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SU et al.(10) **Pub. No.: US 2017/0154938 A1**(43) **Pub. Date: Jun. 1, 2017**(54) **DISPLAY PANELS AND METHODS FOR
FABRICATING THE SAME****H01L 51/56** (2006.01)**H01L 51/52** (2006.01)(71) Applicants: **SHANGHAI TIANMA AM-OLED
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51/56 (2013.01); **H01L 51/5246** (2013.01)(72) Inventors: **Congyi SU**, Shanghai (CN); **Junxiong
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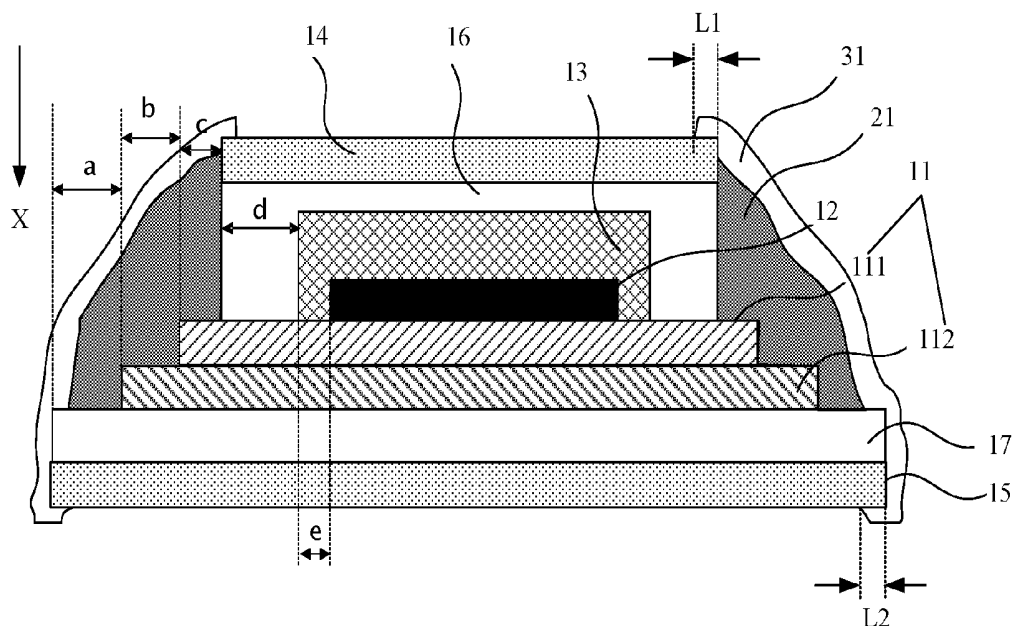
(57)

ABSTRACT

A display panel and a method for fabricating the same are provided. The display panel includes: a TFT array substrate; an OLED array disposed on the TFT array substrate, a package layer which covers the OLED array, an upper protection layer covering the package layer, and a lower protection layer. In a first direction, a first projection of the OLED array on the TFT array substrate is located within a second projection of the package layer on the TFT array substrate, and there is a first distance between a boundary of the first projection and a boundary of the second projection. Also in the first direction, the second projection is located within a third projection of the upper protection layer on the TFT array substrate, and there is a second distance between the boundary of the second projection and a boundary of the third projection.

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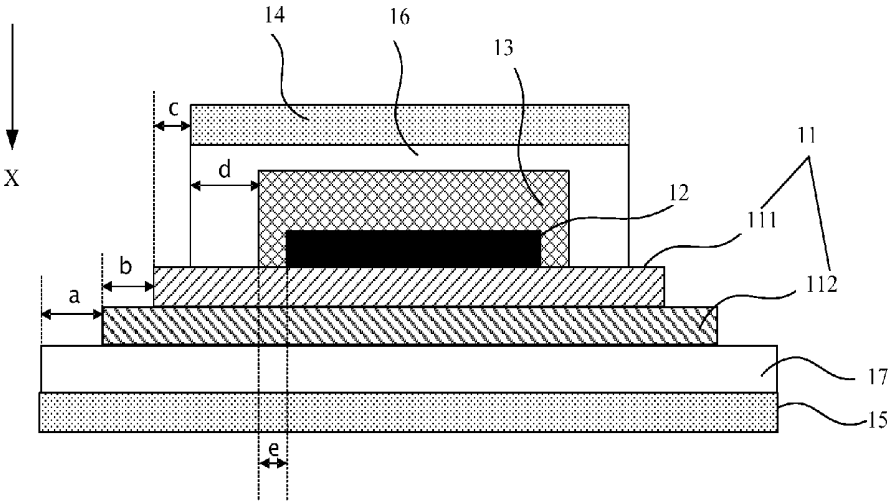


