



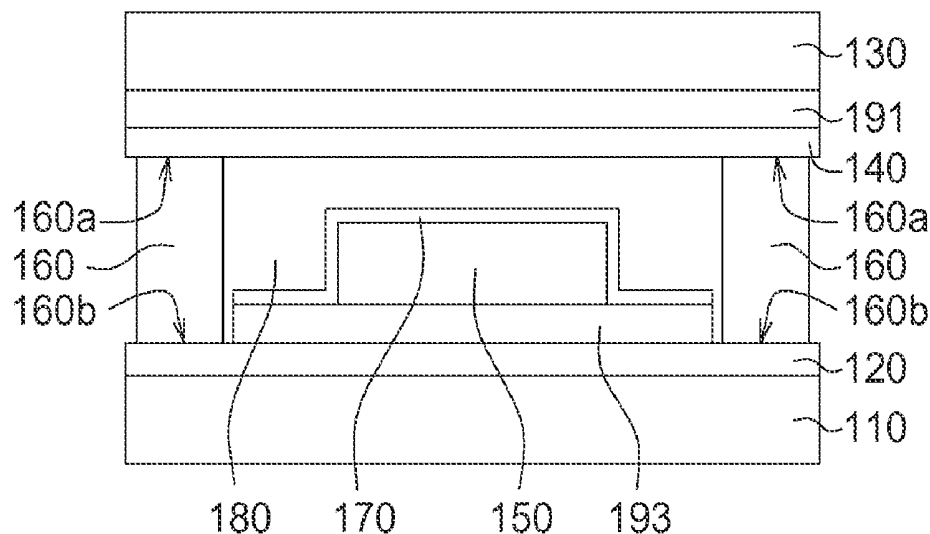
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(19) **United States**(12) **Patent Application Publication**
Tsai et al.(10) **Pub. No.: US 2016/0072100 A1**(43) **Pub. Date: Mar. 10, 2016**(54) **ORGANIC LIGHT EMITTING DIODE
DISPLAY DEVICE AND MANUFACTURING
METHOD THEREOF****Publication Classification**(51) **Int. Cl.**
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Po-Ching Lin, Miao-Li County (TW);
Wei-Yen Wu, Miao-Li County (TW);
Hui-Chen Hsu, Miao-Li County (TW)(57) **ABSTRACT**

An organic light emitting diode display device and a manufacturing method thereof are provided. The organic light emitting diode display device includes a first flexible substrate, a second flexible substrate, a first barrier layer, a second barrier layer, an organic light emitting diode element, and a metal enclosing wall. The first barrier layer is disposed on the first flexible substrate, and the second barrier layer is disposed on the second flexible substrate. The organic light emitting diode element is disposed between the first barrier layer and the second barrier layer. The metal enclosing wall connects the first flexible substrate to the second flexible substrate and surrounds the organic light emitting diode element.

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Jan. 28, 2014, now Pat. No. 9,246,128.(30) **Foreign Application Priority Data**

