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Huang

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(54) **OLED DEVICE ENCAPSULATING METHOD AND STRUCTURE, OLED DEVICE, AND DISPLAY SCREEN**

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(56) **References Cited**

U.S. PATENT DOCUMENTS

6,150,187 A * 11/2000 Zyung H01L 51/5253 438/126
6,506,616 B1 * 1/2003 Kim H01L 51/0018 438/22
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101348048 A 1/2009
CN 101373816 A 2/2009
(Continued)

OTHER PUBLICATIONS

English translation of CN105977394A, Sep. 28, 2016 (Year: 2016).*
English translation of CN102736414A, Oct. 17, 2012 (Year: 2012).*

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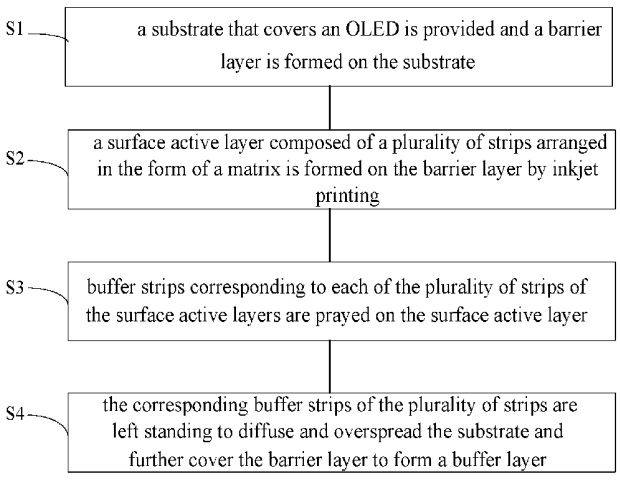
(57) **ABSTRACT**

An OLED device encapsulating structure used to encapsulate an OLED is disclosed. The OLED device encapsulating structure includes a substrate, a barrier layer formed on the substrate, a surface active layer disposed on the barrier layer, and a buffer layer stacked on the surface active layer. An orthogonal projection of the buffer layer onto the barrier layer may coincide with that of the surface active layer onto the barrier layer. A composite layer may further be stacked on the buffer layer. An OLED device and a display screen are also disclosed.

14 Claims, 2 Drawing Sheets



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(58) **Field of Classification Search**
USPC 257/40
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2003/0170496	A1*	9/2003	Hieda	H01L 51/524 428/690
2005/0197031	A1*	9/2005	Yamazaki	H01L 27/3211 445/24
2006/0019034	A1	1/2006	Toyoda	
2006/0046336	A1*	3/2006	Shoji	H01L 27/3244 438/30
2006/0246811	A1*	11/2006	Winters	H01L 51/5253 445/25
2011/0121356	A1*	5/2011	Krawinkel	C03C 27/10 257/100
2012/0100647	A1*	4/2012	Kim	H01L 51/003 438/28
2012/0161141	A1*	6/2012	Jeon	H01L 27/322 257/59
2012/0305981	A1*	12/2012	Park	H01L 51/5253 257/100
2012/0318023	A1*	12/2012	Shimomura	C03C 27/06 65/43
2013/0240848	A1*	9/2013	Lin	H01L 51/52 257/40
2015/0380683	A1*	12/2015	You	H01L 51/5253 257/40
2016/0024322	A1*	1/2016	Jain	C09D 11/30 438/46
2017/0117503	A1*	4/2017	Harikrishna Mohan	H01L 51/5253
2017/0155082	A1*	6/2017	Mu	H01L 27/3244
2017/0346040	A1*	11/2017	Fleissner	H01L 51/56
2018/0138450	A1*	5/2018	Park	H01L 27/3211

