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(54) **ENCAPSULATION UNIT AND ORGANIC LIGHT EMITTING DISPLAY DEVICE INCLUDING THE SAME**

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H01L 23/29 (2006.01)
H01L 23/31 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L 27/3241*** (2013.01); ***H01L 23/291*** (2013.01); ***H01L 23/31*** (2013.01)

(58) **Field of Classification Search**
CPC ... H01L 27/3241; H01L 23/291; H01L 23/31; H01L 23/3121; H01L 23/3135; H01L 23/3142; H01L 23/315; H01L 27/3244; H01L 51/5246; H01L 51/5253
See application file for complete search history.

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(57) **ABSTRACT**

Disclosed are an encapsulation unit which may prevent deterioration of thin film transistors so as to improve reliability and an organic light emitting display device including the same. At least one transparent oxide film is disposed under at least one of a plurality of inorganic encapsulation films disposed on a light emitting element and, thus, oxygen in the at least one transparent oxide film combines with hydrogen introduced during formation of the inorganic encapsulation films to prevent hydrogen from diffusing into the thin film transistors.

23 Claims, 4 Drawing Sheets

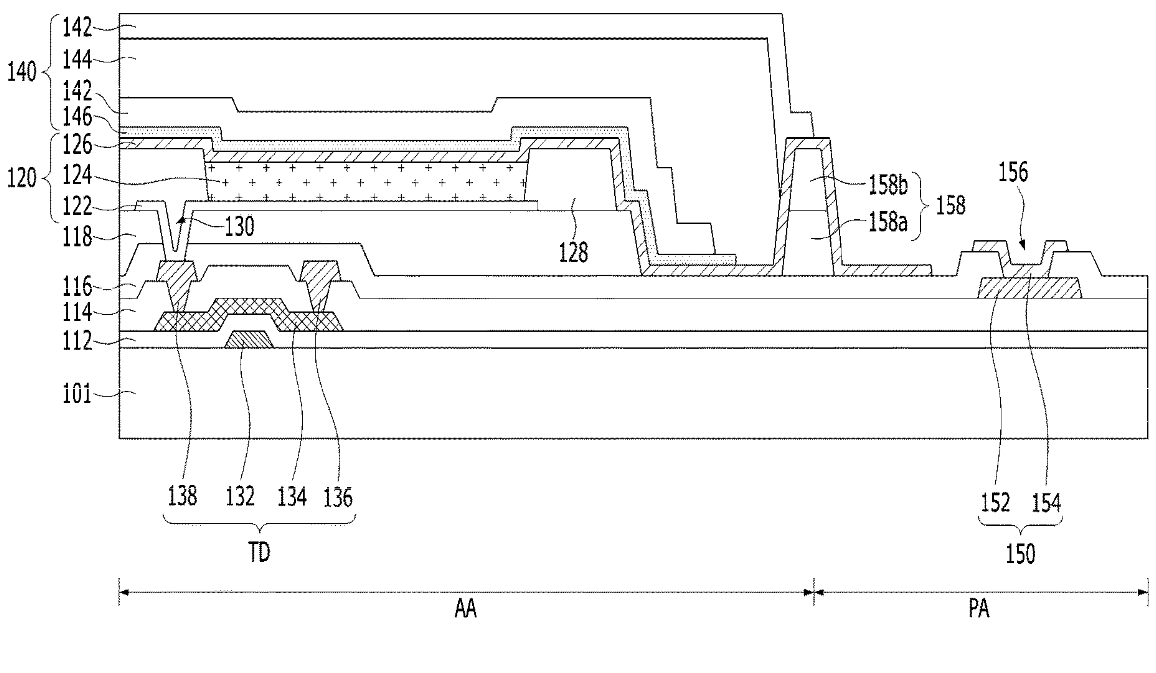


FIG. 1

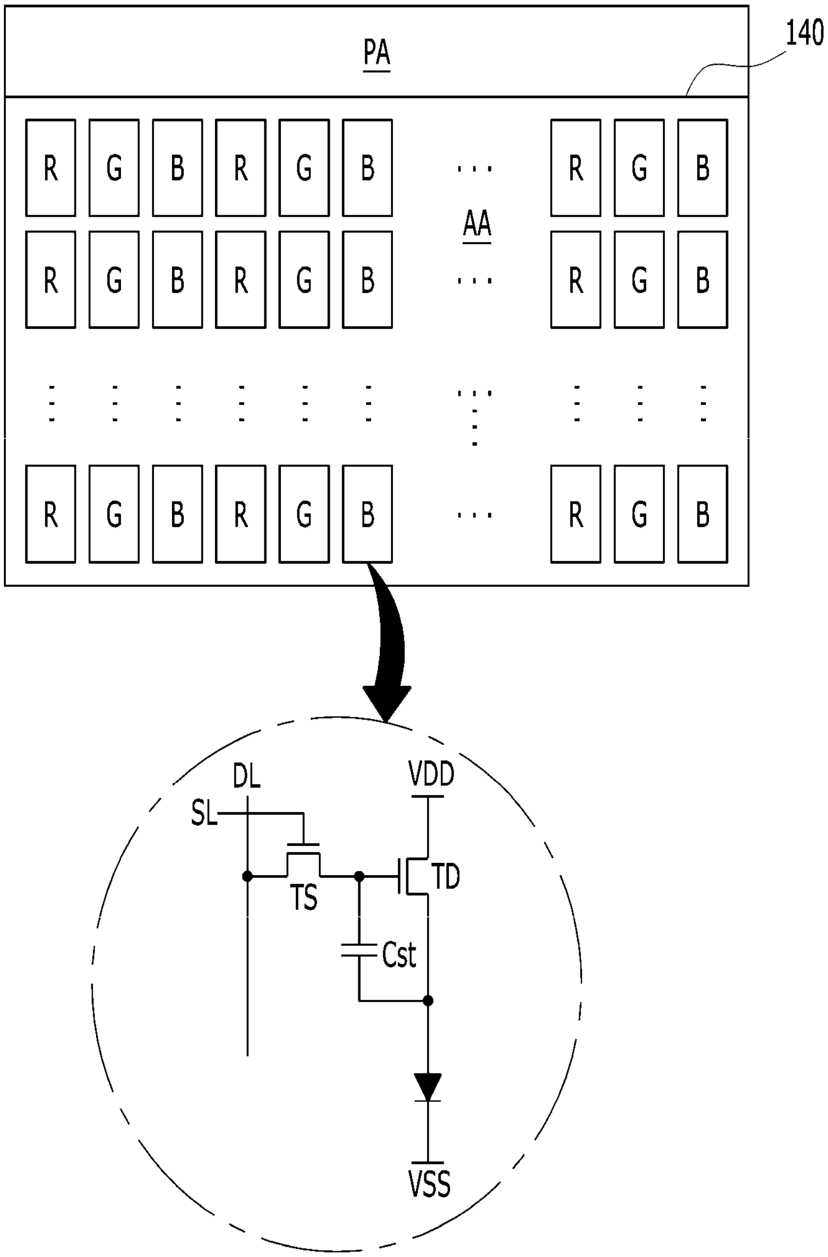


FIG. 2

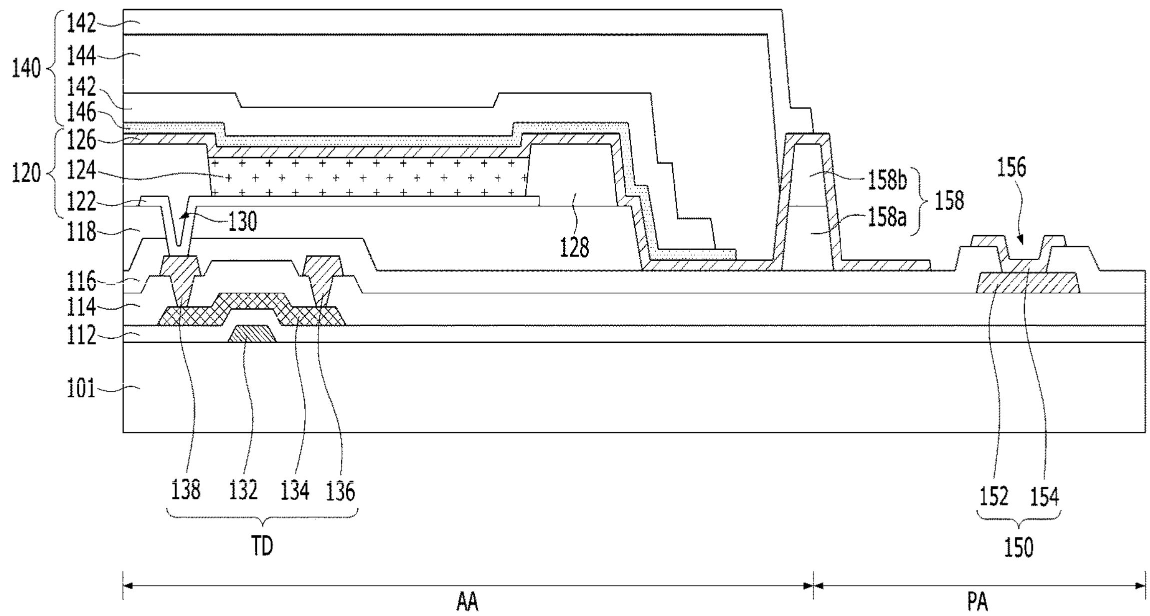
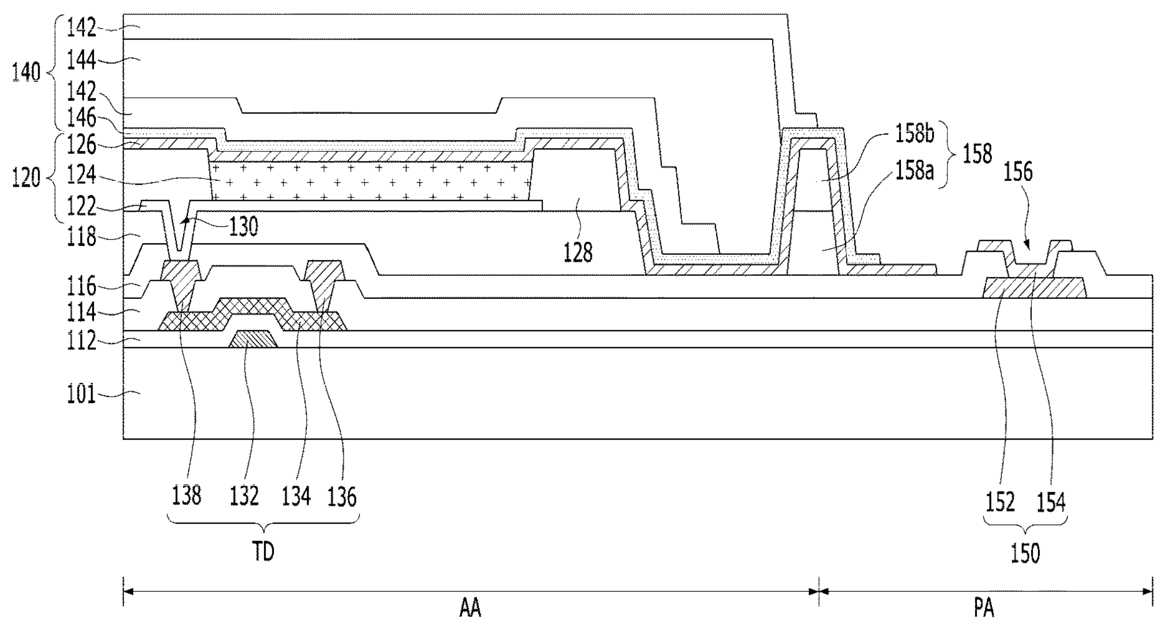

142
140
144
142
146
126
120
124
122
118
130
128
158b
158
158a
156
116
114
112
101
138
132
134
136
TD
152
154
150
AA
PA

FIG. 3A


142
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158b
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FIG. 3B

