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(54) **FLEXIBLE DISPLAY APPARATUS AND ITS  
WHITE LIGHT ORGANIC  
ELECTROLUMINESCENT DEVICE**

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(58) **Field of Classification Search**  
None  
See application file for complete search history.

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**H01L 51/50** (2006.01)

(Continued)

(57) **ABSTRACT**

The present application provides a flexible display apparatus and a white light organic electroluminescent device including an anode, a first blue light emitting unit, a second yellow light emitting unit, a third blue light emitting unit, and a cathode successively laminated and disposed, wherein the second yellow light emitting unit including a red light emitting layer. The flexible display apparatus and a white light organic electroluminescent device provided by the application enhances the luminous intensity of the red light band in the three-laminated layer white light organic electroluminescent device by adding a red light emitting layer, and optimizes the spectrum of the white OLED device, when used as a display device it can reduce power consumption of the display apparatus.

**16 Claims, 2 Drawing Sheets**

cathode	118
Al (100nm)	
third electron injection layer	117
LiF(1nm)	
third electron transport layer	116
BmPyPb(20nm)	
third blue light emitting layer	115
MADN: 3%DSA-ph(25nm)	
third hole transport layer	114
β-NPB(9nm)	
third P-type charge generation layer	113
HATCN(10nm)	
second N-type charge generation layer	112
BmPyPb: 4%Li(20nm)	
second electron transport layer	111
BmPyPb(20nm)	
second yellow light emitting layer	110
DCZPPY: Ir(BT)2(acac) (30nm)	
red light emitting layer	109
TCTA: 3%Ir(piq)3(5nm)	
second hole transport layer	108
β-NPB(30nm)	
second p-type charge generation layer	107
HATCN(10nm)	
first N-type charge generation	106
BmPyPb: 4%Li(10nm)	
first hole transport layer	105
BmPyPb(10nm)	
first blue light emitting layer	104
MADN: 3%DSA-ph(25nm)	
first hole transport layer	103
β-NPB(160nm)	
first hole injection layer	102
MoO3(1nm)	
anode	101
ITO(70nm)	

(51) **Int. Cl.***H01L 51/52* (2006.01)*H01L 27/32* (2006.01)(52) **U.S. Cl.**

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(2013.01); *H01L 51/0058* (2013.01); *H01L*  
*51/0061* (2013.01); *H01L 51/0067* (2013.01);  
*H01L 51/0072* (2013.01); *H01L 51/0085*  
(2013.01); *H01L 51/5056* (2013.01); *H01L*  
*51/5072* (2013.01); *H01L 51/5088* (2013.01);  
*H01L 2251/303* (2013.01); *H01L 2251/5338*  
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cathode Al (100nm)	118
third electron injection layer LiF(1nm)	117
third electron transport layer BmPyPb(20nm)	116
third blue light emitting layer MADN: 3%DSA-ph(25nm)	115
third hole transport layer $\beta$ -NPB(95nm)	114
third P-type charge generation layer HATCN(10nm)	113
second N-type charge generation layer BmPyPb: 4%Li(20nm)	112
second electron transport layer BmPyPb(20nm)	111
second yellow light emitting layer DCZPPY: Ir(BT)2(acac) (30nm)	110
red light emitting layer TCTA: 3%Ir(piq)3(5nm)	109
second hole transport layer $\beta$ -NPB(30nm)	108
second p-type charge generation layer HATCN(10nm)	107
first N-type charge generation BmPyPb: 4%Li(10nm)	106
first hole transport layer BmPyPb(10nm)	105
first blue light emitting layer MADN: 3%DSA-ph(25nm)	104
first hole transport layer $\beta$ -NPB(160nm)	103
first hole injection layer MoO3(1nm)	102
anode ITO(70nm)	101

FIG. 1

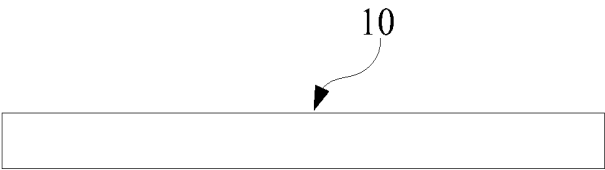


FIG. 2

1

# **FLEXIBLE DISPLAY APPARATUS AND ITS WHITE LIGHT ORGANIC ELECTROLUMINESCENT DEVICE**

## **FIELD OF THE INVENTION**

The present application relates to an optical technology field, and more particularly to a flexible display apparatus and its white light organic electroluminescent device.

