Title: LIGHT EMITTING DEVICE

Abstract: The disclosed light emitting device comprises at least one first light emitting element including at least one light emitting chip for emitting light having a wavelength of 400 to 500nm and a phosphor; and at least one second light emitting element disposed adjacent to the first light emitting element to emit light having a wavelength of 560 to 880 nm.
Description

LIGHT EMITTING DEVICE

Technical Field

[1] The present invention relates to a light emitting device having light emitting elements or light emitting cells for emitting light of a red-based wavelength, which is suitable for improving CRI property.

Background Art

[2] Recently, light emitting elements driven under high voltage and AC power have been developed to be used for general illumination. Such a light emitting element has been disclosed in PCT Patent Publication No. WO 2004/023568(AI), entitled "Light-emitting device having light emitting elements" by SAKAI et. al.

[3] A conventional light emitting element has a plurality of light emitting diodes (hereinafter, referred as light emitting cells) on a single substrate, and the plurality of light emitting cells are connected in series and reverse parallel through metal wires, which can be used by directly connecting to high voltage or an AC power source.

[4] However, in order to use the conventional light emitting element for illumination, the light emitting element emits blue-based light and the blue-based light is applied to a wavelength converting substance containing a phosphor to be color converted, or the light emitting element is implemented by mixing lights respectively emitted from red, blue and green light emitting elements.

[5] However, since light emitted from the conventional light emitting element has a low color rendering index (CRI), the natural color of an object cannot be clearly shown when the light is thrown on the object.

[6] Fig. 1 is a graph showing CRI property when a blue light emitting chip is provided and a wavelength converting substance containing a yellow phosphor is applied to the blue light emitting chip.

[7] Meanwhile, Fig. 2 is a graph showing CRI property when lights emitted from red, blue and green light emitting elements are mixed.

[8] According to the conventional light emitting element, intensity of red-based light is extremely weak compared with those of blue- and green-based lights. In this case, it is difficult to express a red-based color, and thus CRI property essential to a light source for illumination may be lowered.

[9] In particular, the CRI property (color rendering) is considered as being very important in the illumination facility market. Thus, it is required to improve the CRI property in order to use a light emitting diode (LED) as a light source for illumination.

Disclosure of Invention
Technical Problem
[10] An object of the present invention is to provide a light emitting device suitable for improving CRI property necessarily required to use an LED as a light source for illumination.

Technical Solution
[11] According to an aspect of the present invention, there is provided a light emitting device, comprising: at least one first light emitting element including at least one light emitting chip for emitting light having a wavelength of 400 to 500nm and a phosphor; and at least one second light emitting element disposed adjacent to the first light emitting element to emit light having a wavelength of 560 to 880nm.
[12] Preferably, the first light emitting element is formed as a package type.
[13] Preferably, the first and second light emitting elements are mounted in a molding member containing a phosphor.
[14] Preferably, the first light emitting element is mounted in a first molding member containing a phosphor, and the second light emitting element is mounted in a second molding member formed to cover the first molding member.
[15] Preferably, the first light emitting element comprises a plurality of light emitting cells, the plurality of light emitting cells are connected in series to form at least a first array and at least a second array, and the first and second arrays are connected in reverse parallel to each other.
[16] Preferably, the phosphor includes a yellow phosphor.
[17] According to another aspect of the present invention, there is provided a light emitting device, comprising: a substrate; a plurality of light emitting cells formed on the substrate, each of the light emitting cells having a lower semiconductor layer, an upper semiconductor layer formed on a portion of the lower semiconductor layer and an active layer interposed between the lower and upper semiconductor layers; and wires for electrically connecting the light emitting cells, each of the wires connecting the lower semiconductor layer of one of the light emitting cells to the upper semiconductor layer of another adjacent one of the light emitting cells, wherein at least one of the plurality of light emitting cells emit light having a wavelength of 560 to 880nm.
[18] Preferably, the plurality of light emitting cells are connected in series to form at least a first array and at least a second array, and the first and second arrays are connected in reverse parallel to each other.
[19] Preferably, the light emitting cells except the light emitting cell for emitting light having a wavelength of 560 to 880nm emit light having a wavelength of 400 to 500nm.
[20] Preferably, a wavelength conversion substance for converting a wavelength of light emitted from the light emitting device is additionally disposed to an outside of the light
emitting device, and the wavelength conversion substance includes a yellow phosphor.