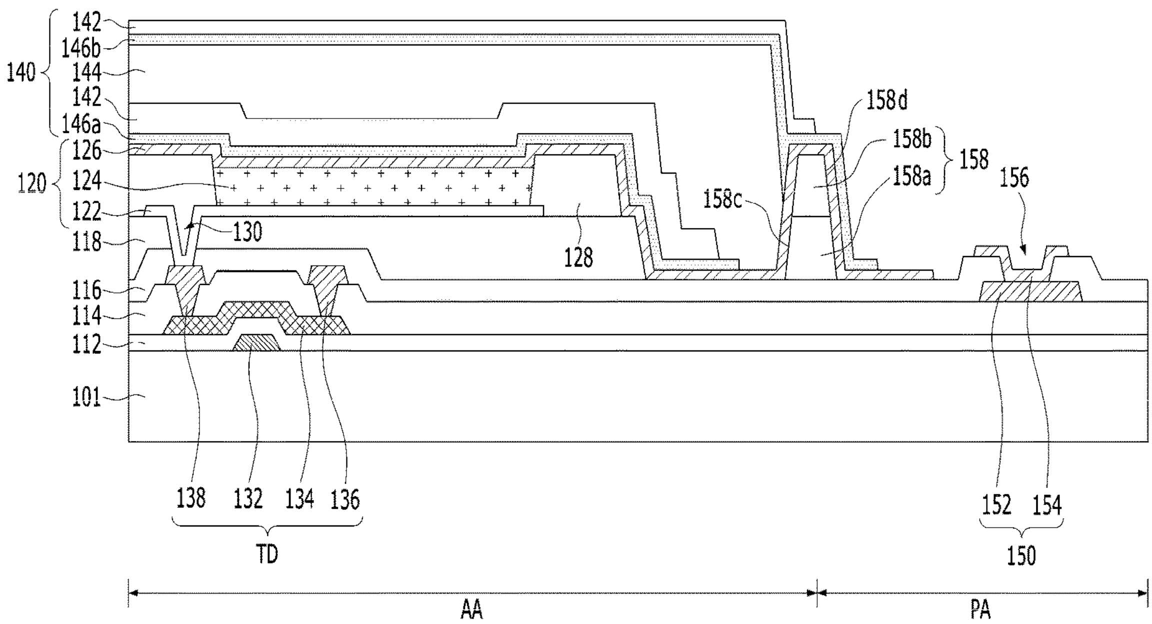
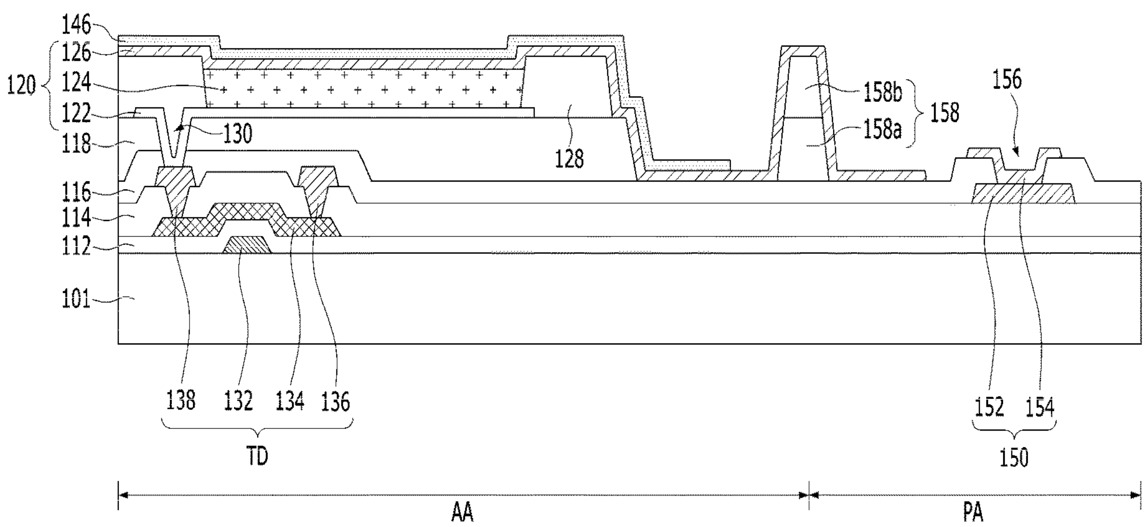

142
146b
140
144
142
146a
126
120
124
122
118
116
114
112
101
130
128
158d
158b
158
158a
156
158c
138
132
134
136
TD
152
154
150
AA
PA

FIG. 4A


146
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158b
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158a
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TD
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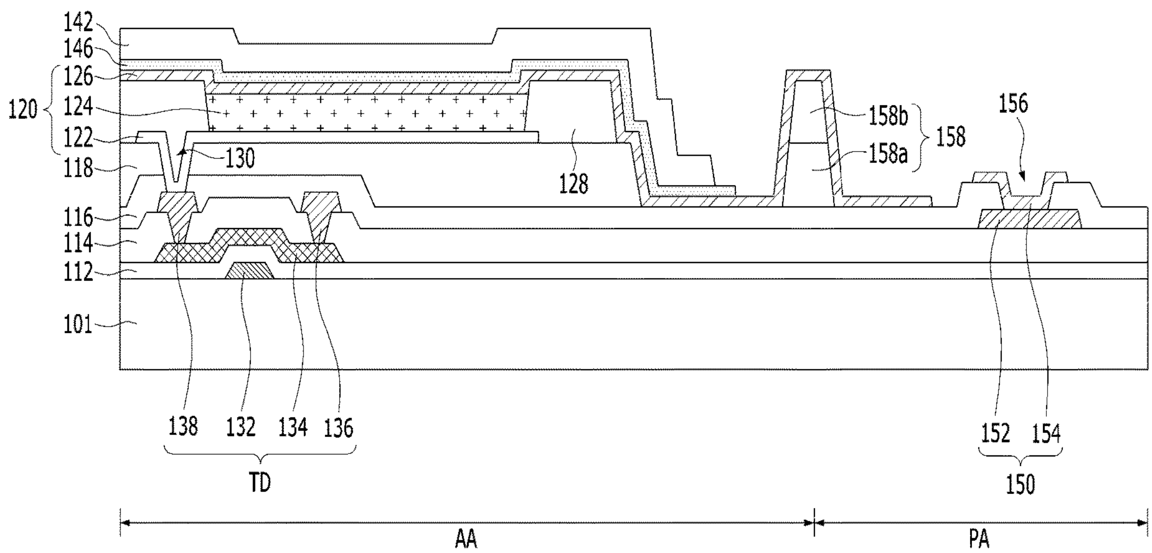
154
150
AA
PA

FIG. 4B



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158b
158a
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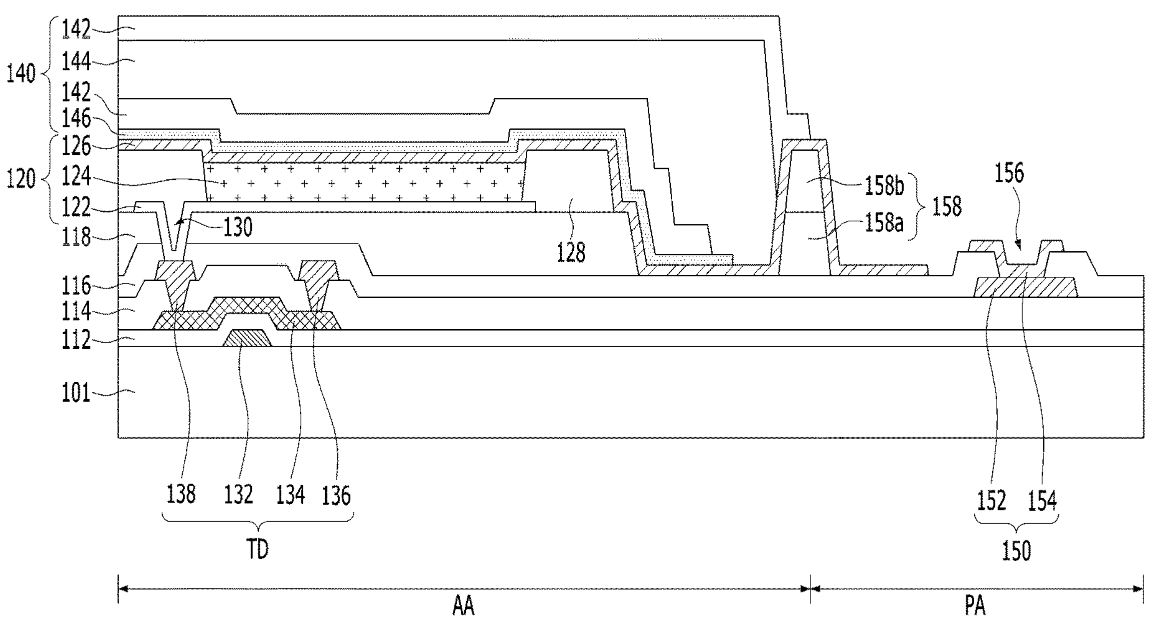
AA
PA