FOREIGN PATENT DOCUMENTS

CN	102736414	A	10/2012
CN	105355647	A	2/2016
CN	105977394	A	9/2016
CN	106654042	A	5/2017
KR	20070060973	A	6/2007

* cited by examiner

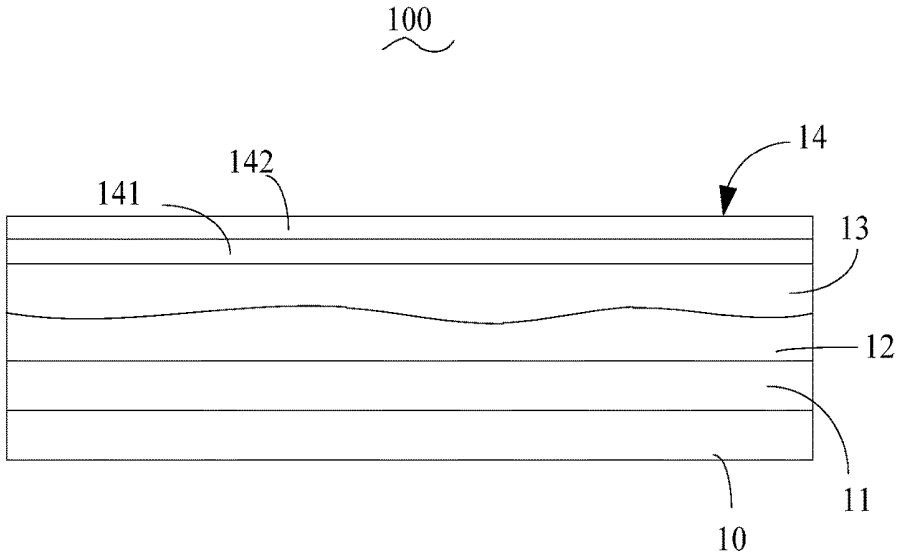

FIG. 1

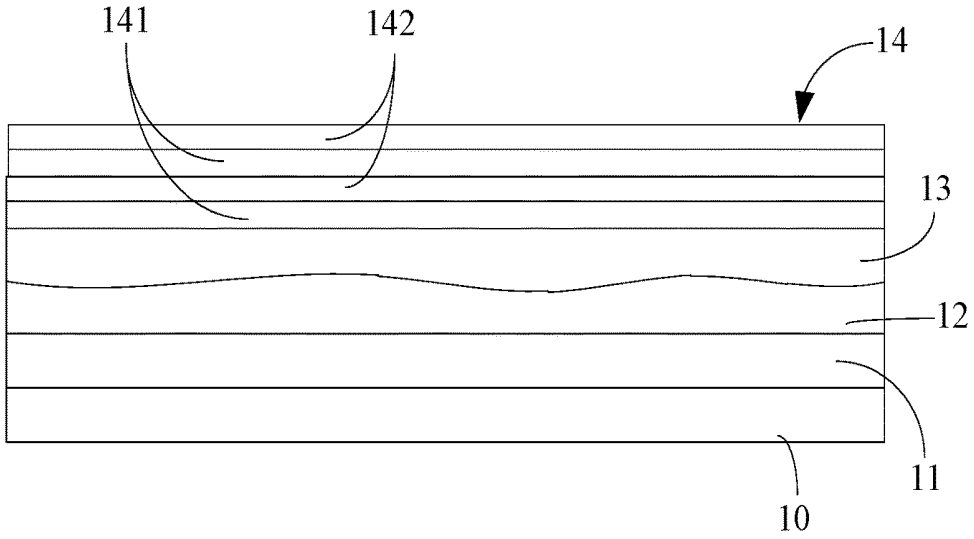

FIG. 2

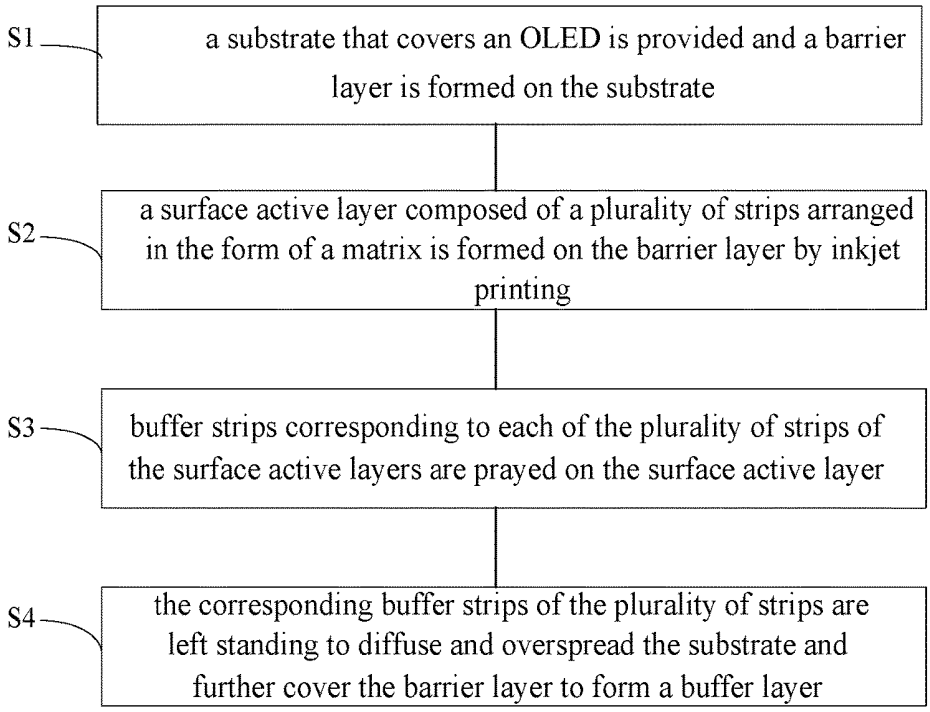

FIG. 3

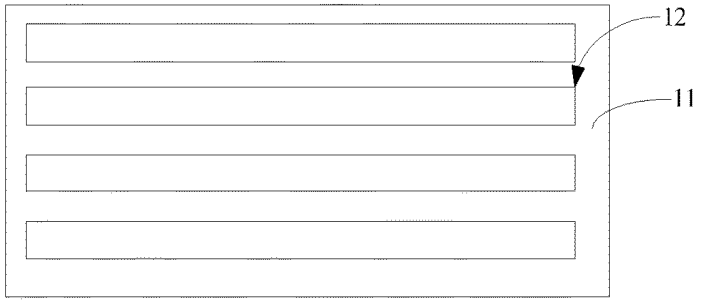

FIG. 4

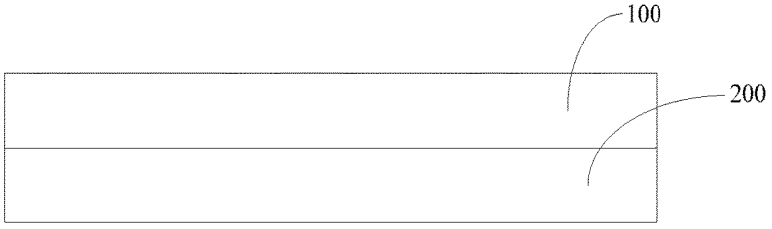

FIG. 5

OLED DEVICE ENCAPSULATING METHOD AND STRUCTURE, OLED DEVICE, AND DISPLAY SCREEN

TECHNICAL FIELD

The present disclosure relates to display technology, and more particularly relates to an OLED device encapsulating method, an OLED device encapsulating structure, an OLED device, and a display screen.

BACKGROUND

In the current lighting and display field, an organic light-emitting diode (OLED) (also known as organic optoelectronic display) features a low starting voltage, thinness, lightweight, self-luminous etc. and has by virtue of these received increasing and extensive study for development of lighting products and the panel industry to meet the demands for low energy consumption, thinness, lightweight, and surface light source.

OLED devices are extremely sensitive to water and oxygen. In current OLED thin-film encapsulating, the common technology is depositing alternately a polymer organic thin-film and an inorganic thin-film onto the OLED so that the OLED could be encapsulated by stacks of several layers. To achieve better buffering effects, a buffer layer is formed using inkjet printing. But there exists a gap among the inkjet printing heads, the time required for film-forming encapsulating is lengthened and the encapsulating cost is increased.

SUMMARY

It is an object of the disclosure to provide an OLED device encapsulating method and an OLED device encapsulating structure, which can shorten the film-forming time and reduce the cost.

An OLED device and a display screen are also provided.

