US007839084B2

(12) United States Patent
Nishikawa et al.

(10) Patent No.: US 7,839,084 B2
(45) Date of Patent: Nov. 23, 2010

(54) ORGANIC EL ELEMENT AND ORGANIC EL PANEL

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 287 days.

(21) Appl. No.: **12/187,105**

(22) Filed: **Aug. 6, 2008**

(65) **Prior Publication Data**

US 2008/0297043 A1 Dec. 4, 2008

Related U.S. Application Data

(63) Continuation of application No. 10/953,667, filed on Sep. 29, 2004, now Pat. No. 7,531,958.

(30) **Foreign Application Priority Data**

Sep. 30, 2003 (JP) 2003-342665
Sep. 22, 2004 (JP) 2004-275673

(51) **Int. Cl.**
H05B 33/04 (2006.01)

(52) **U.S. Cl.** **313/506**; 313/504

(58) **Field of Classification Search** 313/498–512; 428/690
See application file for complete search history.

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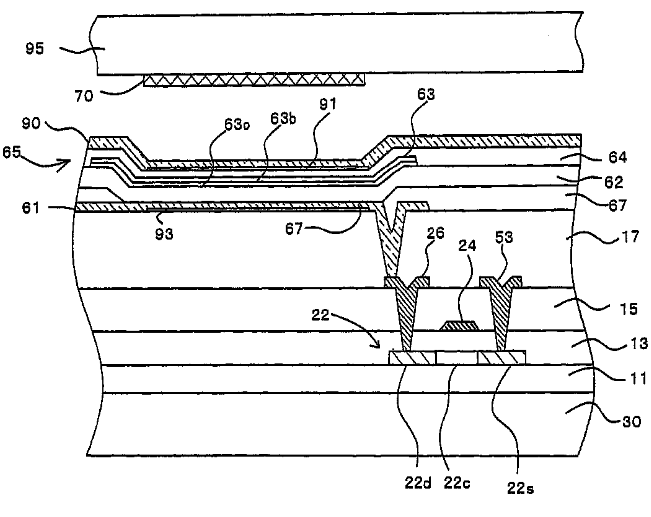
(57) **ABSTRACT**

A light-emitting device may include a light-emitting element, a microresonator, and a color filter. The light-emitting element may include first and second electrode and an emissive layer provided between the first and second electrodes, and may emit light of a predetermined color when a voltage is applied between the first and second electrodes to allow a current to flow in the emissive layer. The microresonator may repetitively reflect light of a predetermined color emitted from the emissive layer within an interval having an optical length corresponding to the predetermined color, and thereby intensifying and selecting the light of the predetermined color. The color filter may pass the light intensified and selected by the microresonator and further limiting to light having a wavelength of the predetermined color.

14 Claims, 11 Drawing Sheets



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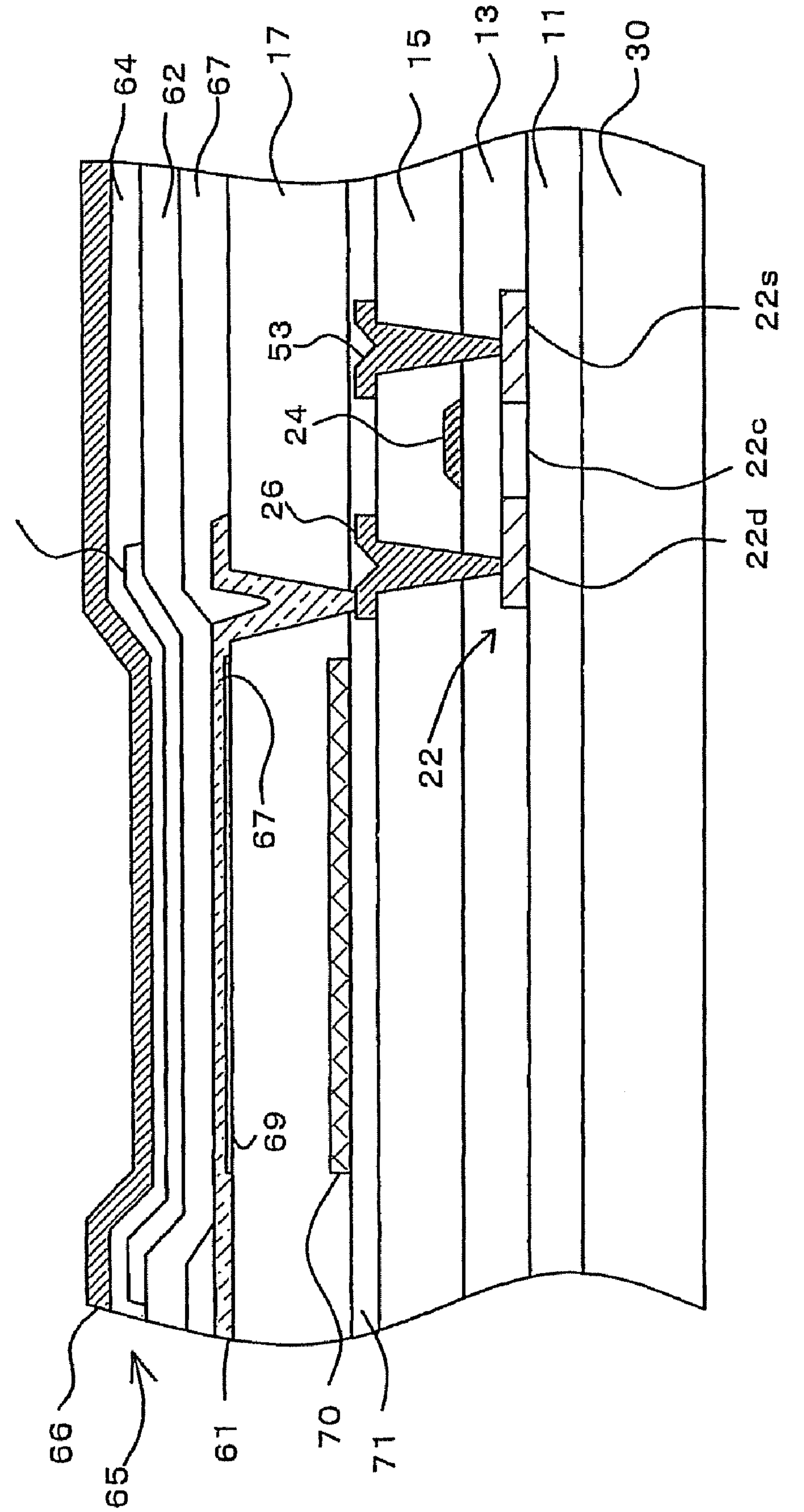


