US 20190371213A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0371213 A1**

LIU (43) **Pub. Date: Dec. 5, 2019**

(54) **MICRO LED DISPLAY PANEL AND METHOD FOR MAKING SAME**

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(21) Appl. No.: **16/421,821**

(22) Filed: **May 24, 2019**

Related U.S. Application Data

(60) Provisional application No. 62/677,679, filed on May 30, 2018.

Publication Classification

(51) **Int. Cl.**

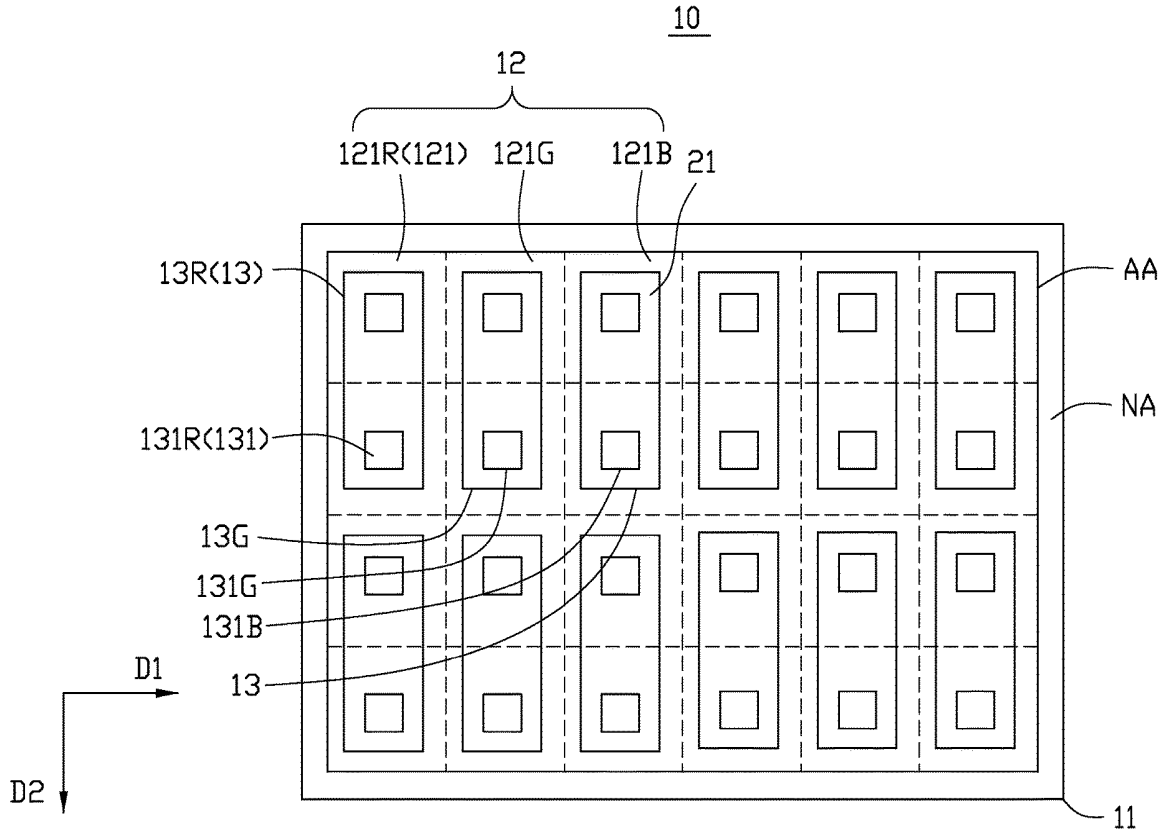
G09F 9/33	(2006.01)
G09G 3/32	(2006.01)
G09G 3/20	(2006.01)
H01L 27/15	(2006.01)

(52) **U.S. Cl.**

CPC ***G09F 9/33*** (2013.01); ***H01L 27/156*** (2013.01); ***G09G 3/2003*** (2013.01); ***G09G 3/32*** (2013.01)

(57) **ABSTRACT**

A micro LED display panel capable of simpler but more precise manufacture by pre-loading micro LEDs onto wafers which are then transferred to a substrate includes the substrate and light-emitting units. Each light-emitting unit includes a wafer unit and at least two micro LEDs on the wafer unit. The display panel includes pixel regions, each pixel region including at least three adjacent sub-pixel regions. Each sub-pixel region has one micro LED therein. Each micro LED of the light-emitting units is located in one sub-pixel region and the micro LEDs in each pixel regions emit light of different colors.



