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(54) **ORGANIC LIGHT EMITTING DIODE DISPLAY PIXEL, DISPLAY PANEL AND DISPLAY DEVICE**

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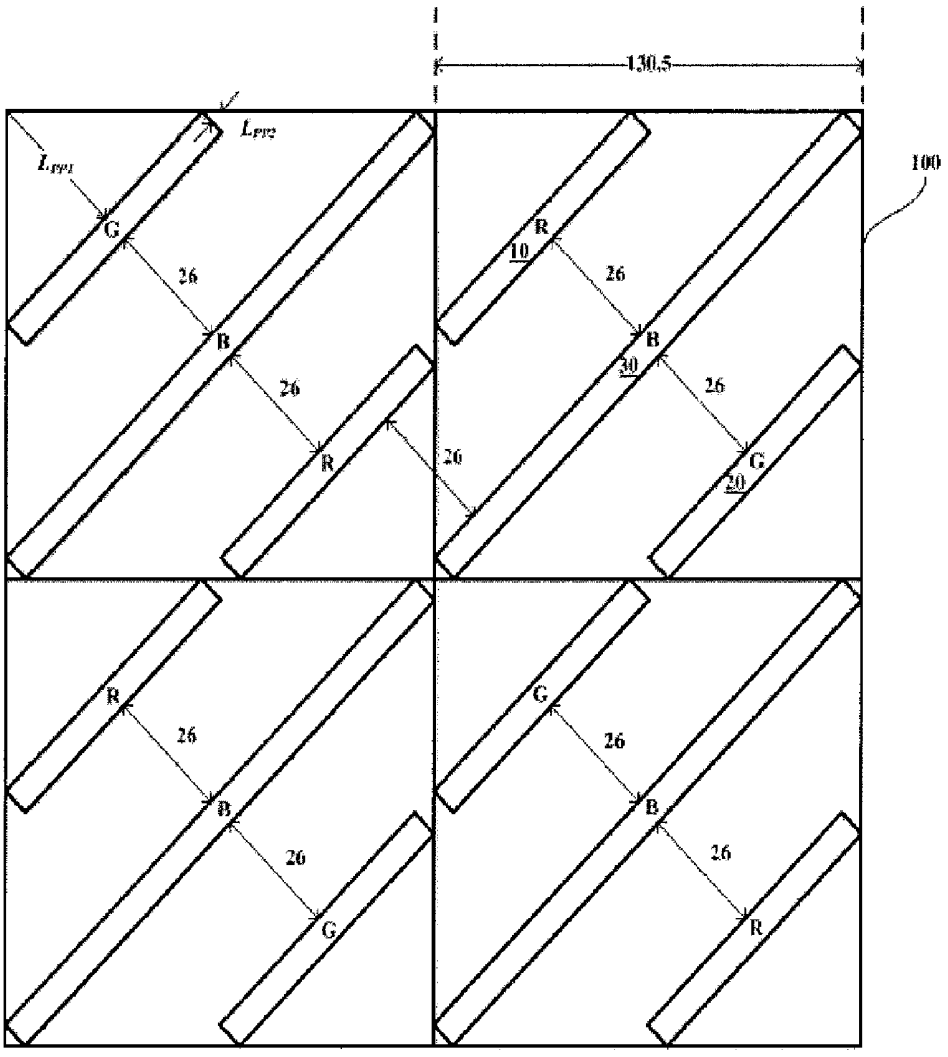
(57) **ABSTRACT**

An organic light emitting diode display pixel, a display panel and a display device are provided. The organic light emitting diode display pixel comprises a red light emitting device, a green light emitting device and a blue light emitting device arranged side by side and disposed oblique with respect to a border of the pixel. The red light emitting device and the green light emitting device are located on both sides of the blue light emitting device, which has a length larger than those of the red one and the green one. The display pixel can prolong the service life of a display panel without reducing the total aperture ratio of pixels.