Fig. 1

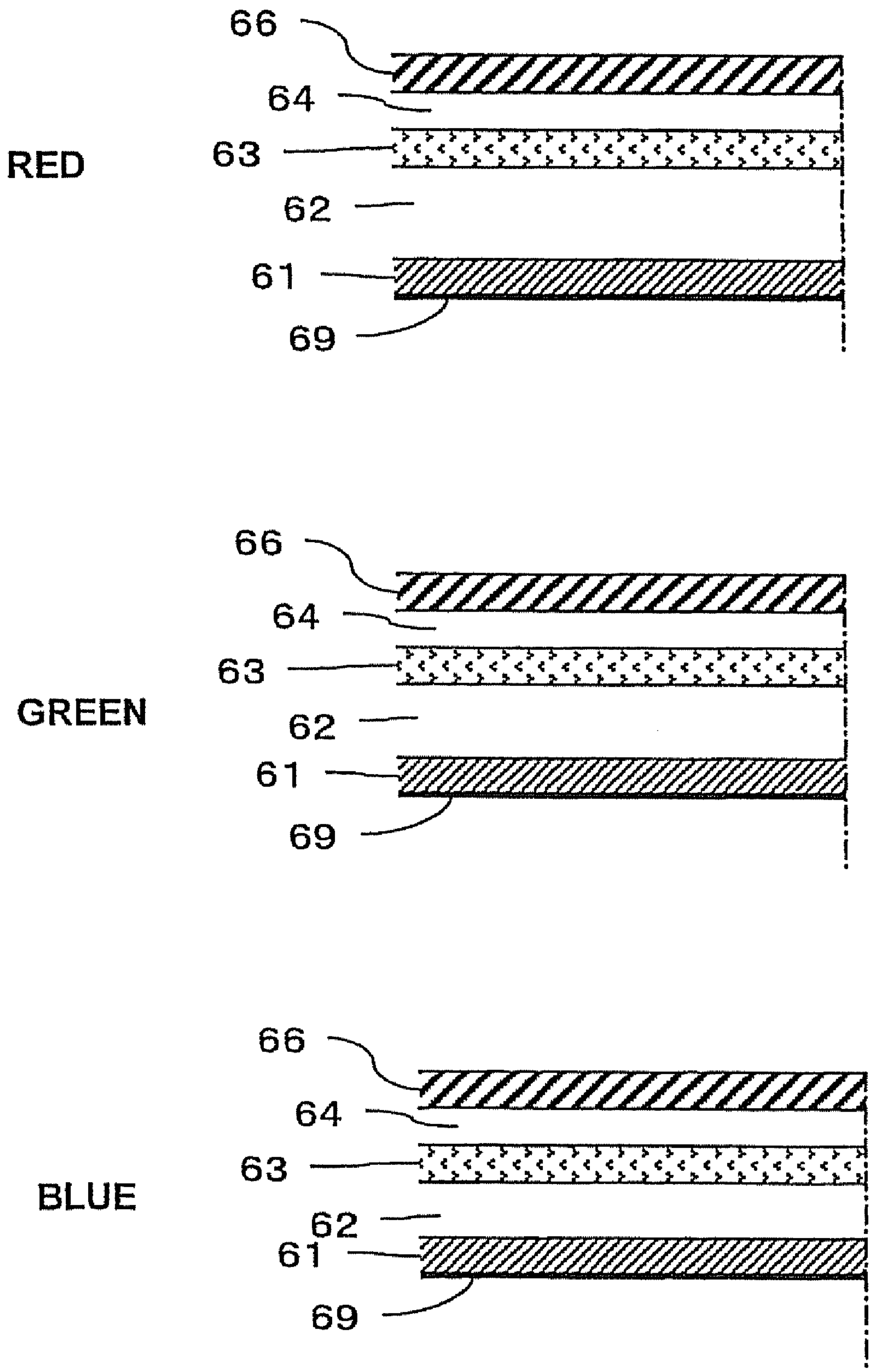


Fig. 2

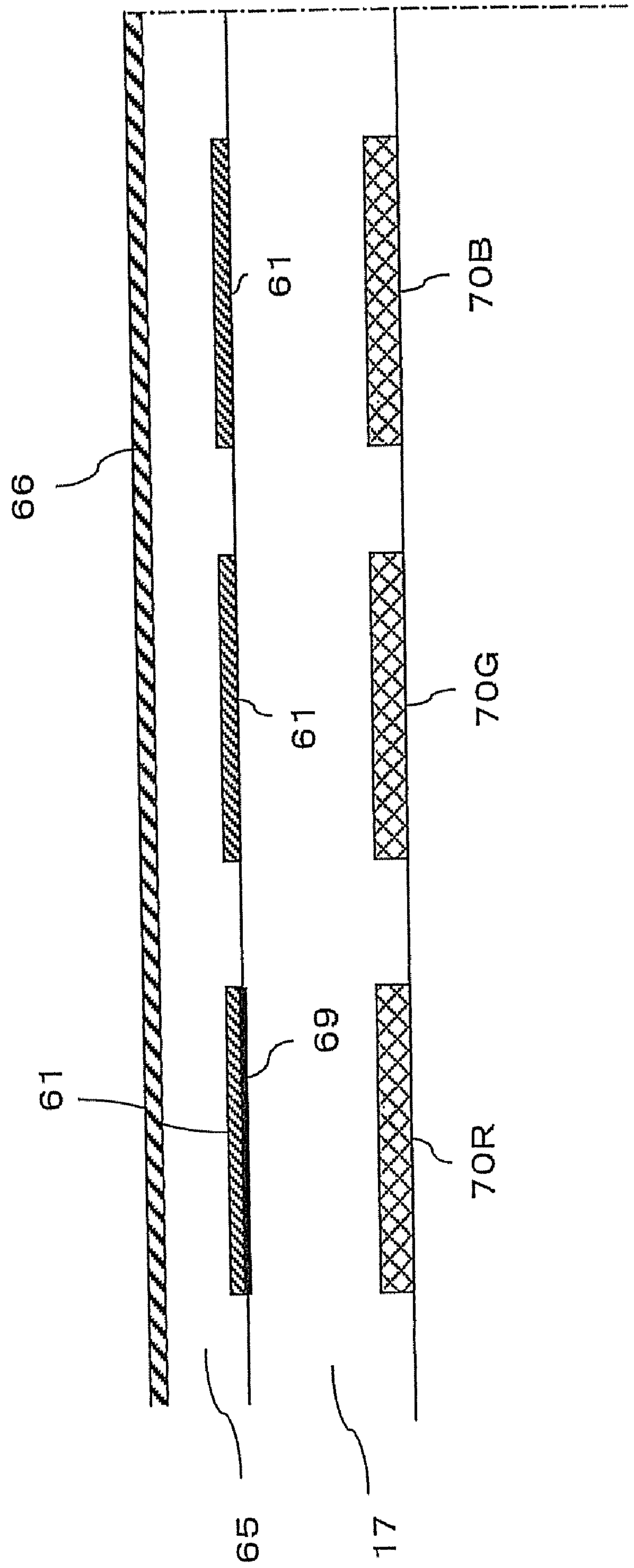


Fig. 3

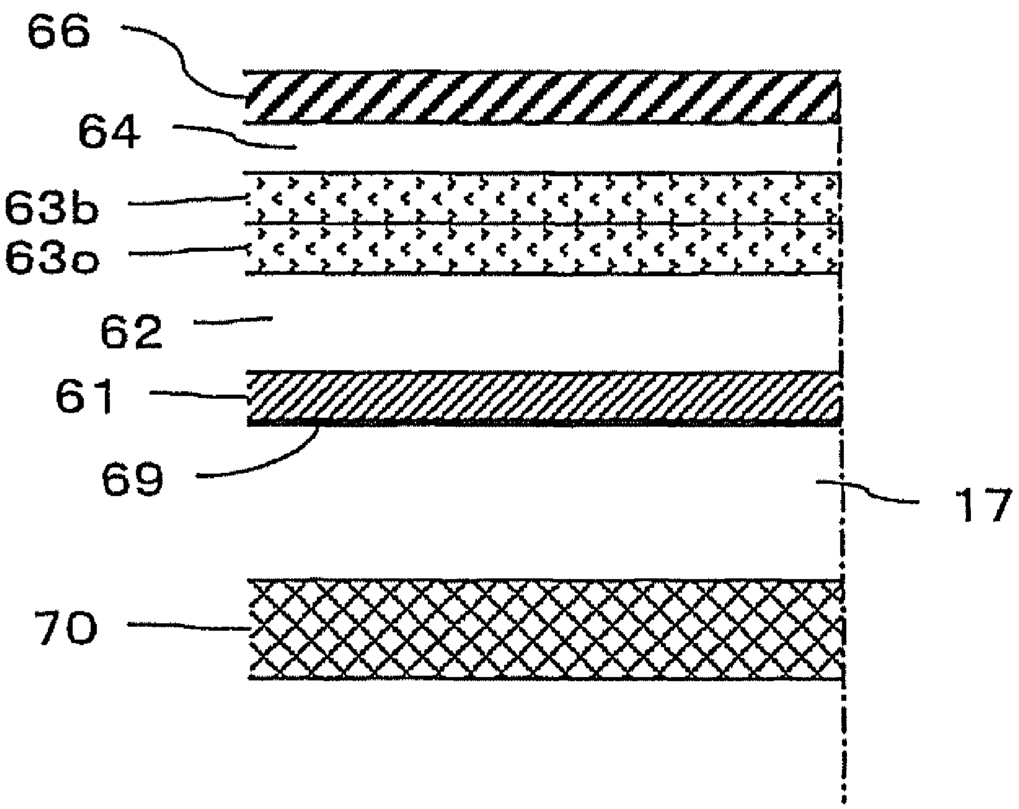
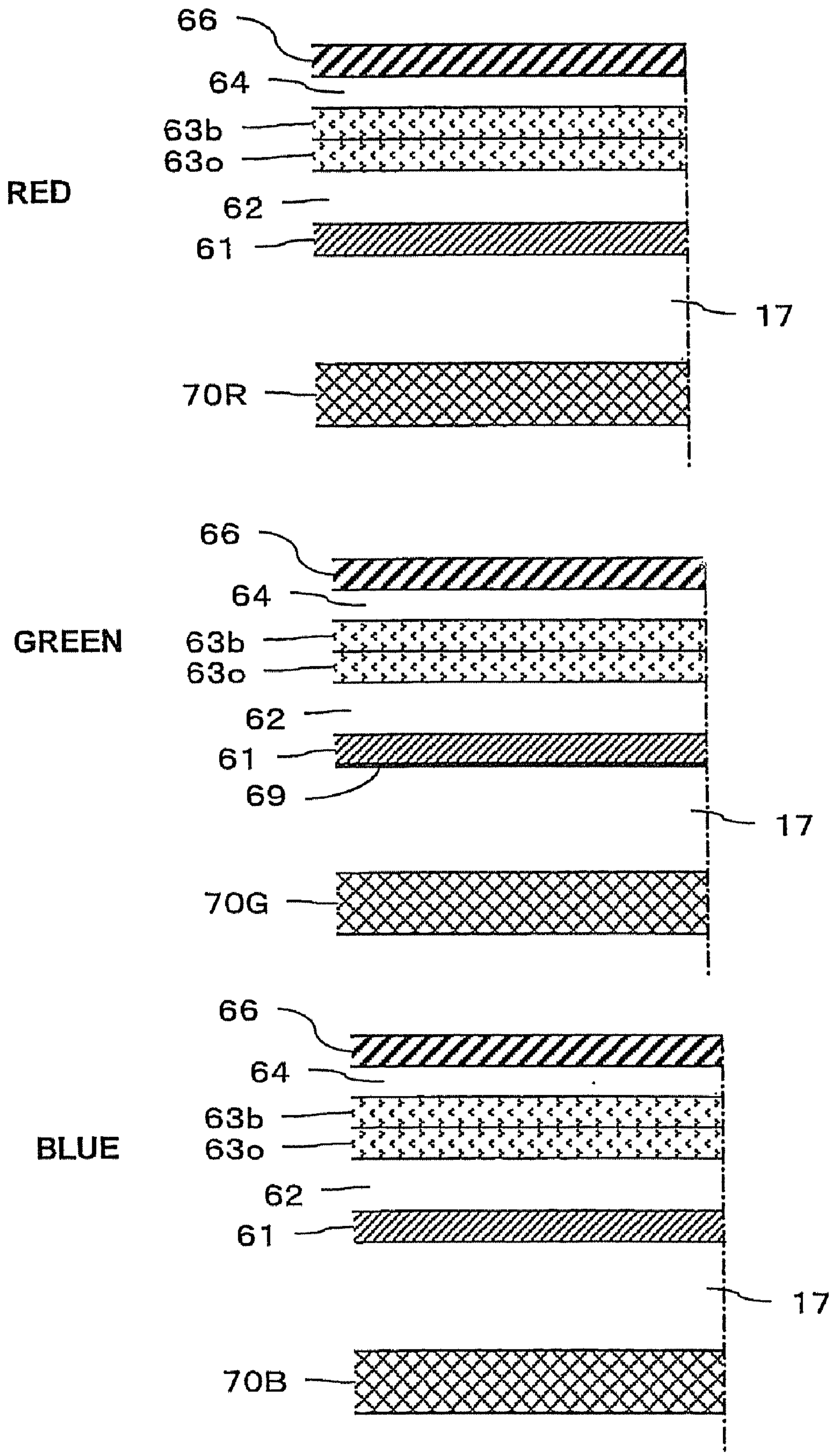


Fig. 4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66
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63b