FIG. 4C



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ENCAPSULATION UNIT AND ORGANIC LIGHT EMITTING DISPLAY DEVICE INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from and the benefit of Korean Patent Application No. P2016-0161514, filed on Nov. 30, 2016, which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND

Technical Field

The present disclosure relates to an encapsulation unit and an organic light emitting display device including the same, and more particularly, to an encapsulation unit which prevents deterioration of thin film transistors so as to improve reliability and an organic light emitting display device including the same.

Description of the Related Art

In a flat panel display device, thin film transistors (TFTs) are used as switching elements and/or driving elements. Thin film transistors include thin film transistors using amorphous silicon, thin film transistors using polycrystalline silicon, and thin film transistors using an oxide semiconductor according to materials used as an active layer. Among all those, thin film transistors using an oxide semiconductor have higher mobility than thin film transistors using amorphous silicon, remarkably lower leakage current than thin film transistors using amorphous silicon and thin film transistors using polycrystalline silicon, and relatively high reliability. Further, thin film transistors using an oxide semiconductor are advantageous in that threshold voltage (Vth) distribution is uniform, as compared to thin film transistors using polycrystalline silicon.

A plurality of inorganic films is formed on such thin film transistors using an oxide semiconductor. If these inorganic films are grown through a PECVD process, a hydrogen content in the inorganic films is about 15 to 30%. When hydrogen contained in the inorganic films is diffused into an active layer of the thin film transistor, diffused hydrogen reacts with oxygen contained in the oxide semiconductor and, thus, characteristics (for example, threshold voltage, etc.) of the thin film transistor are changed and reliability of the thin film transistor may be lowered.

BRIEF SUMMARY

Accordingly, the present disclosure is directed to an encapsulation unit and an organic light emitting display device including the same that, among others, substantially obviate one or more problems due to limitations and disadvantages of the related art.

An object of the present disclosure is to provide an encapsulation unit which prevents deterioration of thin film transistors so as to improve reliability and an organic light emitting display device including the same.

Additional advantages, objects, and features of the disclosure will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the disclosure. The objectives and other advantages of the disclosure may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these objects and other advantages and in accordance with the purpose of the disclosure, as embodied and broadly described herein, an organic light emitting display device includes light emitting elements disposed on a substrate, and an encapsulation unit disposed on each of the light emitting elements, wherein the encapsulation unit includes a plurality of inorganic encapsulation films, at least one organic encapsulation film disposed between the inorganic encapsulation films, and at least one transparent oxide film disposed under at least one of the inorganic encapsulation films.

In another aspect of the present disclosure, an encapsulation unit includes a plurality of inorganic encapsulation films, at least one organic encapsulation film disposed between the inorganic encapsulation films, and at least one transparent oxide film disposed under at least one of the inorganic encapsulation films.

It is to be understood that both the foregoing general description and the following detailed description of the present disclosure are examples and explanatory and are intended to provide further explanation of the disclosure as claimed.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the disclosure and together with the description serve to explain the principle of the disclosure. In the drawings:

FIG. **1** is a plan view of an organic light emitting display device in accordance with the present disclosure;

FIG. **2** is a cross-sectional view of the organic light emitting display device shown in FIG. **1**;

FIGS. **3**A and **3**B are cross-sectional views of encapsulation units in accordance with various embodiments as shown in FIG. **2**; and

FIGS. **4**A to **4**C are cross-sectional views illustrating a method of manufacturing the organic light emitting display device shown in FIG. **2**.

DETAILED DESCRIPTION

Reference will now be made in detail to the preferred embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings.

FIG. **1** is a plan view of an organic light emitting display device in accordance with the present disclosure and FIG. **2** is a cross-sectional view of the organic light emitting display device shown in FIG. **1**.

The organic light emitting display device shown in FIGS. **1** and **2** is provided with a pixel array area (referred to herein as "array area") AA and a pad area PA.

In the pad area PA, a plurality of pads **150** to respectively supply driving signals to scan lines SL, data lines DL, a high voltage (VDD) supply line and a low voltage (VSS) supply line located in the array area AA is formed. The pads **150** are exposed by an encapsulation unit **140** formed to cover the array area AA. Each of the pads **150** includes a pad electrode **152** and a pad cover electrode **154**.

The pad electrode **152** is formed of the same material as at least one of a gate electrode **132** and a source electrode **136**. The pad electrodes **152** of the pads **150** are connected to signal lines including the scan lines SL, the data lines DL, the high voltage (VDD) supply line and the low voltage (VSS) supply line located in the array area AA.

The pad cover electrode **154** is conductively connected to the pad electrode **152** exposed through a pad contact hole **156** formed through a protective film **116**. Further, the pad cover electrode **154** is exposed to the outside and contacts a circuit transfer film connected to a driving circuit. Here, the pad cover electrode **154** is formed of a metal having high corrosion resistance and high acid resistance, on the protective film **116** and may thus be prevented from being corroded by external moisture even if it is exposed to the outside. For example, the pad cover electrode **154** is formed of the same material as one of an anode **122** and a cathode **126**, on the protective film **116**. That is, the pad cover electrode **154** is formed of a transparent conductive film having high corrosion resistance and high acid resistance, such as indium-tin-oxide (ITO) or indium-zinc-oxide (IZO).

The array area AA displays an image through unit pixels including light emitting elements **120**. The unit pixels include red (R) sub-pixels, green (G) sub-pixels and blue (B) sub-pixels, or include red (R) sub-pixels, green (G) sub-pixels, blue (B) sub-pixels and white (W) sub-pixels. Each sub-pixel generates color light using the light emitting element **120**, or generates color light using the light emitting element **120** emitting white light and a color filter (not shown).