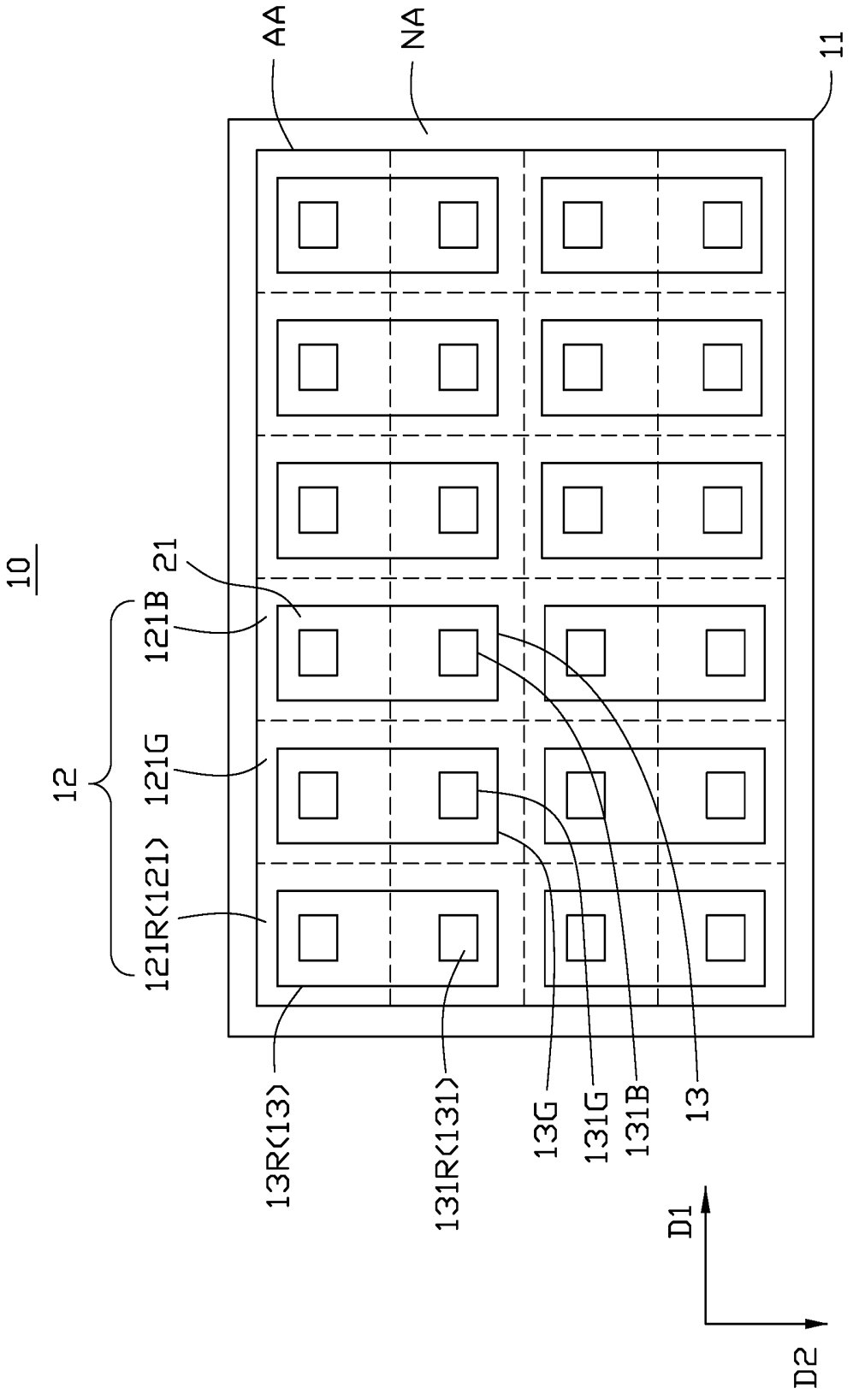

10
AA
NA
11
12
121B
21
121G
121R(121)
13R(13)
131R(131)
13G
131G
131B
13
D1
D2

FIG. 1

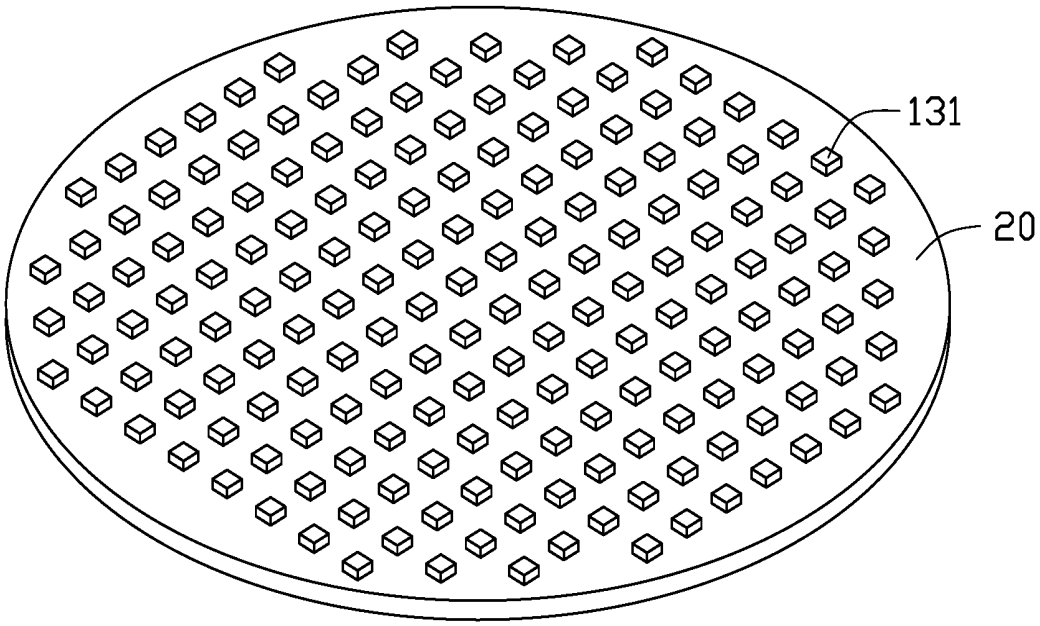


FIG. 2

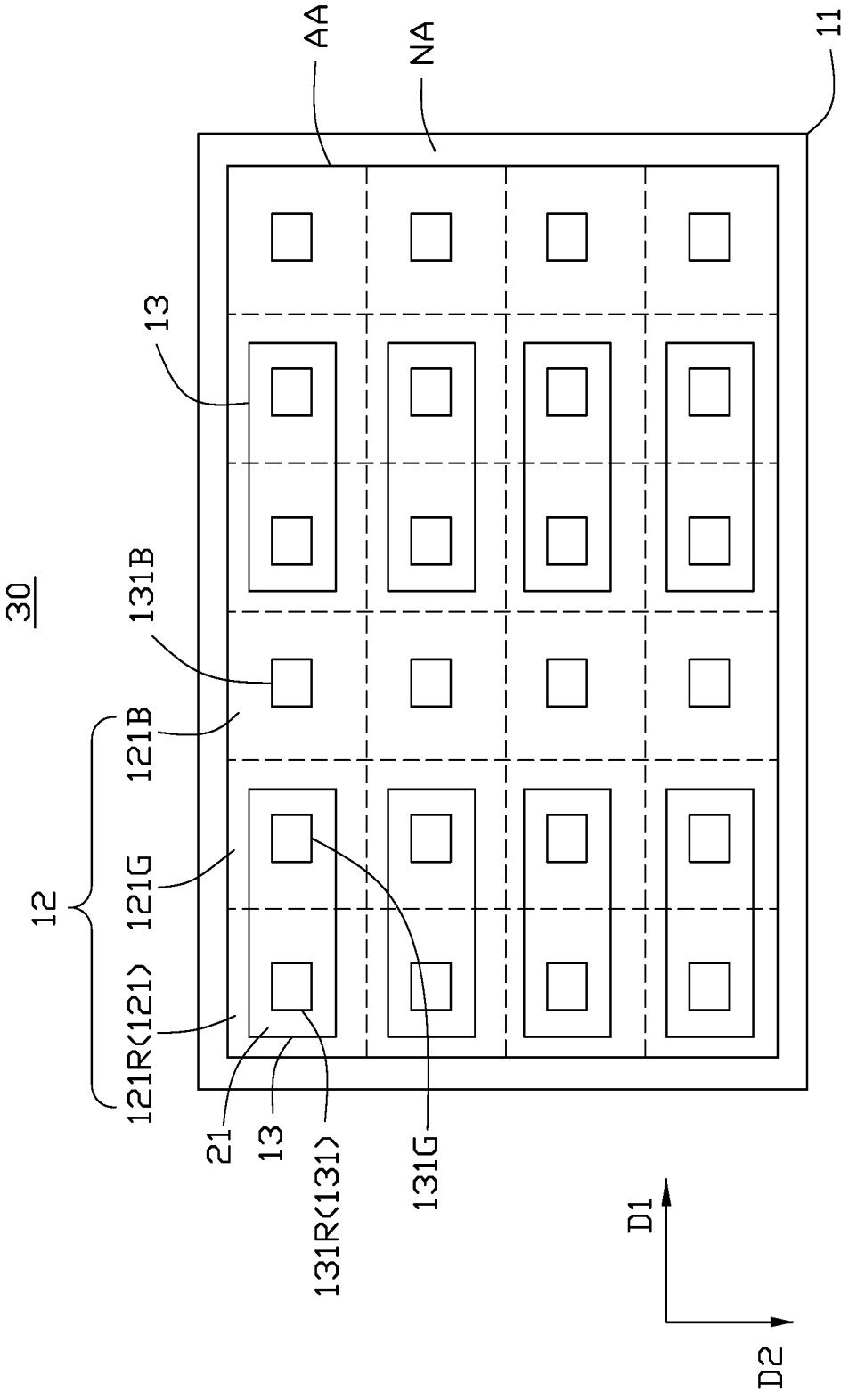

AA
NA
11
13
30
131B
121B
12
121G
121R(121)
21
13
131R(131)
131G
D1
D2

FIG. 3

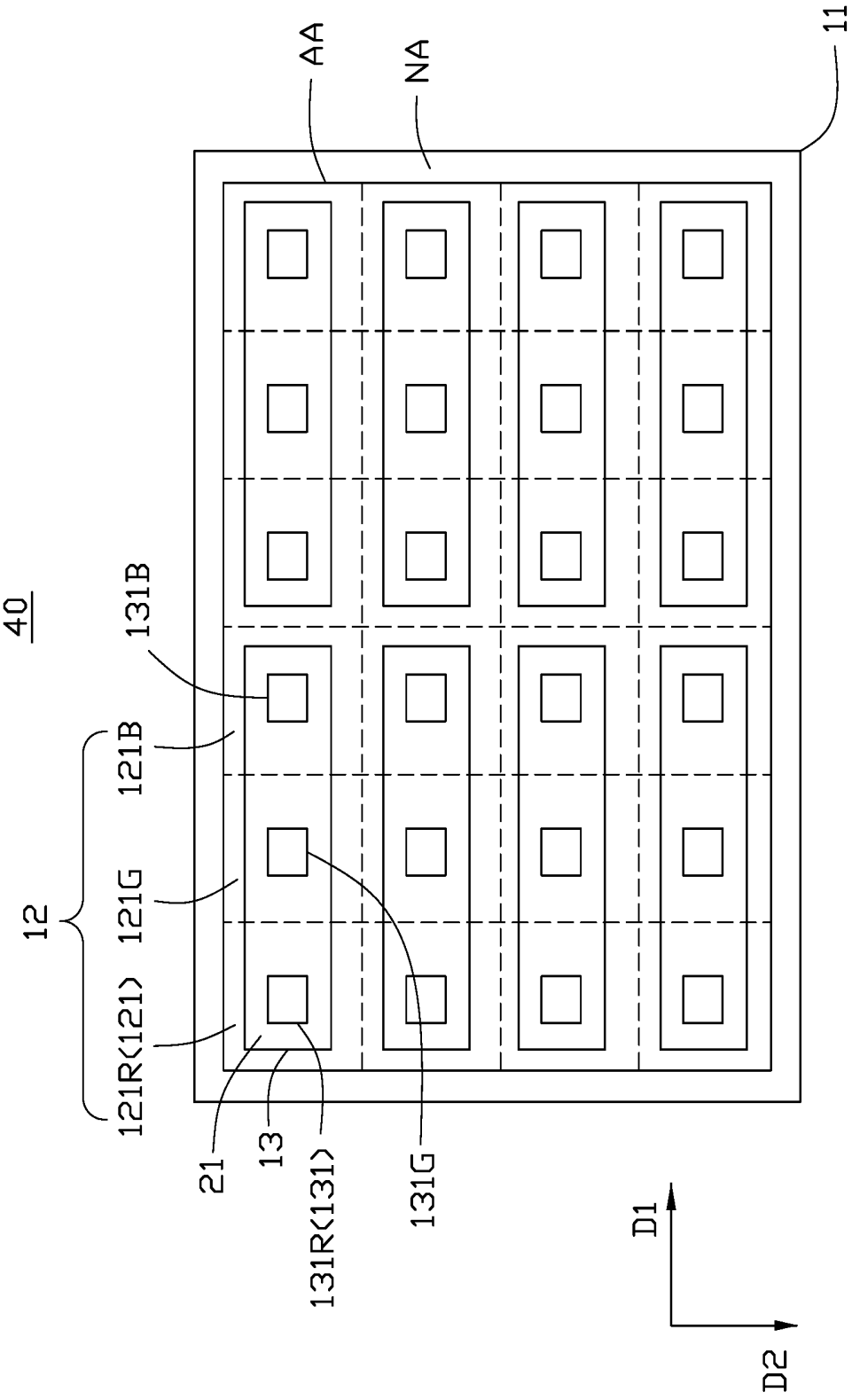


FIG. 4

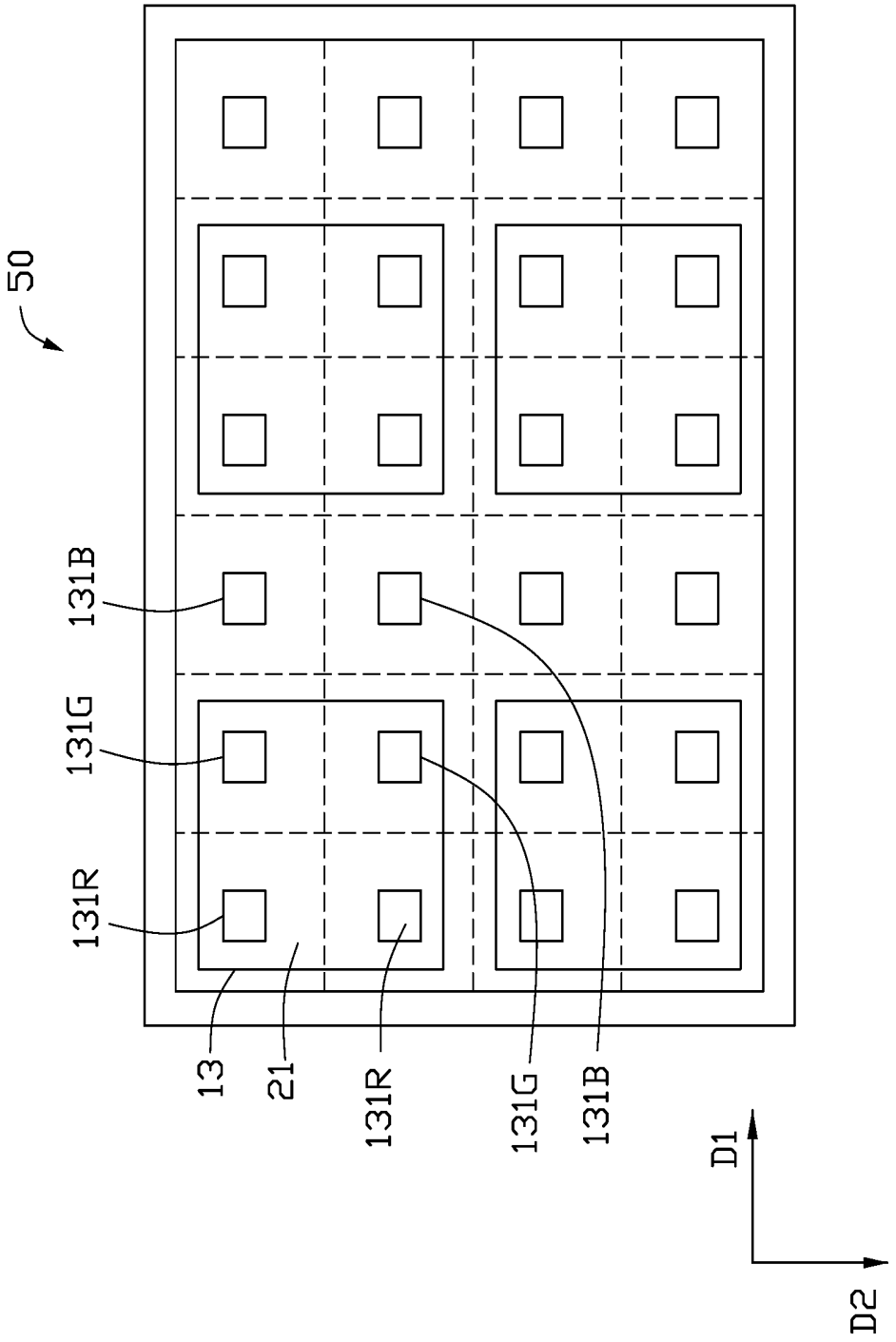


FIG. 5

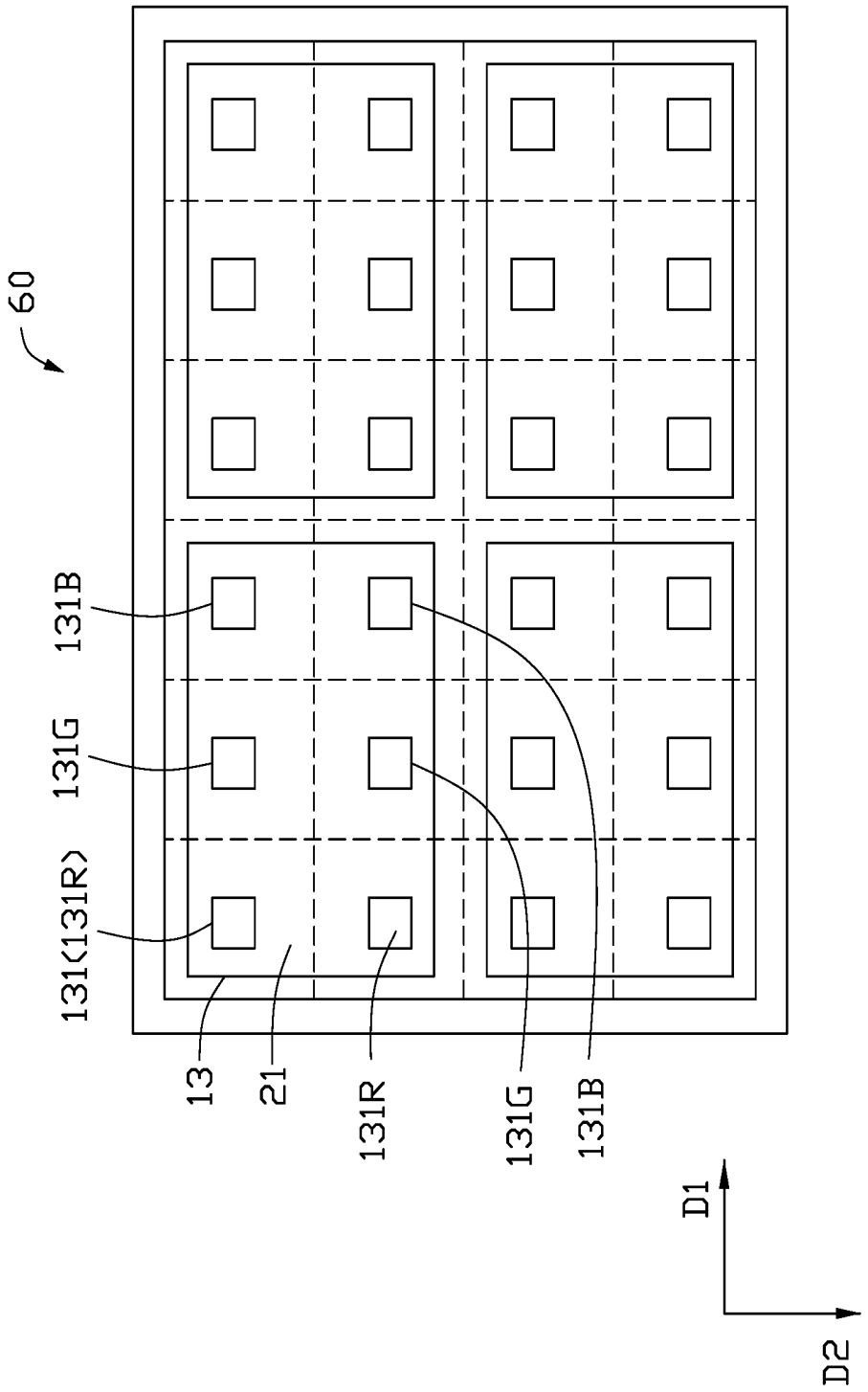


FIG. 6

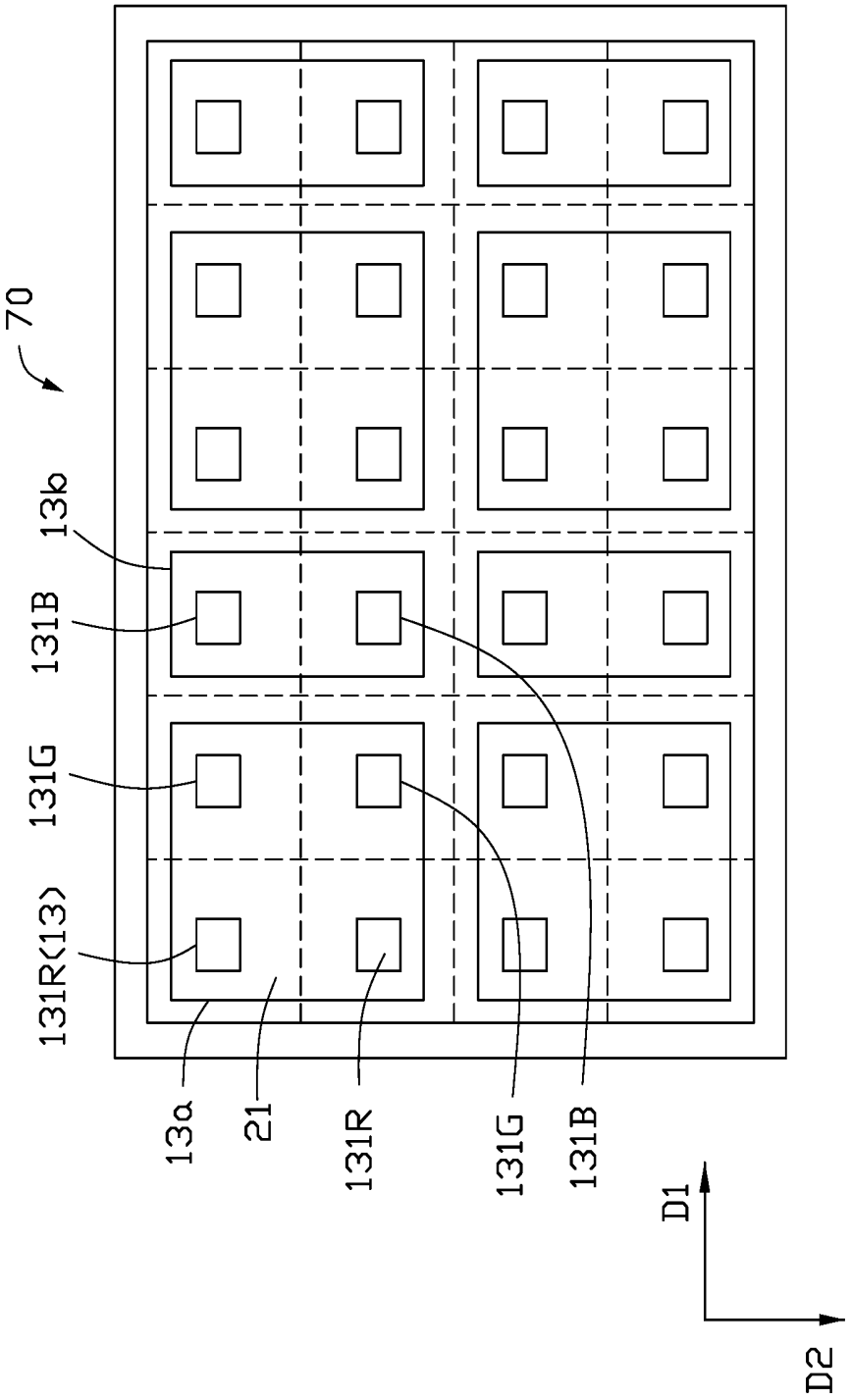


FIG. 7

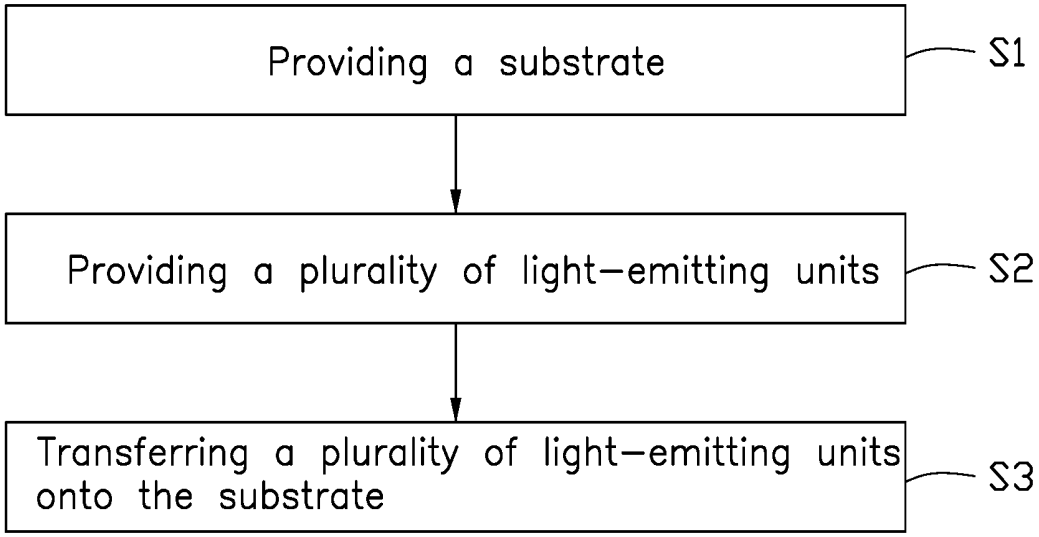

