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(54) METHOD FOR PACKAGING ORGANIC ELECTROLUMINESCENT COMPONENTS WITH POLYMER PASSIVATION LAYER AND STRUCTURE THEREOF

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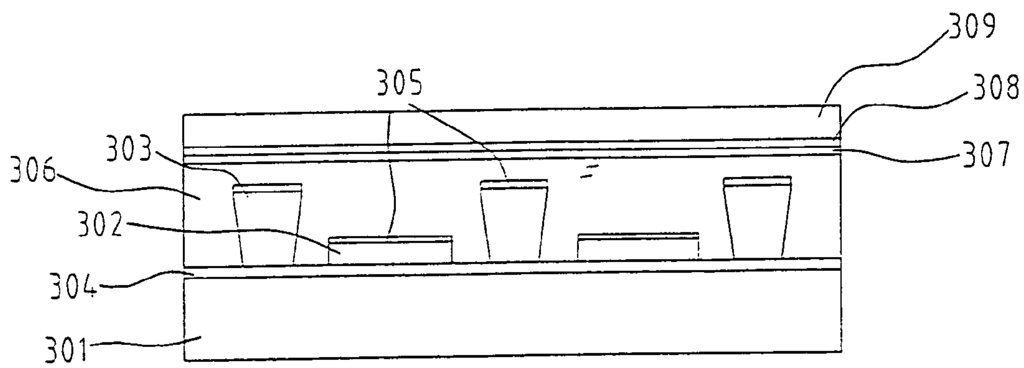
(57) **ABSTRACT**

A method for packaging organic electroluminescent (EL) components with polymer passivation layer and structure thereof is developed on the basis of a multi-layer passivation concept to form a wet-adsorption polymer passivation layer for packaging and separating the EL components from moisture and oxygen by a coating or plating process, wherein a surface structure of cathode separators is also put into consideration for enhancement of the passivation layer which is then sealed to substitute for the conventional package-can design.