Feb. 18, 2013 (TW) 102105491

100

100

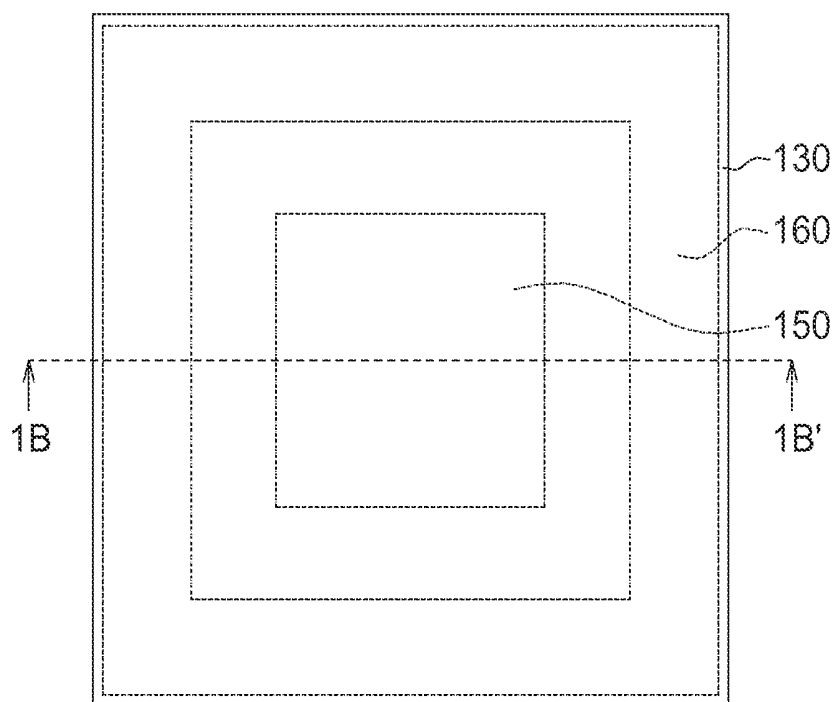


FIG. 1A

100

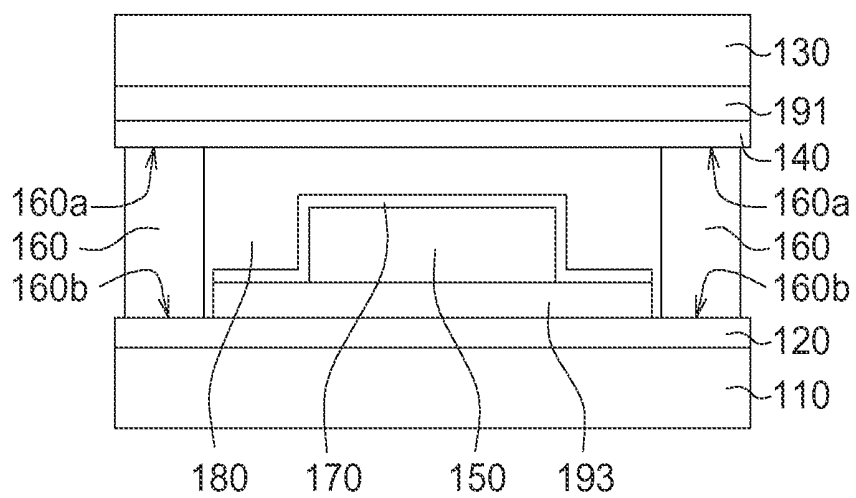


FIG. 1B

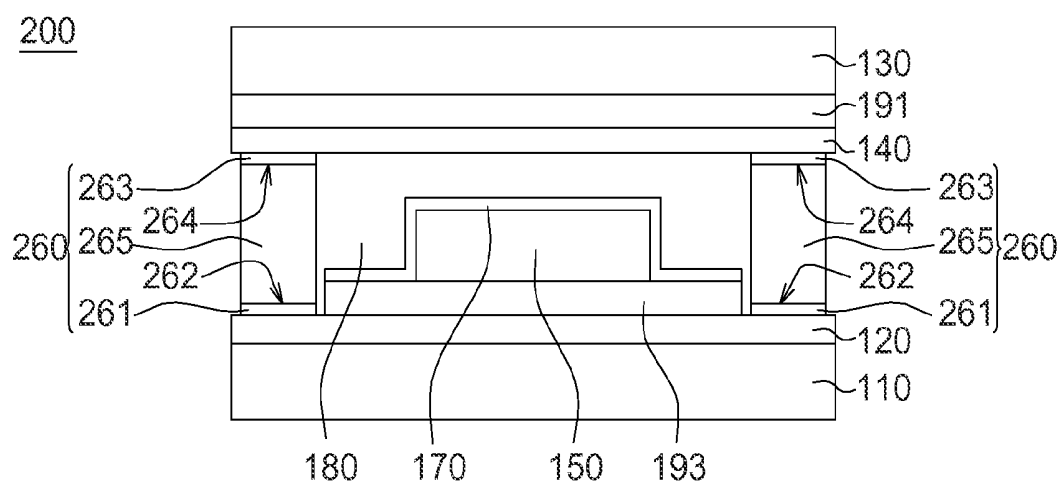


FIG. 2

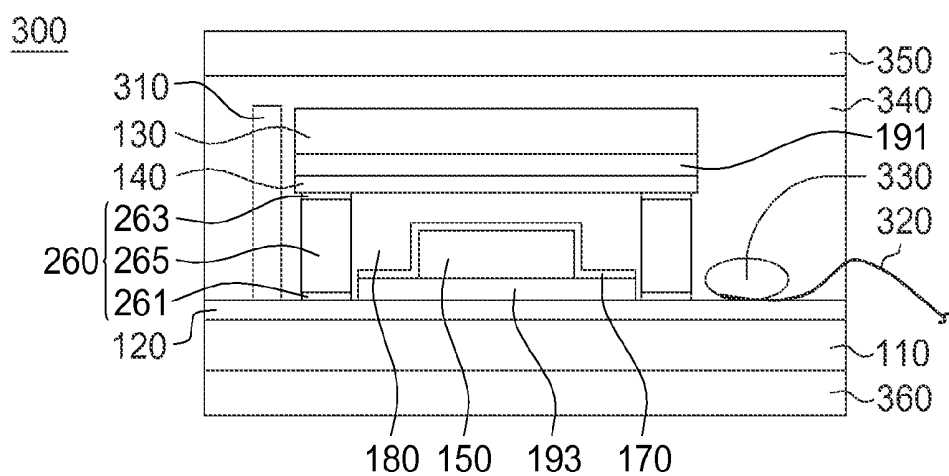


FIG. 3

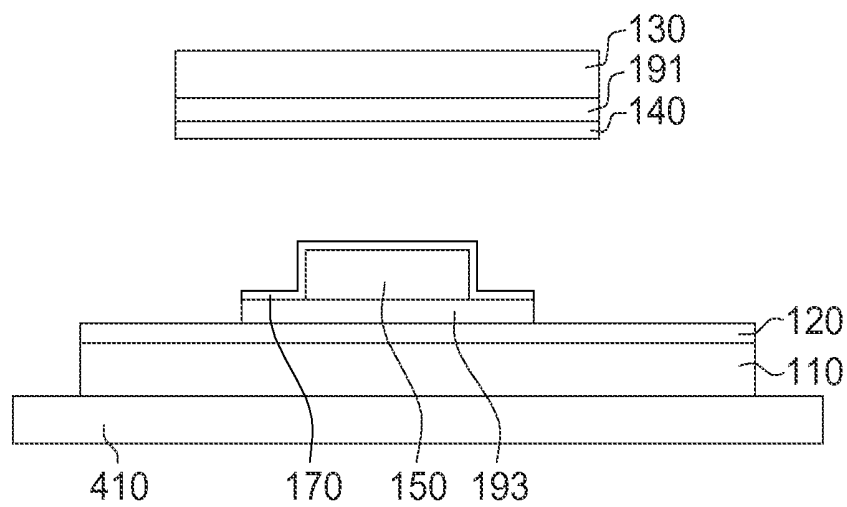


FIG. 4A

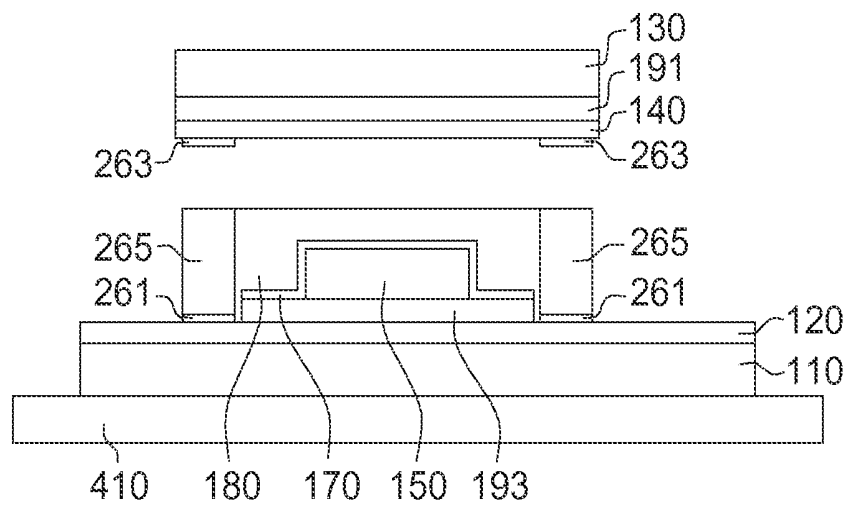


FIG. 4B

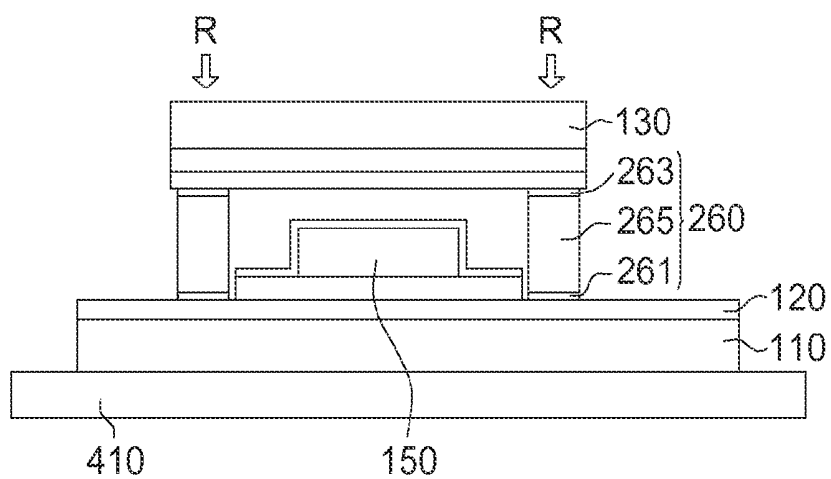


FIG. 4C

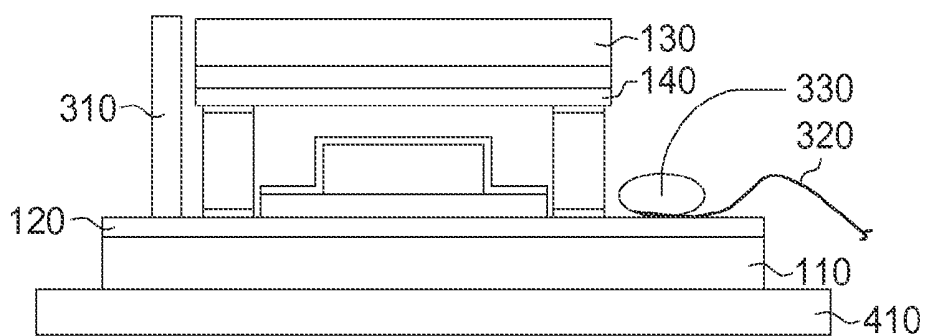


FIG. 4D

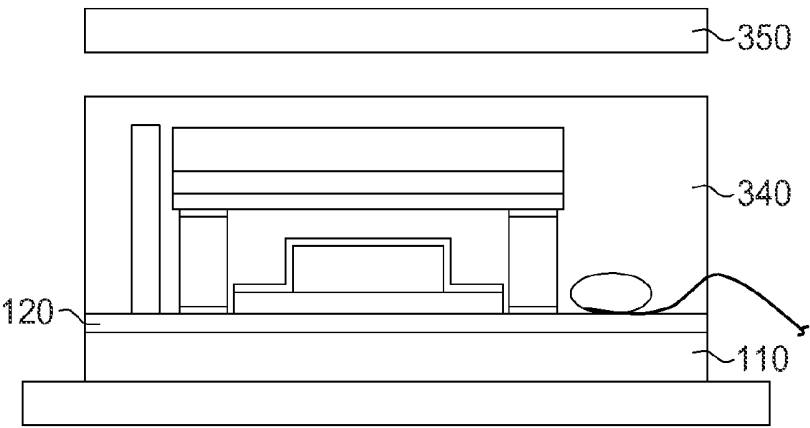


FIG. 4E

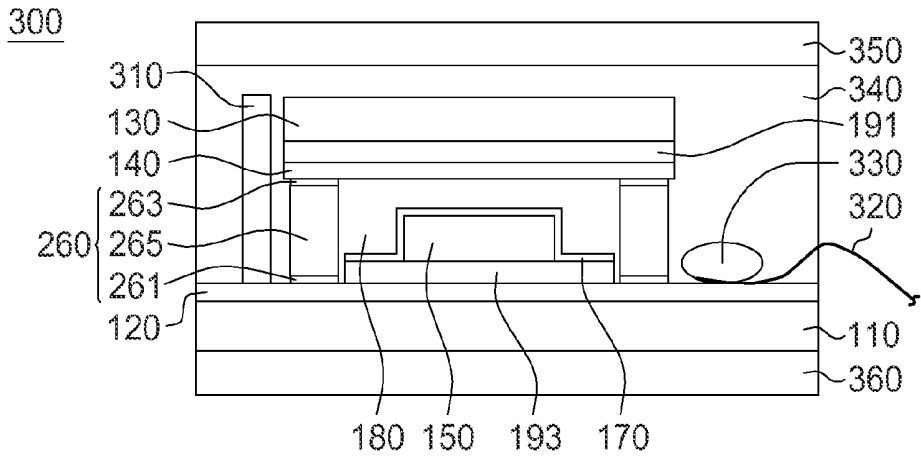


FIG. 4F

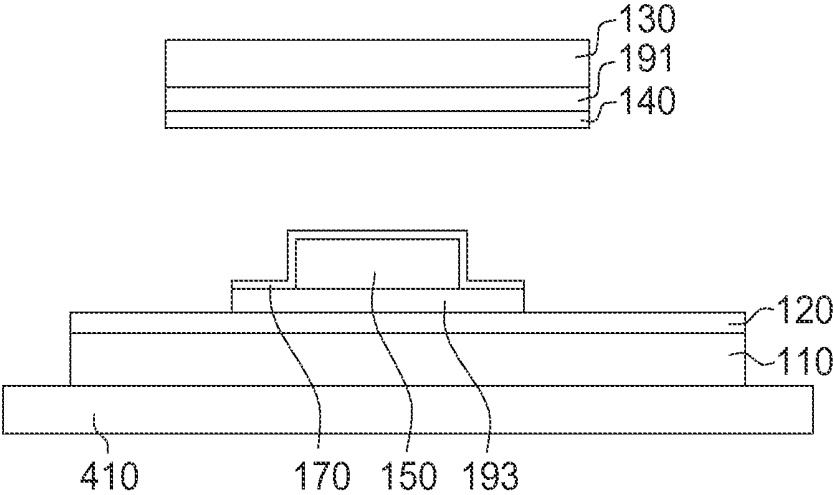


FIG. 5A

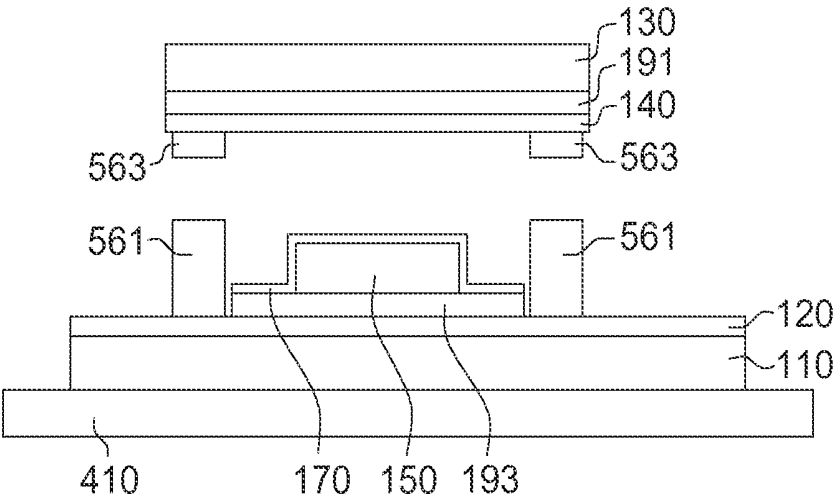


FIG. 5B

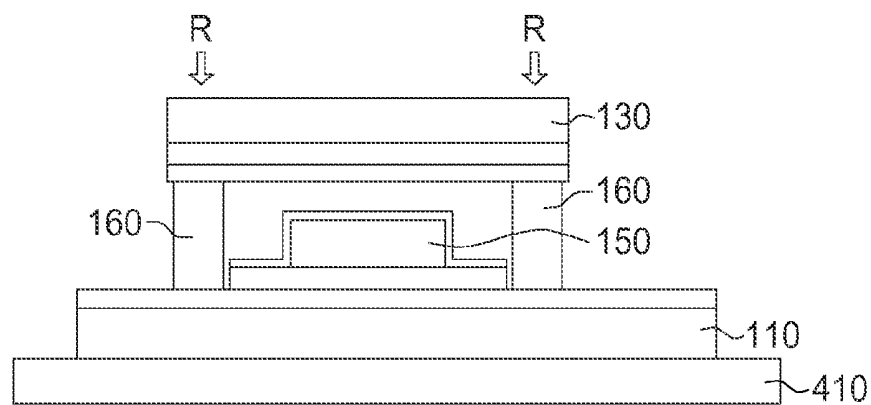


FIG. 5C

400

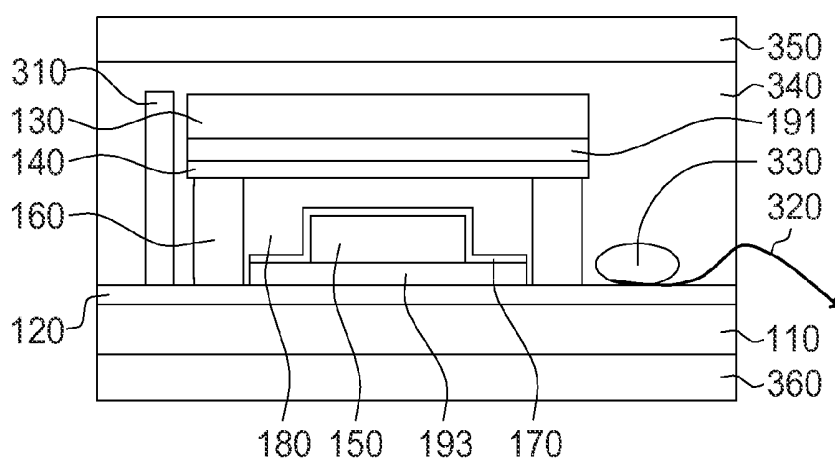


FIG. 5D

ORGANIC LIGHT EMITTING DIODE DISPLAY DEVICE AND MANUFACTURING METHOD THEREOF

[0001] This application is a continuation application of U.S. application Ser. No. 14/165,617, filed Jan. 28, 2014, which claims the benefit of Taiwan application Ser. No. 102105491, filed Feb. 18, 2013, the subject matter of which is incorporated herein by reference.

BACKGROUND

[0002] 1. Technical Field

[0003] The disclosure relates in general to an organic light emitting diode display device and a manufacturing method thereof, and particularly to an organic light emitting diode display device with superior water-oxygen resistant abilities and a manufacturing method thereof.

[0004] 2. Description of the Related Art

[0005] Along with the progress of display technology, various types of display devices have been developed, among which organic light emitting diode display devices have become one of the most important research targets of display technology. Therefore, the development and design of arranging organic light emitting diodes in flexible display devices have advanced rapidly as well.

[0006] However, organic light emitting diodes are vulnerable to the oxidation by water (moisture) and oxygen, and thus the operating functions thereof are influenced. On the other hand, despite having superior water-oxygen resistant abilities, frits are rarely adopted as barrier structures due to the difficulties of frits conforming to the requirements of flexibility of display devices. In view of that, the research and development of the resistance to water and oxygen for flexible organic light emitting diode display devices have become a huge challenge. Therefore, researchers have been working on providing flexible organic light emitting diode display devices with superior water-oxygen resistant abilities.

SUMMARY

[0007] The disclosure relates to an organic light emitting diode display device and a manufacturing method thereof. In the organic light emitting diode display device, a metal enclosing wall connects two flexible substrates and surrounds the organic light emitting diode element to form a lateral barrier structure to prevent water and oxygen penetration, together with the barrier layers disposed above and below the organic light emitting diode element, respectively, the water-oxygen resistant abilities of the whole display device can be significantly increased.