Each of the sub-pixels includes a pixel driving circuit, and the light emitting element **120** connected to the pixel driving circuit.

The pixel driving circuit includes a switching thin film transistor TS, a driving thin film transistor TD and a storage capacitor Cst, or further includes a sensing transistor. The configuration of the pixel driving circuit shown in FIG. **1** is just one embodiment and the present disclosure is not limited thereto.

The switching thin film transistor TS is turned on when a scan pulse is supplied to the scan line, and supplies a data signal supplied to the data line to the storage capacitor Cst and the gate electrode **132** of the driving thin film transistor TD.

The driving thin film transistor TD controls current I supplied from the high voltage (VDD) supply line to the light emitting element **120** in response to the data signal supplied to the gate electrode **132** of the driving thin film transistor TD, thus adjusting an amount of light emitted from the light emitting element **120**. Further, even if the switching thin film transistor TS is turned off, the driving thin film transistor TD supplies constant current I due to voltage charged in the storage capacitor Cst until a data signal of a next frame is supplied, and thus maintains emission of light from the light emitting element **120**.

The driving thin film transistor TD includes the gate electrode **132**, an active layer **134**, the source electrode **136** and a drain electrode **138**.

The gate electrode **132** is formed on a substrate **101** and overlaps the active layer **134** with a gate insulating film **112** interposed therebetween. The gate electrode **132** may have a single layer structure including one selected from the group of molybdenum (Mo), aluminum (Al), chrome (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd) and copper (Cu) or an alloy thereof or have a multilayer structure including the same, but the present disclosure is not limited thereto.

The active layer **134** is formed on the gate insulating film **112** so as to overlap the gate electrode **132**, thus forming a channel between the source and drain electrodes **136** and **138**. The active layer **134** is formed of an oxide semiconductor including at least one metal selected from the group consisting of Zn, Cd, Ga, In, Sn, Hf and Zr, or is formed of polycrystalline silicon or amorphous silicon.

The source and drain electrodes **136** and **138** are formed so as to be opposite each other across the channel **134** of the active layer **134**. The source and drain electrodes **136** and **138** are formed on an interlayer insulating film **114** so as to have a single layer structure or a multilayer structure including one selected from the group of molybdenum (Mo), aluminum (Al), chrome (Cr), gold (Au), titanium (Ti), nickel (Ni), neodymium (Nd) and copper (Cu) or an alloy thereof, but the present disclosure is not limited thereto. The interlayer insulating film **114** to cover the active layer **134** exposed between the source and drain electrodes **136** and **138** is formed on the gate insulating film **112**, and the interlayer insulating film **114** protects the active layer **134** from oxygen, moisture, etc. and thus prevents damage to the active layer **134**. Instead of the interlayer insulating film **114** formed on the gate insulating film **112**, an etch stopper to cover only a region of the active layer **134** exposed between the source and drain electrodes **136** and **138** may be provided.

The light emitting element **120** includes the anode **122**, at least one light emitting stack **124** formed on the anode **122**, and the cathode **126** formed on the light emitting stack **124**. If the anode **122** is a transflective electrode and the cathode **126** is a reflective electrode, the organic light emitting display device is a rear emission type light emitting structure in which light is emitted from the rear surface of the substrate **101**. If the anode **122** is a reflective electrode and the cathode **126** is a transflective electrode, the organic light emitting display device is a front emission type light emitting structure in which light is emitted from the front surface of an encapsulation unit **140**. In the present disclosure, the anode **122** formed as a reflective electrode and the cathode **126** formed as a transflective electrode will be described as an illustrative example.

The anode **122** is conductively connected to the drain electrode **138** of the driving thin film transistor TD exposed through a pixel contact hole **130** formed through the protective film **116** and a planarization film **118**. If the anode **122** is applied to a front emission type light emitting structure, the anode **122** is formed to have a multilayer structure in which an opaque conductive film and a transparent conductive film formed of indium-tin-oxide (ITO) or indium-zinc-oxide (IZO) are stacked. The light emitting stack **124** is formed on the anode **122** in an emission area defined by a bank **128**. The at least one light emitting stack **124** is formed by stacking a hole related layer, an organic light emitting layer and an electron related layer on the anode **122** in regular order or in reverse order. For example, the light emitting stack **124** may include first and second light emitting stacks disposed opposite each other with a charge generation layer interposed therebetween. In this case, an organic light emitting layer of one of the first and second light emitting stacks generates blue light, and an organic light emitting layer of the other of the first and second light emitting stacks generates yellowish green light, thus producing white light through the first and second light emitting stacks. The cathode **126** is formed to be opposite the anode **122** with the light emitting stack **124** interposed therebetween. If the cathode **126** is applied to a front emission type organic light emitting display device, the cathode **126** is formed of a metal, an inorganic material, a metal mixed layer or a mixture thereof. Here, the metal forming the cathode **126** may be Ag, Mg, Yb, Li or Ca, the inorganic material may be Li_2O, CaO, LiF or MgF_2, and they assist movement of electrons so as to supply a large amount of electrons to the light emitting stack **124**. For example, the cathode **126** is formed of MgAg.

The encapsulation unit **140** prevents external moisture or oxygen from permeating into the light emitting element **120**, which is vulnerable to external moisture or oxygen. For this purpose, the encapsulation unit **140** includes at least one transparent oxide film **146**, at least two inorganic encapsulation films **142**, and at least one organic encapsulation film **144**. In an embodiment, one inorganic encapsulation film **142** is disposed as the uppermost layer of the encapsulation unit **140**, and the transparent oxide film **146** is disposed as the lowermost layer of the encapsulation unit **140**. In the present disclosure, the encapsulation unit **140** having a structure in which a transparent oxide film **146**, an inorganic encapsulation film **142**, an organic encapsulation film **144** and an inorganic encapsulation film **142** are sequentially stacked will be described as an illustrative example.

The at least one organic encapsulation film **144** is disposed between the inorganic encapsulation films **142**. The organic encapsulation film **144** is formed of an organic insulating material, such as an acrylic resin, an epoxy resin, polyimide, polyethylene or silicon oxycarbide (SiOC). The organic encapsulation film **144** formed of an organic insulating material serves a buffer to relieve stress between respective layers due to bending of the organic light emitting display device, and reinforces planarization performance of the organic light emitting display device. The organic encapsulation film **144** is formed to have a smaller line width than the organic encapsulation film **142** located on the organic encapsulation film **144**. Therefore, the upper and side surfaces of the organic encapsulation film **144** are encapsulated by the inorganic encapsulation film **142**.