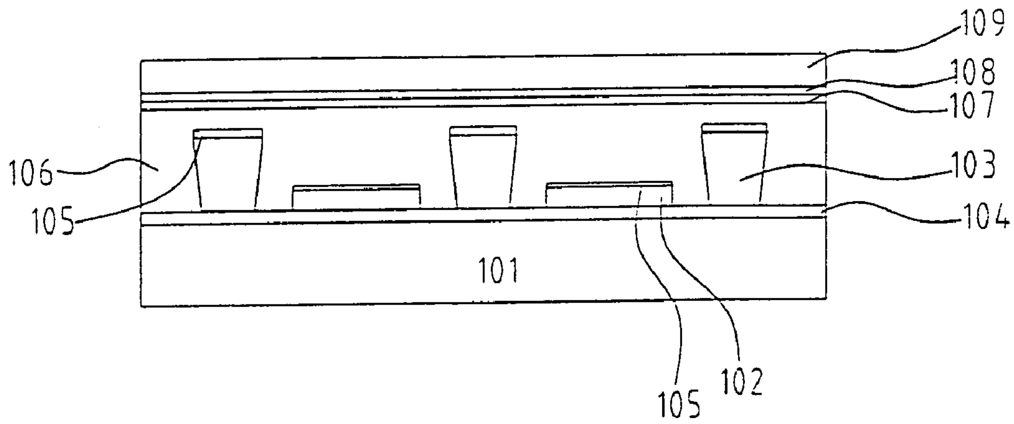

109
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FIG. 1

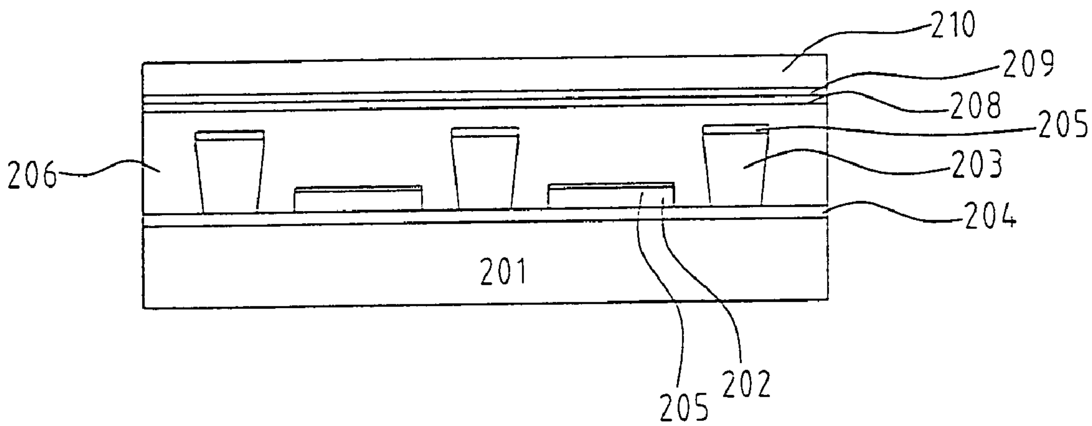
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FIG. 2

