

ANHYDROUS METHOD OF PACKAGING ORGANIC LIGHT EMITTING DISPLAYS

Cross Reference to Related Applications

This application relates to and claims priority on U.S. Provisional Application Serial No. 60/052,239, entitled "ANHYDROUS ORGANIC LIGHT EMITTING DEVICE DISPLAY PACKAGING METHOD," filed on July 11, 1997.

5 Field of the Invention

The present invention relates to organic light emitting devices. In particular, the present invention relates to a method of moisture-free packaging an organic light emitting display ("OLED"). Additionally, the present invention is directed to a sealed OLED.

Background of the Invention

10 Organic light emitting devices have been known for approximately two decades. All OLEDs work on the same general principles. An OLED is typically a thin filmed structure formed on a substrate such as soda-lime glass or silicon. A light-emitting layer of a luminescent organic solid, as well as adjacent semiconductor layers, are sandwiched between a cathode and an anode. The semiconductor layers may be hole-injecting or electron-injecting
15 layers. The light-emitting layer may be selected from any of a multitude of fluorescent organic solids. The light-emitting layer may consist of multiple sublayers.

When a potential difference is applied across the device, negatively charged electrons move from the cathode to the electron-injecting layer and finally into the layer(s) of organic material. At the same time positive charges, typically referred to as holes, move from the
20 anode to the hole-injecting layer and finally into the same organic light-emitting layer. When the positive and negative charges meet in the center layers (i.e., the semiconducting organic material), they combine, and produce photons. The wave-length -- and consequently the color -- of the photons depends on the electronic properties of the organic material in which the photons are generated.

25 The color of light emitted from the OLED device can be controlled by the selection of the organic material. White light is produced by generating and mixing blue, red and green lights simultaneously. The precise color of the light emitted by a particular structure can be controlled both by the selection of the organic material, as well as by the selection of dopants.

In a typical OLED, either the cathode or the anode is transparent. The cathode is typically constructed of a low work function material. The holes are typically injected from a high work function anode material into the organic material via a hole transport layer. Typically, the devices operate with a DC bias of 2 to 30 volts. The films may be formed by evaporation, spin casting or other appropriate polymer film-forming techniques, or chemical self-assembly. Thicknesses typically range from a few mono layers to about 1 to 2,000 angstroms.

OLEDs typically work best when operated in a current mode. The light output is much more stable for constant current drive than for a constant voltage drive. This is in contrast to many other display technologies, which are typically operated in a voltage mode.

An active matrix display using OLED technology, therefore, requires a specific pixel architecture to provide for a current mode of operation. In a typical matrix-addressed OLED device, numerous OLEDs are formed on a single substrate and arranged in groups in a regular grid pattern. Several OLED groups forming a column of the grid may share a common cathode, or cathode line. Several OLED groups forming a row of the grid may share a common anode, or anode line. The individual OLEDs in a given group emit light when their cathode line and anode line are activated at the same time.

OLEDs have a number of beneficial characteristics. These include a low activation voltage (about 5 volts), fast response when formed with a thin light-emitting layer, and high brightness in proportion to the injected electric current. OLEDs also provide high visibility due to self-emission, as well as superior impact resistance, and ease of handling of the solid state devices in which they are used. OLEDs, have practical application in television, graphic display systems, and digital printing.

Although substantial progress has been made in the development of OLEDs to date, substantial additional challenges remain. For example, the class of devices continue to face a general series of problems associated with their long-term stability. In particular, the sublimed organic film may undergo recrystallization or other structural changes that adversely affect the emissive properties of the device.

Exposure to air and moisture presents unique problems with respect to OLEDs. OLEDs must be protected from the atmosphere, since exposing a conventional OLED to the atmosphere will shorten its life. The fluorescent organic material in the light-emitting layer

will react with water vapor, oxygen, etc. Lifetimes of 5,000 to 35,000 hours have been obtained for evaporated films at 1,000 - 2,000 cd/m² and greater than 5,000 hours for polymers. These values, however, are typically reported for room temperature operation in the absence of water vapor and oxygen. Lifetimes associated with operations outside these conditions are much shorter.

Similarly, the low work function cathode is susceptible to oxidation by either water vapor or oxygen. Electroluminescence from these oxidized spots is typically lower than other areas. It is suspected that the oxidation induces delamination of the device. Moisture and oxygen may cause a reduction in the useful life of the light-emitting device. The anode may also be affected by oxidation.

