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(54) LARGE ORGANIC LIGHT-EMITTING DIODES AND METHODS OF FABRICATING LARGE ORGANIC LIGHT-EMITTING DIODES

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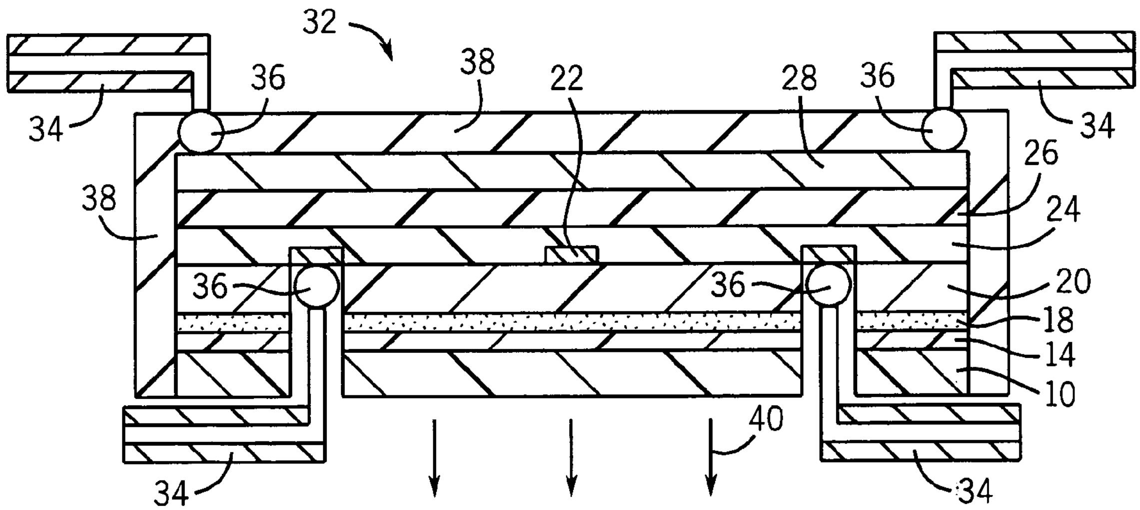
(52) U.S. Cl. **313/511**; 313/512

(57) **ABSTRACT**

Large, light-weight organic light emitting diode (OLED) devices and methods of preparing large, light-weight displays of organic light emitting diode (OLED) devices for area-lighting. Specifically, flexible and rigid light-weight plastics are implemented. The flexible plastic may be disposed from a reel. A metal grid is fabricated on the flexible plastic to provide current conduction over the large area. A transparent oxide layer is provided over the metal grid to form the bottom electrode of the OLED. A light emitting organic layer is disposed on the transparent oxide layer. A second electrode is disposed over the organic layer. Electrodes are coupled to the metal grid and the second electrode to provide electrical current to facilitate light emission from the organic layer.