Providing a substrate
S1
Providing a plurality of light-emitting units
S2
Transferring a plurality of light-emitting units onto the substrate
S3

FIG. 8

MICRO LED DISPLAY PANEL AND METHOD FOR MAKING SAME

FIELD

[0001] The subject matter herein generally relates to a micro light emitting diode (LED) display panel and a method for making the micro LED display panel.

BACKGROUND

[0002] A micro LED display panel includes a plurality of pixels, wherein each pixel includes several sub-pixel regions. A method for making a micro LED display panel includes transferring a plurality of micro LEDs emitting light of different colors into sub-pixel regions on a substrate. The micro LEDs in each pixel are mounted on the substrate by multiple transfers. Since a size of the micro LED is small, accurate transfers of the micro LEDs may be problematic. As a number of transfers increases, a yield of successful micro LED display panels decreases.

[0003] Therefore, there is room for improvement in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Implementations of the present technology will now be described, by way of embodiments only, with reference to the attached figures.

[0005] FIG. **1** is a planar view of a micro LED display panel of a first embodiment.

[0006] FIG. **2** is an isometric view of a substrate with a plurality of micro LEDs.

[0007] FIG. **3** is a planar view of a micro LED display panel of a second embodiment.

[0008] FIG. **4** is a planar view of a micro LED display panel of a third embodiment.

[0009] FIG. **5** is a planar view of a micro LED display panel of a fourth embodiment.