The penetration of oxygen and moisture into the interior of the OLED may result in the formation of metal oxide impurities at the metal-organic material interface. These metal oxide impurities may cause separation of the cathode or anode from the organic material in a matrix addressed OLED. Oxidation sensitive cathode materials such as Mg-Ag or Al-Li are especially susceptible. The result may be dark, non-emitting spots at the areas of separation due to a lack of current flow.

Edge shorting between the cathode and anode layers is another major problem affecting most conventional OLED devices. Edge shorting reduces the illumination potential of the display devices.

To obtain a practical, usable OLED, it is necessary to protect the device, so that water, oxygen, etc., do not infiltrate the light-emitting layer or oxidize the electrodes. Methods commonly employed for protecting or sealing inorganic electroluminescent devices are typically not effective for sealing OLED. For example, when the "silicon oil method," sometimes used for sealing inorganic electroluminescent devices, is used on an OLED, the silicon oil infiltrates the light-emitting layer, the electrodes, and any hole-injecting or electron-injecting layers. It alters the organic light-emitting layer, reducing or eliminating its light emission properties.

Likewise, resin coatings that have been used to protect inorganic EL devices are also not suited for OLEDs. The solvent used in the resin coating solution tends to infiltrate the light-emitting layer, degrading the light emission properties of the device. Most of these organic coatings also have a high permeability to water.

One method currently employed with OLEDs consists of depositing a film of an electrically insulating polymer on an outer surface of the OLED, however, the lifetime of an OLED sealed in this manner is limited due to water permeability. Evaporated metal films are also used to seal OLEDs in a similar manner. To avoid pinholes these films must be relatively thick and hence result in poor light transmission.

Accordingly, there is a need for a method of sealing an OLED that does not add manufacturing complexity or expense. The present invention meets this need, and provides other benefits as well.

Objects of the Invention

It is therefore an object of the present invention to provide a sealing method for obtaining a moisture free OLED.

It is a further object of the present invention to provide a method and apparatus for sealing an OLED which minimizes moisture leakage to the device structure.

It is still another object of the present invention to provide a method and apparatus to provide for the capture of residual reactive gas in an OLED in order to provide additional moisture removal after manufacture.

It is yet another object of the present invention to provide a method and apparatus for sealing an OLED that has low moisture and oxygen permeability.

It is still a further object of the present invention to provide an OLED with a reduced amount of moisture contained within the layers of the device.

It is a further object of the present invention to provide an OLED with an amount of reactive gas contained within the layers of the device.

It is still another object of the present invention to provide a sealed OLED.

Additional objects and advantages of the invention are set forth, in part, in the description which follows, and, in part, will be apparent to one of ordinary skill in the art from the description and/or from the practice of the invention.

Summary of the Invention

In response to the foregoing challenges, Applicants have developed an innovative process for fabricating an OLED. The process includes a method for removing moisture from the OLED structure through the introduction of a gas which reacts with water vapor. In summary, the applicants invention includes a method for removing water vapor from within

an organic light emitting device comprising the steps of: providing an organic light emitting device comprising upper and lower plates; providing a separation between the upper and lower plates; introducing a reactive gas between the upper and lower plates; bringing the upper and lower plates together; and sealing the upper and lower plates.

5 The upper plate of the organic light emitting device may comprise a glass layer and a conductor layer, and the lower plate of the organic light emitting device may comprise a substrate, conductor pad and at least one layer of organic light emitting material. The upper plate's components may be baked prior to introducing the reactive gas in order to remove additional moisture. The method of the present invention contemplates the use of trimethyl
10 aluminum (TMA) as the reactive gas.

The method of the present invention may also include the step of sealing the upper and lower plates using a sealing gasket. The sealing gasket may be formed by melting a gold rim on the upper plate and a gold rim on the lower plate. When the plates are forced together the rims contact each other forming a tight seal upon cooling.

15 The present invention's innovative process may be conducted with the upper and lower plates in a chamber. The chamber is evacuated and the device fabricated. As an alternative to chamber evacuation the present invention contemplates flooding the chamber with an inert gas.