## **BACKGROUND OF THE INVENTION**

Since the organic electroluminescent diode, OLED has the excellent features of self-luminous, no need of backlight, high contrast, thin thickness, wide viewing angle, fast response, can be used for flexible panel, can be used in a wide temperature range, construction and process is relatively simple at the same time, is considered as the new application technology in the next generation of flat display apparatus.

The OLED device structure is constructed by an anode (ITO), a cathode, and an organic functional layer sandwiched between them. The organic functional layers include HIL (hole injection layer), HTL (hole transport layer), EML (light emitting layer), ETL (electron transport layer) and other layers.

The red light component is not sufficient in the existing three-laminated layers of the white light device OLED device, the power consumption of the display apparatus is larger because of the low efficiency of red light by using the white light OLED plus color filter as a display apparatus or a TV.

## **SUMMARY OF THE INVENTION**

The present application provides a flexible display apparatus and its white light organic electroluminescent device to solve the larger power consumption of the display apparatus caused by the low efficiency of red light by using the white light OLED plus color filter as a display apparatus or a TV in the conventional technology. In order to solve the above-mentioned technical problems, a technical aspect of the present application is to provide a white light organic electroluminescent device, the white light organic electroluminescent device includes: an anode, a first blue light emitting unit, a second yellow light emitting unit, a third blue light emitting unit, and a cathode successively laminated and disposed, wherein the second yellow light emitting unit including a red light emitting layer, and the material used for the red light emitting layer is TCTA: 3% Ir(piq)3, the thickness of the red light emitting layer is less than or equal to 5 nm.

In order to solve the above-mentioned technical problems, another technical aspect of the present application is to provide a white light organic electroluminescent device, wherein the white light organic electroluminescent device includes: an anode, a first blue light emitting unit, a second yellow light emitting unit, a third blue light emitting unit, and a cathode successively laminated and disposed, wherein the second yellow light emitting unit including a red light emitting layer.

In order to solve the above-mentioned technical problems, another technical aspect of the present application is to provide a flexible display apparatus, wherein the flexible display apparatus is using a white light organic electroluminescent device as a light emitting source.

2

The advantages of the present application is, comparing to the conventional technology, the flexible display apparatus and the white light organic electroluminescent device provided by the application are characterized by adding a red light emitting layer and enhancing the light-emitting intensity of the red light band in the three-laminated white light organic electroluminescent device, optimized the spectrum of the white OLED device, reducing the display power consumption when used as a display device.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

In order to more clearly illustrate the embodiments of the present application or prior art, the following FIGS. will be described in the embodiments are briefly introduced. It is obvious that the drawings are merely some embodiments of the present application, those of ordinary skill in this field can obtain other FIGS. according to these FIGS. without paying the premise.

FIG. 1 is a simplified schematic diagram of a white light organic electroluminescent device according to an embodiment of the present application; and

FIG. 2 is a simplified schematic view of a flexible display apparatus according to an embodiment of the present application.

## **DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

Embodiments of the present application are described in detail with the technical matters, structural features, achieved objects, and effects with reference to the accompanying drawings as follows. It is clear that the described embodiments are part of embodiments of the present application, but not all embodiments. Based on the embodiments of the present application, all other embodiments to those of ordinary skill in the premise of no creative efforts acquired should be considered within the scope of protection of the present application.

Specifically, the terminologies in the embodiments of the present application are merely for describing the purpose of the certain embodiment, but not to limit the invention.

In the drawings, the thickness of the layers and regions is exaggerated in order to clarify the device. The same reference numerals denote the same elements throughout the drawings.

It will also be understood that when an element is referred to as being "over" or "upper" on another element, it can be disposed directly on the other element, or an intermediate element can also be present.

Referring to FIG. 1, a white light organic electroluminescent device is provided as an embodiment of the present application, the white light organic electroluminescent device includes an anode **101**, a first blue light emitting unit **100**, a second yellow light emitting unit **200**, a third blue light emitting unit **300**, and a cathode **118** successively laminated and disposed, wherein the second yellow light emitting unit **200** includes a red light emitting layer **109**. Wherein the adapted material of the anode **101** is indium tin oxide, ITO, and having a thickness of 70 nm. The adapted material of the cathode **118** is aluminum, Al, and having a thickness of 100 nm.