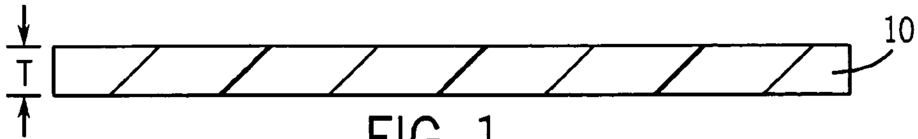


FIG. 1

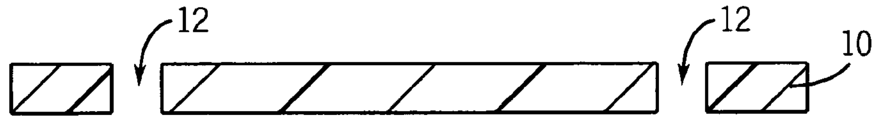


FIG. 2

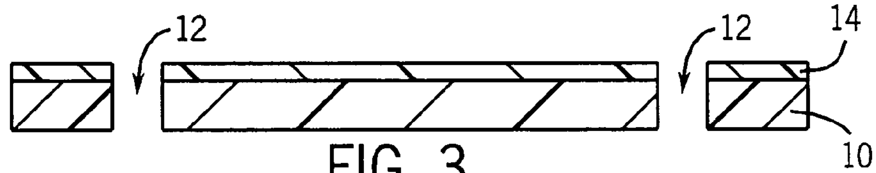


FIG. 3

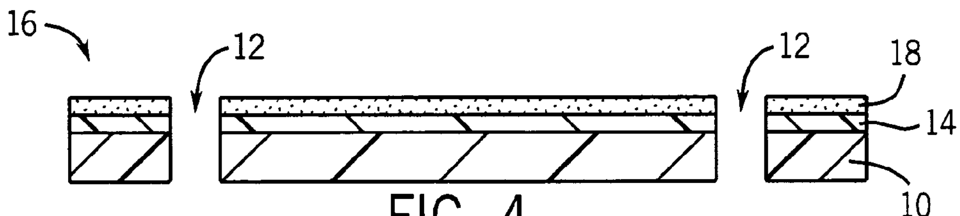


FIG. 4

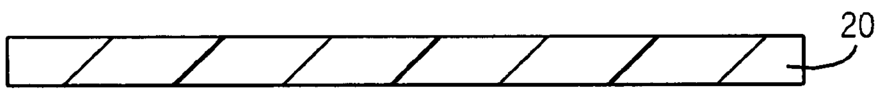


FIG. 5

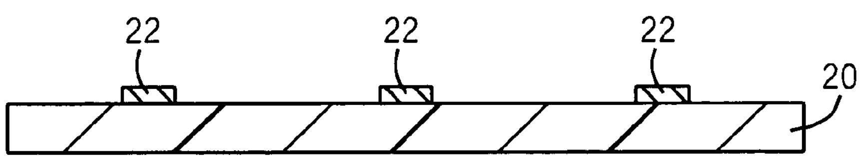


FIG. 6

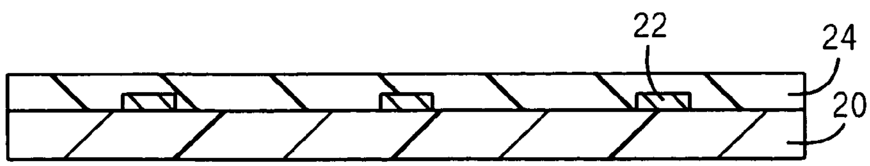


FIG. 7

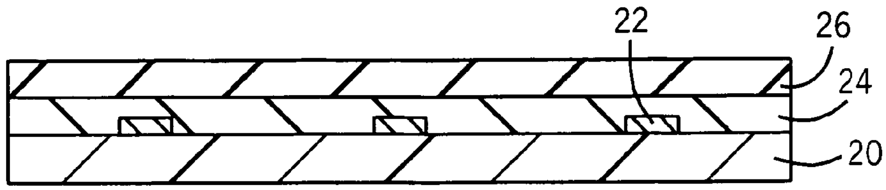


FIG. 8

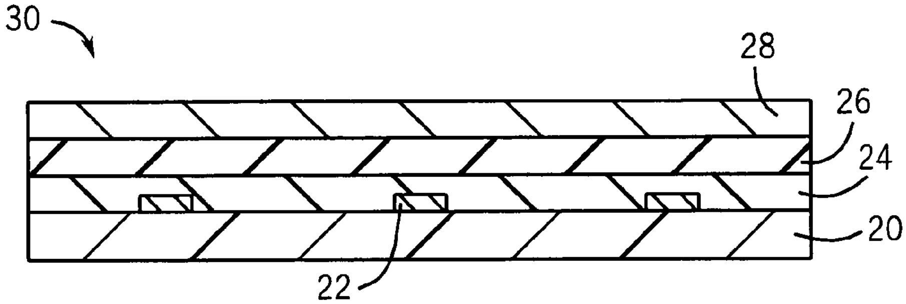


FIG. 9

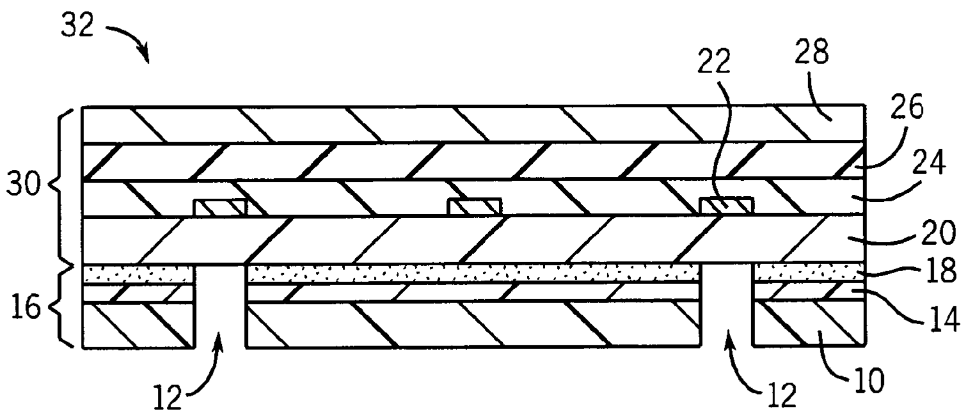


FIG. 10

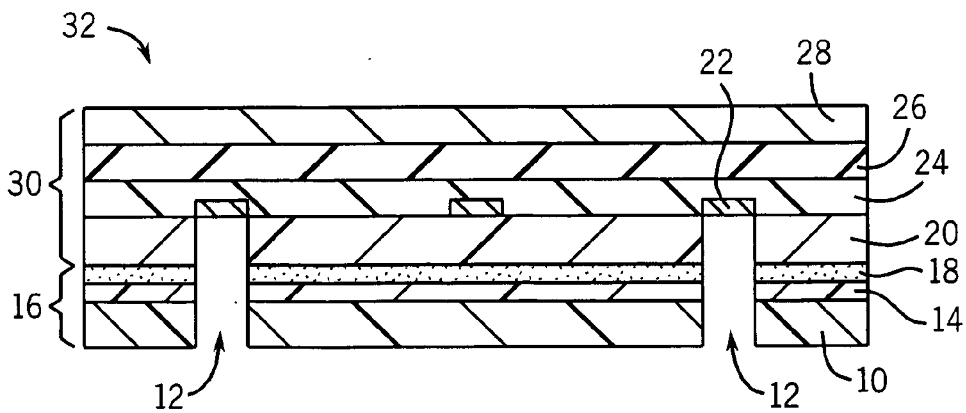


FIG. 11

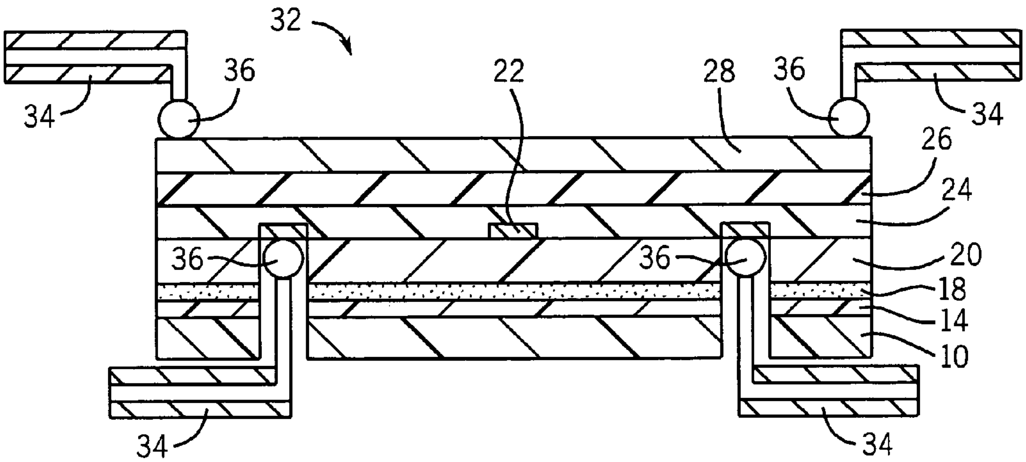

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FIG. 12

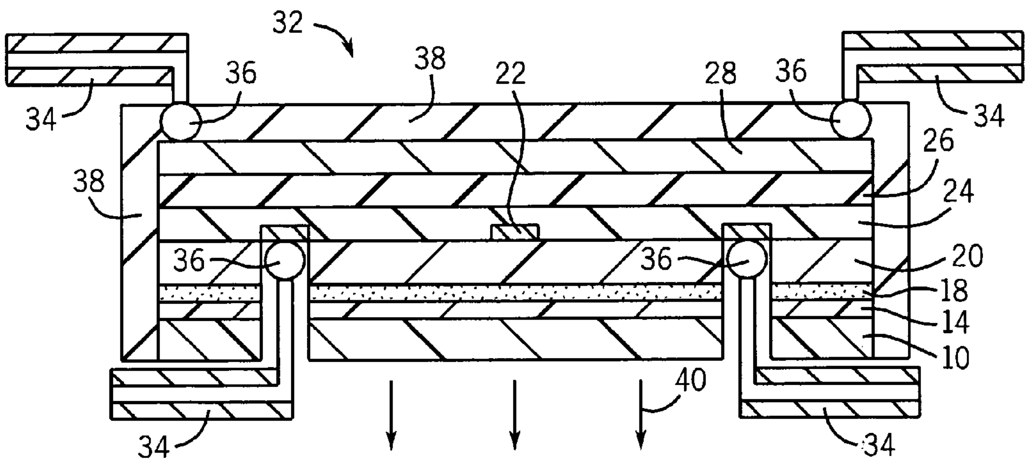
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FIG. 13

LARGE ORGANIC LIGHT-EMITTING DIODES AND METHODS OF FABRICATING LARGE ORGANIC LIGHT-EMITTING DIODES

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This is a divisional of co-pending application Ser. No. 10/324,417 filed on Dec. 20, 2002.

BACKGROUND OF THE INVENTION

[0002] High efficiency lighting sources are continually being developed to compete with traditional area lighting sources, such as fluorescent lighting. For example, while light emitting diodes have traditionally been implemented FOR indicator lighting and numerical displays, advances in light emitting diode technology have fueled interest in using such technology for area lighting. Light Emitting Diodes (LEDs) and Organic Light Emitting Diodes (OLEDs) are solid-state semiconductor devices that convert electrical energy into light. While LEDs implement inorganic semiconductor layers to convert electrical energy into light, OLEDs implement organic semiconductor layers to convert electrical energy into light. Generally, OLEDs are fabricated by disposing multiple layers of organic thin films between two conductors or electrodes. The electrode layers and the organic layers are generally disposed between two substrates, such as glass substrates. When electrical current is applied to the electrodes, light is produced. Unlike traditional LEDs, OLEDs can be processed using low cost, large area thin film deposition processes. OLED technology lends itself to the creation of ultra-thin lighting displays that can operate at lower voltages than LEDs. Significant developments have been made in providing general area lighting implementing OLEDs.