The present invention may also be characterized as a method of removing moisture
20 from an organic light emitting device comprising the steps of: providing an organic light emitting device with upper and lower plates; reducing the pressure surrounding the device below atmospheric pressure; introducing a reactive gas between the upper and lower plates; applying a force and bringing the upper and lower plates together; and sealing the upper and lower plates. The force applied to the center of the upper and lower plates bows the plates so
25 that the outer edges do not initially contact one another.

The method includes introducing the reactive gas after the plates are forced together. The method also includes the use of a hermetic organic adhesive seal around the edges of the plates. The seal includes a metal layer evaporated on the outside edge of the adhesive seal. In order to remove additional moisture, at least one of the plates is heated prior to their sealing
30 together.

The lower plate may comprise a substrate upon which a plurality of organic light emitting devices are mounted, and the upper plate may comprise a glass cover corresponding to the plurality of organic light emitting devices. Following their sealing, the plates may be scribed and separated in order to obtain a plurality of light emitting devices.

5 The inventive organic light emitting device formed by the aforementioned methods comprises the following components: a substrate having a perimeter; a first conductor layer located above said substrate; at least one layer of organic light emitting material, wherein the organic material is located on top of the first conductor layer; a top cover layer having a perimeter; a second conductor layer located adjacent and below the top cover layer; a top
10 conductor layer, wherein the top conductor layer is positioned under the second conductor layer and on top of the layer(s) of organic material; a sealing rim located around the perimeter of the substrate and the perimeter of the cover layer. The sealing rim connects the substrate to the top cover layer and seals the layers located therebetween. The device also includes an amount of trapped reactive gas within the various layers.

15 The device may further include a layer of getter material located between the top conductor layer and the second conductor layer. The substrate layer may include circuitry for controlling the emission of light from the layer of organic material. The substrate layer may also include a plug connecting the second conductor layer to the circuitry.

20 It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory only, and are not restrictive of the invention as claimed. The accompanying drawings, which are incorporated herein by reference and which constitute a part of this specification, illustrate certain embodiments of the invention, and together with the detailed description serve to explain the principles of the present invention.

25 **Brief Description of the Drawings**

The invention will be described in conjunction with the following drawings in which like reference numerals designate like elements and wherein:

Fig. 1 is a cross-sectional side view of an organic light emitting device with top hole injection fabricated according to the process of the present invention;

Fig. 2 is a cross-sectional side view of an alternative embodiment of an organic light emitting device with bottom hole injection fabricated according to the process of the present invention;

5 Fig. 3 is a cross-sectional side view of another alternative embodiment of an organic light emitting device fabricated according to the present invention;

Fig. 4 is a cross-sectional side view of another alternative embodiment of an organic light emitting device fabricated according to the present invention;

Fig. 5 is a cross-sectional side view of another alternative embodiment of an organic light emitting device fabricated according to the present invention; and

10 Fig. 6 is a partial cross-sectional view showing the introduction of a reactive gas between the upper and lower plates of the device.

Detailed Description of the Invention

Fig. 1 depicts an organic light emitting device 100 according to the present invention. The device 100 has a transparent glass cover or top plate 101 and a substrate 104. Sandwiched
15 between the substrate 104 and the top plate 101 are the hole and electron injecting conductors and light emitting organic material. A top conductor layer 110 overlies a layer of organic light emitting material 105. The layer of light emitting organic material 105 overlies a conductor pad 103. The conductor pad 103 is located directly over the substrate 104. It is within the scope of the present invention that the top conductor layer 110 and the conductor pad 103 may
20 serve as either hole or electron injectors. Holes and electrons combine in the organic material 105 causing light to be emitted. The light passes out through the transparent top plate 101 to the viewer.

The top plate 101 has a preferred thickness of .2mm. However, any thickness in the range of .1 to 1.2mm would be suitable. The top conductor layer 110 preferably has a
25 thickness in the range of 2-10 nm. The invention contemplates a variety of materials that can be used to construct the top conductor layer 110, depending on the selection of organic material. The top conductor layer may be formed from a thin metal material (50Å - 200Å), which is effectively transparent. Au, Pd, Pt, In₂O₃, In₂O₃ + SnO₂, Al, Mg, Al + Li, Mg + Ag, or Al/LiF may comprise the metal conductor. The top conductor layer 110 may also comprise
30 a transparent conductor material such as ITO or IZO. Alternatively, the top conductor layer 110 may comprise a combination of the thin metal material and the ITO or IZO material. It

is also within the scope of the present invention that the top conductor layer 110 comprises a combination of a barrier or transition material, e.g. CuPc, and the transparent conductor material. The thickness of the top conductor layer 110 should be chosen to provide reasonable conductivity over and across voids and maximize transparency.