63o
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17
70R
GREEN
66
64
63b
63o
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70G
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63b
63o
62
61
17
70B

Fig. 5

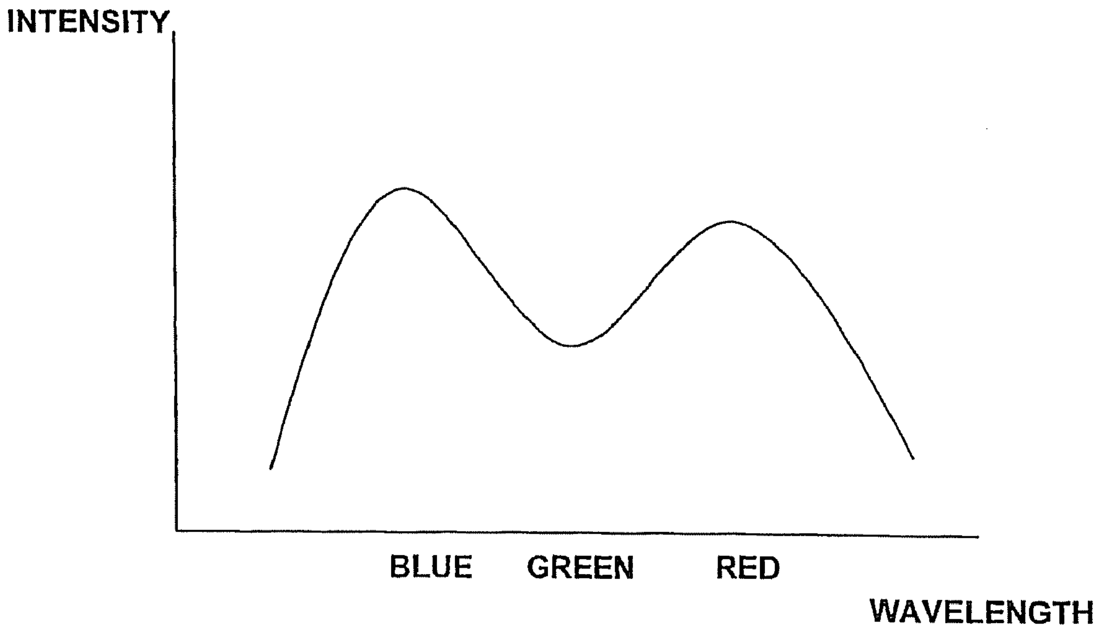
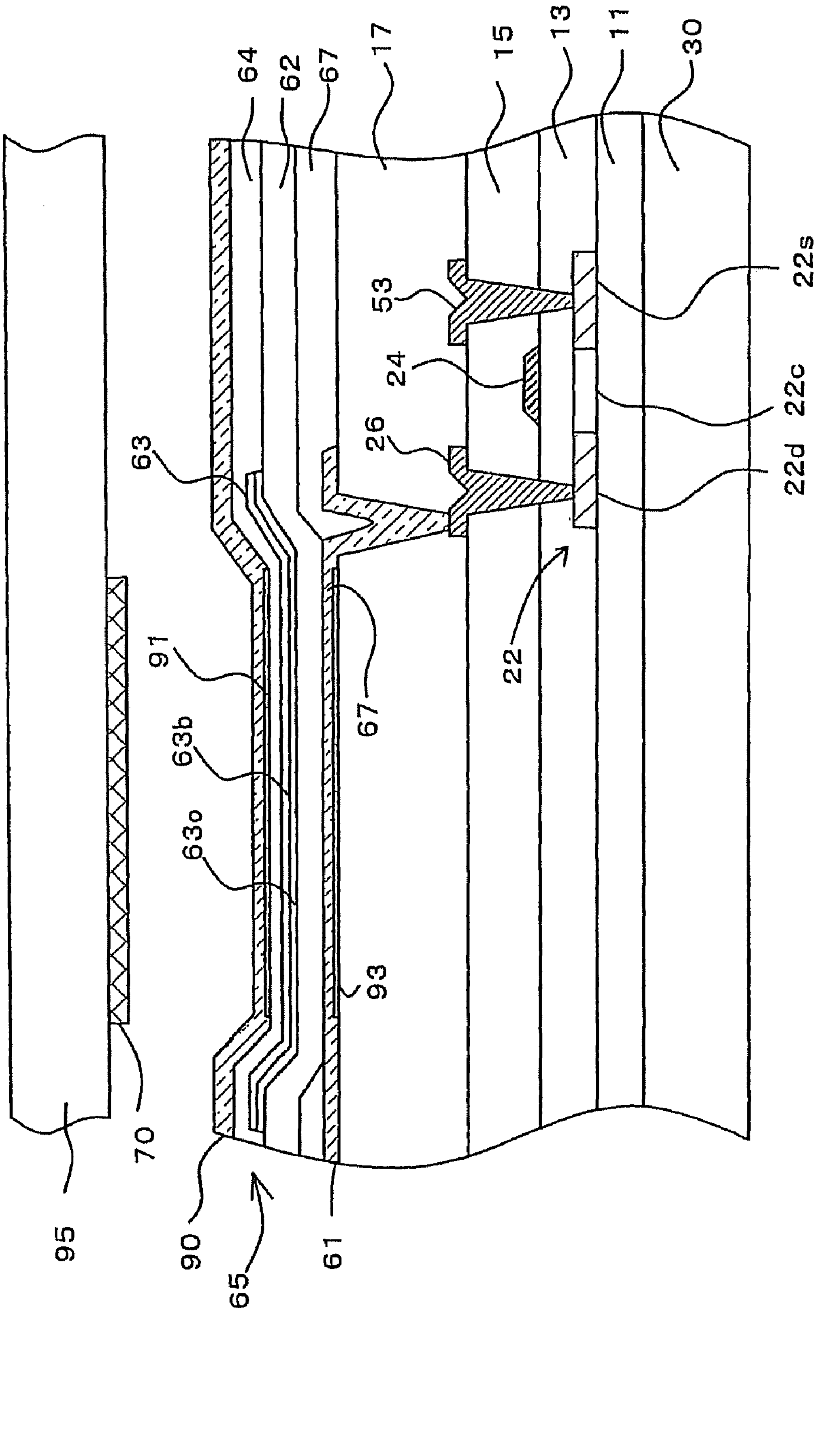