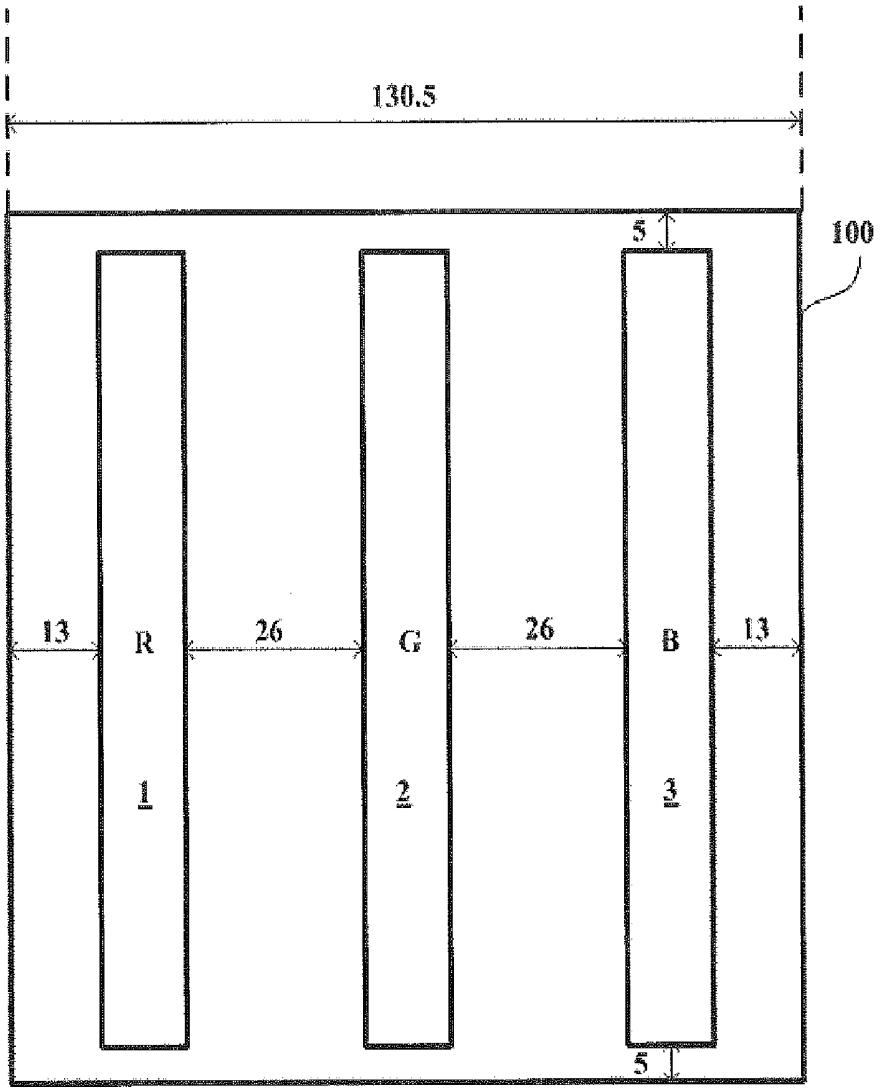


FIG.1

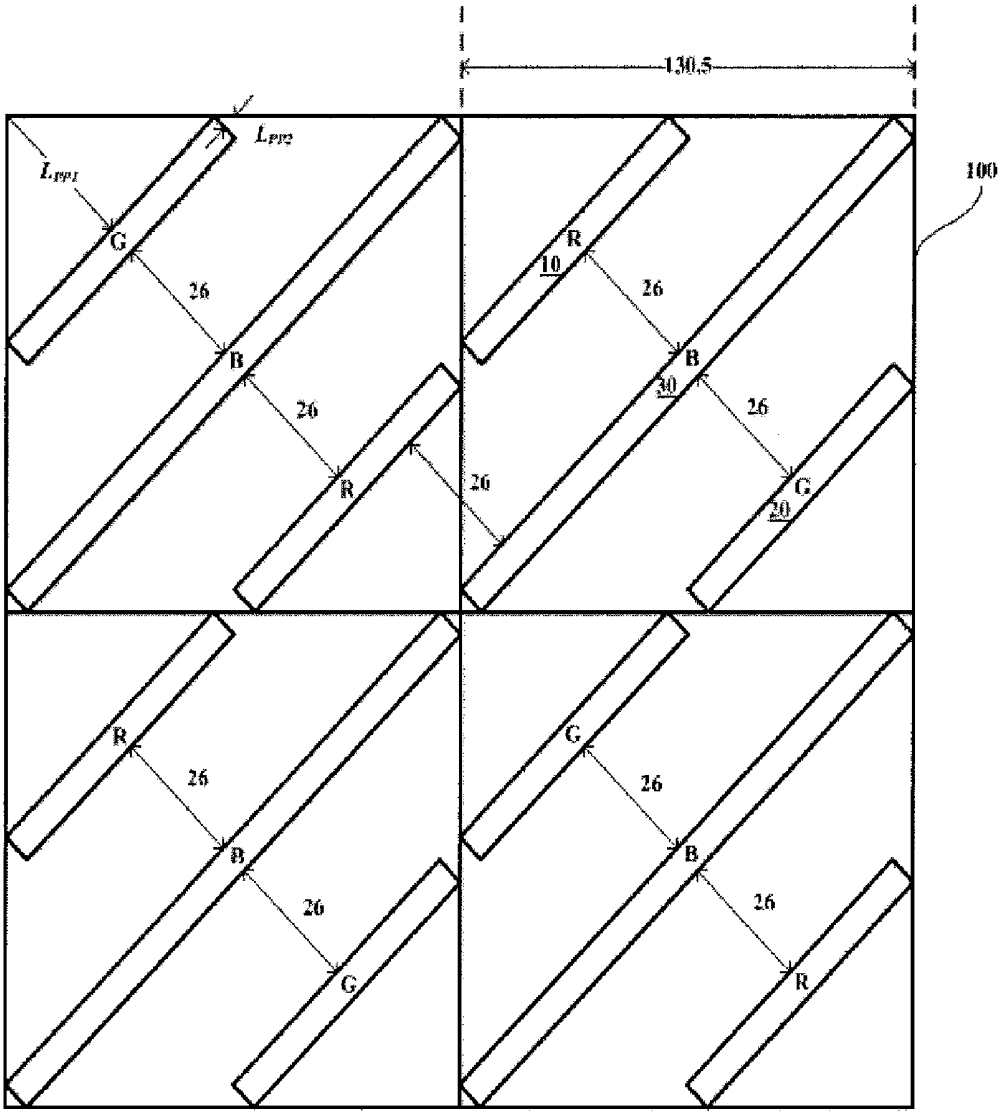


FIG.2

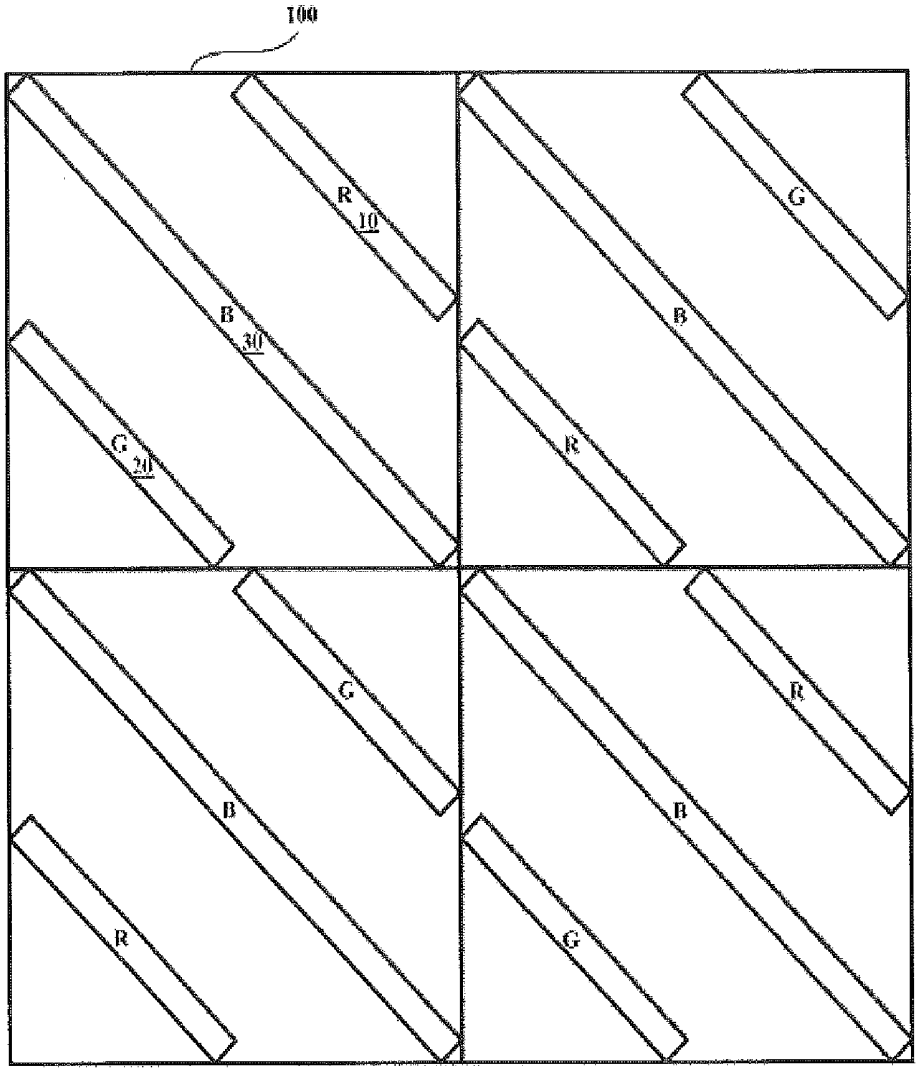


FIG.3

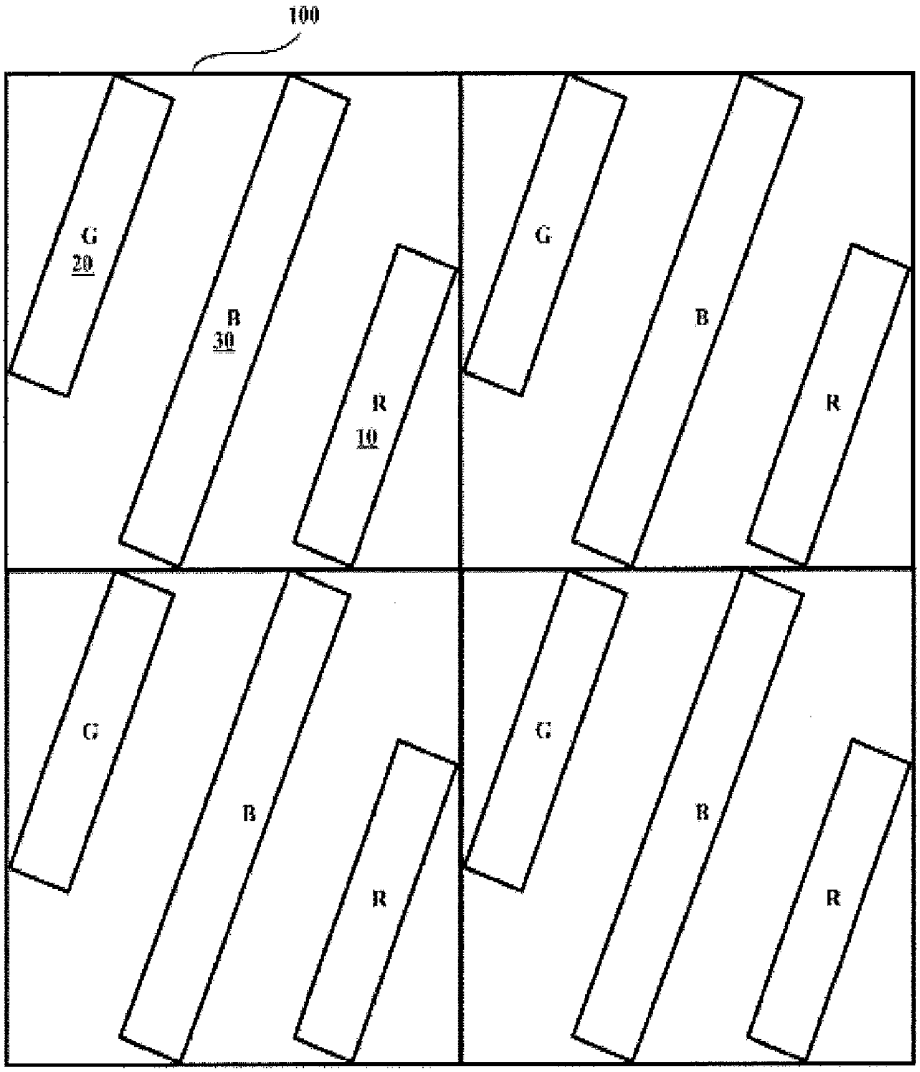


FIG.4

ORGANIC LIGHT EMITTING DIODE DISPLAY PIXEL, DISPLAY PANEL AND DISPLAY DEVICE

TECHNICAL FIELD

[0001] Embodiments of the present invention relate to an organic light emitting diode display pixel, a display panel and a display device.

BACKGROUND

[0002] Organic Light Emitting Diode (OLED) display screens have become the display technology of the next generation having promising future due to their advantages, such as thinness, lightness, wide visual angle, active light-emitting, continuously tunable luminous colors, low costs, fast response, low energy consumption, low driving voltages, wide range of operation temperatures, simple fabricating process, high luminous efficiency, flexible display etc.

[0003] The basic structure of an OLED comprises an anode and a cathode with an organic light emitting layer disposed therebetween. The organic light emitting layer is driven by an applied electric field and gives rise to a luminescence phenomenon through injection and recombination of carriers from the anode and the cathode respectively. Specifically, electrons and holes, as carriers, are injected from the cathode and anode respectively, migrate to the organic light emitting layer under the action of the electric field, and recombine there resulting in excitors, which release energy with their attenuation, the released energy exciting the luminous molecules to emit visible light through radiative relaxation of the excited luminous molecules.