In the embodiment of the present application, the material used for the red light emitting layer **109** includes TCTA: 3% Ir(piq)3, the thickness of the red light emitting layer **109** is less than or equal to 5 nm, wherein Ir(piq)3 is doped in

TCTA, and the mass percentage is 3%. TCTA is 4,4',4"-Tris (carbazol-9-yl)-triphenylamine; Ir(piq)3 is Tris (1-phenyl-isoquinoline) iridium (III).

In the embodiment of the present application, the first blue light emitting unit **100** includes a first hole injection layer **102**, a first hole transport layer **103**, a first blue light emitting layer **104**, a first electron transport layer **105**, a first N-type charge generation layer **106** successively laminated and disposed.

Wherein the material of the first hole injection layer **102** is molybdenum trioxide, MoO<sub>3</sub>, having a thickness of 1 nm;

The material of the first hole transport layer **103** is  $\beta$ -NPB (N,N'-diphenyl-N,N'-Di(2-naphthyl)-1,1'-biphenyl-4,4'-diamine), having the thickness of 160 nm;

The material of the first blue light emitting layer **104** is MADN: 3% DSA-ph and having a thickness of 25 nm, wherein MADN is 2-Methyl-9,10-bis(naphthalen-2-yl)anthracene; 9,10-Di(2-naphthyl)-2-methylanthracene; DSA-ph is 1-4-di-[4-(N, N-diphenyl)amino]styryl-benzene);

The material of the first electron transport layer **105** is BmPyPb (1,3-bis[3,5-di(pyridin-3-yl)phenyl]benzene), and having a thickness of 10 nm;

The material of the first N-type charge generation layer **106** is BmPyPb:4% Li and having a thickness of 10 nm.

In the embodiment of the present application, the second yellow light emitting unit **200** successively laminated and disposed on the first N-type charge generation layer **106** includes a second p-type charge generation layer **107**, a second hole transport layer **108**, a second yellow light emitting layer **110**, a second electron transport layer **111**, a second N-type charge generation layer **112**, and the red light emitting layer **109** are located above the second hole transport layer **108**.

Wherein the material of the second P-type charge generation layer **107** is HATCN (2,3,6,7,10,11-Hexacyano-1,4,5,8,9,12-hexaazatriphenylene), and having a thickness of 10 nm;

The material of the second hole transport layer **108** is  $\beta$ -NPB and having a thickness of 30 nm;

The material of the second yellow light emitting layer **110** is DCZPPY:Ir(BT)2(acac), and having a thickness of 30 nm, wherein the DCZPPY is 2,6-bis((9H-carbazol-9-yl)-3,1-phenylene)pyridine; Ir(BT)2(acac) is Bis(2-phenyl-benzothiazole)(acetylacetonate)

The material of the second electron transport layer **111** is BmPyPb (1,3-bis[3,5-di(pyridin-3-yl)phenyl]benzene), and having a thickness of 20 nm;

The material of the second N-type charge generation layer **112** is BmPyPb: 4% Li, and having a thickness of 20 nm.

In the embodiment of the present application, the third blue light emitting unit **300** successively laminated and disposed on the second N-type charge generation layer **112** includes a third P-type charge generation layer **113**, a third hole transport layer **114**, a third blue light emitting layer **115**, a third electron transport layer **116**, and a third electron injection layer **117**.

Wherein the material of the third P-type charge generation layer **113** is HATCN (2,3,6,7,10,11-Hexacyano-1,4,5,8,9,12-hexaazatriphenylene), and having a thickness of 10 nm;

The material of the third hole transport layer **114** is  $\beta$ -NPB, and having a thickness of 95 nm;

The material of the third blue light emitting unit **300** is MADN: 3% DSA-ph, and having a thickness of 25 nm;

The material of the third electron transport layer **116** is BmPyPb, and having a thickness of 20 nm;

The material of the third electron injecting layer **117** is LiF (lithium fluoride), and having a thickness of 1 nm.

Combined referring to FIG. 2, the embodiment of the present application also provides a flexible display apparatus **10**, the flexible display apparatus **10** is using the above-described white light organic electroluminescent device as a light emitting source.

In view of the above, it will be readily understood by those skilled in the art that the flexible display apparatus and the white light organic electroluminescent device provided by the present application can enhance the luminous intensity of the red light band in the three-laminated layer white light organic electroluminescent device by adding a red light emitting layer, and optimizes the spectrum of the white OLED device, when used as a display device it can reduce power consumption of the display apparatus.