In the specification of the present invention, the term "Light emitting device" may be a chip or package type device. Thus, a chip-type light emitting element having a plurality of light emitting cells formed therein may be expressed as a light emitting device in some claims or a portion of the detailed description. Further, the term "Light emitting device" may be expressed as a device having at least one light emitting element or at least one LED package. Furthermore, the term "Light emitting element" may be used as an LED chip or an LED package having the LED chip.

Advantageous Effects

According to the present invention, CRI property necessarily required to use an LED as a light source for illumination can be considerably improved using a light emitting element or a light emitting cell for emitting light having a wavelength of 560 to 880nm.

According to an embodiment of the present invention, in addition to at least one first light emitting element having at least one light emitting chip for emitting light having a wavelength of 400 to 500nm and a phosphor, at least one second light emitting element for emitting light having a wavelength of 560 to 880nm is disposed in various forms, thereby relatively increasing intensity of light having a wavelength of 560 to 880nm. Accordingly, it is easier to express a color of a wavelength of 560 to 880nm, and therefore, CRI property improved, whereby the LED is suitable for being used as a light source for illumination.

According to another embodiment of the present invention, a light emitting device is provided to have a structure in which at least one of a plurality of light emitting cells formed on a substrate emits light having a wavelength of 560 to 880nm that is different from the wavelength (particularly, 400 to 500nm) of other light emitting cells, and therefore, CRI property is improved at a chip level, whereby a light emitting device suitably used as a light source for illustration can be implemented.

Brief Description of the Drawings

Fig. 1 is a graph showing CRI property when a yellow phosphor is applied to a light emitting element that emits blue-based light.

Fig. 2 is a graph showing CRI property when lights emitted from red, blue and green light emitting elements are mixed.

Fig. 3 is a circuit diagram schematically showing a configuration of a light emitting device according to an embodiment of the present invention.

Fig. 4 and 5 are a plan view and a sectional view illustrating a first light emitting element in Fig. 3, respectively.

Fig. 6 is a graph showing CRI property of a light emitting device according to the
present invention.

Fig. 7 is a circuit diagram schematically showing a configuration of a light emitting device according to another embodiment of the present invention.

Fig. 8 is a view illustrating a package-type light emitting device according to a further embodiment of the present invention.

Fig. 9 is a view illustrating a package-type light emitting device according to a still further embodiment of the present invention.

Fig. 10 is a sectional view showing a light emitting element according to an embodiment of the present invention.

Fig. 11 is a plan view showing the light emitting element according to the embodiment of the present invention.

Fig. 12 is a sectional view showing a light emitting element according to another embodiment of the present invention.

Best Mode for Carrying Out the Invention

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. The following embodiments are provided only for illustrative purposes so that those skilled in the art can fully understand the spirit of the present invention. Therefore, the present invention is not limited to the following embodiments but may be implemented in other forms. In the drawings, the widths, lengths, thicknesses and the like of elements may be exaggerated for convenience of illustration. Like reference numerals indicate like elements throughout the specification and drawings.

Fig. 3 is a circuit diagram schematically showing a configuration of a light emitting device according to an embodiment of the present invention.

Referring to Fig. 3, the light emitting device according to the embodiment of the present invention comprises a current stabilizing circuit 1, a first light emitting element 2 provided with blue light emitting chips and a yellow phosphor to thereby emit white light, and a second light emitting element 3 provided with red light emitting chips to emit light of a red-based wavelength, which are connected in series.

The first and second light emitting elements 2 and 3 are AC light emitting elements operated by AC power. A plurality of light emitting cells are connected in series or parallel through wires in each of the first and second light emitting elements 2 and 3 and emit light when AC power is supplied.

Each of the light emitting cells provided in the first light emitting element 2 has the blue light emitting chip and the yellow phosphor. Thus, the yellow phosphor converts color of blue light (400 to 500nm) and a portion of the blue light emitted from the blue light emitting chip provided in each of the light emitting cells, and thus white light is
emitted.