[0004] OLEDs are classified into passive matrix OLEDs (PMOLEDs) and active matrix OLEDs (AMOLEDs) according to the driving modes. With respect to a PMOLED, cathodes and anodes are arranged in a matrix, and pixels in an array are lit in a sweeping manner with each pixel operating in a short pulse mode. A PMOLED has a simple structure to illuminate instantaneously with a high brightness, which can reduce manufacturing costs effectively, but PMOLED requires a relatively higher driving voltage and thus is not applicable to a large-sized display panel with a high resolution. With respect to an AMOLED, each pixel is controlled by an individual thin film transistor (TFT) and driven to illuminate individually and continuously. An AMOLED requires a relatively low driving voltage, has a relatively long service life, and thus is applicable to a large-sized flat panel display, however its fabricating process is relatively complex and its costs are relatively high.

SUMMARY

[0005] At least one embodiment of the present invention provides an organic light emitting diode display pixel, a display panel and a display device so as to prolong the service life of the display panel without reducing the total aperture ratio of the pixel.

[0006] At least one embodiment of the present invention provides an organic light emitting diode display pixel comprising a red light emitting device, a green light emitting device and a blue light emitting device arranged side by side and disposed oblique with respect to a border of the pixel, wherein the red light emitting device and the green light emitting device are located on both sides of the blue light emitting device, and the length of the blue light emitting device is larger than those of the red light emitting device and the green light emitting device.

[0007] At least one embodiment of the present invention provides an organic light emitting diode display panel, which comprises a plurality of display pixels described above with the pixels being arranged in an array, and the service life of the whole display panel is prolonged owing to the decrease of the degradation rate of the blue light emitting device.

[0008] At least one embodiment of the present invention further provides an organic light emitting diode display device, and its service life is also prolonged for the longer service life of the display panel.

BRIEF DESCRIPTION OF DRAWINGS

[0009] In order to clearly illustrate the technical solution of the embodiments of the invention, the drawings of the embodiments will be briefly described in the following; it is obvious that the described drawings are only related to some embodiments of the invention and thus are not limitative of the invention.

[0010] FIG. **1** is a structure diagram of an OLED display pixel;

[0011] FIG. **2** is a schematic top view of the structure of an OLED display pixel in a first embodiment of the present invention;

[0012] FIG. **3** is a schematic top view of the structure of an OLED display pixel in a second embodiment of the present invention; and

[0013] FIG. **4** is a schematic top view of the structure of an OLED display pixel in a third embodiment of the present invention.

MAIN REFERENCE NUMERALS

[0014] **100**—pixel; **10**—red light emitting device; **20**—green light emitting device; **30**—blue light emitting device.

DETAILED DESCRIPTION

[0015] In order to make objects, technical details and advantages of the embodiments of the invention apparent, the technical solutions of the embodiments will be described in a clearly and fully understandable way in connection with the drawings related to the embodiments of the invention. It is obvious that the embodiments to be described are only some, not all, of the embodiments of the present invention. Based on the described embodiments herein, those skilled in the art can obtain other embodiment(s), without any inventive work, which should be within the scope of the invention.

[0016] An AMOLED display panel comprises a plurality of pixels arranged in an array. As shown in FIG. **1**, each pixel **100** comprises a red light emitting device **1** (corresponding to a red sub-pixel), a green light emitting device **2** (corresponding to a green sub-pixel) and a blue light emitting device **3** (corresponding to a blue sub-pixel) with the same size and arranged side by side, the red, green, and blue light emitting devices **1**, **2**, **3** having an opening area ratio of 1:1:1.

[0017] The AMOLED display panel as shown in FIG. **1** has the defect that the degradation rates of the red, green, and blue light emitting devices **1**, **2**, **3** are not exactly the same, and among those devices the blue light emitting

device **3** has the highest degradation rate and the shortest service life, which has a strong impact on the service life of the display panel so that significant color casts may occur in the display panel along with service time. If the aperture ratio of the red, green, and blue light emitting devices **1**, **2**, **3** is regulated, the total aperture ratio of the pixel will be reduced.

[0018] In order to prolong the service life of the display panel without reducing the total aperture ratio of the pixel, at least one embodiment of the present invention provides an organic light emitting diode (OLED) display pixel, a display panel and a display device.

[0019] In an embodiment of the present invention, the red, green and blue light emitting devices are disposed oblique with respect to a border of the pixel, and the blue one is between the red one and the green one and is the longest. In this pixel structure, if the light emitting devices of various colors have the same width, the blue light emitting device will have an opening area larger than those of the red one and the green one, and have a relatively low current density, so that the degradation rate of the blue light emitting device is reduced and the service life of the display panel is prolonged without reducing the total aperture ratio of the pixel.