Fig. 1

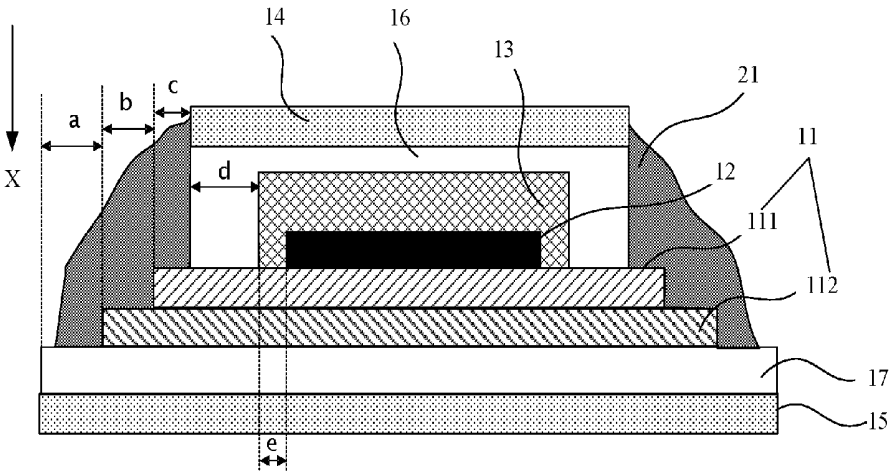


Fig. 2

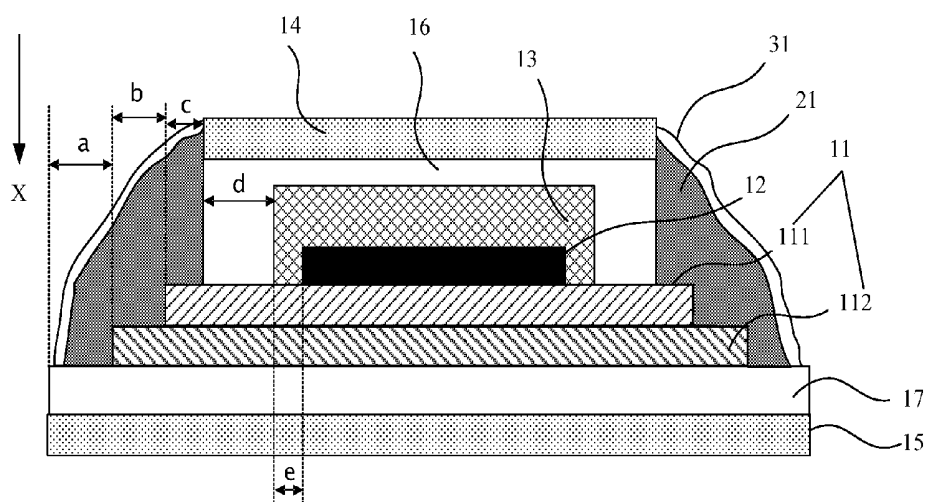


Fig. 3

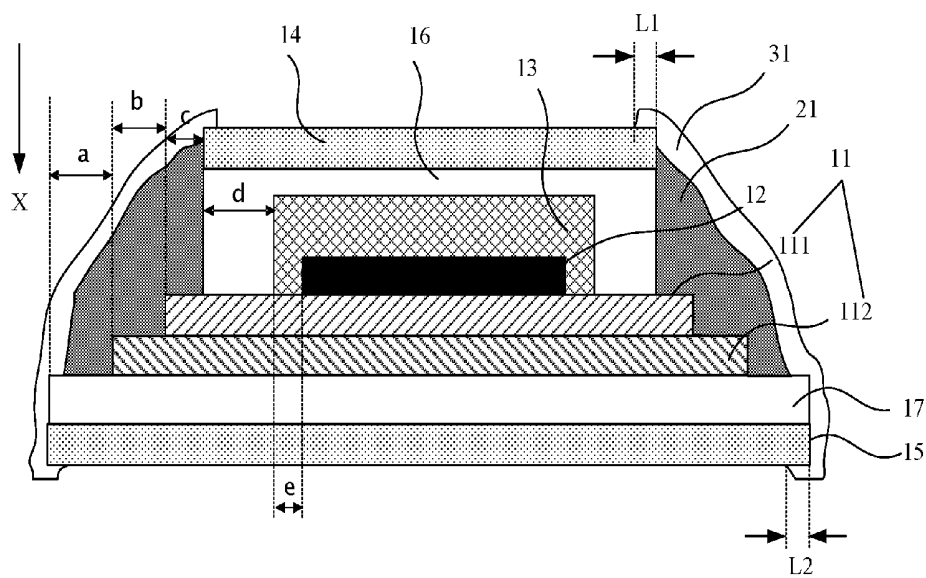
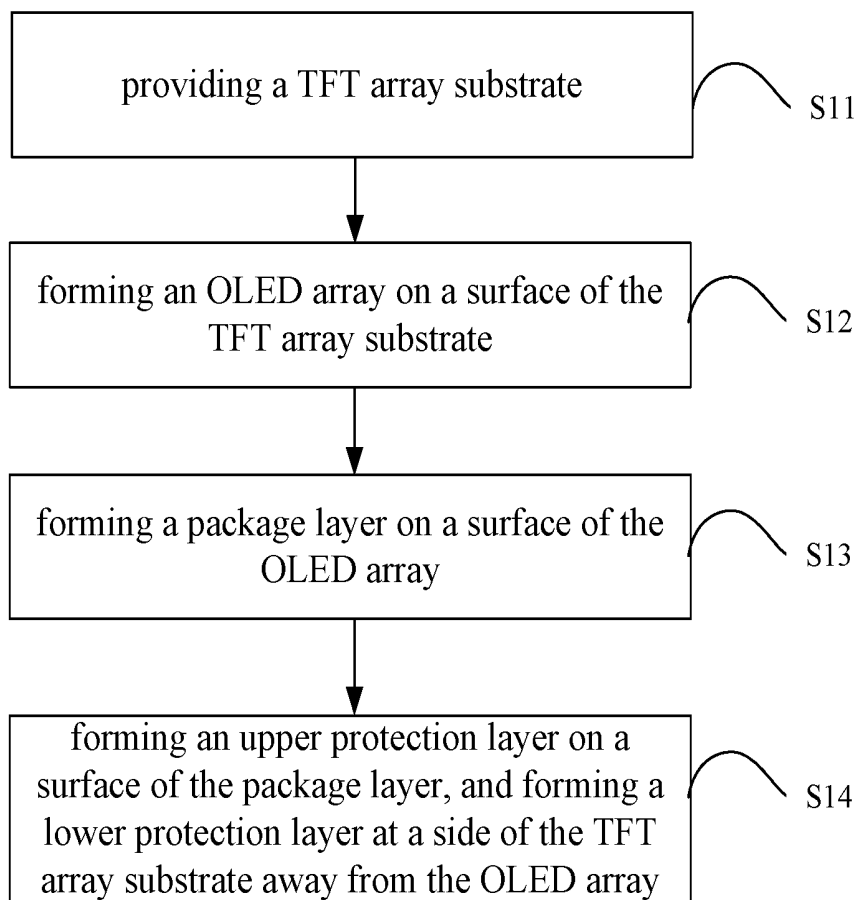


Fig. 4

**Fig. 5**

DISPLAY PANELS AND METHODS FOR FABRICATING THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the priority to Chinese Patent Application No. 201510862357.5, titled “DISPLAY PANELS AND METHODS FOR FABRICATING THE SAME”, filed on Nov. 30, 2015 with the State Intellectual Property Office of People’s Republic of China, which is incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates to the technical field of display device, and in particular to a display panel and a method for fabricating the same.

BACKGROUND

[0003] With the constant development of science and technology, more and more electronic display devices are widely used in people’s daily life and work, which brings great convenience to people’s daily life and work, and the display devices become indispensable and important tools in people’s daily life and work today.

[0004] The main component of the electronic display device is a display panel, and an OLED display panel becomes one of mainstream display panels nowadays due to advantages such as a wide viewing angle, an even image quality, a fast response speed, a colorful display and a simple process.

[0005] It is required to protect the OLED display panel by packaging, to avoid aging of a function layer caused by vapor intrusion. However, the protection package of a conventional display panel has a poor seal effect, and the conventional display panel has a short service life.

SUMMARY

[0006] To solve the problem above, a display panel and a method for fabricating the same are provided according to the present disclosure, which improves the seal effect of the package protection of the display panel, and prolongs the service life of the display panel.

[0007] For solving the problem above, the following technical solutions are provided according to the present disclosure.