Fig. 6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62
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15
13
11
30
22s
53
24
22c
26
22d
63
91
63b
63o
93
67
22
95
70
90
65
61

Fig. 7

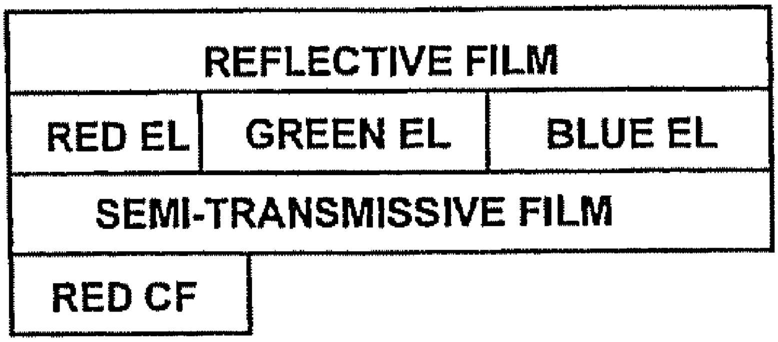

REFLECTIVE FILM
RED EL
GREEN EL
BLUE EL
SEMI-TRANSMISSIVE FILM
RED CF

Fig. 8

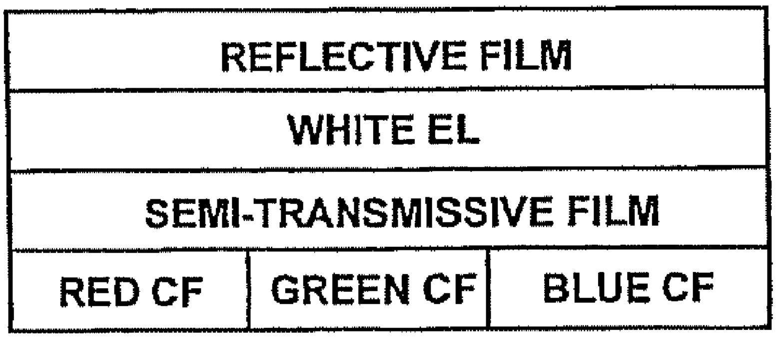

REFLECTIVE FILM
WHITE EL
SEMI-TRANSMISSIVE FILM
RED CF
GREEN CF
BLUE CF

Fig. 9

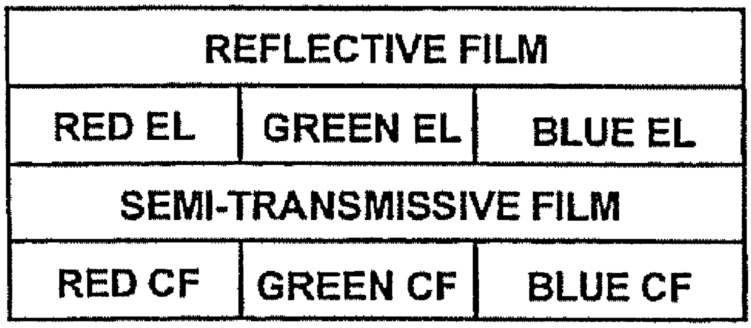

REFLECTIVE FILM
RED EL
GREEN EL
BLUE EL
SEMI-TRANSMISSIVE FILM
RED CF
GREEN CF
BLUE CF

Fig. 10

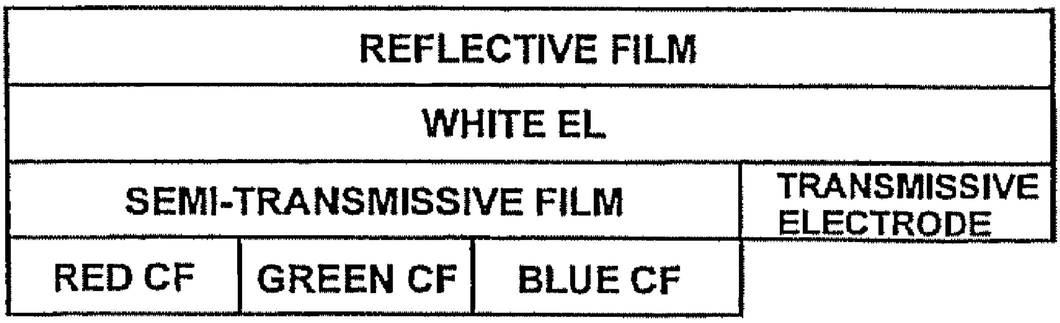
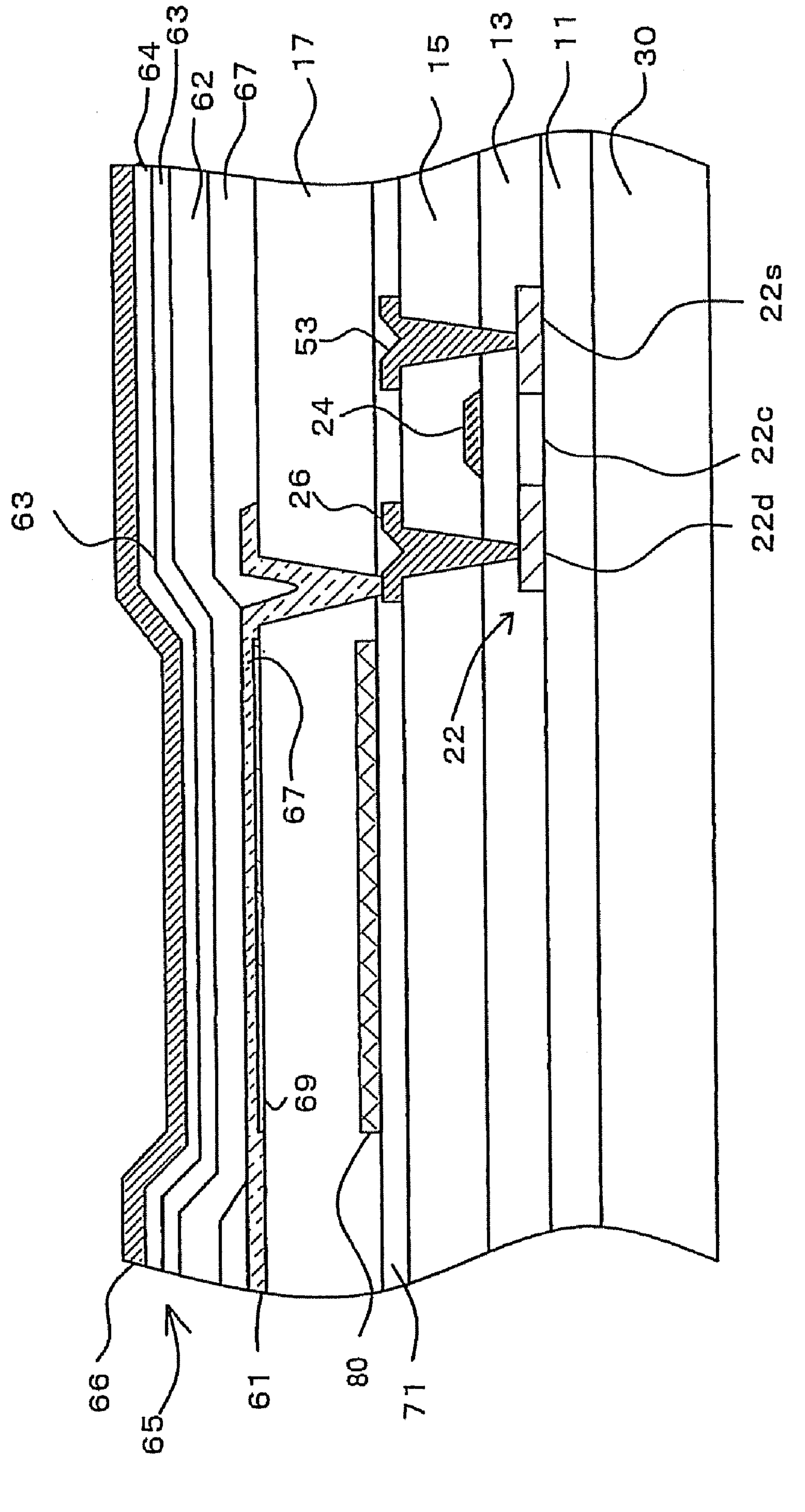

REFLECTIVE FILM
WHITE EL
SEMI-TRANSMISSIVE FILM
TRANSMISSIVE ELECTRODE
RED CF
GREEN CF
BLUE CF

Fig. 11



64
63
62
67
17
15
13
11
30
63
53
24
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22s
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22d
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67
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65
61
71

Fig. 12

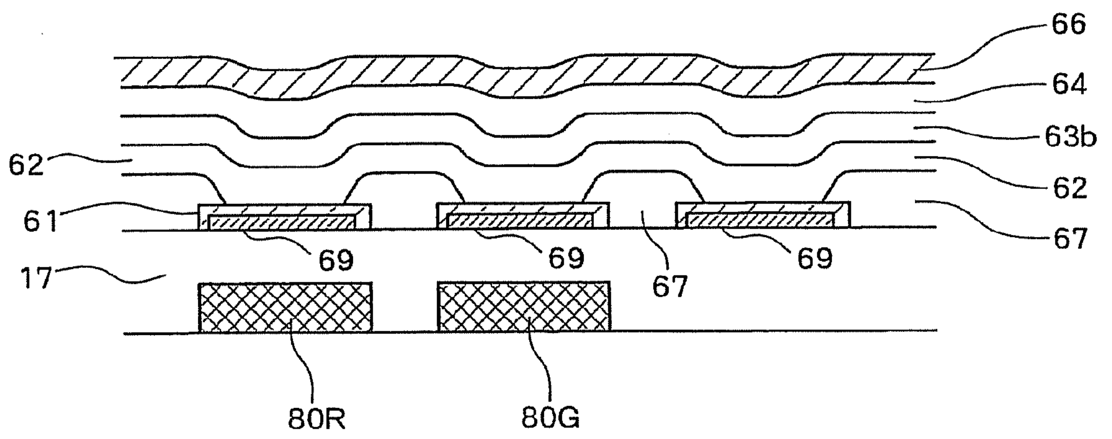

Fig. 13

ORGANIC EL ELEMENT AND ORGANIC EL PANEL

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application is a continuation application under 35 U.S.C. §120 of U.S. application Ser. No. 10/953,667 filed on Sep. 29, 2004, priority to which is claimed herein and the contents of which are incorporated herein by reference. U.S. application Ser. No. 10/953,667 claims priority to Japanese Application No. 2003-342665, filed on Sep. 30, 2003, and Japanese Application No. 2004-275673, filed on Sep. 22, 2004, priority to both of which is claimed herein, and the contents of both of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an organic EL element which comprises a transparent electrode, an organic emissive layer disposed over the transparent electrode, and a counter electrode disposed over the organic emissive layer, and emits light when a voltage is applied between the transparent electrode and the counter electrode.

2. Description of the Related Art