If the organic encapsulation film **144** is formed through an ink jet method, at least one dam **158** forming the boundary with the organic encapsulation film **144** is formed between the pad area PA and the array area AA. The dam **158** prevents the organic encapsulation film **144** in a liquid phase from invading the pad area PA, when the organic encapsulation film **144** in the liquid phase is dropped onto the array area AA. The dam **158** is formed of the same material as at least one of the planarization layer **118**, the bank **128** and a diaphragm (not shown) simultaneously with the at least one of the planarization layer **118**, the bank **128** and the diaphragm so as to have a single layer structure or a multilayer structure. For example, the dam **158** includes a first dam layer **158*a*** formed of the same material as the planarization layer **118** simultaneously with the planarization layer **118**, and a second dam layer **158*b*** formed of the same material as the bank **128** simultaneously with the bank **128**, thus omitting an additional mask process for formation of the dam **158** and preventing increase in costs.

The inorganic encapsulation films **142** minimize or prevent permeation of moisture and gases (hydrogen and/or oxygen) into the thin film transistors TS and TD and the organic light emitting element **120**. The inorganic encapsulation films **142** are formed to cover the upper and side surfaces of the organic encapsulation film **144** disposed thereunder. These inorganic encapsulation films **142** are formed to have a single layer structure or a multilayer structure including an inorganic insulating material which may be deposited at a low temperature, such as silicon nitride (SiN_x), silicon oxide (SiO_x), silicon oxy-nitride (SiON) or aluminum oxide (Al_2O_3). Since the inorganic encapsulation films **142** are deposited at a low temperature, it is possible to prevent the light emitting stack **124**, which is vulnerable to high temperature, from being damaged during the deposition process of the inorganic encapsulation films **142**.

The transparent oxide film **146** is disposed under at least one of the inorganic encapsulation films **142**. Oxygen contained in the transparent oxide film **146** combines with hydrogen introduced when the inorganic encapsulation films **142** are formed, and thus prevents hydrogen from diffusing into the active layer **134**. Therefore, the transparent oxide film **146** may be disposed under the lowermost inorganic encapsulation film **142** out of the inorganic encapsulation films **142**. That is, the transparent oxide film **146** may be disposed between the lowermost inorganic encapsulation film **142** which is closest to the light emitting element **120**, and the cathode **126**.

Although FIG. **2** shows that the transparent oxide film **146** is disposed under the lower inorganic encapsulation films **142** and is disposed as the lowermost layer of the encapsulation unit **140**, the disclosure is not limited to this embodiment. It is possible that the transparent oxide film is disposed under the upper inorganic encapsulation films **142**, which is also included in the disclosure.

The transparent oxide film **146** is formed of a transparent material, which transmits light emitted from the light emitting element **120** and includes oxygen combining with hydrogen. For example, the transparent oxide film **146** is formed to have a single layer structure or a multilayer structure using the same material as the active layer **134**, i.e., at least one of IGZO, IZO, ITO and ZnO.

In this example, in the transparent oxide film **146**, an oxygen rate is set to be equal to or higher than a metal rate. For example, a ratio of oxygen to metal in the transparent oxide film **146** is 1:1 or more. Due to the transparent oxide film **146** in which an oxygen rate is higher than a metal rate, transmissivity of light emitted from the light emitting element **120** is increased and a combination rate of hydrogen, introduced when the inorganic encapsulation films **142** are formed, with oxygen is increased.

When oxygen in the transparent oxide film **146** combines with hydrogen and thus the oxygen rate in the transparent oxide film **146** is decreased, the transparent oxide film **146** may become conductive. The conductive transparent oxide film **146** is conductively connected to the cathode **126** and thus conductivity of the cathode **126** is increased.

Further, the transparent oxide film **146** is formed to have a thickness of 10-5,000 Å, and may be formed to have a thickness of 400-600 Å in consideration of transmissivity and deposition time. Here, if the thickness of the transparent oxide film **146** exceeds 5,000 Å, the increased thickness of the transparent oxide film **146** lowers transmissivity of light emitted from the light emitting element **120** and increases a deposition time and, thus, process efficiency is lowered. Further, if the thickness of the transparent oxide film **146** is less than 10 Å, the content of oxygen contained in the transparent oxide film **146** is lower than the content of hydrogen introduced when the inorganic encapsulation films **142** are formed and, thus, the transparent oxide film **146** does not remove hydrogen permeating into the active layer **134**.

The transparent oxide film **146** is disposed under the lowermost inorganic encapsulation film **142** of the inorganic encapsulation films **142**, as shown as an example in S **2** and **3**A, or is disposed under each of the inorganic encapsulation films **142**, as shown as an example in FIG. **3**B.

The transparent oxide film **146** shown in FIG. **2** is disposed to have a greater area than the lowermost inorganic encapsulation film **142** in the array area AA. Since the end of the transparent oxide film **146** protrudes toward the side surface of the dam **158** further or more than the end of the lowermost inorganic encapsulation film **142**, a part of the transparent oxide film **146** is exposed by the lowermost inorganic encapsulation film **142**. Oxygen contained in the part of the transparent oxide film **146** exposed by the lowermost inorganic encapsulation film **142** combines with hydrogen introduced from the outside. Therefore, the transparent oxide film **146** may prevent not only hydrogen introduced when the inorganic encapsulation films **142** are formed but also hydrogen introduced from the outside from diffusing into the active layer **134**.

The transparent oxide film **146** shown in FIG. **3**A is disposed not only in the array area AA but also in a part of the pad area PA so as to cover both side surfaces and the upper surface of the dam **158**. The transparent oxide film **146** is formed to have a greater area than the uppermost inorganic encapsulation film **142** which is farthest from the light emitting element **120**, out of the inorganic encapsulation films **142**. Since the end of the transparent oxide film **146** protrudes toward the pads **150** further or more than the end of the uppermost inorganic encapsulation film **142**, a part of the transparent oxide film **146** is exposed by the uppermost inorganic encapsulation film **142**. Oxygen contained in the part of the transparent oxide film **146** exposed by the uppermost inorganic encapsulation film **142** combines with hydrogen introduced from the outside. Therefore, the transparent oxide film **146** may prevent not only hydrogen introduced when the inorganic encapsulation films **142** are formed but also hydrogen introduced from the outside from diffusing into the active layer **134**.

The transparent oxide film **146** shown in FIG. **3**B includes a first transparent oxide film **146***a* contacting the cathode **126**, and a second transparent oxide film **146***b* contacting the organic encapsulation film **144** so as to be disposed above the first transparent oxide film **146***a*.