[0003] However, while traditional OLEDs having a relatively low efficacy (e.g. 3-4 lumens per watt) may be able to achieve sufficient brightness for area lighting at low voltages, the operating life of the OLED may be limited due to the heat generated by the high power level and relatively low efficiency of the device. To provide commercially viable light sources implementing OLEDs, the efficacy of the devices should be improved to reduce the heat generation when operating at a brightness sufficient to provide general illumination.

[0004] To emit light having a brightness that is equivalent to the light produced by conventional lighting sources such as fluorescent lighting sources, the OLED may be large, approximately one square meter, for example. A number of issues may arise when contemplating fabrication of a large OLED, such as and OLED having a front surface area of one square meter. When fabricating OLED devices, conventional OLED devices implement top and bottom glass plates. Advantageously, glass substrates provide adequate hermeticity to seal the device from exposure to water and oxygen. Further, glass substrates allow for high temperature processing of the OLED devices. However, glass substrates may be impractical and less desirable when contemplating the fabrication of large area OLED devices for area lighting when compared to conventional area lighting sources, such as fluorescent lighting sources. Generally speaking, glass may be impractically heavy for area-lighting applications. For instance, to produce the light equivalent to a four foot T12 fluorescent lamp, for example, an OLED device implementing glass substrates having a thickness of ⅛ of an inch and a front surface area of one square meter may weigh approximately 31 pounds. The T12 fluorescent lamp weighs less than one-half a pound. One method of reducing the weight of the OLED device is to implement plastic substrates. However, while plastic substrates advantageously reduce the weight of the device, the hermeticity of the device may be compromised.