In recent years, organic electroluminescence (hereinafter referred to as "EL") displays have gained attention as one type of flat display which would replace liquid crystal displays in the coming generation. In a display panel of an organic EL display (hereinafter referred to as "organic EL panel"), the color of light emitted from each pixel may be determined depending on the emissive material used in the organic emissive layer of each pixel. By allowing the pixels to emit light of different colors using different emissive materials, RGB indication can be achieved.

However, when employing this method, the panel manufacturing process becomes difficult and complex because measures must be effected to compensate for differences in emissive efficiency of the emissive materials for different colors, and steps for applying different emissive materials to corresponding pixels must be carried out separately.

In order to achieve full color indication, other methods for determining pixel colors are proposed. In such methods, light of a single color alone is initially emitted, and color filters or color conversion layers are employed to obtain light of other colors. However, according to these methods, it is difficult to achieve sufficient emissive efficiency for each color.

Another alternative method using microcavities is disclosed in the following document: Takahiro NAKAYAMA and Atsushi KADOTA, "Element Incorporating Optical Resonator Structure, Third Meeting (1993)", in "From the Basics to the Frontiers in the Research of Organic EL Materials and Devices", Dec. 16 and 17, 1993, Tokyo University Sanjo Conference Hall, Japan Society of Applied Physics, Organic Molecular Electronics and Bioelectronics Division, JSAP Catalog Number AP93 2376, p. 135-143. According to this method, a microcavity which functions as a microresonator is provided in each pixel to extract light having a specific wavelength. Using this microresonator, light having a specific wavelength can be selectively intensified.

However, an EL element configured with a conventional microresonator disadvantageously has high dependency on viewing angle, such that unintended colors are detected when the element is viewed at an angle. Further, in order to select light having a specific wavelength using a conventional microresonator, the optical length of the microcavity must be set precisely, resulting in difficulties in the manufacturing process.