[0008] According to an aspect of the present disclosure, an organic light emitting diode (OLED) display device is provided. The organic light emitting diode display device comprises a first flexible substrate, a second flexible substrate, a first barrier layer, a second barrier layer, an organic light emitting diode element, and a metal enclosing wall. The first barrier layer is disposed on the first flexible substrate, and the second barrier layer is disposed on the second flexible substrate. The organic light emitting diode element is disposed between the first barrier layer and the second barrier layer. The metal enclosing wall connects the first flexible substrate to the second flexible substrate and surrounds the organic light emitting diode element.

[0009] According to another aspect of the present disclosure, a manufacturing method of an organic light emitting diode display device is provided. The manufacturing method includes the following steps:

[0010] providing a first flexible substrate and a second flexible substrate; disposing a first barrier layer on the first flexible substrate; disposing a second barrier layer on the second flexible substrate; disposing an organic light emitting diode element on the first flexible substrate; forming a first patterned metal layer on the first flexible substrate and forming a second patterned metal layer on the second flexible substrate; assembling the first flexible substrate to the second flexible substrate; and heating the first patterned metal layer and the second patterned layer to form a metal enclosing wall, the metal enclosing wall connecting the first flexible substrate to the second flexible substrate and surrounding the organic light emitting diode element.

[0011] According to a further aspect of the present disclosure, a manufacturing method of an organic light emitting diode display device is provided. The manufacturing method includes the following steps: providing a first flexible substrate and a second flexible substrate; disposing a first barrier layer on the first flexible substrate; disposing a second barrier layer on the second flexible substrate; disposing an organic light emitting diode element on the first flexible substrate; forming a first metal layer on the first flexible substrate and forming a second metal layer on the second flexible substrate; forming a third metal layer between the first metal layer and the second metal layer, wherein the material of the third metal layer is different from the materials of the first metal layer and the second metal layer; providing a filler covering the organic light emitting diode element; assembling the first flexible substrate to the second flexible substrate; and heating the first metal layer, the second metal layer, and the third metal layer to form a metal enclosing wall, the metal enclosing wall connecting the first flexible substrate to the second flexible substrate and surrounding the organic light emitting diode element.