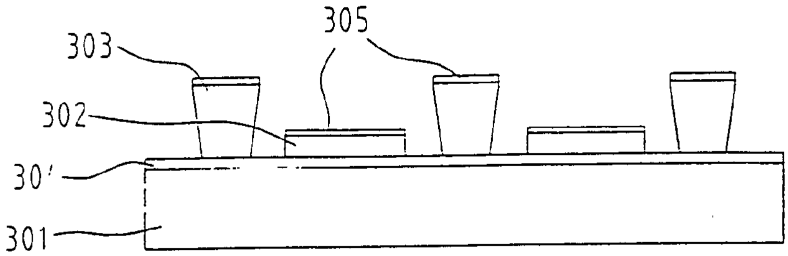

FIG. 3A

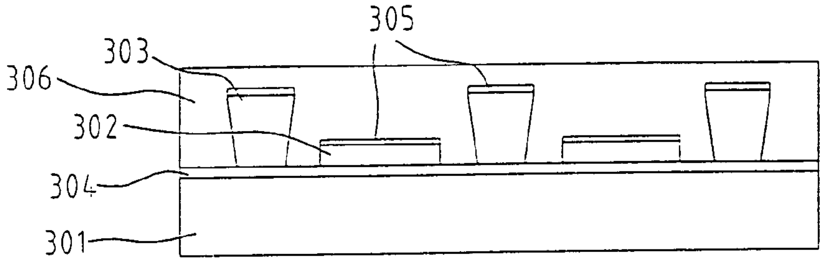

FIG. 3B

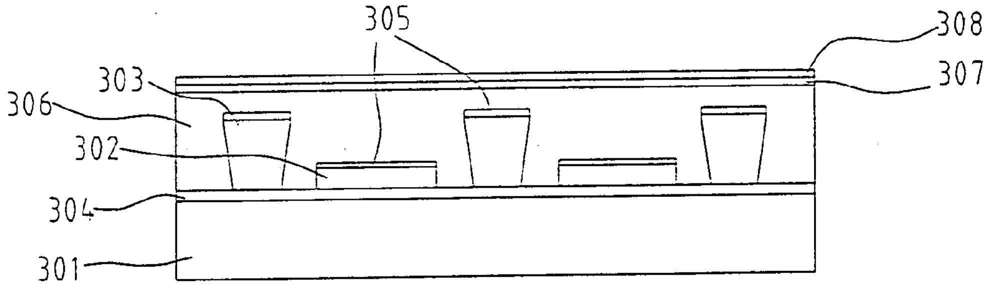

FIG. 3C

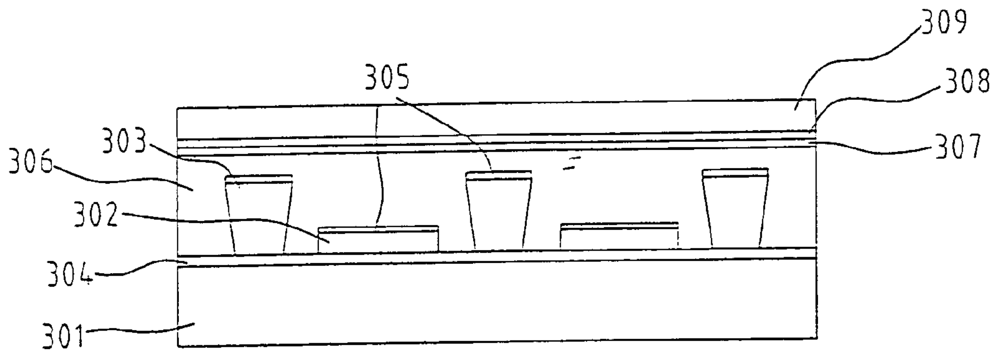

FIG. 3D

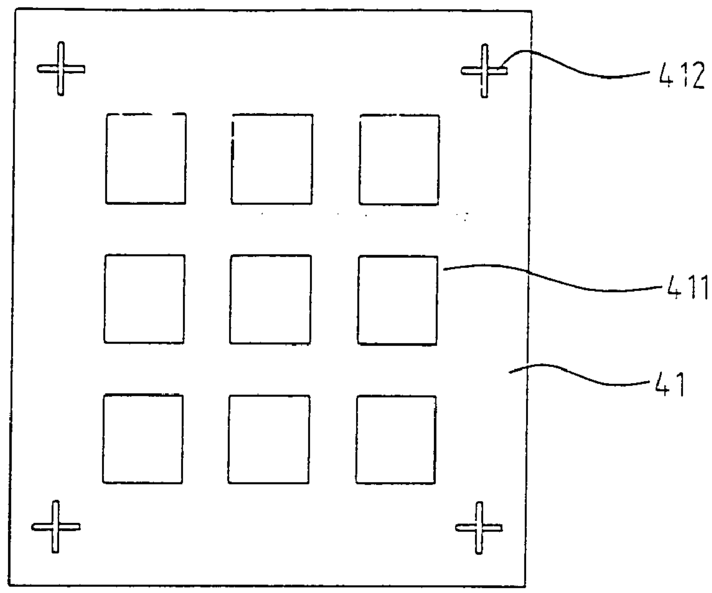

FIG. 4A

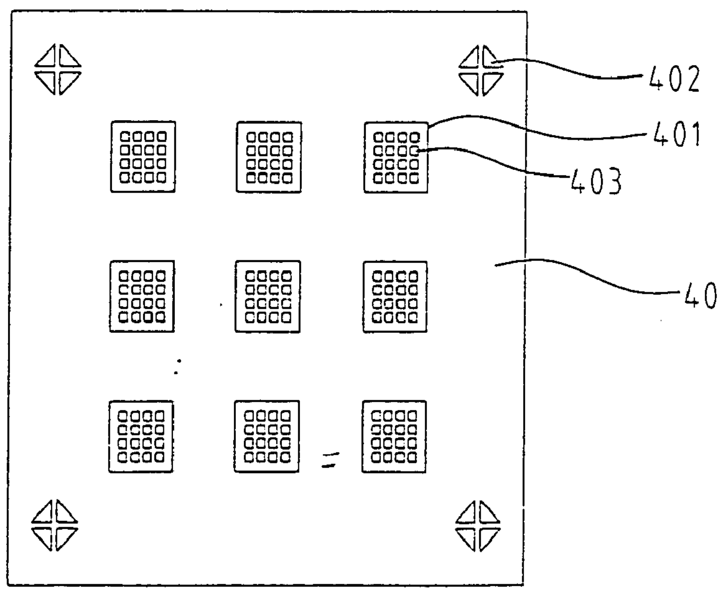

FIG. 4B

METHOD FOR PACKAGING ORGANIC ELECTROLUMINESCENT COMPONENTS WITH POLYMER PASSIVATION LAYER AND STRUCTURE THEREOF

FIELD OF THE INVENTION

[0001] This invention relates to a polymer passivation layer formed by way of spraying, screen-printing, dispensing or spincoating for protection of organic electroluminescent (EL) components disposed on a substrate in an organic light-emitting diode (OLED).