[0005] Further, as can be appreciated, general area lighting is widely used and the demands for such lighting are understandably high. Accordingly, to provide a viable alternative source for area lighting to that of fluorescent lighting, for example, the alternative source should be fairly robust and easy to manufacture. OLED devices implementing large glass substrates may be difficult to mass produce in a highly automated process. The weight of glass and fragility of glass substrates may disadvantageously burden the manufacturing process.

[0006] Still further, as can be appreciated, the active layers of organic polymers implemented in OLED devices are disposed between conducting electrodes. The bottom electrode generally comprises a reflective metal such as aluminum, for example. The top electrode generally comprises a transparent conductive oxide (TCO) material, such as Indium-Tin-Oxide (ITO), that allows light produced by the active layers to be emitted through the top electrode. To maximize the amount of light that is emitted from the OLED device, the thickness of the ITO layer may be minimized. In typical OLED devices, the ITO layer has a thickness of approximately 1000 angstroms. However, the conductivity of 1000 angstroms of ITO may not be adequate to supply sufficient electrical current across the entire surface area of the large OLED. Accordingly, the electrical current may be insufficient to generate enough light across the large OLED for use in area lighting applications.

BRIEF DESCRIPTION OF THE INVENTION

[0007] In accordance with one aspect of the present techniques, there is provide a method of fabricating a general area lighting source comprising the acts of: fabricating a transparent backer portion; fabricating an active portion, wherein the active portion comprises an organic layer disposed between a first electrode and a second electrode; coupling the transparent backer portion to the active portion; and coupling electrical leads to each of the first electrode and the second electrode.

[0008] In accordance with another aspect of the present techniques, there is provide a method of fabricating a general area lighting source comprising the acts of: providing a flexible transparent film; forming a metal grid pattern on the flexible transparent film; disposing a transparent conductive oxide (TCO) layer over the metal grid pattern and the transparent film; disposing the organic layer over the transparent conductive oxide layer; and disposing a metal layer over the organic layer.

[0009] In accordance with yet another aspect of the present techniques, there is provide an area lighting system comprising: a rigid plastic layer; a hermetic coating layer disposed on the rigid plastic layer; a flexible transparent film coupled to the hermetic coating layer; a metal grid pattern formed on the flexible transparent film; a transparent conductive oxide (TCO) layer disposed over the metal grid pattern and the transparent film; an organic layer disposed over the transparent conductive oxide layer; and a metal layer disposed over the organic layer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Advantages and features of the invention may become apparent upon reading the following detailed description and upon reference to the drawings in which:

[0011] **FIGS. 1-4** illustrate cross-sectional views of an exemplary fabrication process for a transparent backer implemented in a large-area OLED device fabricated in accordance with the present techniques;

[0012] **FIGS. 5-9** illustrate cross-sectional views of an exemplary fabrication process of an active portion of a large-area OLED device fabricated in accordance with the present techniques; and

[0013] **FIGS. 10-13** illustrate cross-sectional views of an exemplary fabrication process of a large-area OLED device implementing the transparent backer of **FIGS. 1-4** and the active portion of **FIGS. 5-9** in accordance with the present techniques.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

[0014] **FIGS. 1-4** illustrate cross-sectional views of an exemplary process for fabricating a transparent backer implemented in a large-area OLED device in accordance with the present techniques. Referring initially to **FIG. 1**, a film or sheet of transparent plastic **10** which may comprise any suitable polycarbonate, such as a sheet of LEXAN polycarbonate, for example, is provided. Preferably, the plastic **10** comprises any material having a high melting point, thereby allowing for high processing temperatures (e.g., >200° C.). Further, the plastic **10** is advantageously transparent and has a high rate of transmission of visible light (e.g., >85% transmission). Further, the plastic **10** may advantageously comprise a material having a high impact strength, flame retardancy and thermoformability, for example. Because the plastic **10** may be rigid, the plastic **10** may also provide structural support for the large area OLED device, as described further below.

[0015] The plastic **10** should be large enough to provide sufficient light for use in area-lighting. In the present exemplary embodiment, the plastic **10** may have a length of approximately 4 feet and a width of approximately 1 foot, for example. As can be appreciated, other desirable dimensions of the plastic **10** may be implemented. The plastic **10** may have a thickness T in the range of approximately 1-125 mils. As can be appreciated, a material having a thickness of less than 10 mils may generally be referred to as a "film" while a material having a thickness of greater than 10 mils may generally be referred to as a "sheet." It should be understood that the plastic **10** may comprise a plastic film or a plastic sheet. Further, while the terms may connote particular thicknesses, the terms may be used interchangeably, herein. Accordingly, the use of either term herein is not meant to limit the thickness of the respective material, but rather, is provided for simplicity. Generally speaking, a thinner plastic **10** may provide a lighter and less expensive material. However, a thicker plastic **10** may provide more rigidity and thus structural support for the OLED device. The thickness of the plastic **10** may depend on the particular application.