[0012] The above and other aspects of the disclosure will become better understood with regard to the following detailed description of the non-limiting embodiment(s). The following description is made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1A shows a schematic diagram of the organic light emitting display device according to an embodiment of the present disclosure;

[0014] FIG. 1B shows a cross-sectional view along the section line 1B-1B' in FIG. 1A;

[0015] FIG. 2 shows a schematic diagram of the organic light emitting display device according to another embodiment of the present disclosure;

[0016] FIG. 3 shows a schematic diagram of the organic light emitting display device according to a further embodiment of the present disclosure;

[0017] FIGS. 4A-4F illustrate a process for manufacturing an organic light emitting diode display device according to an embodiment of the present disclosure; and

[0018] FIGS. 5A-5D illustrate a process for manufacturing an organic light emitting diode display device according to another embodiment of the present disclosure.

DETAILED DESCRIPTION

[0019] In the embodiments of the present disclosure, an organic light emitting diode display device and a manufacturing method thereof are provided. In the organic light emitting diode display device, a metal enclosing wall connects two flexible substrates and surrounds the organic light emitting diode element to form a lateral barrier structure to prevent water and oxygen penetration, together with the barrier layers disposed above and below the organic light emitting diode element, respectively, the water-oxygen resistant abilities of the whole display device can be significantly increased. The following embodiments are for the purpose of elaboration only, not for limiting the scope of protection of the disclosure. Detailed structures and processes may be modified or changed by one skilled in the art after having the benefit of this description of the disclosure.

[0020] Referring to FIGS. 1A-1B, FIG. 1A shows a schematic diagram of the organic light emitting display device 100 according to an embodiment of the present disclosure, and FIG. 1B shows a cross-sectional view along the section line 1B-1B' in FIG. 1A. As shown in FIGS. 1A-1B, the organic light emitting diode display device 100 comprises a first flexible substrate 110, a first barrier layer 120, a second flexible substrate 130, a second barrier layer 140, an organic light emitting diode element 150, and a metal enclosing wall 160. The first barrier layer 120 is disposed on the first flexible substrate 110, and the second barrier layer 140 is disposed on the second flexible substrate 130. The organic light emitting diode element 150 is disposed between the first barrier layer 120 and the second barrier layer 140. The metal enclosing wall 160 connects the first flexible substrate 110 to the second flexible substrate 130 and surrounds the organic light emitting diode element 150, such that the organic light emitting diode element 150 can be sealed between the first flexible substrate 110 and the second flexible substrate 130.