SUMMARY OF THE INVENTION

According to the present invention, a microresonator (microcavity) is provided in a portion of a pixel having an organic EL element. Light ejected through a semi-transmissive film is thereby limited to a specific wavelength while the specific wavelength is intensified. The light obtained after the wavelength selection by the microresonator is subsequently passed through a color filter so as to further restrict the wavelength. According to this arrangement, viewing angle dependency of a displayed color can be eliminated significantly. Furthermore, the required precision concerning the thickness of the EL element portion constituting the microresonator can be reduced, facilitating the panel manufacturing process.

In place of the color filter, a color conversion layer may alternatively be employed to convert light of a specific color into light of another color. When using color conversion layers, microresonators in the respective pixels can be configured to intensify light of one specific color alone.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional view showing a configuration of a pixel portion of an organic EL element according to the present invention.

FIG. **2** shows an example configuration of organic EL elements for the respective colors of R, G, and B, according to the present invention.

FIG. **3** shows another configuration of organic EL elements for the respective colors of R, G, and B, according to the present invention.

FIG. **4** shows a configuration of an organic EL element which emits white light.

FIG. **5** shows an example configuration for the respective colors of R, G, and B using white-emitting organic EL elements, according to the present invention.

FIG. **6** is a diagram showing an example spectrum of a white-emitting organic EL element.

FIG. **7** shows an example configuration of a white-emitting organic EL element having a top-emission structure.

FIGS. **8-11** are schematic diagrams showing example pixel configurations of an organic EL panel.

FIG. **12** is a cross-sectional view showing a configuration of a pixel portion of an organic EL element using a color conversion layer, according to the present invention.

FIG. **13** is a schematic diagram showing an example RGB pixel configuration using color conversion layers, according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will next be described referring to the drawings.

FIG. **1** is a cross-sectional view showing a configuration of a light-emitting region and a drive TFT (thin film transistor) within one pixel. It should be noted that each pixel actually includes a plurality of TFTs. The drive TFT is the TFT which controls a current supplied from a power line to an organic EL element within the pixel. On a glass substrate **30**, a buffer layer **11** composed of a lamination of an SiN layer and an SiO_2 layer is formed over the entire surface. Further on top, an active layer **22** made of polysilicon is disposed in predetermined areas (where TFTs are to be created).

Covering the active layer **22** and the buffer layer **11**, a gate insulation film **13** is formed over the entire surface. The gate insulation film **13** may be formed by laminating an SiO_2 layer and an SiN layer. On top of the gate insulation film **13** at a position above a channel region **22***c*, a gate electrode **24** composed of chromium or the like is arranged. Subsequently, impurities are doped into the active layer **22** while using the gate electrode **24** as a mask. As a result of this process, in the active layer **22**, the channel region **22***c* without impurities is provided in the central portion under the gate electrode **24**, while a source region **22***s* and a drain region **22***d* doped with impurities are formed on both sides of the channel region **22***c*.

Next, covering the gate insulation film **13** and the gate electrode **24**, an interlayer insulation film **15** is formed over the entire surface. Contact holes are then created in the interlayer insulation film **15** at positions corresponding to the source region **22***s* and the drain region **22***d* located under the interlayer insulation film **15**. Subsequently, a source electrode **53** and a drain electrode **26** are provided through these contact holes and on the upper surface of the interlayer insulation film **15**, so as to connect with the source region **22***s* and the drain region **22***d*, respectively. It should be noted that the source electrode **53** is connected to a power line (not shown). While the drive TFT formed as described above is a p-channel TFT in this example, the drive TFT may alternatively be constituted as an n-channel TFT.

Covering the interlayer insulation film **15**, source electrode **53**, and drain electrode **26**, a film **71** of SiN or the like is formed over the entire surface. A color filter **70** is next formed on top of the SiN film **71** at a position corresponding to the light-emitting region in each pixel.

Covering the SiN film **71** and the color filter **70**, a planarization film **17** is provided over the entire surface. On top of the planarization film **17** at the position of the light-emitting region, a semi-transmissive film **69** composed of a thin film of Ag or the like is formed. A transparent electrode **61** which serves as an anode is then disposed on the semi-transmissive film **69**. At a position above the drain electrode **26**, a contact hole is created through the planarization film **17**. The drain electrode **26** and the transparent electrode **61** are connected via this contact hole.

While an organic film such as acrylic resin is typically used to form the interlayer insulation film **15** and planarization film **17**, it is also possible to employ TEOS or an inorganic film. A metal such as aluminum may be favorably used to create the source electrode **53** and drain electrode **26**. For the transparent electrode **61**, ITO is typically employed.

The transparent electrode **61** normally has a substantially rectangular overall shape with a contacting portion protruding laterally and downward through the contact hole for connection with the drain electrode **26**. As can be seen in FIG. **1**, the semi-transmissive film **69** is formed slightly smaller than the anode **61**.

An organic layer **65** and a counter electrode **66** are arranged on top of the transparent electrode **61**. The organic layer **65** comprises a hole transport layer **62** formed over the entire surface, an organic emissive layer **63** formed slightly larger than the light-emitting region, and an electron transport layer **64** formed over the entire surface. The counter electrode **66**, which serves as a cathode, is made of metal such as aluminum, and is formed over the entire surface.

A planarization film **67** is provided at a position on the upper surface of the peripheral portion of the transparent electrode **61** and underneath the hole transport layer **62**. The planarization film **67** limits the portion in which the hole transport layer **62** directly contacts the transparent electrode **61**, thereby defining the light-emitting region in each pixel. It should be noted that, while an organic film such as acrylic resin is typically used for the planarization film **67**, it is also possible to employ TEOS or an inorganic film.

The hole transport layer **62**, the organic emissive layer **63**, and the electron transport layer **64** are composed of materials that are conventionally used in an organic EL element. The color of emitted light is determined depending on the material (usually the dopant) of the organic emissive layer **63**. For example, the hole transport layer **62** may be composed of NPB, the organic emissive layer **63** for emitting red light may be composed of TBADN+DCJTB, the organic emissive layer **63** for emitting green light may be composed of Alq_3+CFD-MQA, the organic emissive layer **63** for emitting blue light may be composed of TBADN+NPB, and the electron transport layer **64** may be composed of Alq_3.

In the above-described arrangement, when the drive TFT is turned on by a voltage set in the gate electrode **24**, current from the power line flows from the transparent electrode **61** to the counter electrode **66**. This current causes light emission in the organic emissive layer **63**. The emitted light passes through the transparent electrode **61**, planarization film **17**, interlayer insulation film **15**, gate insulation film **13**, and glass substrate **30**, to be ejected downward in FIG. **1**.

In the present embodiment, a semi-transmissive film **69** composed of a thin film of silver (Ag) or the like is provided on the underside of the transparent electrode **61** at the position of the light-emitting region. Accordingly, light generated in the organic emissive layer **63** is reflected by the semi-transmissive film **69**. Because the counter electrode **66** functions as a reflective layer, the light is repetitively reflected between the semi-transmissive film **69** and the counter electrode **66**.

The interval structure between the semi-transmissive film **69** and the counter electrode **66** is configured such that this interval optically functions as a microresonator for a specific color. In other words, the optical length of the interval is set to a value obtained by multiplying the wavelength of a desired color by an integer or a reciprocal of an integer (such as ½, 1, and 2). For example, the values of refractive index for the materials constituting each layer in the interval may be approximately as follows: 1.9 for ITO constituting the transparent electrode **61**; 1.46 for SiO_2 constituting the gate insulation film **13**; 2.0 for SiN also used for the gate insulation film **13**; and 1.7 for an organic layer including the organic emissive layer **63**. By multiplying the physical thickness of each layer between the semi-transmissive film **69** and the counter electrode **66** by a corresponding refractive index, and then summing the calculated values, the optical thickness of the interval can be obtained. In the present embodiment, this optical thickness is set to a value relative to the wavelength of light to be extracted. With this arrangement, the interval between the semi-transmissive film **69** and the counter electrode **66** functions as a microresonator, and enables efficient extraction of light having a desired wavelength. More specifically, light emitted from the organic emissive layer **63** is repetitively reflected between the semi-transmissive film **69** and the counter electrode **66**, and as a result, light components having a specific wavelength are selectively passed through the semi-transmissive film **69**. By further repeating such reflection within the microresonator, the probability that light having the specific frequency will be ejected can be increased, resulting in enhanced efficiency.