The OLED device encapsulating structure of the disclosure is used to encapsulate the OLED layer, and includes a substrate, a barrier layer formed on the substrate, a surface active layer disposed on the barrier layer, and a buffer layer stacked on the surface active layer. An orthogonal projection of the buffer layer onto the barrier layer may align and coincide with that of the surface active layer onto the barrier layer. A composite layer may further be stacked on the buffer layer.

The surface active layer material may be one of a hydrophilic polymer active material, polyol based salt, or polyol based ethers.

The surface active layer may be formed by inkjet printing.

The composite layer may include a first barrier layer and a first buffer layer stacked on the first barrier layer, or alternatively a plurality of first barrier layers and a first buffer layer sandwiched between every two first barrier layers. The first one of the plurality of first barrier layers may be in contact with the buffer layer.

The OLED device encapsulating method of this disclosure is used to encapsulate an OLED. The method includes the follows.

A substrate that covers the OLED is provided and a barrier layer is formed on the substrate.

A surface active layer composed of a plurality of strips arranged in the form of a matrix is formed on the barrier layer by inkjet printing.

Buffer strips in one-to-one correspondence with the plurality of strips are sprayed on the surface active layer.

The corresponding buffer strips of the plurality of strips are left standing to diffuse and overspread the substrate and further cover the barrier layer, to form a buffer layer.

The surface active layer may have a thickness in the range of less than 100 microns.

The surface active layer material may be one of a hydrophilic polymer active material, polyol based salt, or polyol based ethers.

The OLED device encapsulating method may further include the follows. The substrate is heated to remove the surface active layer.

The OLED device according to the disclosure may include the OLED device encapsulating structure.

The display screen according to the disclosure may include the OLED device.

According to the OLED device encapsulating method of the disclosure, the surface active layer is formed on the barrier layer, and then the buffer material is sprayed to diffuse and cover the entire barrier layer before the buffer layer is formed, through the chemical reaction of the surface active layer and the buffer material. Thus, the film-forming time is shortened and the cost is reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to better illustrate the technical solutions embodied by the embodiments of the disclosure or by the prior art, the accompanying drawings for use with description of the embodiments or the prior art are briefly described below. It will be apparent that the drawings described in the following represent merely some embodiments of the disclosure, and that those of ordinary skill in the art will be able to obtain other drawings from these drawings without performing any creative work.

FIG. **1** is a schematic diagram of an OLED device encapsulating structure according to an embodiment of the disclosure.

FIG. **2** is a schematic diagram of an OLED device encapsulating structure according to another embodiment of the disclosure.

FIG. **3** shows a flow chart of an OLED device encapsulating method according to an embodiment of the disclosure.

FIG. **4** is a schematic diagram of forming the surface active layer in the OLED device encapsulating method according to an embodiment of the disclosure.

FIG. **5** is a schematic diagram of an OLED device according to an embodiment of the disclosure.

DETAILED DESCRIPTION OF ILLUSTRATED EMBODIMENTS

Hereinafter, technical solutions embodied by the embodiments of the disclosure will be described in a clear and comprehensive manner in reference to the accompanying drawings intended for the embodiments. It is evident that the embodiments described herein constitute merely some rather than all of the embodiments of the disclosure, and that those of ordinary skill in the art will be able to derive other embodiments based on these embodiments without making inventive efforts, which all such derived embodiments shall all fall in the protection scope of the disclosure.

Referring to FIG. **1**, an exemplary embodiment of the disclosure provides an OLED device encapsulating structure **100**, used to encapsulate an OLED layer. OLED device encapsulating structure **100** may include a substrate **10**, a barrier layer **11** formed on substrate **10**, a surface active layer **12** disposed on barrier layer **11**, and a buffer layer **13**

stacked on surface active layer **12**. An orthogonal projection of buffer layer **13** onto barrier layer **11** may align and coincide with that of surface active layer **12** onto barrier layer **11**. In this embodiment, surface active layer **12** material may be one of a hydrophilic polymer active material, polyol based salt, or polyol based ethers. As long as surface active layer **12** material has a free hydroxyl group or H+ that can create a hydrogen bond with the hydroxyl group and H+ of buffer layer **13** to enhance their bonding ability, this material will suffice the purpose of the disclosure. That is, after being sprayed, the buffer material could be diffused by bonding with surface active layer **12** thus forming buffer layer **13**.