[0021] As shown in FIG. 1A, the second flexible substrate 130 is assembled to the first flexible substrate 110, and the metal enclosing wall 160 surrounds the organic light emitting diode element 150 to form a lateral barrier structure to prevent water and oxygen penetration. With the metal enclosing wall 160 together with the first barrier layer 120 below the organic light emitting diode element 150 and the second barrier layer 140 above the organic light emitting diode element 150, the whole display device is provided with an excellent water-oxygen resistant ability with a water vapor transmission rate (WVTR) of 10^{-6} .

[0022] As shown in FIG. 1B, the metal enclosing wall 160 may have a microstructure (not shown) formed on the surface 160b thereof connected to the first flexible substrate 110, and the metal enclosing wall 160 may further have a microstructure (not shown) formed on the surface 160a thereof connected to the second flexible substrate 130. The microstructure(s) are such as roughened surfaces. Due to the differences in the thermal expansion coefficients between layers, the holding stress between layers may result in peeling of layers; and in view of that, the microstructure(s) can compensate the stress and prevent the layers from peeling. In addition, the microstructure(s) may increase the connection between the metal enclosing wall 160 and the flexible substrates 110 and 130 as well, and the water-oxygen resistant effect can be further improved. Furthermore, the microstructure(s) formed on the connection surfaces between adjacent layers can prolong the penetration paths for water and oxygen, which can further improve the water-oxygen resistant effect as well.

[0023] In the embodiment, the material of the metal enclosing wall 160 may include a metal with a low melting point or a solid solution metal. In the embodiment, the metal with a low melting point is such as tin (Sn). In the embodiment, the solid solution metal is such as tin-gold (SnAu) alloy, tin-nickel (SnNi) alloy, tin-antimony (SnSb) alloy, tin-lead (SnPb) alloy, tin-bismuth (SnBi) alloy, and/or tin-copper (SnCu) alloy. These alloys have alloy phases formed by dissolving solute atoms into lattices of metal solvents at set ratios of the solute atoms to the metal solvents. The elements from the solute and from the solvent are miscible in both liquid phase and solid phase, forming a uniform material. In one embodiment, the tin-lead (SnPb) alloy includes such as 63% atomic ratio of tin and 37% atomic ratio of lead, and the melting point of the alloy is 183° C.

[0024] In the embodiment, the materials of the first flexible substrate 110 and the second flexible substrate 130 are retractable thin transparent substrates, such as polyimide (PI), and of which the thicknesses are about 10-15 μm . In the embodiment, the first barrier layer 120 and the second barrier layer 140 are independently silicon nitride (SiN) or stacked layers of silicon nitride and silicon oxide ($\text{SiN}_x/\text{SiO}_x$), and both have water-oxygen resistant abilities.

[0025] As shown in FIG. 1B, the organic light emitting diode display device 100 may further include a third barrier layer 170, and the third barrier layer 170 is formed on and covering the organic light emitting diode element 150.

[0026] The third barrier layer 170 is provided with water-oxygen resistant abilities, which is advantageous to preventing the organic light emitting diode element 150 from being oxidized by water and oxygen. The third barrier layer 170 is such as a silicon nitride layer or stacked layers of silicon nitride and silicon oxide.

[0027] As shown in FIG. 1B, the organic light emitting diode display device 100 may further include a filler 180. The filler 180 is filled inside the metal enclosing wall 160 and covering the organic light emitting diode element 150.

[0028] The organic light emitting diode display device 100 may further include a color filter 191 and/or a thin film transistor layer 193. In one embodiment, as shown in FIG. 1B, the organic light emitting diode element 150 is such as a white light organic light emitting diode, the color filter 191 is disposed between the second flexible substrate 130 and the organic light emitting diode 150, and the thin film transistor layer 193 is disposed between the first flexible substrate 110 and the organic light emitting diode element 150. In an alternative embodiment, the organic light emitting diode element 150 is such as a RGB organic light emitting diode, and in such case, a color filter is not required to be disposed between the second flexible substrate 130 and the organic light emitting diode element 150.

[0029] Referring to FIG. 2, FIG. 2 shows a schematic diagram of the organic light emitting display device 200 according to another embodiment of the present disclosure. As shown in FIG. 2, the present embodiment and the embodiment as shown in FIGS. 1A-1B are different in that, in the organic light emitting diode display device 200, the metal enclosing wall 260 further includes a first metal layer 261, a second metal layer 263, and a third metal layer 265. The first metal layer 261 is connected to the first flexible substrate 110, the second metal layer 263 is connected to the second flexible substrate 130, and the third metal layer 265 is formed between the first metal layer 261 and the second metal layer 263. In the embodiment, the materials of the first metal layer 261 and the

second metal layer **263** may be the same or different from each other. The material of the third metal layer **265** is different from the materials of the first metal layer **261** and the second metal layer **263**. The elements in the present embodiment sharing the same labels with those in the previous embodiment are the same elements, and the description of which is omitted.

[0030] As shown in FIG. 2, the interface **262** between the first metal layer **261** and the third metal layer **265** may have a microstructure (not shown) formed thereon, and the interface **264** between the second metal layer **263** and the third metal layer **265** may have a microstructure (not shown) formed thereon as well. The microstructures can increase the connection between the first metal layer **261**, the second metal layer **263**, and the third metal layer **265**, contributing to forming the continuous wall structure of the metal enclosing wall **260**. In other words, in the structure of the metal enclosing wall **260**, the joint surfaces between the first metal layer **261**, the second metal layer **263**, and the third metal layer **265** can be regarded as not existed; accordingly, the overall water-oxygen resistant ability is greatly improved.

[0031] In the embodiment, the thickness of the first metal layer **261** and the thickness of the second metal layer **263** are such as 300-1000 nm.

[0032] In the embodiment, the materials of the first metal layer **261** and the second metal layer **263** may include at least a conductive metal commonly used in general manufacturing processes, such as aluminum (Al), molybdenum (Mo), or aluminum-niobium (AlNb) alloy. In the embodiment, the materials of the first metal layer **261** and the second metal layer **263** may include a metal with a low melting point or a solid solution metal. The metal with a low melting point is such as tin (Sn). The solid solution metal is such as tin-gold (SnAu) alloy, tin-nickel (SnNi) alloy, tin-antimony (SnSb) alloy, tin-lead (SnPb) alloy, tin-bismuth (SnBi) alloy, and/or tin-copper (SnCu) alloy. These alloys have alloy phases formed by dissolving solute atoms into lattices of metal solvents at set ratios of the solute atoms to the metal solvents. The elements from the solute and from the solvent are miscible in both liquid phase and solid phase, forming a uniform material. In one embodiment, the tin-lead (SnPb) alloy includes such as 63% atomic ratio of tin and 37% atomic ratio of lead, and the melting point of the alloy is 183° C. In the embodiment, the material of the third metal layer **265** comprises such as an organic-inorganic mixture material, the organic-inorganic mixture material comprising an organic material portion and an inorganic material portion. The organic material portion may comprise water resistant colloid, such as epoxy or silicone; the inorganic material portion may comprise a metal with a low melting point or a solid solution metal. The metal with a low melting point is such as tin. The solid solution metal is such as tin-gold (SnAu) alloy, tin-nickel (SnNi) alloy, tin-antimony (SnSb) alloy, tin-lead (SnPb) alloy, tin-bismuth (SnBi) alloy, and/or tin-copper (SnCu) alloy.