Since the end of the first transparent oxide film **146***a* protrudes toward the side surface of the dam **158** in the array area AA further or more than the end of the lowermost inorganic encapsulation film **142**, a part of the first transparent oxide film **146***a* is exposed by the lowermost inorganic encapsulation film **142**. The second transparent oxide film **146***b* is disposed not only in the array area AA but also in a part of the pad area PA so as to cover the outer side surface **158***d* of dam **158**. In an embodiment as shown in FIG. **2**, second transparent oxide film **146***b* cover both side surfaces of the dam **158**. Specifically, as shown in FIG. **2**, second transparent oxide film **146***b* covers partially, the upper portion, of inner side surface **158***c* and covers fully the outer side surface **158***d*. The inner side surface **158***c* and outer side surface **158***d* are defined with respect to pad **156**, **154**. Namely, the outer side surface **158***d* is closer to pad **156**, **154** than inner side surface **158***c*. It should be appreciated that it is not necessary that the second transparent oxide film **146***b* covers both side surfaces **158***c* and **158***d* of dam **158**. It is possible that the second transparent oxide film **146***b* covers **158***d* without covering side surface **158***c* of dam **158**, which is included in the disclosure. Since the end of the second transparent oxide film **146***b* protrudes toward the pads **150** further or more than the end of the uppermost inorganic encapsulation film **142**, a part of the transparent oxide film **146***b* is exposed by the uppermost inorganic encapsulation film **142**. Although FIG. **3**B illustrates the first and second transparent oxide films **146***a* and **146***b* as not contacting each other, the first transparent oxide film **146***a* may be formed to cover both side surfaces of the dam **158** and thus the first and second transparent oxide films **146***a* and **146***b* may contact each other.

Beyond the examples shown herein, in FIGS. **2**, **3**A and **3**B, other variants with respect to the relative positions of transparent oxide film **146** and inorganic encapsulation films **142** are also possible and included in the disclosure. For example, there may be multiple transparent oxide films **146** and multiple inorganic encapsulation films **142**. Each of the multiple transparent oxide films **146** is disposed under a corresponding different one of the inorganic encapsulation films **142**. Between a transparent oxide film **146** and the corresponding inorganic encapsulation film **142**, there is no other transparent oxide film **142** and/or other inorganic encapsulation film **142**. There might be some inorganic encapsulation film **142** that does not have a corresponding transparent oxide film **146** disposed therebelow.

Further each of the multiple transparent oxide film **146** may extend outward, with respect to the array area AA, beyond the corresponding one of the multiple inorganic encapsulation film **142**. And, each of the multiple transparent oxide films **146** may cover an area larger than the corresponding one of the multiple inorganic encapsulation films.

As such, oxygen contained in the first and second transparent oxide films **146***a* and **146***b* exposed by the inorganic encapsulation films **142** combines with hydrogen introduced from the outside. Therefore, the first and second transparent oxide films **146***a* and **146***b* may prevent not only hydrogen introduced when the inorganic encapsulation films **142** are formed but also hydrogen introduced from the outside from diffusing into the active layer **134**.

Hereinafter, test results of threshold voltage characteristics of a thin film transistor provided with no transparent oxide film **146** in accordance with a comparative example and a thin film transistor provided with a transparent oxide film **146** in accordance with a test example will be described as an illustrative example.

In the thin film transistor provided with no transparent oxide film **146** in accordance with the comparative example, threshold voltage is shifted by 5.1-7.3V from an initial state thereof due to hydrogen introduced when the inorganic encapsulation films **142** are formed. On the other hand, in the thin film transistor provided with the transparent oxide film **146** in accordance with the test example, the transparent oxide film **146** blocks hydrogen introduced when the inorganic encapsulation films **142** are formed and thus threshold voltage is shifted only by 0-1.25V. As such, as compared to the thin film transistor of the comparative example, in the thin film transistor of the test example of the present disclosure, change in threshold voltage of the thin film transistor in the positive direction is minimized. Therefore, in the thin film transistor of the test example of the present disclosure, Positive Bias Temperature illumination Stress (PBTiS) characteristics may be improved, as compared to the thin film transistor of the comparative example.

FIGS. **4**A to **4**C are cross-sectional views illustrating a method of manufacturing the organic light emitting display device shown in FIG. **2**.

First, as shown in FIG. **4**A, as an example, thin film transistors TS and TD having an active layer **134**, a light emitting element **120**, a dam **158** and pads **150** are formed on a substrate **101** through a plurality of mask processes. Thereafter, a transparent oxide film **146** is formed on the substrate **101** provided with the light emitting element **120** through a deposition method, such as sputtering. Here, the transparent oxide film **146** is formed of IGZO, IZO, ITO or ZnO. As shown in FIG. **4**B, an inorganic encapsulation film **142** is formed on the substrate **101** provided with the transparent oxide film **146** through a deposition method, such as Chemical Vapor Deposition (CVD), Low Pressure Chemical Vapor Deposition (LPCVD) or Plasma Enhanced Chemical Vapor Deposition (PECVD). Here, the inorganic encapsulation film **142** is formed of SiOx, SiNx or SiON. Thereafter, as shown in FIG. **4**C, an organic encapsulation film **144** is formed by coating the substrate **101** provided with the inorganic encapsulation film **142** with an organic insulating material. Here, the organic encapsulation film **144** is formed of an organic insulating material, such as an acrylic resin, an epoxy resin, polyimide, polyethylene or silicon oxycarbide (SiOC). Thereafter, another inorganic encapsulation film **142** is formed on the substrate **101** provided with the organic encapsulation film **144** through the above-described deposition, thus forming an encapsulation unit **140** having a multilayer structures. Thereafter, a protective film (not shown) is attached to the upper and side surfaces of the encapsulation unit **140** by an adhesive layer.

Although the organic light emitting display device including pixel driving circuits, each of which includes a switching thin film transistor TS and a driving thin film transistor TD, is described as an example, each of the pixel driving circuits of the organic light emitting display device in accordance with the present disclosure may further include a sensing transistor to sense threshold voltage of the driving thin film transistor TD.

As apparent from the above description, an organic light emitting display device in accordance with the present disclosure includes a transparent oxide film disposed between a cathode of a light emitting element and the lowermost inorganic encapsulation film closest to the light emitting element out of inorganic encapsulation films of an encapsulation unit. Therefore, oxygen in the transparent oxide film combines with hydrogen introduced when the inorganic encapsulation films are formed and thus hydrogen is prevented from permeating into thin film transistors, thereby preventing deterioration of the thin film transistors and improving reliability of the organic light emitting display device.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present disclosure without departing from the spirit or scope of the disclosure. Thus, it is intended that the present disclosure cover the modifications and variations of this disclosure provided they come within the scope of the appended claims and their equivalents.

The various embodiments described above can be combined to provide further embodiments. All of the U.S. patents, U.S. patent application publications, U.S. patent applications, foreign patents, foreign patent applications and non-patent publications referred to in this specification and/or listed in the Application Data Sheet are incorporated herein by reference, in their entirety. Aspects of the embodiments can be modified, if necessary to employ concepts of the various patents, applications and publications to provide yet further embodiments.