[0010] FIG. **6** is a planar view of a micro LED display panel of a fifth embodiment.

[0011] FIG. **7** is a planar view of a micro LED display panel of a sixth embodiment.

[0012] FIG. **8** is a flowchart of a method for making the micro LED display panel.

DETAILED DESCRIPTION

[0013] It will be appreciated that for simplicity and clarity of illustration, where appropriate, reference numerals have been repeated among the different figures to indicate corresponding or analogous elements. In addition, numerous specific details are set forth in order to provide a thorough understanding of the embodiments described herein. However, it will be understood by those of ordinary skill in the art that the embodiments described herein may be practiced without these specific details. In other instances, methods, procedures, and components have not been described in detail so as not to obscure the related relevant feature being described. Also, the description is not to be considered as limiting the scope of the embodiments described herein. The drawings are not necessarily to scale and the proportions of certain parts may be exaggerated to better illustrate details and features of the present disclosure.

[0014] The term "coupled" is defined as coupled, whether directly or indirectly through intervening components, and is not necessarily limited to physical connections. The connection can be such that the objects are permanently coupled or releasably coupled. The term "comprising" when utilized, means "including, but not necessarily limited to"; it specifically indicates open-ended inclusion or membership in the so-described combination, group, series, and the like. The term "micro LED" herein refers to an LED having a size of less than or equal to 100 micrometers (for example more than 10 micrometers and less than 100 micrometers).

First Embodiment

[0015] FIG. **1** illustrates a micro LED display panel **10** that uses micro LEDs **131** as a light source to realize the display of images. The micro LED display panel **10** includes a substrate **11** and a plurality micro LEDs **131** on the substrate **11**. The micro LED display panel **10** includes a display area AA for displaying images and a non-display area NA surrounding the display area AA. An array of pixel regions **12** is defined in the display area AA. Each of the pixel regions **12** serves as a minimum independent full color display area, and all of the pixel areas **12** independently display to form a complete image of a frame. Further, each pixel region **12** includes several sub-pixel regions **121**. In this embodiment, one pixel region **12** includes three sub-pixel regions which are a sub-pixel region **121**R, a sub-pixel region **121**G and a sub-pixel region **121**B. The sub-pixel region **121**R emits red light, the sub-pixel region **121**G emits green light, and the sub-pixel region **121**B emits blue light.

[0016] One micro LED **131** is located in each sub-pixel region **121**. Since the sub-pixel regions **121** in one pixel region **12** need to emit light of different colors, the micro LEDs **131** in each of the pixel regions **12** emit light of different colors. In this embodiment, in one pixel region **12**, the sub-pixel region **121**R is provided with a micro LED **131**R emitting red light; the sub-pixel region **121**G is provided with a micro LED **131**G emitting green light; and the sub-pixel region **121**B is provided with a micro LED **131**B emitting blue light.

[0017] For all of the micro LEDs **131** in one pixel region **12**, at least one micro LED **131** and another micro LED **131** in the same pixel region **12** or in an adjacent pixel region **12** belong to a light-emitting unit **13**. That is, adjacent micro LEDs **131** share a common wafer and form one light-emitting unit **13**. All of the micro LEDs **131** in one pixel region **12** may belong to one light-emitting unit **13** or to different light-emitting units **13**.

[0018] The light-emitting units **13** are formed and transferred into the sub-pixel regions **121**. Each light-emitting unit **13** includes at least two micro LEDs **131**. Each micro LED **131** in one light-emitting unit **13** can emit light of a same color or light of different colors.

[0019] Referring to FIG. **2**, in this embodiment, the micro LEDs **131** are formed on a wafer **20**. A plurality of cut wafer units **21** form a wafer **20**, creating a plurality of light-emitting units **13** independent from each other. The light-emitting units **13** are then transferred into the display area AA on the substrate **11** of the Micro-LED display panel **10**, each of the light-emitting units **13** occupying at least two adjacent sub-pixel regions **121**. A number of sub-pixel regions **121** occupied by one of the light-emitting units **13** is equal to a number of micro LEDs **131** in the light-emitting unit **13**. The micro LEDs **131** in one light emitting unit **13** share one single wafer unit **21**. Each light emitting unit **13** includes a wafer unit **21** and at least two micro LEDs **131** on the wafer unit **21**.

[0020] All of the micro LEDs **131** in a light-emitting unit **13** on the substrate **11** emit light of a same color, and some of the light-emitting units **13** include same number of micro LEDs **131**.

[0021] Referring to FIG. **1**, in the present embodiment, each light-emitting unit **13** on the substrate **11** includes same number of micro LEDs **131**. In each light-emitting unit **13**, the micro LEDs **131** emit light of a same color.

[0022] As shown in FIG. **1**, three adjacent sub-pixel regions **121** in a first direction D**1** form one pixel region **12**. FIG. **1** shows a plurality of light-emitting units **13** on the substrate **11** and the light-emitting units **13** include a plurality of first light-emitting units **13**R, a plurality of second light-emitting units **13**G and a plurality of third light-emitting units **13**B. The light-emitting units **13** are arranged in an array. Each light emitting unit **13** includes two micro LEDs **131** and occupies adjacent sub-pixel regions **121**. Each light emitting unit **13** is shared by adjacent pixel regions **12** in a second direction D**2**. The second direction D**2** is perpendicular to the first direction D**1**. The two LEDs **131** of each first light unit **13**R emit red light, the two LEDs **131** of each second light unit **13**G emit green light, and the two LEDs **131** of each third light unit **13**B emit blue light. Thus, one micro LED **131**R which emits red light, one micro LED **131**G which emits green light, and one micro LED **131**B which emits blue light are disposed in the three sub-pixel regions **121** of each pixel region **12**.

[0023] In other embodiments, each light emitting unit **13** may include micro LEDs **131** of three or other number. An arrangement of such light emitting units **13** is similar to the above described, and details are not described herein again.

[0024] In other embodiments, all of the micro LEDs **131** in each light-emitting unit **13** emit light of a same color, but different light-emitting units **13** may include different numbers of micro LEDs **131**.

[0025] The micro-LED display panel **10** of the present embodiment includes a substrate **11** and a plurality of light-emitting units **13** disposed on the substrate **11**. The micro-LED display panel **10** defines a plurality of sub-pixel regions **121** in an array. Each light-emitting unit **13** includes at least two micro LEDs **131**. Each micro LED **131** is located in one sub-pixel region **121**. During the manufacturing process, the micro LEDs **131** need to be transferred to the substrate **11** in a one-to-one correspondence with the sub-pixel regions **121**. All of the micro LEDs **131** in one light-emitting unit **13** are formed on a single wafer **20**.