[0020] As shown in FIG. **2**, the OLED display pixel **100** provided in the first embodiment of the present invention comprises a red light emitting device **10**, a green light emitting device **20** and a blue light emitting device **30** arranged in parallel and disposed oblique with respect to a border of the pixel **100**. The red light emitting device **10** and the green light emitting device **20** are located on both sides of the blue light emitting device **30**, which has a length larger than those of the red one **10** and the green one **20**. The borders of the pixel **100** are parallel with sides of the display panel with this pixel.

[0021] The red, green and blue light emitting devices **10**, **20**, **30** have the same width and may have their lengths specifically designed according to the aperture ratio to be achieved. The oblique angles formed by the red, green and blue light emitting devices **10**, **20**, **30** with respect to the borders of the pixel **100** are angles not limited, such as 45, 60 degree or the like. The pixel structures shown in FIG. **2** and FIG. **3** are in a mirror symmetry. In the embodiment shown in FIG. **2** and FIG. **3**, the angles formed by the red, green and blue devices **10**, **20**, **30** with respect to the horizontal border of the pixel **100** are all 45 degree. In the embodiment as shown in FIG. **4**, the angles formed by the red, green and blue light emitting devices **10**, **20**, **30** with respect to the horizontal border of the pixel **100** are all 60 degree.

[0022] In at least one embodiment of the present invention, the lengths of the red, green and blue light emitting devices **10**, **20**, **30** satisfy the following relational expression:

$$|L_R+L_G-L_B|<\lambda$$

[0023] where L_R is the length of the red light emitting device **10**, L_G is the length of the green one **20**, L_B is the length of the blue one **30**, and λ is a preset error value.

[0024] The value of λ can be determined according to structural dimensions in combination with experiences in industry. If the sum of the lengths of the red and green light emitting devices **10**, **20** is equal to or approximates the length of the blue one **30**, this pixel structure can increase the opening area ratio of the blue light emitting device **30** to the red one **10** and the green one **20**, reduce the current density of the blue light emitting device **30** and slow its degradation more significantly.

[0025] As shown in FIG. **2**, the red and green light emitting devices **10**, **20** are of the same length and distributed symmetrically on sides of the blue one **30**. This design can simplify the process of coating by vaporization for the light emitting device and can realize a better display effect for the display panel. Furthermore, the pixel **100** has a square shape, the blue light emitting device **30** is located on a diagonal line of the square, and the red, green and blue light emitting devices **10**, **20**, **30** have their both ends extend to the borders of the pixel **100**. This design can increase the opening areas of the red, green and blue light emitting devices **10**, **20**, **30** to a broader extent so as to increase the total aperture ratio, improve the display quality of the display panel and lower the energy consumption. With respect to two adjacent pixels **100**, one pixel has the structure of the other after being transformed centro-symmetrically (the red light emitting device **10** in the first pixel is in the same position of the pixel structure as the green light emitting device **20** in the second pixel, and the green light emitting device **20** in the first pixel is in the same position of the pixel structure as the red light emitting device **10** in the second pixel, i.e., the second pixel has the structure of the first pixel after being transformed centro-symmetrically by 180°), and two red light emitting devices **10** or two green light emitting devices **20** between two blue ones **30** are in the direction of the same oblique line. In this way, among a plurality of pixels arranged in an array, the light emitting devices arranged in the direction of the same oblique line are of the same color, which can further simplify the process of coating by vaporization for the light emitting device and reduce facility costs.

[0026] In at least one embodiment of the present invention, the red, green and blue light emitting devices **10**, **20**, **30** are disposed oblique with respect to a border of the pixel **100**, and the blue one **30** is between the red one **10** and the green one **20** and is the longest. In this pixel structure, if the light emitting devices of various colors have the same width, the blue light emitting device **30** will have an opening area larger than those of the red one **10** and the green one **20**, and have a relatively low current density, so that the degradation rate of the blue light emitting device **30** is reduced and the service life of the display panel is prolonged without reducing the total aperture ratio of the pixel.