[0016] In fabricating the transparent backer, apertures **12** are provided to facilitate the electrical connection of the OLED, as illustrated in **FIG. 2**. The apertures **12** may be any suitable size and shape to facilitate the electrical connection of the leads to the bottom electrode, as will be illustrated and further described with respect to **FIGS. 12 and 13**. As can be appreciated, the apertures **12** may be formed through laser ablation, for example. Alternatively, the apertures **12** may be formed through a drilling process, a stamping process or a molding process wherein the plastic **10** is heated and dispensed into a mold having structures configured to form the apertures **12**. As used herein, "adapted to,""configured to," and the like refer to elements that are sized, arranged or manufactured to form a specified structure or to achieve a specified result.

[0017] In the present embodiment of the transparent backer, a hermetic coating **14** is applied over the plastic **10**, as illustrated in **FIG. 3**. As can be appreciated, one of the degradation mechanisms that may reduce the mean-time-to-failure of an unencapsulated OLED is exposure of the organic cathode interface (described further below) to atmospheric oxygen and water. Disadvantageously, exposure to oxygen or water may lead to oxidation and/or delamination of the metal cathode as well as to chemical reactions within the organic layers. Accordingly, the hermetic coating **14** is implemented to impart water and oxidation resistance on the light-emitting side of the device, as better illustrated and described with reference to **FIGS. 10-13**. The hermetic coating **14** may comprise two or more polymer-based materials, such as LEXAN polycarbonate, separated by layers of transparent inorganic materials. The layers of inorganic materials may comprise diamond-like-carbon (DLC), silicon dioxide, silicon nitride or silicon oxy nitride, for example.

[0018] In one specific exemplary embodiment, the hermetic coating **14** comprises a hybrid organic-inorganic multi-layer barrier coating formed on a heat stabilized polyethylene terephthalate (PET) material having a thickness of approximately 175 microns. The composite barrier may comprise alternating layers of polyacrylate films and an inorganic oxide, for example. An acrylic monomer layer may be deposited onto the surface of the PET material by flash evaporation in a vacuum, for example. After deposition, the condensed acrylic monomer maybe cured using ultraviolet light to form a non-conformal highly cross-linked polyacrylate film that planarizes the surface of the PET layer. Next a layer of aluminum oxide (Al_2O_3) may be deposited onto the polyacrylate film layer at a thickness in the range of approximately 100-300 angstoms, for example, to provide a barrier to the diffusion of water and oxygen. Advantageously, by alternately repeating the processes to deposit multiple layers, the polymer layers (e.g., polyacrylate film) decouple any defects in the oxide layers (e.g., aluminum oxide layer) thereby preventing propagation of defects through the multi layer hermetic coating **14**. In one embodiment, the processes are repeated 4-5 times, for example.

[0019] **FIG. 4** illustrates one embodiment of the exemplary transparent backer **16**. The light produced by the organic layers (described with reference to **FIG. 8**) will be emitted through the transparent backer **16**. To facilitate the coupling of the transparent backer **16** to the active portion of the large area OLED device (described with reference to **FIGS. 5-9**), an adhesive layer **18** may be applied to the surface of the hermetic coating **14**. The adhesive layer **18** comprises a highly transmissive material so as to allow the light produced by the organic layers to be emitted to the ambient environment. As can be appreciated, it may also be desirable to change the color of the light produced by the organic layer of the OLED. Accordingly, to change the color of the light emitted by the organic layer of the OLED, the adhesive layer **18** may include phosphor particles, as can be appreciated by those skilled in the art. For instance, short wavelength blue light produced by certain organic materials may activate phosphor particles in the adhesive layer **18** to emit a longer wavelength broadband spectrum that is perceived as white light, which may be preferable for area lighting. Alternatively, a color changing layer comprising phosphor particles, for example, may be disposed separately, below the adhesive layer **18**.

[**0020**] **FIGS. 5-9** illustrate cross-sectional views of an exemplary fabrication process of an active portion of a large-area OLED device fabricated in accordance with the present techniques. Referring initially to **FIG. 5**, a layer of transparent film **20** is illustrated. The transparent film **20** is transparent to visible light and may comprise a polymer material, such as MYLAR, for example. The transparent film **20** is generally thin (2-50 mils) and flexible. The transparent film **20** may be dispensed from a roll, for example. Advantageously, implementing a roll of transparent film **20** enables the use of high-volume, low cost, reel-to-reel processing and fabrication of the active portion. The roll of transparent film **20** may have a width of 1 foot, for example, to match the width of the plastic **10** of the transparent backer **16**. The transparent film **20** may also be cut to a length to match the length of the plastic **10**, such as a length of four (4) feet, for example. As can be appreciated, the transparent film may be cut before or after the fabrication steps described with reference to **FIGS. 5-9**. Alternatively, the transparent film **20** may comprise a less flexible transparent material, such as MYLAR.

[**0021**] As previously described, typical OLEDs which are implemented for indicator lighting, for example, generally comprise a number of organic layers disposed between two electrodes. One of the electrodes generally comprises a transparent conductive oxide (TCO), such as indium-tin-oxide (ITO), for example. ITO is a conductive ceramic having a conductivity of approximately 10 ohms/square. This amount of electrical conductivity is generally adequate to produce the necessary light emissions to illuminate the small OLEDs used for indicator lighting. However, as can be appreciated, the power output of a conventional ITO layer may be insufficient to produce the necessary current to illuminate a large area OLED, such as the present device, since the resistance losses across the large surface area may be large. Because the electrode comprises a transparent material to allow light emissions to pass from the underlying organic layers to the ambient environment, a metal layer having a higher conductivity may not be used. Further, while increasing the thickness of the ITO layer may increase the conductivity, the increased thickness may disadvantageously reduce the transparency of the layer.