BACKGROUND OF THE INVENTION

[0002] Package technology is one of the important factors to have the existing electroluminescent (EL) components been well protected. An EL component is generally multilayer constructed, wherein the material in each layer is extremely sensitive to the external environments.

[0003] In order to facilitate infusion of electrons, a low-work function material is adopted for the cathode, however with a side effect of being oxidized easily that would degrade the component's function. Besides, a lighting layer formed by fluorescent organic solid material and an electrons transport layer and emitting materials layer are also extremely sensitive to humidity, oxygen, and some environmental factors, and any of which may render the organic substance crystallized to result in detachment of the organic material layer from the cathode to have the so-called "dark-spot" phenomenon happened. Therefore, a conventional organic EL component can light only in a short lifetime if lacking a perfect package.

[0004] In order to prevent the organic EL component from being spoiled, a generic measure is taken by applying some binder of epoxy resin to the inner face of a panel in a component's package cover, and at this moment, the sealed portion is limited to the panel verge while dry nitrogen is sealed in the central hollow portion.

[0005] This measure does work to block moisture infiltration, however, the environment is still kept under highly humidified conditions to some extent on the other hand. When temperature goes higher and higher to reach 100° C. for example, the moisture remained on the substrate, the glass surface, or the package-can surface is supposed to invade into the package to enlarge the darkspot phenomenon. Some kind of desiccants, such as barium oxide or calcium chloride, is filled in the package cover for dissolving this problem so far, nevertheless, moisture will damage the EL component after the desiccants material is saturated and swollen, however.

[0006] In the schematic structure view of a conventional organic passive EL component shown in **FIG. 1**, an ITO (Indium-Tin oxide) anode layer **104** is disposed on a substrate **101**, wherein a plurality of EL component's pixels **102** and cathode separators **103** are formed on the ITO anode layer **104**, wherein a cathode layer **105** is formed on top of each pixel **102** and each rib **103**; a polymer or an organic metallic material or layer **106** is filled in a gap between the pixels **102** and the ribs **103** or vapor-plated on each pixel **102** and rib **103**; and finally, an inorganic or metallic protective layer **107, 108** and a polymer package layer **109** are laid one after another in sequence.

[0007] The cathode separators **103** are provided for eliminating cross talk, however, as uncountable step-like cavities and protrusions are formed between the organic metallic layer **106** and the cathode separators **103** to render the passivation package process difficult, hence, an intensively plated passivation structure without the conventional metallic or glass package-can is preferred for enhancing segregation of the organic EL component from moisture and oxygen and for facilitating an easy package and prolonging lifetime thereof.

[0008] The organic EL component and passivation thereof made by the prior art are regarded defective as the following:

[0009] 1. Employed metallic or glass package-can for isolating external effects is relatively heavier and liable to be oxidized; the adhesion between metal and glass is rather poor; the juncture flatness is strictly requested; the unevenness of package stress will probably result in a detachment; the polymer binding material cannot prevent the moisture from invading thoroughly; and in the case barium oxide is adopted to serve as a desiccant, an environmental problem may arouse.

[0010] 2. The polymer passivation layer is usually designed to serve for a polymer buffer layer between a metallic electrode and an inorganic layer, however because of its larger expansion coefficient than that of the metallic and the inorganic layer, a change in ambient air temperature will probably make the inside stress uneven and incur detachment of the polymer from the inorganic or the metallic layer.

[0011] 3. A fair polymer passivation layer is generally not a wet-adsorbent layer, moisture can infiltrate through pin holes in the layer to reach and affect the component, and furthermore, if few water oozes through the cathode passivation material and the organic material that contact the polymer layer, moisture is then diffused inside to spoil the component.

[0012] In view of abovesaid defects of the prior art, this invention provides a method for packaging EL components and structure thereof by directly plating a passivation layer on the EL components for preventing water or oxygen from permeating so as to substitute for the conventional metallic or glass package-can to save the space, weight, and package alignment procedure.