If the temperature of the OLED device encapsulating structure is increased by heating in its manufacturing process, or the OLED device is able to gain sufficient temperature in use, then surface active layer **12** will volatilize, without affecting the encapsulating effect. In this embodiment, surface active layer **12** is formed by inkjet printing.

A composite layer **14** may further be stacked onto buffer layer **13**. In this embodiment, composite layer **14** includes a first barrier layer **141** and a first buffer layer **142** stacked on first barrier layer **141**. Barrier layer **11** and first barrier layer **141** may be made of an inorganic material. Buffer layer **13** and first buffer layer **142** may be of an organic material.

Referring now to FIG. **2**, composite layer **14** may alternatively include a plurality of first barrier layers **141** and a first buffer layer **142** sandwiched between every two first barrier layers **141**. The first one of the plurality of first barrier layers **141** may be in contact with buffer layer **13**. According to actual requirements, a thin-film encapsulating layer of an alternate organic layer and inorganic layer structure can be deposited on the substrate to effect the insulation from water and oxygen and effectively extend the folding and curling lifetime.

Referring now to FIG. **3**, the OLED device encapsulating method provided by the disclosure is used to encapsulate an OLED layer and may include the following steps.

In S**1**, referring also to FIG. **1**, a substrate **10** is provided that covers the OLED and a barrier layer **11** is then formed on the substrate **10**. Barrier layer **11** may be formed by vacuum deposition.

In S**2**, referring also to FIG. **4**, inkjet printing may be used to form on barrier layer **11** a surface active layer **12** that may be composed of a plurality of strips **120** arranged in the form of a matrix. Surface active layer **12** may have a thickness in the range of less than 100 microns. Surface active layer **12** material may be one of a hydrophilic polymer active material, polyol based salt, or polyol based ethers. Specifically, surface active layer **12** may be formed by inkjet printing as a plurality of strips arranged on the surface and evenly spaced from each other.

In S**3**, buffer strips **131** that are in one-to-one correspondence with the plurality of strips of the surface active layer is sprayed onto surface active layer **12**. Buffer strips **131** may be formed by inkjet printing, formation (such as manner or path) of the buffer strips may be the same as the surface active layer **12** is formed.

In S**4**, the corresponding buffer strips **131** of the plurality of strips, after standing, may overspread the substrate by diffusion and cover the barrier layer, to form a buffer layer **13**.

The inkjet-printed buffer material generally overspreads the entire device in a static leveling manner, to achieve the purpose of covering and encapsulating. By comparison, in this disclosure surface active layer **12** is first firmed on the barrier layer and then the buffer material is sprayed so that the buffer material will diffuse and spread over the entire barrier layer to form buffer layer **13** through the chemical reaction of surface active layer **12** and the buffer material, thus shortening the film-forming time and reducing the cost.

The method may further include a step S**5** in which a composite layer **14** is formed on buffer layer **13**. Specifically, a first barrier layer may be deposited onto the barrier layer, and a first buffer layer may then be deposited onto the first barrier layer.

In this embodiment, barrier layer **11** may be made of an inorganic material, including but not limited to, Al_2O_3, SiN_x, TiO_2, SiO_x, which may be used to form the barrier layer using a method including but not limited to plasma enhanced chemical vapor deposition (PECVD).

Buffer layer **13** may be of a polymeric material, including, but not limited to, Plasma Polymerized HMDSO (pp-HMDSO (Hexamethyl-dimethyl silyl (HMDSO)), polyacrylates, polycarbonates, polystyrenes and other transparent polymers, which may be used to form a stress layer to alleviate the stress in the barrier layer.

Referring now FIG. **5**, an OLED device is provided that includes OLED device encapsulating structure **100** and an OLED **200**. Adopting the encapsulating structure described above, the OLED can save the encapsulating cost. A display incorporating the OLED device is further provided.

While the disclosure has been described above in detail in reference to some exemplary embodiments, the scope of the disclosure is not limited thereto. As will occur to those of ordinary skill in the art that all or part of the embodiments described above as well as the equivalent substitutes of the appended claims shall all fall in the scope of the disclosure.