[0027] Taking the embodiment as shown in FIG. **2** as an example, the angles formed by the red, green and blue light emitting devices **10**, **20**, **30** with respect to the horizontal border of the pixel **100** are all 45 degree, the light emitting devices of various colors are set to have the same width, the side length of the pixel **100** is 130.5 μm, and the lateral spacing between adjacent light emitting devices is 26 μm. Assuming that B_{R2}, B_{G2}, B_{B2} are the widths of the red, green and blue light emitting devices **10**, **20**, **30** respectively; L_{R2}, L_{G2}, L_{B2} are the lengths of the red, green and blue light emitting devices **10**, **20**, **30** respectively; L_{PP1} and L_{PP2} are as shown in the figure respectively; Ar_R, Ar_G, Ar_B are the opening areas of the red, green and blue light emitting devices **10**, **20**, **30** respectively; S_{RGB} is the total opening area; Ar is the total aperture ratio of the pixel yields:

$$B_{R2} = B_{G2} = \quad \text{(Equation 1)}$$
$$B_{B2} = \frac{1}{2} \times \left(\frac{1}{2} \times 130.5 \times \sqrt{2} - 26 \times 2 \right) = 20.1318 \text{ um},$$

$$L_{B2} = \sqrt{2} \times 130.5 - B_{B2} = \quad \text{(Equation 2)}$$
$$\sqrt{2} \times 130.5 - 20.1318 = 164.3952 \text{ um},$$

$$L_{R2} = L_{G2} = 2L_{PP1} = \quad \text{(Equation 3)}$$
$$2 \times \left(\frac{\sqrt{2}}{2} \times 130.5 - 26 - 1.5B_{R2} \right) = 72.1319 \text{ um},$$

and

$$L_{PP2} = \frac{1}{2} \times B_{R2} = \frac{1}{2} \times 20.1318 = 10.0659 \text{ um}. \quad \text{(Equation 4)}$$

[0028] The limitation of $L_{PP2} \geq 5$ um by the fabricating process for an OLED gives

$$L_{R2max} = L_{G2max} = 72.1319 + (10.0659 - 5) = 77.2014 \text{ um}, \quad \text{(Equation 5)}$$

so

$$Ar_B : Ar_R : Ar_G = \quad \text{(Equation 6)}$$
$$(L_{B2} \times B_{B2}) : (L_{R2max} \times B_{R2}) : (L_{G2max} \times B_{G2}) = 1 : 0.47 : 0.47,$$

$$S_{RGB} = B_{R2} \times (2L_{R2max} + L_{B2}) = \quad \text{(Equation 7)}$$
$$20.1318 \times (77.2014 \times 2 + 164.3952) = 6417.9776 \text{ um}^2$$

and

$$Ar = \frac{6417.9776}{130.5^2} = 37.6858\%. \quad \text{(Equation 8)}$$

[0029] Since in the display pixel shown in FIG. **1** let

$$Ar'_B : Ar'_R : Ar'_G = 1:1:1, \quad \text{(Equation 9)}$$

thus,

$$S'_{RGB} = (130.5 - 26 \times 3) \times (130.5 - 5 \times 2) = 6326.25 \text{ um}^2 \quad \text{(Equation 10)}$$

and

$$Ar' = \frac{6326.25}{130.5^2} - 37.1471\%. \quad \text{(Equation 11)}$$

[0030] By comparing Equation (6) and Equation (9), it can be seen that the opening area ratio of the blue light emitting device **30** to the red light emitting device **10** and the green light emitting device **20** in the pixel structure shown in FIG. **2** is obviously larger than that in the pixel structure shown in FIG. **1**. Moreover, by comparing Equation (8) and Equation (11), it can be seen that the total aperture ratio of the pixel with the pixel structure shown in FIG. **2** is not reduced, but increased relatively to the pixel structure shown in FIG. **1**. Therefore, in contrast to the pixel structure shown in FIG. **1**, embodiments of the present invention can slow the degradation of the blue light emitting device and prolong the service life of the display panel without reducing the total aperture ratio of the pixel.

[0031] At least one embodiment of the present invention provides an organic light emitting diode display panel, which comprises a plurality of display pixels according to any of the technical solutions described above with the pixels being arranged in an array, and the service life of the whole display panel is prolonged owing to the decrease of the degradation rate of the blue light emitting device. The OLED display panel is not limited in type. For example, it can be a PMOLED display panel or an AMOLED display panel.

[0032] At least one embodiment of the present invention further provides an organic light emitting diode display device, and its service life is also prolonged for the longer service life of the display panel. The display device can be any devices, for example, but not limited to an OLED display, an OLED TV set etc.

[0033] What are described above is related to the illustrative embodiments of the disclosure only and not limitative to the scope of the disclosure; the scopes of the disclosure are defined by the accompanying claims.

[0034] The present application claims priority of China patent application No. 201410115315.0 filed on Mar. 25, 2014, which is incorporated herein in its entirety by reference as a part of the present application.