[0013] The method of this invention is to: form an ITO anode layer on a transparent substrate of EL component; form an organic thin film on the anode layer by vapor plating or coating; form a low-work function cathode layer on the thin film; coat with polymer to form a layer by spraying, screen-printing, dispensing, or spincoating etc., in order to fill up the space between the component and cathode separators and provide a flat surface to avoid the "step effect" when masking and ensure tightness of a plated passivation layer for protection of the EL components.

[0014] Moreover, this invention further provides a passivation layer containing a polymer mixed with a filler agent for prevention of moisture infiltration and reduction of expansion coefficient of the passivation layer in order not to get peeled easily.

[0015] The merits of the passivation layer of this invention may be summarized in the following:

[0016] 1. As the metallic or glass package-can is discarded, weight, thickness, and volume of this invention may be reduced or shrinked for application to an organic EL component disposed on a flexible substrate and to the portable 3C products.

[0017] 2. The rugged surface between the cathode and the component is flatted and thereby to eliminate the "step effect" caused by change of temperature in a plated inorganic layer.

[0018] 3. The usable polymer may include Epoxy, Acrylic, Urethane, Epoxy/Acrylic. Acrylic/Urethane, Silicone, Siloxane, Organic/Inorganic hybride. etc. The filler agent can be coated easily on the substrate for mass production by way of spraying, screen-printing, dispensing, or spincoating etc.

[0019] 4. Wet-adsorbent substance is also added to have wet adsorbed in the polymer layers without diffusing to inside of the EL component to prolong the component's lifetime.

SUMMARY OF THE INVENTION

[0020] The primary object of this invention is to provide a method for packaging organic electroluminescent components with polymer passivation layer and structure thereof developed on the basis of multi-layer passivation concept for separating the components from moisture and oxygen by a coating process, wherein a surface structure of cathode separators is also put into consideration for enhancement of the passivation layer which is then sealed to substitute for the conventional package-can design.

[0021] Another object of this invention is to use a polymer layer or a wet-adsorption polymer layer to form a passivation layer, wherein the wet-adsorption polymer layer will chemically adsorb moisture and retain it in order not to diffuse to inside of the components.

[0022] To realize abovesaid objects, in forming the passivation layer, the craggy surface of the organic EL component must be taken into consideration, which may cause detachment of the polymer layer from an inorganic layer or a metallic electrode. For getting rid of such a situation, this invention has provided a fabrication process suitable for mass production to form a passivation layer on a substrate by way of spraying, screen-printing, dispensing, or spincoating for preventing moisture from diffusing into the component's inside to lessen the possibility of spoilage accordingly.

[0023] For more detailed information regarding advantages or features of this invention, at least an example of preferred embodiment will be elucidated below with reference to the annexed drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] **FIG. 1** shows a schematic structure of a conventional passive organic EL component.

[0025] **FIG. 2** shows a schematic structure of an organic EL component of this invention;

[0026] **FIGS. 3A through 3D** illustrate a method for packaging organic EL components with a wet-adsorption polymer passivation layer; and

[0027] **FIGS. 4A and 4B** show mask patterns of this invention.

DETAILED DESCRIPTION OF THE INVENTION

[0028] This invention is basically to provide a wet-adsorption polymer protective layer to substitute for a widely used passivation layer in a conventional organic electroluminescent (EL) component.

[0029] As illustrated in **FIG. 2**, an organic EL component in an embodiment of this invention mainly comprises a transparent substrate **201**, at least a polymer passivation layer **206**, and a polymer package layer **210**.

[0030] On the transparent substrate **201**, a plurality of pixels **202** and cathode separators **203**, an anode layer of Indium-Tin oxide (ITO) **204** interfaced between the substrate **201** and the pixels **202**, and a cathode layer **205** residing on the pixels **202** are disposed.

[0031] In the polymer passivation layer **206**, a polymer or wet-adsorption polymer layer is directly formed to fill up the gaps between the pixels **202** and the cathode separators **203** and on the surface of the pixels **202** themselves. In addition, an inorganic layer **208** and a metallic layer **209** may be laid on the passivation layer **206** depending on requirements irrespective or the overlay order thereof.