[**0022**] One solution to the limited conductivity of the ITO is to implement a metal grid **22**, as indicated in **FIG. 6**. The metal grid **22** is electrically coupled to the ITO layer **24** (illustrated in **FIG. 7**) to provide increased conductivity across the bottom electrode (i.e., the ITO layer **24**). The metal grid **22** may comprise aluminum, for example. Alternatively, the metal grid **22** may comprise another conductive metal such as silver or copper, for example. To form the metal grid **22**, a metal layer may be disposed over the transparent film **20** at a thickness in the range of 0.5-2.0 microns, by a sputtering technique, for example. The metal layer may be patterned and etched to provide a metal grid **22** having a plurality of metal square disposed thereon. The metal squares may comprise ½"×½" squares or 1"×1" squares, for example. The squares may be located every 2-4 inches, for example. Alternatively, the metal layer may be patterned to provide any other desirable pattern having interdispersed metal areas for increased conductivity. For instance, circles, rectangles or linear strips may be patterned to provide the metal grid **22**. The metal grid **22** will be electrically coupled to conductive leads, as will be illustrated and described further with reference to **FIGS. 12 and 13**. As can be appreciated, the metal grid **22** provides increased conductivity through the ITO layer **24**, illustrated with reference to **FIG. 7**.

[**0023**] **FIG. 7** illustrates a transparent conductive layer, such as an ITO layer **24** disposed over the transparent film **20** and the metal grid **22**. The ITO layer **24** may be disposed at a thickness in the range of approximately 500-2500 angstroms, for example, and may be disposed by a sputtering technique, for example. Preferably, the ITO layer **24** has a transmission ratio of at least 0.8. The transparent conductive layer may comprise other suitable conductive materials that may be disposed at other suitable thicknesses and having a transmission ratio of at least 0.8, as can be appreciated by those skilled in the art. The ITO layer **24** may be referred to herein as the "bottom electrode" or the "anode" of the OLED device being described. Further, the ITO layer **24** may not comprise a continuous layer. As can be appreciated by those skilled in the art, the electrodes (and possibly the organic layer disposed therebetween) of an OLED device may be patterned or "pixelated" to provide a dense layer of discrete, electrically isolated patches or "pixels." By pixelating the electrodes of the OLED device (including the ITO layer **24**) such that the patterns align, shorting between the top and bottom electrodes will only effect the pixels that are shorted, rather than shorting the entire electrode. These techniques are well known to mitigate complete failure of the OLED devices.

[**0024**] After formation of the bottom electrode (here, ITO layer **24**), an organic layer **26** may be disposed on the surface of the ITO layer **24**, as illustrated in **FIG. 8**. As can be appreciated, the organic layer **26** may comprise several layers of organic light-emitting polymers, such as a polyphenylene vinylene or a polyfluorene, typically from a xylene solution. The number of layers and the type of organic polymers disposed will vary depending on the application, as can be appreciated by those skilled in the art. The organic layer **26** may be disposed at a thickness in the range of approximately 500-2500 angstroms, for example. However, as can be appreciated, the thickness of the organic layer **26** may vary, depending on the application. In one exemplary embodiment, the organic layer **26** may comprise a blue-light emitting polymer such as poly(3,4)-ethylendioxythiophene/

polystrene sulfonate (PEDOT/PSS). As previously described, to convert the blue-light to white light for use in area lighting, one or more conversion layers comprising organic molecules, such as perylene orange and perylene red, and inorganic phosphor particles, such as [Y(Gd)AG:Ce)], may be included in the adhesive layer **18** (**FIG. 4**) or disposed below the adhesive layer **18**. Various layers may be implemented in the organic layer **26** to provide light in a desired color. Certain colors may be easier and/or cheaper to produce in the organic layer **26** based on the available materials and the processes for disposing the materials, as can be appreciated by those skilled in the art.

[0025] As previously described, the transparent film **20** is advantageously capable of reel-to-reel processing. Accordingly, the deposition of the thin organic light emitting polymer layers in the organic layer **26** may be more difficult than in conventional, small-area indicator lighting OLEDs. It should be understood that to apply the various layers that constitute the organic layer **26**, a number of coating steps may be implemented. Accordingly, further discussion regarding disposition of the organic layer **26** generally refers to a number of iterative coating steps. Also, as previously described, the layers deposited on the transparent film **20** may not comprise continuous layers. That is to say that each of the ITO layer **24**, the organic layer **26** and the top electrode **28** (described below with reference to **FIG. 9**) may be deposited or pattered into precisely aligned patches or pixels. While patterned deposition of the ITO layer **24** and the top electrode **28** may be achieved by conventional means, deposition of the organic layers may be more difficult. The following techniques for disposing the organic layer **26** are merely provided by way of example. As can be appreciated, other techniques for disposing the organic layer **26** may be implemented.

[0026] One technique of disposing the organic layer **26** is "micro-gravure coating" which is a continuous coating process specially adapted to apply thin uniform layer of low-viscosity liquids. An engraved roll ("gravure roll") having a small diameter is dipped with coating solution, thereby filling the cells or grooves in the surface of the roll. Excess liquid may be scraped from the surface of the roll. The gravure roll is reverse-wiped across a moving tensioned reel-to-reel surface, such as the transparent film **20** having the ITO layer **24** disposed thereon, to transfer a fraction of the liquid contained in the engraving onto the surface. Because microgravure is a continuous coating technique, the disposed layer may be subsequently patterned. One patterning technique is to apply a patterned monolayer that will either attract or repel the underlying coating. Alternatively, the coating may be patterned via a laser ablation process. As can be appreciated, the organic layer **26** may remain as a continuous layer since the patterning (pixelating) of the electrodes (ITO layer **24** and the top electrode **28**) may provide sufficient electrical isolation.