5 The substrate 104 may be formed from a silicon wafer or glass layer having a thickness of approximately .8mm. Other thicknesses of the silicon or glass layer are contemplated to be within the scope of the invention, with the preferred range being from .3mm to 1.3 mm in thickness.

10 The conductor pad 103 is generally formed from Al plus 4 percent Cu under a layer of Mg/Ag or LiF for a top hole injecting device, such as that shown in Fig. 5. The conductor pad 103 for a bottom hole injection display device preferably consists of Al with an Au overlayer. The conductor pad 103 may also be formed from the materials ITO, MoSi₂, WSi₂, Mo, Al, or Aluminum alloys such as Al-2%Cu or Al+5% Ti. The conductor pad 103 shown in Fig. 1 is planarized and initially formed thicker than its final intended thickness. A dielectric layer 130
15 may overlie the conductor pad 103 as shown in Fig. 3. A dielectric such as SiO₂ is placed on the surface of the conductor using chemical vapor and/or sputter depositing. The surface is then chemical-mechanically polished to leave a planar surface of conductor and dielectric.

20 The organic material 105 deposited upon the conductor pad 103 may consist of only one blended layer, but preferably is comprised of multilayer stack. Each layer of the stack of organic material should preferably possess different properties of hole transport, electron transport and light emission. The preferred composition of the stack 105 for a device in which holes are injected from below the organic material 105 is Alq/NPB/CuPc with the Alq layer on top. The preferred organic for a top hole injecting device is configured in the reverse order CuPc/NPB/Alq.

25 Fig. 2 shows an alternative embodiment of the present invention, in which the substrate 104 is comprised of several elements. The substrate 104 may include integrated circuits 107. The circuitry 107 controls the application of different current or voltage states to the conductive layers and, as a result, the emission of light from the device 100. The integrated circuitry 107 is typically built into a silicon wafer 106. A thin film transistor array on glass, foil, or ceramic
30 may alternatively used as the substrate 104. The substrate includes a via or plug 109 for connecting the conducting pad 103 to the integrated circuitry 107. The plug 109 may be filled

with hot aluminum or tungsten which is chemical vapor deposited and planarized using chemical-mechanical polishing. The substrate 104 may also include a layer of insulating material 108. The insulator layer 108 is typically an oxide layer (SiO_2) formed by chemical vapor and/or sputter deposition.

5 Fig. 3 further shows the preferred form of the conductor pad 103. The conductor pad 103 as shown has tapered sidewalls. The sidewalls may be at an angle of 30 degrees or more to the underlying substrate 104. A planarized conductor pad 103, such as shown in Fig. 1, may provide a better functioning device, but the sloped version shown in Fig. 3 may be less expensive and functions almost as well. The slope of the pad 103 is formed by undercut edges
10 achieved through resist or bilayer adhesion loss or by resist edge ablation during reactive ion etching.

Fig. 4 discloses that a top plate conductor layer 102 may be attached to the underside of the top plate 101. The top plate conductor layer 102 is preferably formed from indium tin oxide (ITO). However, other materials such as indium oxide doped with aluminum oxide, tin
15 oxide doped with antimony; zinc doped with zinc oxide or any other suitable conductor may be used.

The organic light emitting devices of the present invention may include a getter layer 111. The optional getter layer 111 is shown in Fig. 5. The getter layer 111 is positioned above the top conductor layer 110 and preferably consists of Mg. The getter layer 111 reacts with or
20 absorbs water vapor and other reactive gases that may be released during operation of the device. Fig. 5 further discloses the optional transition layer 115, preferably comprising LiF or Barium Titanate.

The present invention may further include an optional color filter or color converter layer (not shown) above the top conductor layer 103 and below the getter layer 111. The color
25 filter or color converter layers can be used to obtain a color display from white or blue emitting OLEDs.