The invention claimed is:

1. An organic light emitting diode (OLED) device encapsulating structure configured to encapsulate an OLED, comprising:

a substrate;

a barrier layer formed on the substrate;

a surface active layer disposed on the barrier layer;

a buffer layer stacked on the surface active layer, an orthogonal projection of the buffer layer onto the barrier layer coinciding with that of the surface active layer onto the barrier layer; and

a composite layer stacked on the buffer layer;

wherein the surface active layer is sandwiched between and in direct contact with the barrier layer and the buffer layer and the surface active layer is a material that creates a hydrogen bond with a material of the buffer layer to enhance bonding therebetween.

2. The OLED device encapsulating structure of claim **1**, wherein the material of the surface active layer is of one of a hydrophilic polymer active material, polyol based salt, and polyol based ethers.

3. The OLED device encapsulating structure of claim **2**, wherein the surface active layer is formed by inkjet printing.

4. The OLED device encapsulating structure of claim **1**, wherein the composite layer comprises a first barrier layer and a first buffer layer stacked on the first barrier layer, or a plurality of first barrier layers and a first buffer layer sandwiched between every two first barrier layers, a first one of the plurality of first barrier layers contacting the buffer layer.

5. An organic light emitting diode (OLED) device comprising an OLED device encapsulating structure, the OLED device encapsulating structure being configured to encapsulate an OLED and comprising:

a substrate;

a barrier layer formed on the substrate;

a surface active layer disposed on the barrier layer;

a buffer layer stacked on the surface active layer, an orthogonal projection of the buffer layer onto the barrier layer coinciding with that of the surface active layer onto the barrier layer; and

a composite layer stacked on the buffer layer;

wherein the surface active layer is sandwiched between and in direct contact with the barrier layer and the buffer layer and the surface active layer is a material that creates a hydrogen bond with a material of the buffer layer to enhance bonding therebetween.

6. The OLED device of claim **5**, wherein the material of the surface active layer is of one of a hydrophilic polymer active material, polyol based salt, and polyol based ethers.

7. The OLED device of claim **6**, wherein the surface active layer is formed by inkjet printing.

8. The OLED device of claim **5**, wherein the composite layer comprises a first barrier layer and a first buffer layer stacked on the first barrier layer, or a plurality of first barrier layers and a first buffer layer sandwiched between every two first barrier layers, a first one of the plurality of first barrier layers contacting the buffer layer.

9. The OLED device of claim **8**, wherein the barrier layer and the first barrier layer are made of an inorganic material.

10. The OLED device of claim **8**, wherein the buffer layer and the first buffer layer are made of an organic material.

11. The OLED device of claim **5**, wherein the buffer layer is made of polymeric material.

12. The OLED device encapsulating structure of claim **4**, wherein the barrier layer and the first barrier layer are made of an inorganic material.

13. The OLED device encapsulating structure of claim **4**, wherein the buffer layer and the first buffer layer are made of an organic material.

14. The OLED device encapsulating structure of claim **1**, wherein the buffer layer is made of polymeric material.

* * * * *

专利名称(译)	OLED器件封装方法和结构，OLED器件和显示屏		
公开(公告)号	US10361394	公开(公告)日	2019-07-23
申请号	US15/563645	申请日	2017-07-26
[标]申请(专利权)人(译)	深圳市华星光电技术有限公司		
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[标]发明人	HUANG HUI		
发明人	HUANG, HUI		
IPC分类号	H01L51/52 H01L51/00 H01L51/56 H01L33/08		
CPC分类号	H01L51/5253 H01L51/524 H01L51/0005 H01L51/5256 H01L51/56		
代理机构(译)	程，ANDREW C.		
优先权	201710471250.7 2017-06-20 CN		
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外部链接	Espacenet		

摘要(译)

公开了一种用于封装OLED的OLED器件封装结构。 OLED器件封装结构包括基板，形成在基板上的阻挡层，设置在阻挡层上的表面有源层，以及堆叠在表面有源层上的缓冲层。缓冲层在阻挡层上的正交投影可以与阻挡层上的表面活性层的正交投影一致。复合层可以进一步堆叠在缓冲层上。还公开了OLED器件和显示屏。