These and other changes can be made to the embodiments in light of the above-detailed description. In general, in the following claims, the terms used should not be construed to limit the claims to the specific embodiments disclosed in the specification and the claims, but should be construed to include all possible embodiments along with the full scope of equivalents to which such claims are entitled. Accordingly, the claims are not limited by the disclosure.

The invention claimed is:

1. An organic light emitting display device comprising:

light emitting elements disposed on an array area of a substrate, the light emitting elements including an anode, a cathode and an organic light emitting layer positioned between the anode and the cathode; and

an encapsulation unit disposed on each of the light emitting elements, the encapsulation unit including:

a plurality of inorganic encapsulation films;

at least one organic encapsulation film disposed between the inorganic encapsulation films;

at least one transparent metal oxide film disposed under at least one of the inorganic encapsulation films and over an upper one of the anode or the cathode of the light emitting elements; and

a dam forming a boundary of the at least one organic encapsulation film, the at least one transparent metal oxide film including a first transparent metal oxide film that is positioned within the boundary formed by the dam, and the upper one of the anode or the cathode of the light emitting elements extends beyond the dam.

2. The organic light emitting display device according to claim **1**, wherein the at least one transparent metal oxide film is disposed between a cathode of each of the light emitting elements and a lowermost inorganic encapsulation film that is closest to the cathode, out of the inorganic encapsulation films.

3. The organic light emitting display device according to claim **1**, wherein the at least one transparent metal oxide film includes multiple transparent oxide films each disposed under a corresponding different one of the inorganic encapsulation films.

4. The organic light emitting display device according to claim **1**,

wherein the at least one transparent metal oxide film protrudes toward the dam further than the lowermost inorganic encapsulation film out of the inorganic encapsulation films.

5. The organic light emitting display device according to claim **1**, further comprising:

a pad disposed in a pad area of the substrate.

6. The organic light emitting display device according to claim **5**,

wherein the at least one transparent metal oxide film includes a second transparent metal oxide film that is disposed to cover an upper surface and an outer side surface of the dam that is proximal to the pad.

7. The organic light emitting display device according to claim **1**, wherein the at least one transparent metal oxide film contacts a cathode of each of the light emitting elements.

8. The organic light emitting display device according to claim **1**, further comprising:

a thin film transistor connected to each of the light emitting elements,

wherein the at least one transparent metal oxide film is composed of a same material as an active layer of the thin film transistor.

9. The organic light emitting display device according to claim **1**, wherein the at least one transparent metal oxide film is formed of at least one of IGZO, IZO, ITO or ZnO.

10. The organic light emitting display device according to claim **1**, wherein:

the at least one transparent metal oxide film includes metal elements and oxygen elements with an oxygen to metal ratio greater than 1:1.

11. The organic light emitting display device according to claim 1, wherein the at least one transparent metal oxide film each has a thickness of 10 Å-5,000 Å.

12. An encapsulation unit comprising:

a plurality of inorganic encapsulation films;

at least one organic encapsulation film disposed between the inorganic encapsulation films; and

at least one transparent metal oxide film disposed under at least one of the inorganic encapsulation films, the at least one transparent metal oxide including an extension portion extending laterally outward beyond the at least one inorganic encapsulation film that is positioned above the at least one transparent oxide,

wherein the extension portion overlaps with the at least one organic encapsulation film beyond the at least one inorganic encapsulation film that is positioned above the at least one transparent oxide.

13. The encapsulation unit according to claim 12, wherein the at least one transparent metal oxide film is disposed under a lowermost inorganic encapsulation film of the inorganic encapsulation films.

14. The encapsulation unit according to claim 12, wherein the at least one transparent metal oxide film includes multiple transparent oxide films each disposed under a corresponding different one of each of the inorganic encapsulation films.

15. The encapsulation unit according to claim 12, wherein the at least one transparent metal oxide film is formed of IGZO, IZO, ITO or ZnO.

16. The encapsulation unit according to claim 12, wherein:

the at least one transparent metal oxide film includes metal elements and oxygen elements with an oxygen to metal ratio greater than 1:1.

17. The encapsulation unit according to claim 12, wherein the at least one transparent metal oxide film has a thickness of 10 Å-5,000 Å.

18. The encapsulation unit according to claim 14, wherein each of the multiple transparent metal oxide films extends outward beyond the corresponding one of the plurality of inorganic encapsulation films.

19. The encapsulation unit according to claim 14, wherein each of the multiple transparent metal oxide films covers an area larger than the corresponding one of the plurality of inorganic encapsulation films.

20. The organic light emitting display device according to claim 5, wherein the at least one transparent oxide metal film includes a second one transparent metal oxide film that protrudes toward the pad further than an uppermost inorganic encapsulation film out of the inorganic encapsulation films.

21. The organic light emitting display device according to claim 1, wherein the at least one transparent metal oxide film includes:

the first transparent metal oxide film protruding toward the dam further than a lowermost inorganic encapsulation film that is closest to the light emitting element, out of the inorganic encapsulation films, within the array area of substrate; and

a second transparent oxide film disposed on the first transparent oxide film and protruding toward the pad further than an uppermost inorganic encapsulation film out of the inorganic encapsulation films.

22. The organic light emitting display device according to claim 1, further comprising:

a thin film transistor connected to each of the light emitting elements,

wherein the pad includes:

a pad electrode formed on a same layer with a source electrode or a drain electrode of the thin film transistor; and

a pad cover electrode in contact with the pad electrode.

23. The organic light emitting display device according to claim 22, wherein the pad cover electrode is in a same layer with the transparent metal oxide film.

* * * * *

专利名称(译)	封装单元和包括该封装单元的有机发光显示装置		
公开(公告)号	US10553658	公开(公告)日	2020-02-04
申请号	US15/815282	申请日	2017-11-16
[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	OH JAE YOUNG		
发明人	OH, JAE-YOUNG		
IPC分类号	H01L27/32 H01L23/31 H01L23/29		
CPC分类号	H01L23/31 H01L27/3241 H01L23/291 H01L27/3244 H01L51/5253 H01L51/5256 H01L51/5246		
审查员(译)	布拉德福德PETER		
优先权	1020160161514 2016-11-30 KR		
其他公开文献	US20180151642A1		
外部链接	Espacenet		

摘要(译)

公开了一种可以防止薄膜晶体管劣化从而提高可靠性的封装单元以及包括该封装单元的有机发光显示装置。 至少一个透明氧化膜设置在设置在发光元件上的多个无机封装膜中的至少一个下方，因此，至少一个透明氧化膜中的氧与在无机封装膜形成过程中引入的氢结合， 防止氢扩散到薄膜晶体管中。