At this time, light emitted from the first light emitting element 2 has a wavelength property as shown in Fig. 1.

Meanwhile, each of the light emitting cells provided in the second light emitting element 3 comprises light emitting cells for emitting light of a red-based wavelength (560 to 880 nm). The number of light emitting cells provided in the second light emitting element 3 may be determined depending on a degree of emission of red light. The second light emitting element 3 relatively increases intensity of red-based light. Accordingly, it is easier to express a red-base color, thereby improving CRI property.

Figs. 4 and 5 are a plan view and a sectional view illustrating the light emitting cells provided in the first light emitting element in Fig. 3, respectively. It will be apparent that the light emitting cells provided in the second light emitting element may be fabricated in the same form as the light emitting cells provided in the first light emitting element.

Referring to Figs. 4 and 5, the first light emitting element 2 comprises a plurality of light emitting cells 100 on a substrate 10. Each of the light emitting cells 100 comprises a lower semiconductor layer 20, an active layer 30 formed on a portion of the lower semiconductor layer 20, and an upper semiconductor layer 40 formed on the active layer 30. Meanwhile, a buffer layer (not shown) may be interposed between the substrate 10 and the light emitting cells 100. For example, GaN or AlN may be mainly used as the buffer layer. The lower and upper semiconductor layers 20 and 40 may be n-type and p-type semiconductor layers, or p-type and n-type semiconductor layers, respectively. The active layer 30 may be formed in a single or multiple quantum well structure. A first electrode (not shown) may be formed on a portion of the lower semiconductor layer 20, on which the active layer is not formed, and a second electrode (not shown) may be formed on the upper semiconductor layer 40.

The light emitting cells are connected so that the lower semiconductor layer of one of the light emitting cells is connected to the upper semiconductor layer of another adjacent one of the light emitting cells through a wire. At this time, if at least a first array and at least a second array respectively connected in series are formed and then they are connected in reverse parallel with each other, it is possible to suppress generation of flickers even though the light emitting element is connected to an AC power source. The wire may be formed by a process such as a typical step cover or air bridge, which is not limited thereto.

Fig. 6 is a graph showing a relative spectrum power distribution for each wavelength of the light emitting device according to the embodiment of the present invention.

Referring to Fig. 6, the light emitting device has the second light emitting element 3
for emitting light of a red-based wavelength (560 to 880nm), thereby relatively increasing intensity of red-based light. Accordingly, it is easier to express a red-based color, thereby improving CRI property.

Fig. 7 is a circuit diagram schematically showing a configuration of a light emitting device according to another embodiment of the present invention.

Referring to Fig. 7, the light emitting device according to the other embodiment of the present invention comprises a first light emitting element 4 having blue light emitting chips and a yellow phosphor to emit white light, and a second light emitting element 5 having red light emitting chips to emit light of a red-based wavelength. The first and second light emitting elements 4 and 5 respectively have stabilizing circuits 6 and 7 and are connected in parallel.

Fig. 8 is a view illustrating a light emitting device according to a further embodiment of the present invention.

Referring to Fig. 8, a light emitting device 300 according to the embodiment of the present invention comprises two first light emitting elements 320 and 330 and a second light emitting element 340 disposed between the two first light emitting elements 320 and 330 on a single substrate 310. Each of the first light emitting elements has a blue light emitting chip for emitting light of a blue-based wavelength (400 to 500nm) and a yellow phosphor, thereby emitting white light, and the second light emitting element 340 has a red light emitting chip for emitting light of a red-based wavelength (560 to 880nm).

Here, the first light emitting elements 320 and 330 may be light emitting elements that are packaged to be individually used for high power, and the second light emitting element 340 may be a light emitting chip that is not packaged but may be used on a small scale.

Thus, as the second light emitting element 340 for emitting red light is disposed between the two first light emitting elements 320 and 330, a red-based wavelength is effectively compensated, thereby improving CRI property.

Fig. 9 is a view illustrating a light emitting device according to a still further embodiment of the present invention.

Referring to Fig. 9, a light emitting device 400 according to the embodiment of the present invention comprises a first molding member 430 containing a yellow phosphor.