[0008] A display panel is provided, which includes a thin film transistor (TFT) array substrate, an organic light emitting diode (OLED) array disposed on the TFT array substrate, a package layer covering the OLED array, an upper protection layer covering the package layer, a lower protection layer arranged at a side of the TFT array substrate away from the OLED array. In a first direction perpendicular to the TFT array substrate, a first projection of the OLED array on the TFT array substrate is located within a second projection of the package layer on the TFT array substrate, and there is a first distance between a boundary of the first projection and a boundary of the second projection. Also in the first direction, the second projection is located within a third projection of the upper protection layer on the TFT array substrate, and there is a second distance between the boundary of the second projection and a boundary of the third projection.

[0009] A method for fabricating a display panel is further provided according to the present disclosure. The method includes:

[0010] providing a TFT array substrate;

[0011] forming an OLED array on a surface of the TFT array substrate;

[0012] forming a package layer on a surface of the OLED array, where the package layer covers the OLED array, in a first direction, a first projection of the OLED on the TFT array substrate is located within a second projection of the package layer on the TFT array substrate, and there is a first distance between a boundary of the first projection and a boundary of the second projection, where the first direction is perpendicular to the TFT array substrate; and

[0013] forming an upper protection layer on a surface of the package layer, and forming a lower protection layer at a side of the TFT array substrate away from the OLED array, where, in the first direction, the second projection is located within a third projection of the upper protection layer on the TFT array substrate, and there is a second distance between the boundary of the second projection and a boundary of the third projection.

[0014] According to the descriptions above, the display panel according to the present disclosure includes: a TFT array substrate; an OLED array, which is disposed on the TFT array substrate; a package layer, which covers the OLED array, where, in a first direction, a first projection of the OLED on the TFT array substrate is located within a second projection of the package layer on the TFT array substrate, and there is a first distance between a boundary of the first projection and a boundary of the second projection; an upper protection layer, which covers the package layer, where, in the first direction, the second projection is located within a third projection of the upper protection layer on the TFT array substrate, and there is a second distance between the boundary of the second projection and a boundary of the third projection; and a lower protection layer, which is arranged at a side of the TFT array substrate away from the OLED array, where the first direction is perpendicular to the TFT array substrate.

[0015] In the display panel according to the embodiments of the disclosure, there are the first distance and the second distance. The first distance can effectively prevent vapor from intruding through a space between the package layer and the OLED array, and the second distance can effectively prevent vapor from intruding through a space between the upper protection layer and the package layer, such that aging of the display panel caused by vapor intrusion are effectively prevented, and the packaging protection of the display panel has a good seal effect, which prolongs the service life of the display panel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] To illustrate technical solutions according to embodiments of the disclosure or in the conventional technology more clearly, the following briefly describes the drawings according to embodiments of the disclosure. Apparently, the drawings are only some embodiments of the present disclosure, and other drawings may be obtained by those skilled in the art according to those drawings without creative efforts.

[0017] FIG. 1 is a schematic structural diagram of a display panel according to an embodiment of the disclosure;

[0018] FIG. 2 is a schematic structural diagram of a display panel according to another embodiment of the disclosure;

[0019] FIG. 3 is a schematic structural diagram of a display panel according to yet another embodiment of the disclosure;

[0020] FIG. 4 is a schematic structural diagram of a display panel according to yet another embodiment of the invention; and

[0021] FIG. 5 is a flowchart of a method for fabricating a display panel according to an embodiment of the disclosure.

DETAILED DESCRIPTION

[0022] The technical solutions of embodiments of the disclosure will be illustrated clearly and completely in conjunction with the drawings of the embodiments of the disclosure. Apparently, the described embodiments are only a few embodiments rather than all embodiments of the disclosure. Any other embodiments obtained by those skilled in the art on the basis of the embodiments of the present disclosure without creative work will fall within the scope of the present disclosure.

[0023] As described in the background section, package of a conventional OLED display panel has a poor seal effect such that vapor can easily intrude the package, thereby resulting in problems such as damp aging and oxidation aging of a functional layer of the display panel. This can cause a short service life of the display panel.

[0024] For solving the problems above, a display panel is provided according to an embodiment of the invention, as shown in FIG. 1.