[0032] The polymer package layer **210** is laid on the top surface to seal the passivation layer **206**, the inorganic layer **208**, and the metallic layer **209**.

[0033] A wet-adsorption polymer protective layer of this invention for filling or covering the EL component comprises a polymer material containing at least a filler agent which is a wet-adsorbent or an inorganic material, wherein the addition ratio of the filler agent and the polymer material are 1~90% respectively. An adsorption material of the filler agent is either a physical or a chemical wet-adsorbent material, wherein the grain size of the filler agent is about 0.1 mm~10 μm while the chemical wet-adsorbent material should include at least one of the following compounds:

[0034] alkali metallic oxides, such as K_2O or Na_2O:

[0035] alkaline earth metallic oxides, such as CaO, BaO, or MgO;

[0036] sulfate compounds, such as Li_2SO_4, Na_2SO_4, $MgSO_4$, $CoSO_4$, $Ga_2(SO_4)_3$, $Ti(SO_4)_2$, or $NiSO_4$;

[0037] halogen metallic compounds, such as $CaCl_2$, $MgCL_2$, $SrCl_2$, YCl_2, $CuCl_2$, CsF, TaF_5, NbF_5, $CaBr_2$, $CsBr_3$, $SeBr_4$, VBr_2, $MgBr_2$, BaI_2, or MgI_2; or

[0038] perchlorate compounds, such as $Ba(ClO_4)_2$ or $Mg(ClO_4)_2$.

[0039] The filler agent is a low coefficient of thermal expansion material used for lowering the expansion coefficient of a polymer protective layer to approach that of an inorganic or a metallic layer so that the stress of the polymer layer with respect to the inorganic or the metallic layer can be eliminated effectively to avoid any possible detachment of the polymer protective layer. Besides, the sulfate compounds, the halogen metallic compounds, and the perchlorate compounds in the chemical adsorbent material would react on moisture and convert into crystalline water as shown in the following reaction equations from (1) to (4):

$$CaCl_2+6H_2O \rightarrow CaCl_2.6H_2O \quad (1)$$

$$CaSO_4+2H_2O \rightarrow CaSO_4.2H_2O \quad (2)$$

$$CuCl_2+2H_2O \rightarrow CuCl_2.2H_2O \quad (3)$$

$$MgSO_4+7H_2O \rightarrow MgSO_4.7H_2O \quad (4)$$

[0040] The alkali metallic oxides and the alkaline earth metallic oxides in the chemical adsorbent material would react on moisture and convert into hydroxides as shown in the following reaction equations frown (5) to (9):

$$K_2O+H_2O \rightarrow 2KOH \quad (5)$$

$$Na_2O+H_2O \rightarrow 2NaOH \quad (6)$$

$$BaO+H_2O \rightarrow Ba(OH)_2 \quad (7)$$

$$MgO+H_2O \rightarrow Mg(OH)_2 \quad (8)$$

$$CaO+H_2O \rightarrow Ca(OH)_2 \quad (9)$$

[0041] Moreover, the materials of the wet-adsorption polymer protective layer for packaging EL components may be a solvent or a nonsolvent thermo-curing or UV-curing monomer or oligomer, such as Epoxy, Acrylic, Urethane, Epoxy/acrylic, Acrylic/Urethane, Silicone, Silioxane, or Organic/inorganic hybrid, etc.

[0042] The coefficient of thermal expansion wet-adsorption polymer passivation layer of this invention is located in the range of 1~100 ppm/° C., however, 5~20 ppm/° C. is preferable. The wet-adsorption polymer protective layer is formed by spraying or screen-printing to overlay the EL component.

[0043] **FIGS. 3A through 3D** illustrate a method for packaging organic EL components with a wet-adsorption polymer passivation layer.

[0044] As shown in **FIG. 3**A, the method is to form on a substrate **301** a plurality of EL component's pixels **302** and cathode separators **303**: an Indium-Tin oxide (ITO) anode layer **304** serving for an anode of the pixels **302**; and a cathode layer **305** on the top surface of each pixel **302**, wherein the cathode separators **303** are provided for prevention of "cross talk".