In the first molding member 430, a first light emitting element 410 having a blue light emitting chip for emitting light of a blue-based wavelength (400 to 500nm) and a second light emitting element 420 having a red light emitting chip for emitting light of a red-based wavelength (560 to 880nm) are disposed on one slug (not shown). A second molding member 440 surrounds and protects the first molding member 430.

As the first and second light emitting elements 410 and 420 are disposed in one
molding member, it is possible to reduce a mounting area thereof. In addition, a red-based wavelength can be effectively compensated, thereby improving CRI property.

The present invention is not limited to the aforementioned embodiments and various modifications and changes can be made thereto by those skilled in the art. The modifications and changes are covered by the spirit and scope of the invention defined by the appended claims.

For example, the first and second light emitting elements are disposed together in the molding member containing the phosphor in the embodiment of the present invention shown in Fig. 9. However, as a modification, the first light emitting element may be mounted in the first molding member containing the phosphor, and the second light emitting element may be mounted in the second molding member covering the first molding member.

Mode for the Invention

Hereinafter, light emitting devices according to further embodiments of the present invention will be described, which are configured so that one of a plurality of light emitting cells formed on a substrate emits light of a red-based wavelength (560 to 880nm).

Figs. 10 and 11 are a sectional view and a plan view of a light emitting element having a light emitting cell for emitting light of a red-based wavelength, respectively.

Referring to Figs. 10 and 11, a plurality of light emitting cells 100 are formed on a substrate 10. Each of the light emitting cells 100 comprises a lower semiconductor layer 20, an active layer 30 formed on a portion of the lower semiconductor layer 20, and an upper semiconductor layer 40 formed on the active layer 30. Meanwhile, a buffer layer (not shown) may be interposed between the substrate 10 and the light emitting cells 100. For example, GaN or AlN may be mainly used as the buffer layer. The lower and upper semiconductor layers 20 and 40 may be n-type and p-type semiconductor layers, or p-type and n-type semiconductor layers, respectively. The active layer 30 may be formed in a single or multiple quantum well structure. A first electrode (not shown) may be formed on a portion of the lower semiconductor layer 20, on which the active layer 20 is not formed, and a second electrode (not shown) may be formed on the upper semiconductor layer 40.

The light emitting cells are connected so that the lower semiconductor layer of one of the light emitting cells is connected to the upper semiconductor layer of another adjacent one of the light emitting cells through a wire. At this time, if at least a first array and at least a second array respectively connected in series are formed and then they are connected in reverse parallel with each other, it is possible to suppress generation of flickers even though the light emitting element is connected to an AC
power source. The wire may be formed by a process such as a typical step cover or air bridge, which is not limited thereto.

As described above, Fig. 1 is a graph showing a CRI property when a wavelength converting substance containing a yellow phosphor is applied to a blue light emitting element for emitting light of a blue-based wavelength (400 to 500nm). Referring back to Fig. 1, intensity of red-based light is extremely weak as compared with blue- and green-based lights. In this case, it is difficult to express a red-based color, and thus, the CRI property essential to a light source for illumination may be lowered.

If at least one of the plurality of light emitting cells is formed as a light emitting cell 200 for emitting light of a red-based wavelength (560 to 880nm) as shown in Figs. 10 and 11, the CRI property with which the intensity of red-based light is relatively increased is obtained as shown in Fig. 6. Accordingly, it is easier to express a red-based color, thereby improving the CRI property.

As described above, the method of forming at least one of the plurality of light emitting cells as the light emitting cell 200 for emitting light of a red-based wavelength is not limited particularly. For example, it is possible to use a method of removing at least one of the plurality of light emitting cells through a laser lift-off (LLO) process and then bonding a light emitting cell for emitting light of a red-based wavelength to the place where the light emitting cell is removed.

Although a light emitting cell for emitting light of a red-based wavelength is positioned at the edge of the array in the embodiment of the present invention, this is provided only for illustrative purposes, and the light emitting cell may be positioned inside of the array.

Fig. 12 is a sectional view showing a light emitting element according to a further embodiment of the present invention.