[0025] FIG. 1 is a schematic structural diagram of a display panel according to the embodiment. As shown, in this embodiment, the display panel includes: a TFT array substrate 11; an OLED array 12; a package layer 13; an upper protection layer 14; and a lower protection layer 15. As also shown, the OLED array 12 is disposed on the TFT array substrate 11. The package layer 13 covers the OLED array 12. The upper protection layer 14 covers the package layer 13. The protection layer 15 is arranged at a side of the TFT array substrate 11 away from the OLED array

[0026] As still shown, in a first direction X, a first projection of the OLED array 12 on the TFT array substrate is located within a second projection of the package layer 13 on the TFT array substrate 11. As can be seen, there is a first distance e between a boundary of the first projection and a boundary of the second projection. In the first direction X. The second projection is located within a third projection of the upper protection layer 14 on the TFT array substrate 11, and there is a second distance d between the boundary of the second projection and a boundary of the third projection. The first direction X is perpendicular to the TFT array substrate 11.

[0027] In the display panel according to the embodiment of the disclosure, there are the first distance and the second distance. The first distance can effectively prevent vapor from intruding through a space between the package layer and the OLED array, and the second distance can effectively prevent vapor from intruding through a space between the upper protection layer and the package layer. This can prevent damp aging and oxidation aging of the display panel caused by vapor intrusion. The packaging protection of the display panel has a good seal effect, and thus can prolong the service life of the display panel.

[0028] As also shown in FIG. 1, the TFT array substrate 11 may include: a substrate 112 and a TFT array 111 disposed on a surface of the substrate 112. The TFT array 111 is arranged at a side of the substrate 112 facing the OLED array 12.

[0029] As still shown in FIG. 1, In the first direction X, a fourth projection of the TFT array 111 on the lower protection layer 15 is located within a fifth projection of the substrate 112 on the lower protection layer 15, and there is a third distance b between a boundary of the fourth projection and a boundary of the fifth projection. There is a fourth distance a between the boundary of the fourth projection and a boundary of the lower protection layer 15. The fourth projection and the fifth projection are both located on the lower protection layer 15.

[0030] As also shown in FIG. 1 In the first direction X, there is a fifth distance c between a boundary of a sixth projection of the upper protection layer 14 on the substrate 112 and a boundary of the TFT array layer 11. The sixth projection is located on the TFT array 11.

[0031] It should be noted that in the embodiments according to the present disclosure, a distance between boundaries of two projections is the minimum distance between the boundaries of the two projections.

[0032] The third distance b can effectively prevent vapor from intruding through a space between the substrate 112 and the TFT array 111. The fourth distance a can effectively prevent vapor from intruding through a space between the substrate 112 and the lower protection layer 15. The fifth distance c can effectively prevent vapor from intruding through a space between the upper protection layer 14 and the package layer 13 or between the upper protection layer and the TFT array 111. Thus, aging of the display panel due to vapor intrusion can be effectively prevented, and the packaging protection of the display panel has a good seal effect, which prolongs the service life of the display panel.

[0033] In the display panel according to another embodiment of the disclosure, an echelon protection structure is arranged such that vapor intrusion through a space between two structural layers is effectively prevented. Damp aging and oxidation aging of the display panel are thus avoided, and the service life of the display panel is prolonged.

[0034] In certain embodiments, the first distance e is greater than 0.3 mm; the second distance d is greater than 0.2 mm; the third distance b is greater than 0.1 mm; the fourth distance a is greater than 0.1; and the fifth distance c is greater than 0.1 mm. By designing the display panel with these distances, the vapor intrusion through a space between two corresponding structural layers can be effectively prevented, and the effect of the seal protection can be improved.

[0035] In still another embodiment according to the present disclosure, the upper protection layer 14 is bonded with the package layer 13 and the TFT array 111 through an upper glue layer 16; and the lower protection layer 15 is bonded with the substrate 112 through a lower glue layer 17. In the first direction X, a boundary of the top glue layer 16 is flush with a boundary of the upper protection layer 14, and a boundary of the lower glue layer 17 is flush with a boundary of the lower protection layer 15.

[0036] Reference is made to FIG. 2, which is a schematic structural diagram of a display panel according to another embodiment of the disclosure. In addition to the structures

of the display panel shown in FIG. 1, the display panel shown in FIG. 2 further includes a first lateral protection layer 21.

[0037] As shown, in this embodiment, the first lateral protection layer 21 covers a portion of the TFT array 111 not covered by the upper protection layer, covers a portion of the substrate 112 not covered by the TFT array, and covers at least a portion of the lower protection layer 15 not covered by the substrate 112.