[0033] In the embodiment, the metal enclosing wall **260** is formed by such as impregnating and uniformly distributing metal micro-particles in a raw material (e.g. colloidal material), followed by melting the metal micro-particles by such as a thermal-pressing process or a microwave process to form continuous interfaces after assembling, as such a barrier having an organic/inorganic multi-layered structure is formed. The high homogeneity between the materials of the first metal layer **261**, the second metal layer **263**, and the third metal

layer **265** is advantageous to forming the continuous wall structure of the metal enclosing wall **260** in the subsequent processes, by applying heat and pressure.

[0034] Referring to FIG. 3, FIG. 3 shows a schematic diagram of the organic light emitting display device **300** according to a further embodiment of the present disclosure. The metal enclosing wall **260** of the embodiment as shown in FIG. 2 is taken as an example for illustrating the present embodiment but not limited thereto; the metal enclosing wall **160** of the embodiment as shown in FIG. 1 may apply in the present embodiment as well. The elements in the present embodiment sharing the same labels with those in the previous embodiments are the same elements, and the description of which is omitted.

[0035] As shown in FIG. 3, the organic light emitting diode display device **300** may further include an IC component **310** or a flexible cable **320**. The organic light emitting diode display device **300** may include both the IC component **310** and the flexible cable **320** as well. The IC component **310** and the flexible cable **320** are bonded to the first flexible substrate **110**. As shown in FIG. 3, the flexible cable **320** is bonded to the first flexible substrate **110** with the solder pad **330**. In other words, the IC component **310** and the flexible cable **320** are electrically connected to the organic light emitting diode element **150** and/or the thin film transistor layer **193** with the first flexible substrate **110**.

[0036] As shown in FIG. 3, the organic light emitting diode display device **300** may further include an encapsulating glue **340**. The encapsulating glue **340** is formed on the first flexible substrate **110**. In the embodiment, the encapsulating glue **340** is water-oxygen resistant. In the embodiment, as shown in FIG. 3, the size of the second flexible substrate **130** is smaller than the size of the first flexible substrate **110**, and the encapsulating glue **340** covers the first flexible substrate **110**, the second flexible substrate **130**, and the metal enclosing wall **260**. In the embodiment, the top surface of the encapsulating glue **340** is such as planar, which is advantageous to the formation of additional films on the encapsulating glue **340** in the subsequent manufacturing processes.

[0037] As shown in FIG. 3, the organic light emitting diode display device **300** may further include a first functional film **350** and/or a second functional film **360**. The encapsulating glue **340** is provided with a sufficient adhesive ability for the first functional film **350** to be adhered directly on the encapsulating glue **340** without requiring any additional adhesive layers. In the embodiment, the thickness of the first functional film **350** is about 200-300 μm. The second functional film **360** is disposed below the first flexible substrate **110**; in the embodiment, the thickness of the second functional film **360** is lower than the thickness of the first functional film **350**. In the embodiment, the first functional film **350** and the second functional film **360** are such as transparent water-oxygen resistant films, and of which the materials are such as poly methyl methacrylate (PMMA), polyethylene terephthalate (PET), or polycarbonate (PC).

[0038] The embodiments disclosed below are for elaborating a manufacturing method of the organic light emitting diode display device of the disclosure. However, the descriptions disclosed in the embodiments of the disclosure such as detailed manufacturing procedures are for illustration only, not for limiting the scope of protection of the disclosure. People having ordinary skills in the art may modify or change the steps disclosed in the embodiments according actual needs. Referring to FIGS. 4A-4F, a process for manufacturing

an organic light emitting diode display device according to an embodiment of the present disclosure is illustrated.

[0039] As shown in FIG. 4A, a rigid carrier **410** is provided, and the first flexible substrate **110** and the second flexible substrate **130** are provided. The first flexible substrate **110** is such as formed on the rigid carrier **410**. In the embodiment, the material of the rigid carrier **410** is such as stainless steel or glass.

[0040] As shown in FIG. 4A, next, the first barrier layer **120** is disposed on the first flexible substrate **110**, the second barrier layer **140** is disposed on the second flexible substrate **130**, and the organic light emitting diode element **150** is disposed on the first flexible substrate **110**.

[0041] As shown in FIG. 4A, the thin film transistor layer **193** may be further disposed between the organic light emitting diode element **150** and the first barrier layer **120**, and the third barrier layer **170** may be further disposed on the organic light emitting diode element **150** and covering the organic light emitting diode element **150**. The third barrier layer **170** may further protect the organic light emitting diode element **150** from damage by water and oxygen, particularly in the subsequent manufacturing processes of filling liquid or colloidal filler. In the embodiment, when a white organic light emitting diode is adopted as the organic light emitting diode element **150**, the color filter **191** may further be disposed between the second barrier layer **140** and the second flexible substrate **130**.

[0042] As shown in FIG. 4B, the first metal layer **261** is formed on the first flexible substrate **110**, and the second metal layer **263** is formed on the second flexible substrate **130**. Next, the third metal layer **265** is formed between the first metal layer **261** and the second metal layer **263**, wherein the material of the third metal layer **265** is different from the materials of the first metal layer **261** and the second metal layer **263**. In the embodiment, as shown in FIG. 4B, the third metal layer **265** is such as formed on the first metal layer **261**.

[0043] In the embodiment, prior to the formation of the first metal layer **261** and the second metal layer **263**, microstructures may be formed on the surfaces on which the metal layers **261** and **263** are predetermined to be formed. In the embodiment, prior to the formation of the third metal layer **265**, microstructures may also be formed on the predetermined interfaces between the first metal layer **261**, the second metal layer **263**, and the third metal layer **265**. In the embodiment, microstructures are formed on local regions of the surfaces of the first barrier layer **120** and the second barrier layer **140** where the metal layers **261** and **263** are predetermined to be formed on, as well as on the surfaces of the first metal layer **261** and the second metal layer **263**. As such, the metal raw materials of the metal layers **261** and **263** may penetrate through the pores of the microstructures on the interfaces between layers more easily, rendering the formation of more compact structures on the interfaces between the metal layers **261**, **263** and the barrier layers **120**, **140**. Accordingly, the chances that penetration and diffusion of water and/or oxygen through the bottom of the metal enclosing wall **260** into inside the device are reduced, leading to the metal enclosing wall (lateral water-oxygen barrier structure) having excellent water-oxygen resistant abilities. Likewise, the microstructures make the structures of the interfaces between the first metal layer **261**, the second metal layer **263**, and third metal layer **265** more compact, which facilitates the formation of the seamless wall structure of the metal enclosing wall **260**,

leading to the metal enclosing wall (lateral water-oxygen barrier structure) having excellent water-oxygen resistant abilities.