Above are embodiments of the present application, which does not limit the scope of the present application. Any modifications, equivalent replacements or improvements within the spirit and principles of the embodiment described above should be covered by the protected scope of the invention.

What is claimed is:

1. A white light organic electroluminescent device, wherein the white light organic electroluminescent device comprises: an anode, a first blue light emitting unit, a second yellow light emitting unit, a third blue light emitting unit, and a cathode successively laminated and disposed, wherein the second yellow light emitting unit comprising a red light emitting layer; wherein the material used for the red light emitting layer is TCTA: 3% Ir(piq)3.

2. The white light organic electroluminescent device according to claim 1, wherein the thickness of the red light emitting layer is less than or equal to 5 nm.

3. The white light organic electroluminescent device according to claim 1, wherein the first blue light emitting unit comprises: a first hole injection layer, a first hole transport layer, a first blue light emitting layer, a first electron transport layer, a first N-type charge generation layer successively laminated and disposed on the anode.

4. The white light organic electroluminescent device according to claim 3, wherein the second yellow light emitting unit comprises: a second p-type charge generation layer, a second hole transport layer, a second yellow light emitting layer, a second electron transport layer, a second N-type charge generation layer successively laminated and disposed on the first N-type charge generation layer, and the red light emitting layer is located above the second hole transport layer.

5. The white light organic electroluminescent device according to claim 4, wherein the third blue light emitting unit comprises: a third P-type charge generation layer, a third hole transport layer, a third blue light emitting layer, a third electron transport layer, and a third electron injection layer successively laminated and disposed on the second N-type charge generation layer.

6. The white light organic electroluminescent device according to claim 5, wherein the material of the third P-type charge generation layer is HATCN, and having a thickness of 10 nm;

the material of the third hole transport layer is  $\beta$ -NPB, and having a thickness of 95 nm;

the material of the third blue light emitting unit is MADN: 3% DSA-ph, and having a thickness of 25 nm;

the material of the third electron transport layer is BmPyPb, and having a thickness of 20 nm; and

the material of the third electron injecting layer is LiF, and having a thickness of 1 nm.

5

7. The white light organic electroluminescent device according to claim 4, wherein the material of the second P-type charge generation layer is HATCN, and having a thickness of 10 nm;

the material of the second hole transport layer is  $\beta$ -NPB, and having a thickness of 30 nm;

the material of the second yellow light emitting layer is DCZPPY:Ir(BT)2(acac), and having a thickness of 30 nm;

the material of the second electron transport layer is BmPyPb, and having a thickness of 20 nm; and

the material of the second N-type charge generation layer is BmPyPb: 4% Li, and having a thickness of 20 nm.

8. The white light organic electroluminescent device according to claim 3, wherein the material of the first hole injection layer is MoO3, and having a thickness of 1 nm;

the material of the first hole transport layer is  $\beta$ -NPB, and having the thickness of 160 nm;

the material of the first blue light emitting layer is MADN: 3% DSA-ph, and having a thickness of 25 nm;

the material of the first electron transport layer is BmPyPb, and having a thickness of 10 nm; and

the material of the first N-type charge generation layer is BmPyPb:4% Li, and having a thickness of 10 nm.

9. A flexible display apparatus, wherein the flexible display apparatus is using a white light organic electroluminescent device as a light emitting source, the white light organic electroluminescent device comprises: an anode, a first blue light emitting unit, a second yellow light emitting unit, a third blue light emitting unit, and a cathode successively laminated and disposed, wherein the second yellow light emitting unit comprising a red light emitting layer; wherein the material used for the red light emitting layer is TCTA: 3% Ir(piq)3.

10. The white light organic electroluminescent device according to claim 9, wherein the thickness of the red light emitting layer is less than or equal to 5 nm.

11. The white light organic electroluminescent device according to claim 9, wherein the first blue light emitting unit comprises: a first hole injection layer, a first hole transport layer, a first blue light emitting layer, a first electron transport layer, a first N-type charge generation layer successively laminated and disposed on the anode.

12. The white light organic electroluminescent device according to claim 11, wherein the second yellow light emitting unit comprises: a second p-type charge generation layer, a second hole transport layer, a second yellow light emitting layer, a second electron transport layer, a second

6

N-type charge generation layer successively laminated and disposed on the first N-type charge generation layer, and the red light emitting layer is located above the second hole transport layer.