[0038] In the embodiment shown in FIG. 2, the vapor intrusion through a space between two structural layers can be further prevented by arranging the first lateral protection layer 21, which further improves the effect of seal protection of the display panel, better avoids damp aging and oxidation aging of the structural layers of the display panel and further prolongs the service life of the display panel.

[0039] Reference is made to FIG. 3, which is a schematic structural diagram of a display panel according to another embodiment of the disclosure. In addition to the structures of the display panel shown in FIG. 2, the display panel shown in FIG. 3 further includes a second lateral protection layer 31. The second lateral protection layer 31 covers the first lateral protection layer 21.

[0040] In the embodiment shown in FIG. 3, the vapor intrusion through a space between two structural layers can be further prevented by the second lateral protection layer 31, which further improves the effect of seal protection of the display panel, better avoids damp aging and oxidation aging of the structural layers of the display panel and further prolongs the service life of the display panel.

[0041] In some embodiments, the second lateral protection layer 22 may be an Al_2O_3 film thicker than 0.03 mm, and the first lateral protection layer 21 may be a sealant.

[0042] Reference is made to FIG. 4, which is a schematic structural diagram of a display panel according to another embodiment of the disclosure. In the embodiment shown in FIG. 4, for achieving a good package protection effect and more effectively preventing the vapor intrusion, the first lateral protection layer 21 is arranged to cover an interface between the upper glue layer 16 and the upper protection layer 14; and the second lateral protection layer 31 is arranged to cover an interface between the lower glue layer 17 and the lower protection layer 15, to cover an edge portion of a surface of the lower protection layer 15 away from the lower glue layer 17, and to cover an edge portion of a surface of the upper protection layer 14 away from the upper glue layer 16. The lower glue layer 17 has a predetermined width L2. The upper protection layer 14 has a predetermined width L1.

[0043] In certain embodiments, the predetermined width L1 and the predetermined width L2 are both greater than 0.1 mm and smaller than the fourth distance a.

[0044] In the embodiment according to the present disclosure, the substrate 112 is a flexible substrate. The flexible substrate may be a plastic substrate, so that the display panel can be bended, and can be used to fabricate a bendable display panel.

[0045] According to the descriptions above, the display panel according to the embodiment of the present disclosure has a good effect of package protection, which can effectively prevent vapor intrusion, prevent damp aging and oxidation aging of the structural layers and effectively prolong the service life of the display panel.

[0046] Based on the embodiments of the display panel, as shown in FIG. 5, a method for fabricating a display panel is provided according to an embodiment of the disclosure.

[0047] Reference is made to FIG. 5, which is a flowchart of a method for fabricating a display panel according to an embodiment of the disclosure. The method includes steps S11 to S14.

[0048] At step S11 a TFT array substrate is provided.

[0049] The structure of the TFT array substrate may refer to the embodiments illustrated and described herein, which can include a substrate and a TFT array disposed on a surface of the substrate. A third distance b may be arranged between the TFT array and a boundary of the substrate.

[0050] At step S12 an OLED array on a surface of the TFT array substrate is formed.

[0051] The OLED array may be formed on the surface of the TFT array substrate through an evaporation process. The TFT array is located between the OLED array and the substrate.

[0052] At step S13 a package layer on a surface of the OLED array is formed.

[0053] The package layer is formed by a film packaging process, and the package layer may be a multilayer structure, which includes multiple alternatively distributed organic layers and inorganic layers.

[0054] The package layer covers the OLED array. In a first direction, a first projection of the OLED array on the TFT array substrate is located within a second projection of the package layer on the TFT array substrate, and there is a first distance between a boundary of the first projection and a boundary of the second projection, where the first direction is perpendicular to the TFT array substrate.

[0055] At step S14, an upper protection layer on a surface of the package layer is formed and a lower protection layer is formed at a side of the TFT array substrate away from the OLED array.

[0056] In the first direction, the second projection is located within a third projection of the upper protection layer on the TFT array substrate, and there is a second distance between the boundary of the second projection and a boundary of the third projection.

[0057] In order to improve the effect of package protection, the method can further include: a first lateral protection layer, the first lateral protection layer can cover a portion of the TFT array which is not covered by the upper protection layer, covers a portion of the substrate which is not covered by the TFT array, and covers at least a portion of the lower protection layer which is not covered by the substrate.

[0058] In order to improve the effect of package protection, the method can further include forming a second lateral protection layer. The second lateral protection layer can cover the first lateral protection layer.

[0059] A diagram of a final structure of the display panel fabricated by the method according to the embodiment of the disclosure may refer to the display panel shown in FIGS. 1 to 4.