[0027] Alternatively a gravure printing is a process where the desired pattern is directly engraved on the gravure roll as millions of tiny cells. The roll is directly pressed onto the application surface to transfer coating from these cells. The organic material layer may be disposed onto the surface of the ITO layer **24** through a series of elastohydrodynamic processes, as can be appreciated by those skilled in the art.

[0028] Further, flexographic printing, screen printing or inkjet printing may be implemented to dispose the individual organic materials that form the organic layer **12**. Flexographic printing is a process wherein the area to be printed is raised on a flexible plate attached to a roll. Coating is transferred to the raised image from an engraved roll, after which the coating is transferred to the surface. Rotary screen printing uses a squeegee to push coating through open areas of a fine fabric mesh onto the substrate. Inkjet printing starts with drop formation at the nozzle of an inkjet device. The drop is dispensed onto the surface and inertial force causes the drop to spread as it hits the surface. <<Don—please make sure that I have not disclosed anything that should remain GE proprietary with regard to these exemplary coating techniques.>>

[0029] Referring now to **FIG. 9**, the top electrode **28** is disposed to complete the active portion **30** of the large area OLED device. As will be described further below with reference ro **FIGS. 10-13**, after fabrication of the active portion **30**, the active portion **30** may be coupled to the transparent backer **16**. The top electrode **28** may be dipsposed at a thickness in the range of approximately 500-2500 angstroms. The top electrode **28** preferably comprises aluminum. Alternatively, the top electrode **28** may comprise calcium, magnesium or silver, for example. The top electrode **28** is advantageously reflective to reflect impinging light toward the front of the device where it can be coupled to the ambient environment. As can be appreciated, when a voltage potential is produced across the top electrode **28** and the bottom electrode (ITO layer **24**), light is emitted from the organic layer **26**. Further, the top electrode **28** provides hermeticity for the backside of the OLED device, as can be appreciated by those skilled in the art. As previously described, the top electrode **28** may be patterned or pixelated to align with a pattern that may be formed in the TCO layer **24** to reduce device failures caused by shorting between the electrodes.

[0030] **FIGS. 10-13** illustrate cross-sectional views of an exemplary fabrication process of a large-area OLED device implementing the transparent backer of **FIGS. 1-4** and the active portion of **FIGS. 5-9**. Specifically, **FIG. 10** illustrates an OLED device **32** comprising the active portion **30** coupled to the transparent backer **16**. As illustrated in **FIG. 10**, the active portion **30** is coupled to the transparent backer **16** such that the metal grid **22** of the active portion **30** aligns with the apertures **12** of the transparent backer **16**. Advantageously, by applying the transparent backer **16** late in the manufacturing process (i.e. after the formation of the active portion **30**), the active portion **30** may be fabricated using low-cost, high volume reel-to-reel equipment. As can be appreciated, the active portion **30** is coupled to the transparent backer **16** via the adhesive layer **18**. The rigidity of the transparent backer **16** provides structural support for the OLED device **32**. The active portion **30** may be coupled to the transparent backer **16** by applying mechanical pressure to one or both of the active portion **30** and the transparent backer **16** such that they are forced together. In one exemplary technique, the active portion **30** and the transparent backer **16** may be pressed using one or more rollers. Further, depending on the adhesive **18**, the OLED device **32** may be advantageously cured at room temperature, for example. As can be appreciated, because the active portion **30** may have been fabricated in a reel-to-reel system, the active portion **30** may be cut into panels before or after adhesion to the transparent backer **16**. As can be appreciated, the active portion **30** may be cut to match the dimensions defined by the plastic **10** of the transparent backer **16**.

[**0031**] To provide electrical current to the bottom electrode (ITO layer **24**), electrical leads may be coupled to the metal grid **22**. To provide access to the metal grid **22**, the apertures **12** are extended through the transparent film **20**, as illustrated in **FIG. 11**. By creating openings in the transparent film **20** through the apertures **12**, the underlying metal grid **22** is exposed through the apertures **12**. The openings in the transparent film **20** may be created by laser ablation, for example. As can be appreciated, in one exemplary embodiment, openings may not be provided to expose all of the isolated segments in the metal grid **22**, as illustrated in **FIG. 11**.

[**0032**] Referring to **FIG. 12**, exemplary electrical leads **34** are illustrated. The electrical leads **34** may comprise insulated wire having an uninusulated end portion, as illustrated in **FIG. 12**. The length of the uninsulated end portion may vary depending on whether the electrical leads **34** are coupled to the top electrode **28** or the metal grid **22**. For instance, the uninsulated end portion of each electrical lead **34** coupled to the metal grid **22** may be long enough to extend through the depth of the aperture **12**, as illustrated in the present exemplary embodiment. The electrical leads **34** may be coupled to the top electrode **28** or the metal grid **22** via a conductive material **36**. The conductive material **36** may comprise a conductive paste or epoxy that can be cured at room temperature or cured by low temperature heating, for instance. Alternatively, the conductive material **36** may comprise solder ball that may be cured using a low temperature curing process. The conductive material **36** should be such that it can be cured at a temperature (e.g., less than 180° C.). As can be appreciated, exposure of the organic layer **26** to high temperatures (e.g., greater than 180° C.) may be undesirable since it may reduce the light emitting ability of the organic layer **26**. Further, once the electrical leads **34** are attached to the metal grid **22**, the apertures **12** may be filled with a conductive or non-conductive sealing material (not illustrated).