Surrounding the perimeter of the top plate 101 is a sealing rim 303 as shown in Fig. 6. The sealing rim 303 may include a conductive layer 308 and an insulating layer 307. The insulating layer is sandwiched between a conductive connecting pad 306 and the conductive
30 sealing layer 308. The insulating layer 307 may be formed out of SiO_2 or SiO with a thickness of approximately 100 nm. The conductive layer 308 may be formed out of Au over Ni to a

thickness of 60-100 nm. Other materials such as In over Cr or Au may also be used to form the conductive layer 308.

The present invention includes a lower sealing rim 304 located on the substrate 104. Like the upper sealing rim 303, the lower sealing rim 304 consists of an insulating layer 310 overlying a conductive connecting pad 309 and a conducting sealing layer 311. Preferably, the layers that comprise the sealing rim 304 are formed from the same materials as those used to form the sealing rim 303. The rims 303, 304 may be deposited via evaporation, sputtering, or plating around the perimeter of the bottom plate of the display. Immersion plating of gold on nickel is the most economical, but the gold may also be evaporated or sputtered.

The process of fabricating and sealing the organic light emitting device 100 of the present invention will now be described. Fig. 6 shows the upper plate 301, which is comprised of the top plate 101, the top plate conductor layer 102 and the sealing rim 303. Prior to sealing the upper and lower plates 301, 302, the upper plate 301 is heated or baked to remove surface moisture. Any elevated temperature will provide some moisture removal, however, the components are preferably heated to a temperature between 400°C to 500°C. If appropriate the step of baking or heating the device may be omitted altogether. It may be appropriate to omit this step if a long exposure period to the reactive gas is planned. Following heating, the components are handled with the utmost care to ensure that there is no subsequent exposure to moisture.

The top plate conductor layer 102, may also be exposed to an oxygen plasma treatment after the heating process. The plasma treatment will improve surface conductivity and direct hole injection from the top plate conductor layer 102.

The present invention's method of fabricating the lower plate 302 of the organic light emitting device 100 first contemplates the step of placing the conductor pad 103 on the substrate 104, as described above. Following formation of the conductor pad 103 and the substrate 104, the organic light emitting layer(s) 105 is deposited. Following deposition of the organic material, the top conductor layer 110 is deposited over the organic material 105. Care should be taken to minimize or avoid exposure of the device to moisture containing environments between deposition of the organic material 105 and the top conductor 110, and the subsequent sealing process.

Following the fabrication of the upper plate 301 and the lower plate 302, the process of the present invention further includes evacuating a sealing chamber to 10^{-6} Torr and sealing the plates under vacuum. It is also within the scope of the invention to seal the plates in an inert gas atmosphere such as Argon or gas like dry Nitrogen.

5 After the chamber is evacuated, the upper and lower plates 301, 302 are brought into the chamber. The plates are sufficiently separated to permit gas flow between them, as shown in Fig. 6. Separation between the plates as small as a submicron may be sufficient. Larger spacings, however, are contemplated to be within the scope of the present invention. For example, a spacing of 1 cm is preferred for 2 inch plates.

10 Once plate separation is established, the reactive gas 305 is introduced into the chamber. The reactive gas 305 rapidly converts moisture to a low vapor pressure compound at temperatures less than 100°C . The reactive gas 305 may be silane, disilane, trimethyl aluminum (TMA), or tetra ethyl aluminum or other water reactive gases that form a neutral or inert byproduct. The present invention is not limited to the above identified reactive gases.

15 Other suitable gases are considered to be within the scope of the present invention. TMA is a preferred choice since the byproducts of its reaction with water (aluminum oxide and hydroxide) are desiccants. The selected reactive gas should not react with the chosen organic compounds in the stack of organic material 105. The reactive gas should form stable, low reactivity compounds upon contact with water or oxygen at room temperature with very low
20 (<100 ppb) residual partial pressures of H_2O or O_2 . The present invention allows for the use of many different organic materials and dopant choices, as well as many different reactive gases. Verification of the compatibility between the selected reactive gas 305 and the light emitting organic materials 105 is required for each combination.

25 Following the introduction of the reactive gas 305, the plates are pushed together. Light to moderate pressure is used. A few ounces or pounds of pressure is sufficient. Careful alignment of the plates 301 and 302 is required, especially when a color filter or color converter is used.