[0060] It should be noted that the method according to the embodiment of the disclosure is used to fabricate the display panel according to the embodiments, structural diagrams of the display panel can refer to the drawings of the embodiments of the display panel, and one embodiment can refer to other embodiments for the same or similar parts, which are not described herein.

[0061] The method according to the embodiment of the disclosure can be used to fabricate the display panel according to the foregoing embodiments, and the display panel has a good effect of package protection and a long service life.

[0062] The description of the embodiments disclosed herein enables those skilled in the art to implement or use the present disclosure. Numerous modifications to the embodiments are apparent to those skilled in the art, and the general principle herein can be implemented in other embodiments without deviation from the spirit or scope of the present disclosure. Therefore, the present disclosure is not limited to the embodiments described herein, but in accordance with the widest scope consistent with the principle and novel features disclosed herein.

1. A display panel, comprising:
 - a thin film transistor, TFT, array substrate;
 - an organic light emitting diode (OLED) array, wherein the OLED array is disposed on the TFT array substrate;
 - a package layer, which covers the OLED array, wherein, in a first direction, a first projection of the OLED array on the TFT array substrate is located within a second projection of the package layer on the TFT array substrate, and there is a first distance between a boundary of the first projection and a boundary of the second projection;
 - an upper protection layer, which covers the package layer, wherein, in the first direction, the second projection is located within a third projection of the upper protection layer on the TFT array substrate, and there is a second distance between the boundary of the second projection and a boundary of the third projection; and
 - a lower protection layer, which is arranged at a side of the TFT array substrate away from the OLED array, wherein the first direction is perpendicular to the TFT array substrate.
2. The display panel according to claim 1, wherein the TFT array substrate comprises a substrate and a TFT array disposed on a surface of the substrate, wherein the TFT array is arranged at a side of the substrate facing the OLED array, wherein,
 - in the first direction, a fourth projection of the TFT array on the lower protection layer is located within a fifth projection of the substrate on the lower protection layer, and there is a third distance between a boundary of the fourth projection and a boundary of the fifth projection,
 - there is a fourth distance between the boundary of the fourth projection and a boundary of the lower protection layer, and
 - in the first direction, there is a fifth distance between a boundary of a sixth projection of the upper protection layer on the substrate and a boundary of the TFT array layer.
3. The display panel according to claim 2, wherein the first distance is greater than 0.3 mm, the second distance is greater than 0.2 mm, the third distance is greater than 0.1 mm, the fourth distance is greater than 0.1, and the fifth distance is greater than 0.1 mm.
4. The display panel according to claim 2, further comprising a first lateral protection layer,
 - wherein the first lateral protection layer covers a portion of the TFT array not covered by the upper protection layer, covers a portion of the substrate not covered by

the TFT array, and covers at least a portion of the lower protection layer not covered by the substrate.

5. The display panel according to claim 4, further comprising a second lateral protection layer,
 - wherein the second lateral protection layer covers the first lateral protection layer.
6. The display panel according to claim 5, wherein the second lateral protection layer is an Al_2O_3 film and the Al_2O_3 film is thicker than 0.03 mm.
7. The display panel according to claim 5, wherein the upper protection layer is bonded with the package layer and the TFT array through an upper glue layer, and the lower protection layer is bonded with the substrate through a lower glue layer,
 - wherein, in the first direction, a boundary of the upper glue layer is flush with a boundary of the upper protection layer, and a boundary of the lower glue layer is flush with a boundary of the lower protection layer.
8. The display panel according to claim 7, wherein the first lateral protection layer covers an interface between the upper glue layer and the upper protection layer, and the second lateral protection layer covers an interface between the lower glue layer and the lower protection layer, covers an edge portion of a surface of the lower protection layer away from the lower glue layer, the lower glue layer having a predetermined width, and covers an edge portion of a surface of the upper protection layer away from the upper glue layer, the upper glue layer having a predetermined width.
9. The display panel according to claim 8, wherein the predetermined widths are greater than 0.1 mm and smaller than the fourth distance.
10. The display panel according to claim 4, wherein the first lateral protection layer is a sealant.
11. The display panel according to claim 2, wherein the substrate is a flexible substrate.
12. A method for fabricating a display panel, the method comprising:
 - providing a TFT array substrate;
 - forming an OLED array on a surface of the TFT array substrate;
 - forming a package layer on a surface of the OLED array, the package layer covering the OLED array, wherein in a first direction, a first projection of the OLED on the TFT array substrate is located within a second projection of the package layer on the TFT array substrate, and there is a first distance between a boundary of the first projection and a boundary of the second projection, wherein the first direction is perpendicular to the TFT array substrate;
 - forming an upper protection layer on a surface of the package layer; and
 - forming a lower protection layer at a side of the TFT array substrate away from the OLED array, wherein, in the first direction, the second projection is located within a third projection of the upper protection layer on the TFT array substrate and there is a second distance between the boundary of the second projection and a boundary of the third projection.
13. The method according to claim 12, wherein the TFT array substrate comprises a substrate and a TFT array disposed on a surface of the substrate, wherein the TFT array is arranged at a side of the substrate facing the OLED array, wherein,