Second Embodiment

[0026] FIG. **3** illustrates a micro-LED display panel **30** of a second embodiment. The micro-LED display panel **30** includes a plurality of sub-pixel regions **121** arranged in an array and three adjacent sub-pixel regions **121** in a first direction D**1** form one pixel region **12**.

[0027] FIG. **3** shows eight light-emitting units **13** on the substrate **11**. Each light-emitting unit **13** includes two micro LEDs **131**, the two micro LEDs **131** emit light of different colors. Each light-emitting unit **13** is transferred onto the substrate **11** and occupies two sub-pixel regions **121**.

[0028] In the second embodiment, the two micro LEDs **131** in each light-emitting unit **13** are specifically one of micro LED **131**R emitting red light and one of micro LED **131**G emitting green light. The micro LED **131**R and the micro LED **131**G in each light-emitting unit **13** occupy adjacent sub-pixel regions **121** in one pixel region **12**, and one micro LED **131**B emitting blue light is located in the remaining one sub-pixel region **121** in one pixel region **12**.

[0029] In other embodiments, the two micro LEDs **131** in each light-emitting unit **13** can also be one of micro LED **131**R emitting red light and one of micro LED **131**B emitting blue light. Alternatively, the two micro LEDs **131** in each light-emitting unit **13** can also be one micro LED **131**B emitting blue light and one micro LED **131**G emitting green light.

Third Embodiment

[0030] FIG. **4** illustrates a micro-LED display panel **40** of a third embodiment. The micro-LED display panel **40** also includes a plurality of sub-pixel regions **121** arranged in an array; and three adjacent sub-pixel regions **121** in a first direction D**1** form one pixel region **12**.

[0031] FIG. **4** shows eight light-emitting units **13** on the substrate **11**. Each light-emitting unit **13** includes three micro LEDs **131** and each of the three micro LEDs **131** emits light of a different color. Each light-emitting unit **13** is transferred onto the substrate **11** and occupies three adjacent sub-pixel regions **121** of one pixel region **12**.

[0032] As shown in FIG. **4**, the three micro LEDs **131** in each light-emitting unit **13** are one micro LED **131**R emitting red light, one micro LED **131**G emitting green light, and one micro LED **131**B emitting blue light.

Fourth Embodiment

[0033] FIG. **5** illustrates a micro-LED display panel **50** of a fourth embodiment. The micro-LED display panel **50** includes a plurality of sub-pixel regions **121** arranged in an array and three adjacent sub-pixel regions **121** in a first direction D**1** form one pixel region **12**.

[0034] FIG. **5** shows four light-emitting units **13** on the substrate **11**. Each light-emitting unit **13** includes four micro LEDs **131**, the four micro LEDs **131** emit light of two colors. Each light-emitting unit **13** is transferred onto the substrate **11** and occupies four sub-pixel regions **121**. Each light-emitting unit **13** is located in adjacent pixel regions **12** along the second direction D**2**.

[0035] In the present embodiment, the four micro LEDs **131** in each light-emitting unit **13** are two micro LEDs **131**R emitting red light and two micro LED **131**G emitting green light. One of the two micro LEDs **131**R and an adjacent micro LED **131**G in each light-emitting unit **13** occupy adjacent sub-pixel regions **121** in one pixel region **12**. The other micro LED **131**R and the other micro LED **131**G in each light-emitting unit **13** occupy adjacent sub-pixel regions **121** in other one pixel region **12**. One micro LED **131**B emitting blue light is located in the remaining one sub-pixel region **121** in each pixel region **12**.

[0036] In other embodiments, the four micro LEDs **131** in each light-emitting unit **13** can also be two micro LEDs **131**R emitting red light and two micro LEDs **131**B emitting blue light. Alternatively, the four micro LEDs **131** in each light-emitting unit **13** can also be two micro LEDs **131**B emitting blue light and two micro LEDs **131**G emitting green light.

Fifth Embodiment

[0037] FIG. **6** illustrates a micro-LED display panel **60** of a fifth embodiment. The micro-LED display panel **60** also includes a plurality of sub-pixel regions **121** arranged in an

array and three adjacent sub-pixel regions **121** in a first direction D1 form one pixel region **12**.

[0038] FIG. **6** shows four light-emitting units **13** on the substrate **11**. Each light-emitting unit **13** includes six micro LEDs **131** and the six micro LEDs **131** emit light of three colors. Each light-emitting unit **13** is transferred onto the substrate **11** and occupies all of the sub-pixel regions **121** of two pixel regions **12**.

[0039] As shown in FIG. **6**, the six micro LEDs **131** in each light-emitting unit **13** are two micro LEDs **131**R emitting red light, two micro LEDs **131**G emitting green light, and two micro LEDs **131**B emitting blue light.

Sixth Embodiment

[0040] FIG. **7** illustrates a micro-LED display panel **70** of a sixth embodiment. The micro-LED display panel **70** also includes a plurality of sub-pixel regions **121** arranged in an array and three adjacent sub-pixel regions **121** in a first direction D1 form one pixel region **12**.

[0041] FIG. **7** shows a plurality of light-emitting units **13** on the substrate **11**. The eight light-emitting units **13** are a plurality of first light-emitting units **13***a* and a plurality of second light-emitting units **13***b*. Each first light-emitting unit **13***a* includes four micro LEDs **131** emitting light of two colors. Each first light-emitting unit **13***a* is transferred onto the substrate **11** and occupies four sub-pixel regions **121** of two pixel regions **12**. Each second light-emitting unit **13***b* includes two micro LEDs **131** emitting a same color light. Each second light-emitting unit **13***b* is transferred onto the substrate **11** and occupies two sub-pixel regions **121** of two pixel regions **12**. Each first light-emitting unit **13***a* and one adjacent second light-emitting unit **13***b* occupies all of the sub-pixel regions **121** of two adjacent pixel regions **12**.

[0042] As shown in FIG. **7**, the four micro LEDs **131** in each first light-emitting unit **13***a* are two micro LEDs **131**R emitting red light and two micro LEDs **131**G emitting green light. The two micro LEDs **131** in each second light-emitting unit **13***b* are two micro LEDs **131**B emitting blue light.

[0043] In other embodiments, the four micro LEDs **131** in each first light-emitting unit **13***a* can also be two micro LEDs **131**R emitting red light and two micro LEDs **131**B emitting blue light; and the two micro LEDs **131** in each second light-emitting unit **13***b* are two micro LEDs **131**G emitting green light. Alternatively, the four micro LEDs **131** in each first light-emitting unit **13***a* can also be two micro LEDs **131**B emitting blue light and two micro LEDs **131**G emitting green light; and the two micro LEDs **131** in each second light-emitting unit **13***b* are two micro LEDs **131**R emitting red light.