30 Once the plates are in contact with one another, the process further includes sealing the upper and lower plates 301, 302 of the device. An indium gasket (not shown) may be employed. The indium or indium alloy gasket is placed in contact with the conductive layers 308 and 311, which preferably comprise gold. With plates 301 and 302 aligned, the indium

gasket is sandwiched between layers 308 and 311 using mild pressure. Heat is generated in the indium gasket by inductively transforming energy to the gasket from an RF energy generator via a coupling coil and concentrator located outside the plate 301 and above the gasket. The gasket melts as the induced eddy current heating causes the localized temperature to rise. The molten indium wets the gold layers 308 and 311 forming an eutectic of indium and gold. Once the eutectic point is reached, the RF energy generator is decoupled to allow the indium gold alloy to cool and the sealing rims 303 and 304 bond together.

It is within the scope of the present invention to employ conventional radiative heating or direct resistive heating to melt the indium gasket. If radiative heating is used, the temperature of the organic stack must be monitored and maintained in the region where its light emitting properties and light emissive efficiency are preserved.

The present invention is not limited to the above described seal. Other sealing methods are contemplated to be within the scope of the present invention. These methods include knife-edge seals in indium or copper, ultrasonic enhanced eutectic or compression bonding, and very low moisture diffusivity UV cure or mix epoxy or heat melt adhesive seals. The quality of an hermetic organic adhesive seals, including epoxy seals, can be increased by evaporating a metal layer on the outside surface of the seal edge after the plates are connected (e.g., Aluminum titanium alloy 0.5-50 microns).

The present invention allows for the intentional trapping of reactive gas 305 between the upper and lower plates 301, 302. The trapped reactive gas will serve to maximize moisture removal from within the device. Trapping may consist of trapping in the gas state or simply by adsorption of gas on the interior surfaces of the display. The reactive gas may be trapped readily if introduced into the chamber at atmospheric pressure. Alternatively, reactive gas may be reintroduced after the plates are compressed, but before the perimeter seal is completed. The trapped reactive gas acts as an additional getter for moisture. The amount of reactive gas left on or in the surface of the plates may be optimized by heating and then cooling one or more of the plates prior to sealing.

The present invention contemplates using the process to treat multiple displays at a time. A substrate holding many OLED arrays and a corresponding top plate may be placed together during the sealing process. Preform holders can be used. An indium alloy preform could be used to surround many displays at a time. Alternatively, individual preforms could

be used. Multi-component substrates, which may be partly pre-cut, can be sealed and separated into individual OLEDs after sealing.

The aforementioned steps of the inventive method for constructing an OLED may be performed insitu in a multichamber vacuum deposition system. In addition, the steps of layer
5 deposition, semitransparent metal deposition, ITO coverplate fabrication, baking and sealing can be connected in the multichamber system. Automated systems capable of performing many or all of these steps insitu can be configured by those skilled in the art of flat-panel display or semiconductor equipment design.

The present invention includes both top and bottom emitting OLED designs, as well
10 as any OLED technology not adversely effected by any practical water reactive gas. Also, the techniques of this invention could be used with field emitter display vacuum packages to control moisture.

The present invention further includes the method of bowing the upper and lower plates
15 301, 302 during the reactive gas addition stage in order to remove additional moisture from between the plates. The bowing method is used in an inert gas environment rather than in a vacuum. In this method, the upper plate 301 and lower plates 302 are slightly bowed and pushed together. The bowed shape of the plates serves to push gas and moisture out from between the plates. The step of bowing the plates is performed prior to the introduction of the reactive gas 305 into the chamber. Bowing may be accomplished simply by applying initial
20 pressure in the center of the upper and lower plates 301, 302. A top plate 101 having a maximum thickness of 200 microns is preferred for this bowing process due to its flexibility. However, the bowing process of the present invention may be successfully performed using top plates and/or bottom plates 101, 102 of almost any thicknesses since the required gap is very small. The bowing is accomplished by pushing on a flexible pad adjacent the plates. The
25 flexible pad has the characteristic of lower flexibility and compression in the center of the plates. The reduced compression causes maximum pressure to be applied in the center of the plates forcing moisture outward as more pressure is applied.

It will be apparent to those skilled in the art that various modifications and variations may be made in the preparation and configuration of the present invention without departing
30 from the scope and spirit of the present invention. Thus, it is intended that the present

invention covers the modifications and variations of the invention, provided they come within the scope of the appended claims and their equivalents.