[0044] In the embodiment, the first metal layer **261** and the second metal layer **263** are formed by such as opening a mask and performing a sputtering process. Compared to conventional processes of forming frits of plastic materials, which have high viscosity and suffer from a higher difficulty in penetrating through the pores on the interfaces between layers, in the embodiments of the present disclosure, the first metal layer **261** and the second metal layer **263** are formed by a gas sputtering process, and the raw materials of the metal layers are delivered to form the metal layers **261** and **263** in a layer by layer fashion, such that the liquefied metal materials, which are formed after being heated and melted, can penetrate through the pores of the interfaces between the layers more easily, leading to more compact structures of the first metal layer **261** and the second metal layer **263**. Accordingly, the chances of the penetration and diffusion of water or oxygen from the lateral side of the package into the device are reduced, and defects are not formed on the bottom of the metal enclosing wall (lateral water-oxygen barrier structure). However, as long as the patterns of the first metal layer **261** and the second metal layer **263** can be formed, the selections of manufacturing methods of the metal layers **261** and **263** may vary according to actual needs and are not limited thereto. In the embodiment, the third metal layer **265** is formed of a solder particle mixture material with high viscosity, and the third metal layer **265** is formed by, for example, coating a highly-viscous solder particle mixture material on the first metal layer **261**. The third metal layer **265** having a fixed morphology formed on the first metal layer **261** is advantageous to restricting and preventing the liquefied or colloidal filler from overflowing outside the substrates.

[0045] Next, the filler **180** is provided for covering the organic light emitting diode element **150**. In the embodiment, the liquefied or colloidal filler **180** is provided to fill inside the range enclosed by the third metal layer **265**. In the embodiment, a moisture absorbent may be further added into the filler **180** or coated on the inner walls of the first metal layer **261** and the third metal layer **265**. The filler **180**, either with a moisture absorbent added therein or not, may further absorb the residual moisture around the organic light emitting diode element **150** remained during the manufacturing processes.

[0046] As shown in FIG. 4C, the first flexible substrate **110** is assembled to the second flexible substrate **130**, and the first metal layer **261**, the second metal layer **263**, and the third metal layer **265** are heated to form the metal enclosing wall **260**. The metal enclosing wall **260** connects the first flexible substrate **110** to the second flexible substrate **130** and surrounds the organic light emitting diode element **150**, such that the organic light emitting diode element **150** is nicely sealed between the first flexible substrate **110** and the second flexible substrate **130**.

[0047] In the embodiment, prior to heating the metal layers **261**, **263**, and **265**, the filler **180** is solidified for turning it from liquefied or colloidal material to a solid material. The filler **180** is solidified before the metal layers **261**, **263**, and **265** are heated, such that as the metal layers **261**, **263**, and **265** are heated and melted, the solid filler **180** can prevent the liquefied metal layers **261**, **263**, and **265** from overflowing toward the visible area of the display device. In the embodiment, a moisture absorbent may further be added onto the surface of the filler **180**.

[0048] In the embodiment, the heating treatment is performed locally on the regions where the first metal layer 261, the second metal layer 263, and the third metal layer 265 are located. While the regions are being heated, a pressure is applied to the same regions simultaneously as well; for example, as shown in FIG. 4C, the regions are heated and pressed along the direction indicated by the arrow R. In the embodiment, the materials of the first metal layer 261, the second metal layer 263, and the third metal layer 265 have a high homogeneity, such that the first metal layer 261, the second metal layer 263, and the third metal layer 265 can form the metal enclosing wall 260 having a continuous wall structure after being heated and pressed, and hence a more compact structure is manufactured, providing a superior water-oxygen resistant effect. In the embodiment, the first metal layer 261 and the second metal layer 263 are formed of a conductive metal commonly used in general manufacturing processes, such as aluminum (Al), molybdenum (Mo), or aluminum-niobium (AlNb) alloy. In the embodiment, the materials of the first metal layer 261 and the second metal layer 263 may include a metal with a low melting point or a solid solution metal. The metal with a low melting point is such as tin (Sn). The solid solution metal is such as tin-gold (SnAu) alloy, tin-nickel (SnNi) alloy, tin-antimony (SnSb) alloy, tin-lead (SnPb) alloy, tin-bismuth (SnBi) alloy, and/or tin-copper (SnCu) alloy. These alloys have alloy phases formed by dissolving solute atoms into lattices of metal solvents at set ratios of the solute atoms to the metal solvents. The elements from the solute and from the solvent are miscible in both liquid phase and solid phase, forming a uniform material. In one embodiment, the tin-lead (SnPb) alloy includes such as 63% atomic ratio of tin and 37% atomic ratio of lead, and the melting point of the alloy is 183° C. In the embodiment, the material of the third metal layer 265 may comprise an organic-inorganic mixture material, the organic-inorganic mixture material comprising an organic material portion and an inorganic material portion. The organic material portion may comprise a water resistant colloid, such as an epoxy resin or a silicone. The inorganic material portion may comprise a metal with a low melting point or a solid solution metal, the metal with a low melting point is such as tin, and the solid solution metal may be tin-gold (SnAu) alloy, tin-nickel (SnNi) alloy, tin-antimony (SnSb) alloy, tin-lead (SnPb) alloy, tin-bismuth (SnBi) alloy, and/or tin-copper (SnCu) alloy.

[0049] In the embodiment, the manufacturing method of the metal enclosing wall 260 includes, such as, impregnating and uniformly distributing metal micro-particles into a raw material (e.g. colloidal material), followed by manufacturing processes, such as a thermal-pressing process or a microwave process, to melt the metal micro-particles and form a continuous interface after assembling, for forming a barrier with an organic/inorganic multilayered structure. In the embodiment, the first metal layer 261, the second metal layer 263, and the third metal layer 265 are heated at a temperature of lower than 230° C. and pressed at a pressure of lower than 2 MPa. In one embodiment, the first metal layer 261, the second metal layer 263, and the third metal layer 265 are heated at 180° C. and pressed at 1 MPa for about 10 seconds. However, the conditions of the heating and pressing treatments and of which the time durations may vary depending the actual applications and are not limited thereto, as long as the properties of the already-formed elements are not influenced (e.g. when the temperature is too high, the elements or the flexible substrates

may be damaged, or the layers may peel), and the metal layers 261, 263, and 265 can melt and form the metal enclosing wall 260 having a continuous wall structure.

[0050] As shown in FIG. 4D, the IC component 310 and the flexible cable 320 may further be disposed to bond to the first flexible substrate 110. The flexible cable 320 is bonded to the first flexible substrate 110 with the solder pad 330.

[0051] As shown in FIG. 4E, the encapsulating glue 340 may further be formed on the first flexible substrate 110. After the encapsulating glue 340 is coated on the first flexible substrate 110, the first functional film 350 may be further adhered to the encapsulating glue 340. The first functional film 350 is water-oxygen resistant, and the thickness of the first functional film 350 is about 200-300 μm; such thickness makes the first functional film 350 have a higher rigidity compared to the first flexible substrate 110 and the second flexible substrate 130, such that the first functional film 350 can provide a sufficient support for the device after the rigid carrier 410 is removed later, and the whole structure does not bend due to the lack of support, facilitating the proceedings of other subsequent processes (e.g. adhesion of the second functional film 360).

[0052] As shown in FIG. 4F, the rigid carrier 410 may be further removed.