[0044] The light-emitting units **13** described in the above embodiments can also be combined into one single micro-LED display panel.

[0045] FIG. **8** illustrates a flowchart of a method for making a micro LED display panel. The example method is provided by way of example, as there are a variety of ways to carry out the method. Each block shown in FIG. **1** represents one or more processes, methods, or subroutines, carried out in the exemplary method. Furthermore, the illustrated order of blocks is by example only and the order of the blocks can be changed. The exemplary method can begin at block S1 according to the present disclosure. Depending on the embodiment, additional steps can be added, others removed, and the ordering of the steps can be changed.

[0046] At block S1, a substrate **11** is provided.

[0047] At block S2, a plurality of light-emitting units **13** is provided.

[0048] As described above, each light-emitting unit **13** includes a wafer unit **21** and at least two micro LEDs **131** on the wafer unit **21**.

[0049] At block S3, the plurality of light-emitting units **13** are transferred onto the substrate **11**.

[0050] The micro LED display panel includes a plurality of pixel region **12**. Each pixel region **12** is divided into at least three sub-pixel regions **121**. After the light-emitting units **13** have been transferred onto the substrate **11**, each sub-pixel region **121** has one micro LED **131** located therein, and all of the micro LEDs **131** of one pixel region **12** emit light of different colors.

[0051] In one embodiment, there are only light-emitting units **13** on the substrate **11**. That is, the micro LED **131** in each of the sub-pixel regions **121** belongs to one light-emitting unit **13**. In other embodiments, there are both light-emitting units **13** and independent micro LEDs **131** that do not belong to any light-emitting units **13** on the substrate **11**.

[0052] The method for making the micro-LED display panel in this disclosure can transfer at least two micro LEDs **131** onto the substrate **11** at a same time, which is beneficial to improving the production efficiency of the display panel.

[0053] Even though information and advantages of the present embodiments have been set forth in the foregoing description, together with details of the structures and functions of the present embodiments, the disclosure is illustrative only. Changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the present embodiments to the full extent indicated by the plain meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A micro light emitting diode (LED) display panel, comprising:

a substrate; and

a plurality of light-emitting units on the substrate, each of the plurality of light-emitting units comprising a wafer unit and at least two micro LEDs on the wafer unit,

the micro LED display panel defining a plurality of pixel regions, each of the plurality of pixel regions comprising at least three sub-pixel regions adjacent to each other, each of the sub-pixel regions comprising one of the micro LEDs located therein, and

wherein each of the micro LEDs of the plurality of light-emitting units is located in one of the sub-pixel regions; and the micro LEDs located in each of the plurality of pixel regions emit light of different colors.

2. The micro LED display panel of claim **1**, wherein the plurality of light-emitting units comprises a plurality of first light-emitting units, a plurality of second light-emitting units, and a plurality of third light-emitting units; each of the plurality of first light-emitting units comprises at least two of the micro LEDs emitting red light; each of the plurality of second light-emitting units comprises at least two of the micro LEDs emitting green light; each of the plurality of third light-emitting units comprises at least two of the micro LEDs emitting blue light.

3. The micro LED display panel of claim **1**, wherein the at least two micro LEDs in each of the plurality of light-emitting units emit light of different colors.

4. The micro LED display panel of claim **3**, wherein each of the plurality of light-emitting units comprises two of the micro LEDs emitting light of two colors; the two colors are selected from red, green, and blue.

5. The micro LED display panel of claim **4**, wherein a plurality of independent micro LEDs are provided on the substrate, each of the plurality of independent micro LEDs is located in one sub-pixel.

6. The micro LED display panel of claim **3**, wherein each of the plurality of light-emitting units comprises three of the micro LEDs emitting red light, green light, and blue light, respectively.

7. The micro LED display panel of claim **3**, wherein each of the plurality of light-emitting units comprises four or more of the micro LEDs emitting light of at least two different colors.

8. The micro LED display panel of claim **1**, wherein each of the plurality of light-emitting units comprises at least two of the micro LEDs emitting red light, at least two of the micro LEDs emitting green light, and at least two of the micro LEDs emitting blue light.

9. The micro LED display panel of claim **1**, wherein the plurality of light-emitting units comprises a plurality of first light-emitting units and a plurality of second light-emitting units; each of the plurality of first light-emitting units comprises four or more of the micro LEDs emitting light of two colors; each of the plurality of second light-emitting units comprises two or more of the micro LEDs emitting light of a color that is different from the two colors of the plurality of first light-emitting units; the two colors are selected from red, green, and blue; the color of the plurality of second light-emitting units is a remaining color selected from red, green, and blue not emitted by the plurality of first light-emitting units.

10. A method for making a micro light emitting diode (LED) display panel, comprising:

providing a substrate;

providing a plurality of light-emitting units, each of the plurality of light-emitting units comprising a wafer unit and at least two micro LEDs on the wafer unit; and

transferring the plurality of light-emitting units onto the substrate, the micro LED display panel defines a plurality of sub-pixel regions; each of the micro LEDs of the plurality of light-emitting units is located in one of the plurality of sub-pixel regions.

11. The method of claim **10**, wherein the plurality of sub-pixel regions is arranged in an array.

12. The method of claim **11**, wherein the micro LED display panel defines a plurality of pixel regions; each of the plurality of pixel regions comprises three of the plurality of sub-pixel regions adjacent to each other; and the micro LEDs located in each of the plurality of pixel regions emitting light of different colors.

* * * * *

专利名称(译)	微型LED显示面板及其制造方法		
公开(公告)号	US20190371213A1	公开(公告)日	2019-12-05
申请号	US16/421821	申请日	2019-05-24
[标]申请(专利权)人(译)	鸿海精密工业股份有限公司		
申请(专利权)人(译)	鸿海精密工业股份有限公司.		
当前申请(专利权)人(译)	鸿海精密工业股份有限公司.		
[标]发明人	LIU FENG HSIANG		
发明人	LIU, FENG-HSIANG		
IPC分类号	G09F9/33 G09G3/32 G09G3/20 H01L27/15		
CPC分类号	G09G3/32 H01L27/156 G09F9/33 G09G3/2003 H01L33/0095 H01L25/0753		
优先权	62/677679 2018-05-30 US		
外部链接	Espacenet USPTO		

摘要(译)

通过将微型LED预装载到晶片上然后将其转移到衬底上而能够更简单但更精确地制造的微型LED显示面板包括衬底和发光单元。 每个发光单元包括晶片单元和在晶片单元上的至少两个微型LED。 显示面板包括像素区域，每个像素区域包括至少三个相邻的子像素区域。 每个子像素区域中具有一个微型LED。 发光单元的每个微型LED位于一个子像素区域中，并且每个像素区域中的微型LED发出不同颜色的光。