According to the present embodiment, the color filter **70** is arranged in a layer between the interlayer insulation film **15** and the planarization film **17**. The color filter **70** may be composed of a material such as a photosensitive resin or polymer having a pigment mixed therein, similar to color filters used in a liquid crystal display and a CCD camera.

The color filter **70** serves to selectively pass the ejected light so as to limit the wavelength of the obtained light, thereby enabling reliable control of the obtained color. When the microresonator limits light passing through the semi-transmissive film **69** as described above, it may be considered that the color filter **70** is not a fundamental requirement. However, the microresonator basically regulates only the wavelength of light that is incident from a direction perpendicular to the surface of the semi-transmissive film **69**. Accordingly, the wavelength of light ejected from the microresonator is highly dependent on the viewing direction, such that different colors are likely to be detected when the panel is viewed at an angle. By providing the color filter **70** as in the present embodiment to pass the ejected light through the color filter **70**, the obtained light would unfailingly have a specific wavelength. In this manner, the viewing angle dependency of the panel can be substantially eliminated.

The position of the color filter **70** is not limited to the top of the interlayer insulation film **15**. Alternatively, the color filter **70** may be formed on the upper surface or the underside of the glass substrate **30**. A light-shielding film is often provided on the upper surface of the glass substrate **30** in order to prevent external light from irradiating on the drive TFT. In such a case, the color filter **70** may be formed in the same layer as the light-shielding film to simplify the manufacturing process.

FIG. **2** shows a configuration of pixel portions constituting the microresonators in R, G, and B pixels. In this example, resonance frequency is varied among the pixels of the respective colors of RGB by changing the thickness of the hole transport layer **62** in the decreasing order of R, G, and B. Thickness changes are made in the hole transport layer **62** because it is considered that a change in thickness of the hole transport layer **62** would have the least influence on the function compared to when such a change is made in the other layers.

By employing different emissive materials in the organic emissive layer **63**, each pixel is designed to emit light of one color among R, G, and B. In each pixel, the optical length from the upper surface of the semi-transmissive film **69** to the underside of the cathode **66** is configured in accordance with the wavelength of the emitted color. Accordingly, in each pixel, light of the emitted color is intensified by the microresonator, thereby achieving an increase in emissive efficiency.

Further, because color filters **70** are provided, even if the optical length of a microresonator is slightly deviated from the predetermined value, the resulting minor variances in the wavelength of the ejected light do not cause any problems. Accordingly, control of the thickness of each layer constituting the microresonator can be facilitated.

When changing the thickness of the hole transport layer **62** for each color as in the present embodiment, it is preferable to form the hole transport layer **62** only in the necessary portion (display area) in each pixel, similarly to the organic emissive layer **63**. Alternatively, it may be effective to change the thickness of the transparent electrode **61**.

FIG. **3** diagrammatically shows three pixels of R, G, and B. As can be seen, the semi-transmissive film **69** is provided for the pixel of one color alone, while no semi-transmissive film is provided for the pixels of other colors. This arrangement is employed because the interval between the semi-transmissive film **69** and the counter electrode **66** is configured to form a microresonator for the one color alone (red R in the present example). In the pixel for the one color, light of this color is intensified and passed through the semi-transmissive film **69**. In the pixels for the other colors, emitted light is ejected downward without further processing. Further, corresponding RGB color filters **70**R, **70**G, and **70**B are provided for the respective pixels.

While light emission of the three colors of RGB can be achieved using different organic materials, each organic material has a different emissive efficiency (amount of light emission/current) By employing a microresonator for a pixel of the color having the lowest emissive efficiency so as to intensify the emitted light, a more uniform light emission can be accomplished, such that the life of organic EL elements can be equalized among different colors. Moreover, because the microresonator is formed for one color alone, the thickness of each layer constituting the microresonator can be set easily.

Because the microresonator and the color filters **70** are provided in the present embodiment, the color of light emitted by each pixel can be white. In order to achieve emission of white light, the organic emissive layer **63** may be constituted with a two-layer structure including a blue emissive layer **63***b* and an orange emissive layer **63***o*, as shown in FIG. **4**. According to this arrangement, holes and electrons combine in regions near the border between the two emissive layers **63***b* and **63***o*, thereby generating both blue light and orange light. The light of the two colors in combination are emitted as white light. The orange organic emissive layer **63***o* may be composed of materials such as NPB+DBzR.

Subsequently, in the present embodiment, light of a specific color among the emitted white light is intensified and selected using a microresonator, and further selected by a color filter **70** to be ejected.

When employing a white organic emissive layer **63** as described above, the organic emissive layer **63** can be formed over the entire surface, without the need to separately perform the emissive layer forming process for the pixels of different colors. The organic emissive material can be simply deposited without using masks. When adopting this configuration, it is preferable to control the thickness of the transparent electrode **61** in order to adjust the optical length of the microresonator. In this manner, all layers disposed above the transparent electrode **61** can be formed over the entire surface without using masks, further facilitating the panel manufacturing process.

The present embodiment is more specifically illustrated in FIG. **5** showing the respective pixels of R, G, and B. As can be seen, the distance from the underside of the transparent electrode **61** to the underside of the cathode **66** is identical among all of the pixels. This distance is configured to have an optical length which selects and intensifies light of one color (green G, for example). In the pixel for this one color, the semi-transmissive film **69** is disposed beneath the transparent electrode **61**. In the pixels of other colors (red R and blue B, for example), no semi-transmissive film is provided.

According to this arrangement, in the G pixel, the microresonator extracts a specific color (green) from among the emitted white light as described above, and the extracted light is passed and ejected through a green color filter **70**. In the R and B pixels, the white light emitted from the organic emissive layer **63** is simply passed through the color filters **70** to be ejected as light of predetermined colors (red and blue, respectively).

In this embodiment, the only difference among the pixels is whether or not the semi-transmissive film **69** is provided. Further, the optical length can be set easily, and the panel manufacturing process can be very much simplified. Moreover, light for one color can be intensified using the microresonator. When white light obtained by emission of two colors is used, one color among the three primary colors tends to have lower intensity compared to the other two colors. By employing the microresonator for the low-intensity color, a favorable color display can be achieved. For example, when light emission is executed by two emissive layers of blue and orange, the intensity of green light becomes lower than the other colors, as shown in FIG. **6**. In order to equalize intensity, the semi-transmissive film **69** is provided for the green pixel so as to configure the microresonator to intensify the green light. In this manner, effective color display can be accomplished.

While the above-described embodiments refer to a bottom emission type panel in which light is ejected via the glass substrate **30**, an EL panel according to the present invention may alternatively be configured as top emission type in which light is ejected via the cathode.

FIG. **7** shows a configuration of a pixel portion of a top emission type panel. In this example, a transparent cathode **90** composed of ITO is employed as the cathode. Further, a semi-transmissive film **91** is disposed on the underside of the transparent cathode **90**.

Furthermore, a metal reflective layer **93** is formed under the transparent electrode **61**. The interval structure between the surface of the metal reflective layer **93** and the semi-transmissive film **91** functions as the microresonator.

In this embodiment, the color filter **70** is provided on the underside of a sealing substrate **95**. It should be noted that the sealing substrate **95** connects to the substrate **30** at its peripheral portion alone, and serves to seal the upper space of the substrate **30** having components such as the organic EL element formed thereon. The top emission structure shown in FIG. **7** can be employed in any of the above-described configurations according to the present invention.

While the TFTs in the above embodiments are described as top gate type TFTs, bottom gate type TFTs may alternatively be used.

FIGS. **8**-**11** diagrammatically illustrate example configurations of the present invention. To simplify explanation, only the characteristic structures are shown in these drawings.