[**0033**] The OLED device **32** may be sealed by an encapsulating layer **38**, as illustrated in **FIG. 13**. The encapsulating layer **38** provides further hermeticity for the OLED device **32** to further protect the device from external elements. The encapsulating layer **38** may be disposed over the top electrode **28** and along the sides of the OLED device **32**. As can be appreciated, when an electrical potential is provided through the electrodes **34**, the polymers in the organic layer **26** are activated and light is produced. The light is emitted through the transparent layers in the front of the large area OLED device **32** such that it is coupled into the ambient environment, as illustrated by light indicator arrows **40**. As can be appreciated, the present OLED device **32** may be used as a large area, general lighting source.

[**0034**] While the invention may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims.

What is claimed is:

1. A system comprising:

a rigid plastic layer;

a hermetic coating layer disposed on the rigid plastic layer;

a flexible transparent film coupled to the hermetic coating layer;

a metal grid pattern formed on the flexible transparent film;

a transparent conductive oxide (TCO) layer disposed over the metal grid pattern and the transparent film;

an organic layer disposed over the transparent conductive oxide layer; and

a top electrode disposed over the organic layer.

2. The system, as set forth in claim 1, wherein the flexible transparent film comprises a film disposed from a reel.

3. The system, as set forth in claim 1, wherein the metal grid pattern comprises a plurality of electrically isolated metal squares.

4. The system, as set forth in claim 1, wherein the transparent conductive layer comprises an indium-tin-oxide (ITO) layer.

5. The system, as set forth in claim 1, comprising electrical leads coupled to each of the metal grid pattern and the top electrode.

6. The system, as set forth in claim 1, comprising electrical leads coupled to some of the plurality of metal squares.

7. The system, as set forth in claim 1, comprising a hermetic coating disposed over the top electrode.

8. The system, as set forth in claim 1, wherein the top electrode comprises a reflective metal to reflect impinging light through the system.

9. The system, as set forth in claim 1, wherein an adhesive is disposed between the flexible transparent film and the hermetic coating.

10. The system, as set forth in claim 1, wherein a color changing layer is disposed between the flexible transparent film and the hermetic coating.

9. The system, as set forth in claim 1, wherein the system comprises an area lighting system.

10. The system, as set forth in claim 1, wherein the system comprises a photovoltaic system.

11. A system comprising:

a transparent backer portion;

a transparent film coupled to the transparent backer portion;

a metal pattern formed on the flexible transparent film;

a transparent conductive layer disposed over the metal pattern and transparent film;

an organic layer disposed over the transparent conductive layer; and

a top electrode layer disposed over the organic layer.

12. The system, as set forth in claim 11, wherein the transparent backer portion comprises a plastic layer, a hermetic coating disposed over the plastic layer, and an adhesive layer disposed over the hermetic coating.

13. The system, as set forth in claim 12, wherein a color changing layer is disposed between the hermetic coating and the adhesive layer.

14. The system as set forth in claim 11, wherein apertures extend through the transparent backer portion coincident with the metal pattern.

15. The system, as set forth in claim 11, wherein the transparent film comprises a film disposed from a reel.

16. The system, as set forth in claim 11, wherein the metal pattern comprises a plurality of electrically isolated metal squares.

17. The system, as set forth in claim 11, wherein the transparent conductive layer comprises an indium-tin-oxide (ITO) layer.

18. The system, as set forth in claim 11, wherein the top electrode layer comprises a reflective metal to reflect impinging light through the transparent portions of the system.

19. The system, as set forth in claim 11, comprising a hermetic coating disposed over the top electrode layer.

20. The system, as set forth in claim 11, comprising electrical leads coupled to each of the metal pattern and the top electrode layer.

21. The system, as set forth in claim 11, wherein the system comprises an area lighting system.

22. The system, as set forth in claim 11, wherein the system comprises a photovoltaic system.

23. An area lighting system comprising:

a transparent backer portion having a plurality of apertures;

a transparent film coupled to the transparent backer portion and having a plurality of apertures coincident with the plurality of apertures of the transparent backer portion;

a metal pattern formed on the flexible transparent film;

a transparent conductive layer disposed over the metal pattern;

an organic layer disposed over the transparent conductive layer;

a metal layer disposed over the organic layer; and

electrical leads coupled to each of the metal pattern and the metal layer disposed over the organic layer.

24. The area lighting system, as set forth in claim 23, wherein the transparent backer comprises a plastic layer, a hermetic coating over the plastic layer, and an adhesive layer over the hermetic coating.

25. The system, as set forth in claim 24, wherein a color changing layer is disposed between the hermetic coating and the adhesive layer.

26. The area lighting system, as set forth in claim 23, wherein the transparent film comprises a film disposed from a reel.

27. The system, as set forth in claim 23, comprising a hermetic coating disposed over the metal layer disposed over the organic layer.

28. The area lighting system, as set forth in claim 23, wherein the electrical leads coupled to the first electrode are disposed in the apertures extending through the transparent backer portion and the transparent film and coincident with the metal pattern formed on the flexible transparent film.

29. The system, as set forth in claim 23, wherein the system comprises a photovoltaic system.

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