Referring to Fig. 12, a plurality of light emitting cells 100 are formed on a substrate 10. Each of the light emitting cells 100 comprises a lower semiconductor layer 20, an active layer 30 formed on a portion of the lower semiconductor layer 20, and an upper semiconductor layer 40 formed on the active layer 30. Meanwhile, a buffer layer (not shown) may be interposed between the substrate 10 and the light emitting cells 100. The lower and upper semiconductor layers 20 and 40 may be n-type and p-type semiconductor layers, or p-type and n-type semiconductor layers, respectively. The active layer 30 may be formed in a single or multiple quantum well structure.

The plurality of light emitting cells 100 formed on the substrate 10 are flip bonded onto a submount substrate 11 through first and second bumps 21 and 41. At this time, at least one of the plurality of light emitting cells 100 formed on the substrate 10 may be replaced with a light emitting cell 200 for emitting light of a red-based wavelength (560 to 880nm).
A light emitting element having a plurality of flip-chip type light emitting cells with superior color rendering can be fabricated by the method described above.
Claims

[1] A light emitting device, comprising:
at least one first light emitting element including at least one light emitting chip
for emitting light having a wavelength of 400 to 500nm and a phosphor; and
at least one second light emitting element disposed adjacent to the first light
emitting element to emit light having a wavelength of 560 to 880nm.

[2] The light emitting device as claimed in claim 1, wherein the first light emitting
element is formed as a package type.

[3] The light emitting device as claimed in claim 1, wherein the first and second
light emitting elements are mounted in a molding member containing a
phosphor.

[4] The light emitting device as claimed in claim 1, wherein the first light emitting
element is mounted in a first molding member containing a phosphor, and the
second light emitting element is mounted in a second molding member formed to
cover the first molding member.

[5] The light emitting device as claimed in claim 1, wherein the first light emitting
element comprises a plurality of light emitting cells, and the plurality of light
emitting cells are connected in series to form at least a first array and at least a
second array, the first and second arrays being connected in reverse parallel to
each other.

[6] The light emitting device as claimed in claim 1, wherein the phosphor includes a
yellow phosphor.

[7] A light emitting device, comprising:
a substrate;
a plurality of light emitting cells formed on the substrate, each of the light
emitting cells having a lower semiconductor layer, an upper semiconductor layer
formed on a portion of the lower semiconductor layer and an active layer
interposed between the lower and upper semiconductor layers; and
wires for electrically connecting the light emitting cells, each of the wires
connecting the lower semiconductor layer of one of the light emitting cells to the
upper semiconductor layer of another adjacent one of the light emitting cells,
wherein at least one of the plurality of light emitting cells emits light having a
wavelength of 560 to 880nm.

[8] The light emitting device as claimed in claim 7, wherein the plurality of light
emitting cells are connected in series to form at least a first array and at least a
second array, and the first and second arrays being connected in reverse parallel
to each other.
[9] The light emitting device as claimed in claim 7, wherein the light emitting cells except the light emitting cell for emitting light having a wavelength of 560 to 880 nm emit light having a wavelength of 400 to 500 nm.

[10] The light emitting device as claimed in any one of claims 7 to 9, wherein a wavelength conversion substance for converting a wavelength of light emitted from the light emitting device is additionally disposed to an outside of the light emitting device.

[11] The light emitting device as claimed in claim 10, wherein the wavelength conversion substance includes a yellow phosphor.
INTERNATIONAL SEARCH REPORT

PCT/KR2007/006343

A. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC8 HOI 33/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models and applications for Utility models since 1975
Japanese Utility models and application for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS (KIPO internal) "blue light emitting chip", "red light emitting chip", "yellow phosphor"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☐ Further documents are listed in the continuation of Box C

☒ See patent family annex

* Special categories of cited documents
A document defining the general state of the art which is not considered to be of particular relevance
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Y document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
& document member of the same patent family

Date of the actual completion of the international search
19 FEBRUARY 2008 (19 02 2008)

Date of mailing of the international search report
20 FEBRUARY 2008 (20.02.2008)

Name and mailing address of the ISA/KR

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Authorized officer
LEE, Jin Hong
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Form PCT/ISA/210 (second sheet) (April 2007)
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