In FIG. **8**, three types of organic emissive layers, namely, red emissive layer (red EL), green emissive layer (green EL), and blue emissive layer (blue EL) are employed. Further, corresponding to the red EL alone, a red color filter (red CF) is arranged. In this example, the color filter is provided for the color (red, in this case) having the highest dependency on viewing angle. It should be noted that it is also possible to provide a color filter for any of the other colors alone.

FIG. **9** shows an example in which color filters are arranged for all of the three colors. In this example, a white organic emissive layer (white EL) is provided as the organic emissive layer on the entire surface. Each of the pixels for the respective colors is provided with a microresonator along with a color filter of the corresponding color.

In FIG. **10**, color filters are arranged for all of the three colors, while a red emissive layer (red EL), green emissive layer (green EL), and blue emissive layer (blue EL) are employed as the organic emissive layer. Each of the pixels for the respective colors is provided with a microresonator along with a color filter of the corresponding color.

In FIG. **11**, an additional white pixel having a transparent electrode is provided in addition to the configuration of FIG. **9**. By adding a white (W) pixel to RGB pixels as shown, a bright screen display can be easily achieved.

FIG. **12** shows the configuration of FIG. **1** in which the color filter **70** is replaced with a color conversion layer **80**. An example of this color conversion layer **80** is described in Japanese Patent Laid-Open Publication No. 2003-187975. Using this color conversion layer **80**, a specific color can be converted into another specific color. For example, light emitted by a blue emissive layer may be converted into red and green light. In this case, a single blue emissive layer **63** alone is formed as the organic emissive layer over the entire surface. Further, red and green pixels are provided with color conversion layers **80** for converting the emitted blue light into red and green light, respectively. Each of the RGB pixels can be realized in this manner.

FIG. **13** shows an example configuration of three pixels of RGB. It should be noted that FIG. **13** is a schematic diagram in which the TFT structure and the structure connecting the TFT and the transparent electrode **61** are not shown.

A color conversion layer **80**R for converting blue light into red light is arranged below the transparent electrode **61** in a red pixel, while a color conversion layer **80**G for converting blue light into green light is arranged below the transparent electrode **61** in a green pixel. A blue pixel does not include any color conversion layer.

The hole transport layer **62**, blue organic emissive layer **63***b*, electron transport layer **64**, and counter electrode **66** are formed extensively over the entire surface so as to serve commonly for all pixels.

Microresonators are formed in the respective pixels by the layers between the semi-transmissive film **69** and the counter electrode **66**. In the present example, because the microresonators only need to intensify blue light, the interval between the semi-transmissive film **69** and the counter electrode **66** can be made identical in all of the pixels.

According to this arrangement, all of the hole transport layer **62**, organic emissive layer **63** (**63***b*), and electron transport layer can be formed extensively over the entire substrate (commonly for all pixels), thereby simplifying the manufacturing process.

What is claimed is:

1. A light-emitting device comprising:

a light-emitting element including first and second electrodes and an emissive layer provided between the first and second electrodes, and emitting light of a predetermined color when a voltage is applied between the first and second electrodes to allow a current to flow in the emissive layer;

a microresonator for repetitively reflecting light of the predetermined color emitted from the emissive layer within an interval having an optical length corresponding to the predetermined color, and thereby intensifying and selecting the light of the predetermined color; and

a color filter for passing the light intensified and selected by the microresonator and further limiting to light having a wavelength of the predetermined color.

2. The light-emitting device according to claim **1**, wherein the light-emitting element is an organic EL element, and the emissive layer is an organic layer.

3. The light-emitting device according to claim **1**, wherein the predetermined color is one of red, green, and blue.

4. The light-emitting device according to claim **2**, wherein the first electrode includes a semi-transmissive layer, which reflects light from the organic layer,

the second electrode includes a reflective layer for reflecting light from the organic layer,

an interval between the reflective layer and the semi-transmissive layer is configured to have a predetermined optical length, such that when light generated in the organic layer is repetitively reflected between the reflective layer and the semi-transmissive layer, the interval between the reflective layer and the semi-transmissive layer functions as a microresonator which intensifies and selects light of the predetermined color and ejects the selected light through the semi-transmissive layer.

5. The light-emitting device according to claim **4**, wherein the first electrode has a laminated structure composed of the semi-transmissive layer and a transparent electrode, and the second electrode is a metal electrode which functions as the reflective layer.

6. The light-emitting device according to claim **2**, wherein the organic layer includes a hole transport layer, and a thickness of the hole transport layer is determined based on a color of light emitted by a pixel.

7. A display panel comprising a plurality of pixels arranged in a matrix, wherein each pixel includes:

a light-emitting element including first and second electrodes and an emissive layer provided between the first and second electrodes, and emitting light of a predetermined color when a voltage is applied between the first and second electrodes to allow a current to flow in the emissive layer;

a microresonator for repetitively reflecting light of the predetermined color emitted from the emissive layer within an interval having an optical length corresponding to the predetermined color, and there by intensifying and selecting the light of the predetermined color; and

a color filter for passing the light intensified and selected by the microresonator and further limiting to light having a wavelength of the predetermined color.

8. The display panel according to claim **7**, wherein the light-emitting element is an organic EL element, and the emissive layer is an organic layer.

9. The display panel according to claim **8**, wherein

the predetermined color is one of red, green, and blue, and the plurality of pixels arranged in a matrix include a pixel having an organic EL element for red, a pixel having an organic EL element for green, and a pixel having an organic EL element for blue.

10. The display panel according to claim **9**, wherein

the first electrode includes a semi-transmissive layer which reflects light from the organic layer,

the second electrode includes a reflective layer for reflecting light from the organic layer,

an interval between the reflective layer and the semi-transmissive layer is configured to have a predetermined optical length, such that when light of one color among red, green, and blue generated in the organic layer is repetitively reflected between the reflective layer and the semi-transmissive layer, the interval between the reflective layer and the semi-transmissive layer functions as a microresonator which intensifies and selects

the light of one color among red, green, and blue and ejects the selected light through the semi-transmissive layer.

11. The display panel according to claim **10**, wherein

the first electrode has a laminated structure composed of the semi-transmissive layer and a transparent electrode, and the second electrode is a metal electrode which functions as the reflective layer.

12. The display panel according to claim **9**, wherein

the pixels arranged in a matrix are of at least three types including a pixel which emits light of red, a pixel which emits light of green, and a pixel which emits light of blue, and the optical length of the microresonator for each pixel is set corresponding to a wavelength of light to be emitted.

13. The display panel according to claim **12**, wherein the optical length of the microresonator is determined by a thickness of the organic layer.

14. The display panel according to claim **13**, wherein

the organic layer includes a hole transport layer, and a thickness of the hole transport layer is determined based on a color of light emitted by a pixel.

* * * * *

patsnap

专利名称(译)	有机EL元件和有机EL面板		
公开(公告)号	US7839084	公开(公告)日	2010-11-23
申请号	US12/187105	申请日	2008-08-06
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IPC分类号	H05B33/04 H05B33/12 H01L27/32 H01L51/50 H01L51/52 H05B33/00 H05B33/14 H05B33/22 H05B33/24 H05B33/26		
CPC分类号	H01L27/3211 H01L27/322 H01L51/5265 H01L27/3244		
代理机构(译)	康托科尔伯恩LLP		
优先权	2004275673 2004-09-22 JP 2003342665 2003-09-30 JP		
其他公开文献	US20080297043A1		
外部链接	Espacenet USPTO		

摘要(译)

发光装置可包括发光元件，微谐振器和滤色器。发光元件可以包括第一和第二电极以及设置在第一和第二电极之间的发光层，并且当在第一和第二电极之间施加电压时可以发射预定颜色的光以允许电流在第一和第二电极之间流动。发光层。微谐振器可以在具有对应于预定颜色的光学长度的间隔内重复地反射从发光层发射的预定颜色的光，从而增强和选择预定颜色的光。滤色器可以通过由微谐振器增强和选择的光，并进一步限制具有预定颜色波长的光。