13. The white light organic electroluminescent device according to claim 12, wherein the third blue light emitting unit comprises: a third P-type charge generation layer, a third hole transport layer, a third blue light emitting layer, a third electron transport layer, and a third electron injection layer successively laminated and disposed on the second N-type charge generation layer.

14. The white light organic electroluminescent device according to claim 13, wherein the material of the third P-type charge generation layer is HATCN, and having a thickness of 10 nm;

the material of the third hole transport layer is  $\beta$ -NPB, and having a thickness of 95 nm;

the material of the third blue light emitting unit is MADN: 3% DSA-ph, and having a thickness of 25 nm;

the material of the third electron transport layer is BmPyPb, and having a thickness of 20 nm; and

the material of the third electron injecting layer is LiF, and having a thickness of 1 nm.

15. The white light organic electroluminescent device according to claim 12, wherein the material of the second P-type charge generation layer is HATCN, and having a thickness of 10 nm;

the material of the second hole transport layer is  $\beta$ -NPB, and having a thickness of 30 nm;

the material of the second yellow light emitting layer is DCZPPY:Ir(BT)2(acac), and having a thickness of 30 nm;

the material of the second electron transport layer is BmPyPb, and having a thickness of 20 nm; and

the material of the second N-type charge generation layer is BmPyPb: 4% Li, and having a thickness of 20 nm.

16. The white light organic electroluminescent device according to claim 11, wherein the material of the first hole injection layer is MoO3, and having a thickness of 1 nm;

the material of the first hole transport layer is  $\beta$ -NPB, and having the thickness of 160 nm;

the material of the first blue light emitting layer is MADN: 3% DSA-ph, and having a thickness of 25 nm;

the material of the first electron transport layer is BmPyPb, and having a thickness of 10 nm; and

the material of the first N-type charge generation layer is BmPyPb:4% Li, and having a thickness of 10 nm.

\* \* \* \* \*

专利名称(译)	柔性显示装置及其白光有机电致发光器件		
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申请号	US15/553544	申请日	2017-07-17
[标]申请(专利权)人(译)	深圳市华星光电技术有限公司		
申请(专利权)人(译)	深圳市中国恒星光电科技股份有限公司.		
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IPC分类号	H01L51/00 H01L51/50 H01L27/32 H01L51/52		
CPC分类号	H01L51/5278 H01L51/5044 H01L27/3209 H01L51/0034 H01L51/5088 H01L51/5056 H01L51/006 H01L51/0085 H01L51/0058 H01L51/0061 H01L51/0072 H01L51/0067 H01L2251/558 H01L51/5072 H01L2251/303 H01L2251/5338		
代理人(译)	程, ANDREW C.		
优先权	201710480814.3 2017-06-22 CN		
其他公开文献	US20180375051A1		
外部链接	<a href="#">Espacenet</a>		

## 摘要(译)

本申请提供了一种柔性显示装置和白光有机电致发光器件，其包括依次层叠和设置的阳极，第一蓝色发光单元，第二黄色发光单元，第三蓝色发光单元和阴极。第二黄色发光单元包括红色发光层。本申请提供的柔性显示装置和白光有机电致发光器件，通过增加红色发光层，增强了三层式白光有机电致发光器件中红光带的发光强度，并优化了白光的光谱。OLED装置当用作显示装置时，可以减少显示装置的功耗。

cathode	118
Al (100nm)	117
third electron injection layer	116
LiF(1nm)	115
third electron transport layer	114
BmPyPb(20nm)	113
third blue light emitting layer	112
MADN: 3%DPA-ph(25nm)	111
third hole transport layer	110
β-NPB(95nm)	109
third P-type charge generation layer	108
HATCN(10nm)	107
second N-type charge generation layer	106
BmPyPb: 4%Li(20nm)	105
second electron transport layer	104
BmPyPb(20nm)	103
second yellow light emitting layer	102
DCZBPY: Ir(BDQ)(acac) (30nm)	101
red light emitting layer	
TCTA: 3%Ir(piq)3(5nm)	
second hole transport layer	
β-NPB(30nm)	
second p-type charge generation layer	
HATCN(10nm)	
first N-type charge generation layer	
BmPyPb:4%Li(10nm)	
first hole transport layer	
BmPyPb(10nm)	
first blue light emitting layer	
MADN: 3%DPA-ph(25nm)	
first hole transport layer	
β-NPB(160nm)	
first hole injection layer	
MoO3(1nm)	
anode	
ITO(70nm)	