示器，并且由于使用柔性基板，它还具有易于携带和柔性的优点。