in the first direction, a fourth projection of the TFT array on the lower protection layer is located within a fifth projection of the substrate on the lower protection layer, there is a third distance between a boundary of the fourth projection and a boundary of the fifth projection,

there is a fourth distance between the boundary of the fourth projection and a boundary of the lower protection layer, and

in the first direction, there is a fifth distance between a boundary of a sixth projection of the upper protection layer on the substrate and a boundary of the TFT array layer.

14. The method according to claim **13**, wherein the first distance is greater than 0.3 mm, the second distance is greater than 0.2 mm, the third distance is greater than 0.1 mm, the fourth distance is greater than 0.1, and the fifth distance is greater than 0.1 mm.

15. The method according to claim **13**, further comprising forming a first lateral protection layer,

wherein the first lateral protection layer covers a portion of the TFT array not covered by the upper protection layer, covers a portion of the substrate not covered by the TFT array, and covers at least a portion of the lower protection layer which is not covered by the substrate.

16. The method according to claim **15**, further comprising forming a second lateral protection layer,

wherein the second lateral protection layer covers the first lateral protection layer.

17. The method according to claim **16**, wherein the second lateral protection layer is an Al_2O_3 film and the Al_2O_3 film is thicker than 0.03 mm.

18. The method according to claim **16**, wherein the upper protection layer is bonded with the package layer and the TFT array through an upper glue layer, and the lower protection layer is bonded with the substrate through a lower glue layer,

wherein, in the first direction, a boundary of the upper glue layer is flush with a boundary of the upper protection layer, and a boundary of the lower glue layer is flush with a boundary of the lower protection layer.

19. The method according to claim **18**, wherein the first lateral protection layer covers an interface between the upper glue layer and the upper protection layer, and

the second lateral protection layer covers an interface between the lower glue layer and the lower protection layer, covers an edge portion of a surface of the lower protection layer away from the lower glue layer, the lower glue layer having a predetermined width, and covers an edge portion of a surface of the upper protection layer away from the upper glue layer, the upper glue layer having a predetermined width.

20. The method according to claim **19**, wherein the predetermined widths are greater than 0.1 mm and smaller than the fourth distance.

* * * * *

专利名称(译)	显示面板及其制造方法		
公开(公告)号	US20170154938A1	公开(公告)日	2017-06-01
申请号	US15/195227	申请日	2016-06-28
[标]申请(专利权)人(译)	上海天马AM OLED 天马微电子股份有限公司		
申请(专利权)人(译)	上海天马AM-OLED CO., LTD. 天马微电子股份有限公司.		
当前申请(专利权)人(译)	上海天马AM-OLED CO., LTD. 天马微电子股份有限公司.		
[标]发明人	SU CONGYI FANG JUNXIONG		
发明人	SU, CONGYI FANG, JUNXIONG		
IPC分类号	H01L27/32 H01L51/00 H01L51/56 H01L51/52		
CPC分类号	H01L27/3262 H01L51/5253 H01L51/5246 H01L51/56 H01L51/0097 H01L21/77 H01L27/32 H01L27/3244 Y02E10/549 Y02P70/521		
优先权	201510862357.5 2015-11-30 CN		
其他公开文献	US10559638		
外部链接	Espacenet USPTO		

摘要(译)

提供一种显示面板及其制造方法。显示面板包括：TFT阵列基板；OLED阵列设置在TFT阵列基板上，封装层覆盖OLED阵列，上保护层覆盖封装层，下保护层。在第一方向上，OLED阵列在TFT阵列基板上的第一投影位于TFT阵列基板上的封装层的第二投影内，并且在第一投影的边界与第一投影的边界之间存在第一距离。第二个投影。同样在第一方向上，第二凸起位于TFT阵列基板上的上保护层的第三凸起内，并且在第二凸起的边界与第三凸起的边界之间存在第二距离。