**WE CLAIM:**

1. A method of removing water vapor from within an organic light emitting device comprising the steps of: providing an organic light emitting device comprising upper and lower plates; providing a temporary separation between the upper and lower plates; introducing a reactive gas between the upper and lower plates; forcing the upper and lower plates together; and sealing the upper and lower plates.

2. The method according to claim 1, wherein the upper plate of the organic light emitting device comprises a glass layer and a conductor layer; and the lower plate of the organic light emitting device comprises a substrate, conductor pad and at least one layer of organic light emitting material.

3. The method according to claim 1, wherein said step of sealing the upper and lower plates further comprises the use of a sealing gasket, wherein said sealing gasket is formed by melting a metal rim on the upper plate and a metal rim on the lower plate; contacting the rims together during said forcing step in order to provide a seal upon cooling.

4. The method according to claim 1, further comprising the step of heating at least one of the upper and lower plates prior to introducing the reactive gas.

5. The method according to claim 1, wherein after providing an organic light emitting device the method further comprises the steps of providing a chamber; creating a vacuum in the chamber; placing the upper and lower plates in the chamber and performing the remaining steps with the organic light emitting device in the chamber.

6. The method according to claim 1, wherein after providing an organic light emitting device the method further comprises the steps of providing a chamber; placing the upper and lower plates in the chamber; flooding the chamber with an inert gas; and performing the remaining steps with the organic light emitting device in the chamber.

7. The method according to claim 1, wherein said reactive gas reacts with residual water to form a byproduct inert relative to said organic light emitting device.

8. The method according to claim 1, wherein said reactive gas reacts with oxygen to form a byproduct inert relative to said organic light emitting device.

9. The method according to claim 1, wherein said reactive gas is trimethyl aluminum (TMA).



10. A method of removing moisture from an organic light emitting device comprising the steps of: providing an organic light emitting device with upper and lower plates; reducing the pressure surrounding the device below atmospheric pressure; introducing a reactive gas between the upper and lower plates; forcing the upper and lower plates together; and sealing the upper and lower plates.

11. The method according to claim 10, wherein each of the upper and lower plates has a center and outer edges, and said forcing step includes applying a force to the plates at their center whereby the plates are bowed and their outer edges are not in contact.

12. The method according to claim 10, further comprising the step of introducing additional reactive gas, after the plates are forced together.

13. The method according to claim 10, further comprising the steps of heating and cooling at least one of the plates prior to said sealing step.

14. The method according to claim 10, wherein each of the upper and lower plates has outer edges, and said sealing step includes using a hermetic organic adhesive seal around the edges of the plates.

15. The method according to claim 14, wherein the adhesive seal has an outside edge; and said sealing step further includes evaporating a metal layer on the outside edge of the adhesive seal.

16. The method according to claim 10, wherein the lower plate comprises a substrate upon which a plurality of organic light emitting devices are mounted, and the upper plate comprises a glass cover corresponding to the plurality organic light emitting devices.

17. The method according to claim 16, further comprising the additional step of breaking apart the plurality of light emitting devices, following the sealing step.

18. The method according to claim 10, wherein the upper plate is heated prior to the introduction of the reactive gas.

19. An organic light emitting device comprising: a substrate having a perimeter; a first conductor layer located above said substrate; at least one layer of organic light emitting material, wherein said at least one layer of organic material is located on top of said first conductor layer; a top cover layer having a perimeter; a second conductor layer located adjacent and below said top cover layer; a top conductor layer, wherein said top conductor layer is positioned under said second conductor layer and on top of said at least one layer of

organic material; a sealing rim located around said perimeter of said substrate and said perimeter of said cover layer, wherein said sealing rim connects said substrate to said top cover layer and seals the layers located therebetween; and an amount of trapped reactive gas located within said organic light emitting device.

20. The organic light emitting device of claim 19, further comprising a layer of getter material located between said top conductor layer and said second conductor layer.

21. The organic light emitting device of claim 19, wherein said substrate layer includes circuitry for controlling the emission of light from said at least one layer of organic material.

22. The organic light emitting device of claim 21, wherein said substrate includes a plug for connecting said second conductor layer to said circuitry.