[0045] Referring to **FIG. 3**B, the method is to apply a passivation layer **306** or up with at least a polymer sub-layer on abovesaid architecture to fill up the gaps between the pixels **302** and the cathode separators **303**. The reason to form at least a polymer sub-layer is that because uncountable step-like cavities and protrusions are formed between the pixels **302** and the cathode separators **303** to render the passivation package process difficult. The polymer sub-layer is done by spraying, screen-printing, dispensing, or spin-coating to form mask patterns for filling up the gaps mentioned and flatten the surface for eliminating the "step effect" of ensuing plating of a dielectric layer **307** or a metallic layer **308** so as to achieve a dense passivation structure shown in **FIG. 3C**.

[0046] The passivation layer should comprise at least: a wet-adsorption or inorganic filler agent, and a solvent or nonsolvent, thermo-curing or UV-curing, organic or inorganic polymer sub-layer. The thickness of the passivation layer should never be thinner than the height of the cathode separators and is controlled preferably between 1~1000 μm.

[0047] As shown in **FIGS. 4A and 4B**, a plurality of sprayed or screen-printed mask patterns **411** is the same with the EL component domains **401** formed on a substrate **40** in amount at corresponding positions, wherein each unit of the mask pattern **411** is slightly larger than each domain **401** in area; the alignment symbols **412** in the mask or screen **41** must be exactly aligned with the alignment symbols **402** in the substrate **40** when spraying or screen-printing; and the domains **401** comprise organic EL component's pixels **403** at least in thousands or up.

[0048] Finally, **FIG. 3D** shows a procedure for coating or sealing the entire passivation layer by overlaying the passivation layer **306**, the dielectric layer **307**, and the metallic layer **308** with a package material **309** which may be a thermo-curing or UV-curing package material of epoxy, acrylic, or silicon gel.

[0049] In the above described, at least one preferred embodiment has been described in detail with reference to the drawings annexed, and it is apparent that numerous variations or modifications may be made without departing from the true spirit and scope thereof, as set forth in the claims below.

What is claimed is:

1. A passivation layer for packaging organic electroluminescent (EL) components, the passivation layer being a polymer passivation layer or a wet-adsorption polymer passivation layer comprising

at least a wet-adsorption or an inorganic filler agent; and

at least a solvent or nonsolvent, thermo-curing or UV-curing polymer material:

wherein the filler agent is blended with a polymer material to form a wet-adsorption polymer protective layer for filling Up or overlaying the organic EL components.

2. The wet-adsorption polymer passivation layer according to claim 1, wherein the addition ratio of the filler agent and the high molecular material are 1~90% respectively so as to produce the wet-adsorption polymer protective layer.

3. The wet-adsorption polymer passivation layer according to claim 1, wherein the polymer material is any of Epoxy, Acrylic, Urethane, Epoxy/Acrylic, Acrylic/Urethane, Silicone, Silioxane, or Organic/Inorganic hybrid.

4. The wet-adsorption polymer passivation layer according to claim 1, wherein a wet-adsorption material of the filler agent is either a physical or a chemical adsorption material; and the grain size of the filler agent is about 0.1 mm~10 μm.

5. The wet-adsorption polymer passivation layer according to claim 4, wherein the chemical adsorption is at least a compound of the following: namely, an alkali metallic oxide, an alkaline earth metallic oxide, a sulfate compound, a halogen metallic compound, or a perchlorate compound.

6. The wet-adsorption polymer passivation layer according to claim 4, wherein the alkali metallic oxide is either K_2O or Na_2O.

7. The wet-adsorption polymer passivation layer according to claim 4, wherein the alkaline earth metallic oxide is CaO, BaO, or MgO.

8. The wet-adsorption polymer passivation layer according to claim 4, wherein the sulfate compound is Li_2SO_4, Na_2SO_4, $MgSO_4$, $CoSO_4$, $Ga_2(SO_4)_3$, $Ti(SO_4)_2$, or $NiSO_4$.