1. An organic light emitting diode display pixel, comprising a red light emitting device, a green light emitting device and a blue light emitting device arranged side by side and disposed oblique with respect to a border of the pixel, wherein

the red light emitting device and the green light emitting device are located on both sides of the blue light emitting device, and the length of the blue light emitting device is larger than those of the red light emitting device and the green light emitting device.

2. The organic light emitting diode display pixel of claim **1**, wherein the lengths of the red, green and blue light emitting devices satisfy the following relational expression:

$$|L_R L_G - L_B| < \lambda,$$

where L_R is the length of the red light emitting device, L_G is the length of the green light emitting device, L_B is the length of the blue light emitting device, and λ is a preset error value.

3. The organic light emitting diode display pixel of claim **1**, wherein the red and green light emitting devices are of a same length and distributed symmetrically on both sides of the blue light emitting device.

4. The organic light emitting diode display pixel of claim **1**, wherein the pixel has a square shape, the blue light emitting device is located on a diagonal line of the square, and the red, green and blue light emitting devices have their both ends extend to the borders of the pixel.

5. The organic light emitting diode display pixel of claim **4**, wherein one of two adjacent pixels has the structure of the other after being transformed centro-symmetrically, and two red light emitting devices or two green light emitting devices between two blue light emitting devices are in the direction of the same oblique line.

6. An organic light emitting diode display panel, comprising a plurality of pixels according to claim **1** with the plurality of pixels arranged in an array.

7. An organic light emitting diode display device, comprising the organic light emitting diode display panel according to claim **6**.

8. The organic light emitting diode display pixel of claim **2**, wherein the red and green light emitting devices are of a same length and distributed symmetrically on both sides of the blue light emitting device.

9. The organic light emitting diode display pixel of claim **2**, wherein the pixel has a square shape, the blue light emitting device is located on a diagonal line of the square, and the red, green and blue light emitting devices have their both ends extend to the borders of the pixel.

10. The organic light emitting diode display pixel of claim **9**, wherein one of two adjacent pixels has the structure of the other after being transformed centro-symmetrically, and two red light emitting devices or two green light emitting devices between two blue light emitting devices are in the direction of the same oblique line.

11. The organic light emitting diode display pixel of claim **3**, wherein the pixel has a square shape, the blue light emitting device is located on a diagonal line of the square, and the red, green and blue light emitting devices have their both ends extend to the borders of the pixel.

12. The organic light emitting diode display pixel of claim **11**, wherein one of two adjacent pixels has the structure of the other after being transformed centro-symmetrically, and two red light emitting devices or two green light emitting devices between two blue light emitting devices are in the direction of the same oblique line.

* * * * *

专利名称(译)	有机发光二极管显示像素，显示面板和显示装置		
公开(公告)号	US20160358982A1	公开(公告)日	2016-12-08
申请号	US14/436381	申请日	2014-08-07
[标]申请(专利权)人(译)	京东方科技集团股份有限公司		
申请(专利权)人(译)	京东方科技集团股份有限公司.		
当前申请(专利权)人(译)	京东方科技集团股份有限公司.		
[标]发明人	SUN TUO LIU YING		
发明人	SUN, TUO LIU, YING		
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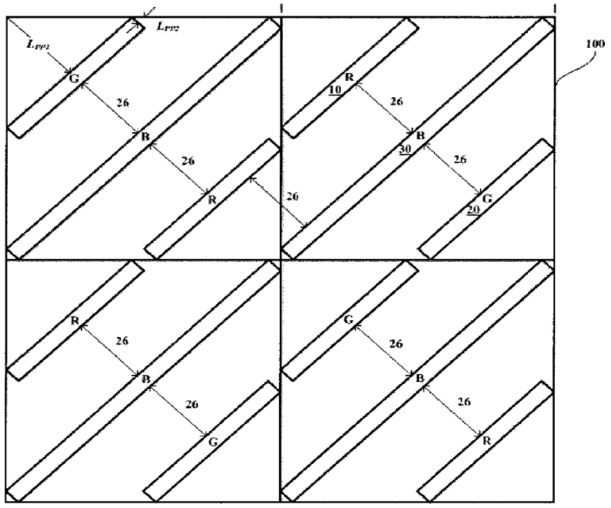
其他公开文献	US9780149		
外部链接	Espacenet USPTO		

摘要(译)

提供一种有机发光二极管显示器像素，显示面板和显示装置。有机发光二极管显示器像素包括并排布置的红色发光装置，绿色发光装置和蓝色发光装置，并且相对于像素的边界倾斜设置。红色发光装置和绿色发光装置位于蓝色发光装置的两侧，其长度大于红色发光装置和绿色发光装置的长度。显示像素可以在不降低像素的总孔径比的情况下延长显示面板的使用寿命。