[0053] Next, the second functional film 360 may be adhered below the second flexible substrate 130. As such, the organic light emitting diode display device 300 as shown in FIG. 4F (FIG. 3) is formed.

[0054] FIGS. 5A-5D illustrate a process for manufacturing an organic light emitting diode display device according to another embodiment of the present disclosure. Please refer to FIGS. 5A-5D and FIGS. 4D-4F.

[0055] As shown in FIG. 5A, the rigid carrier 410 is provided, and the first flexible substrate 110 is formed on the rigid carrier 410. Next, the first barrier layer 120 and the second barrier layer 140 are formed on the first flexible substrate 110 and the second flexible substrate 130, respectively, and the organic light emitting diode element 150 is formed on the first flexible substrate 110. Next, the third barrier layer 170, the thin film transistor layer 193, and/or the color filter 191 may be further disposed.

[0056] As shown in FIG. 5B, the first patterned metal layer 561 is formed on the first flexible substrate 110, and the second patterned metal layer 563 is formed on the second flexible substrate 130. The materials of the first patterned metal layer 561 and the second patterned metal layer 563 are the same. In the embodiment, prior to the formation of the first patterned metal layer 561 and the second patterned metal layer 563, microstructures may be formed on the surfaces where the metal layers 561 and 563 are predetermined to be formed on, such that the later-formed metal enclosing wall (lateral water-oxygen resistant structure) can be provided with superior water-oxygen resistant abilities.

[0057] In the embodiment, the first patterned metal layer 561 and the second patterned metal layer 563 are formed by such as opening a mask and performing a sputtering process. In the embodiment, the thickness of the first patterned metal layer 561 and the thickness of the second patterned metal layer 563 are about 4-5 μm.

[0058] As shown in FIG. 5C, the first flexible substrate 110 is assembled to the second flexible substrate 130, and the first patterned metal layer 561 and the second patterned metal layer 563 are heated to form the metal enclosing wall 160. The metal enclosing wall 160 connects the first flexible substrate

110 to the second flexible substrate **130** and surrounds the organic light emitting diode element **150**, such that the organic light emitting diode element **150** is nicely sealed between the first flexible substrate **110** and the second flexible substrate **130**. In the embodiment, prior to assembling the substrates, the filler **180** is further provided to cover the organic light emitting diode element **150**.

[0059] In the embodiment, the heating treatment is performed locally on the regions where the first patterned metal layer **561** and the second patterned metal layer **563** are located. While the regions are being heated, a pressure is applied to the same regions simultaneously as well; for example, as shown in FIG. 5C, the regions are heated and pressed along the direction indicated by the arrow R. In the embodiment, the materials of the first patterned metal layer **561** and the second patterned metal layer **563** are the same, such that the first patterned metal layer **561** and the second patterned metal layer **563** can form the metal enclosing wall **160** having a continuous wall structure after being heated and pressed, and hence a more compact structure is manufactured, providing a superior water-oxygen resistant effect. In the embodiment, the materials of the first patterned metal layer **561** and the second patterned metal layer **563** may include a metal with a low melting point or a solid solution metal. The metal with a low melting point is such as tin (Sn). The solid solution metal is such as tin-gold (SnAu) alloy, tin-nickel (SnNi) alloy, tin-antimony (SnSb) alloy, tin-lead (SnPb) alloy, tin-bismuth (SnBi) alloy, and/or tin-copper (SnCu) alloy. These alloys have alloy phases formed by dissolving solute atoms into lattices of metal solvents at set ratios of the solute atoms to the metal solvents. The elements from the solute and from the solvent are miscible in both liquid phase and solid phase, forming a uniform material. In one embodiment, the tin-lead (SnPb) alloy includes such as 63% atomic ratio of tin and 37% atomic ratio of lead, and the melting point of the alloy is 183° C. In the embodiment, the first patterned metal layer **561** and the second patterned metal layer **563** are heated at a temperature of lower than 230° C. and pressed at a pressure of lower than 2 MPa. However, the conditions of the heating treatment and the pressing treatments performed to the patterned metal layers **561** and **563** may vary depending the actual applications and are not limited thereto, as long as the properties of the already-formed elements are not influenced (e.g. when the temperature is too high, the elements or the flexible substrates may be damaged, or the layers may peel) and the metal layers **561** and **563** can melt and form the metal enclosing wall **160** having a continuous wall structure.

[0060] Next as described in the previous embodiments as shown in FIGS. 4D-4F, the IC component **310**, the flexible cable **320**, and the solder pad **330** are disposed, the encapsulating glue **340** is formed, the first functional film **350** is adhered, the rigid carrier **410** is removed, and the second functional film **360** is adhered. As such, the organic light emitting diode display device **400** as shown in FIG. 5D is formed.

[0061] While the disclosure has been described by way of example and in terms of the exemplary embodiment(s), it is to be understood that the disclosure is not limited thereto. On the contrary, it is intended to cover various modifications and similar arrangements and procedures, and the scope of the appended claims therefore should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements and procedures.

What is claimed is:

1. A display device, comprising:
 - a first substrate, comprising a first region and a second region adjacent to the first region;
 - a first barrier layer disposed on the first substrate;
 - a second substrate;
 - a second barrier layer disposed on the second substrate;
 - a display element disposed between the first barrier layer and the second barrier layer;
 - a metal enclosing wall connecting the first substrate and the second substrate, wherein the display element and the metal enclosing wall are disposed on the first region; and
 - a flexible cable disposed out of the metal enclosing wall and bonded on the second region.
2. The display device of claim 1, further comprising a microstructure disposed between the first substrate and the metal enclosing wall.
3. The display device of claim 2, wherein the microstructure has a roughened surface.
4. The display device of claim 2, wherein the microstructure has a plurality of pores, and a part of the metal enclosing wall is disposed in the pores of the microstructure.
5. The display device of claim 2, wherein the microstructure prolongs the penetration paths for water and oxygen.
6. The display device of claim 2, wherein the microstructure is disposed between the first barrier layer and the metal enclosing wall.
7. The display device of claim 6, wherein the microstructure has a roughened surface.
8. The display device of claim 6, wherein the microstructure has a plurality of pores, and a part of the metal enclosing wall is disposed in the pores of the microstructure.
9. The display device of claim 6, wherein the microstructure prolongs the penetration paths for water and oxygen.
10. The display device of claim 1, wherein the metal enclosing wall has a first thermal expansion coefficient, the first barrier layer has a second thermal expansion coefficient, and the first thermal expansion coefficient is different from the second thermal expansion coefficient.
11. The display device of claim 1, wherein the first substrate is a transparent substrate.
12. The display device of claim 1, wherein the flexible cable is bonded on the second region with a solder pad.
13. The display device of claim 1, wherein the IC component is bonded on the second region.

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专利名称(译)	有机发光二极管显示装置及其制造方法		
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摘要(译)

提供一种有机发光二极管显示装置及其制造方法。有机发光二极管显示装置包括第一柔性基板，第二柔性基板，第一阻挡层，第二阻挡层，有机发光二极管元件和金属封闭壁。第一阻挡层设置在第一柔性基板上，第二阻挡层设置在第二柔性基板上。有机发光二极管元件设置在第一阻挡层和第二阻挡层之间。金属封闭壁将第一柔性基板连接到第二柔性基板并围绕有机发光二极管元件。