9. The wet-adsorption polymer passivation layer according to claim 4, wherein the halogen metallic compound is

$CaCl_2$, $MgCL_2$, $SrCl_2$, YCl_2, $CuCl_2$, CsF, TaF_5, NbF_5, $CaBr_2$, $CsBr_3$, $SeBr_4$, VBr_2, $MgBr_2$, BaI_2, or MgI_2.

10. The wet-adsorption polymer passivation layer according to claim 4, wherein the perchlorate compound is either $Ba(ClO_4)_2$ or $Mg(ClO_4)_2$.

11. The wet-adsorption polymer passivation layer according to claim 1, wherein the thermal expansion coefficient of the passivation layer is located in the range of 1~100 ppml/° C., however, 5~20 ppm/° C. is preferable.

12. The wet-adsorption polymer passivation layer according to claim 1, which is formed by way of spraying, screen-printing, dispensing, or spincoating so as to fill up or overlay the EL components.

13. A method for packaging organic electroluminescent (EL) components with polymer passivation layer, comprising:

plating at least a wet-adsorption passivation layer on a flexible substrate made in glass, metal, or plastics;

forming a plurality of organic EL component's pixels and cathode separators on the substrate, wherein at least a sub-layer of the passivation layer is a polymer layer; and the passivation layer is applied to fill up the gaps between the pixels and the cathode separators; and

sealing the surface of the entire passivation layer by overlaying a package material thereon.

14. The method for packaging organic EL components according to claim 13, wherein the wet-adsorption passivation layer is composed of

a polymer material, which is a solvent or nonsolvent, thermo-curing or UV-curing, organic or Inorganic material; and

a filler agent, which is a wet-adsorption material or an inorganic material.

15. The method for packaging organic EL components according to claim 13, wherein the wet-adsorption passivation layer is formed by spraying, screen-printing, dispensing, or spincoating to produce a plurality of mask patterns for overlaying the EL components.

16. The method for packaging organic EL components according to claim 15, wherein the amount of mask pattern is equal to that of the EL component's domains; and each mask pattern is slightly larger than a paired off domain in area occupied at a correspondent position.

17. The method for packaging organic EL components according to claim 13, wherein the thickness of the polymer passivation layer should never be thinner than the height of the cathode separators and is controlled preferably between 1~1000 μm.

18. The method for packaging organic EL components according to claim 13, wherein the package material is an Epoxy gel, an Acrylic gel, a Silicone gel, or any of various thermo-curing or UV-curing materials.

19. A package structure for organic EL components with polymer or wet-adsorption polymer passivation layer, comprising:

a flexible substrate made in glass, metal or plastics, having a plurality of organic EL component's pixels and cathode separators disposed thereon, an Indium-Tin oxide (ITO) anode layer formed between the substrate and the pixels to serve as an anode of the latter, wherein a cathode layer is laid on each pixel;

at least a polymer or a wet-adsorption polymer passivation layer being formed directly between the pixels and the cathode separators and on surface of the pixels; an optional inorganic or metallic layer being formed in an arbitrary order on top of the wet-adsorption polymer passivation layer depending on requirements; and

a polymer package layer for sealing the entire surface of the passivation layer, or the inorganic and/or the metallic layer if applied.

* * * * *

专利名称(译)	用聚合物钝化层包装有机电致发光组件的方法及其结构		
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[标]申请(专利权)人(译)	WINDELL		
申请(专利权)人(译)	WINDELL CORPORATION		
当前申请(专利权)人(译)	胜华科技股份有限公司		
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发明人	HWANG, CHIN-PEI NI, JUI-MING CHEN, KUANG-JUNG CHEN, HSUEH-WEN		
IPC分类号	H01L51/52 H05B33/00		
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外部链接	Espacenet USPTO		

摘要(译)

基于多层钝化概念开发了一种用于包装具有聚合物钝化层的有机电致发光(EL)组件的方法及其结构，以形成用于通过以下方式包装和分离EL组分与水分和氧气的湿吸收聚合物钝化层。涂层或电镀工艺，其中还考虑阴极隔板的表面结构以增强钝化层，然后将其密封以代替传统的封装罐设计。