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[Continued on next page]

(54) Title: LIGHT EMITTING DEVICE WITHIN MAGNETIC FIELD

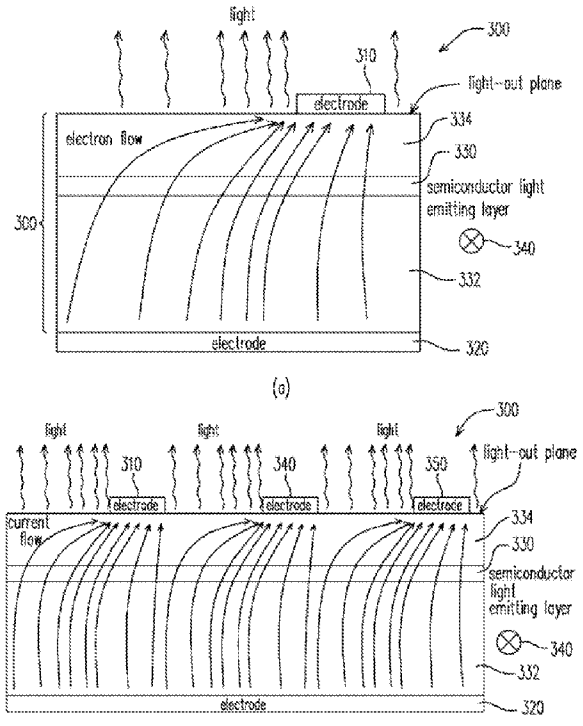


FIG. 3

(57) Abstract: A light-emitting device includes a light-emitting structure and a magnetic-source structure. The light-emitting structure includes a first doped structural layer, a second doped structural layer, an active layer between the two doped structural layers, a first electrode, and a second electrode, wherein the first electrode and the second electrode are respectively electrically coupled to the first doped structural layer and the second doped structural layer. The magnetic-source structure is adjacent to the light-emitting structure to produce a magnetic field in the light-emitting structure.

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LIGHT EMITTING DEVICE WITHIN MAGNETIC FIELD

BACKGROUND OF THE INVENTION

Field of Invention

The present invention relates to a light-emitting device. More particularly, the present invention relates to a light-emitting device with magnetic field.

Description of Related Art

Distinct from regular fluorescent lamps or incandescent lamps that generate heat to emit light, semiconductor light-emitting devices such as light-emitting diodes (LEDs) adopt the specific property of semiconductor to emit light, in which the light emitted by the light-emitting devices is referred to as cold luminescence. The light-emitting devices have advantages of long service life, light weight, and low power consumption, such that the light-emitting devices have been employed in a wide variety of applications, such as optical displays, traffic lights, data storage apparatus, communication devices, illumination apparatus, and medical treatment equipment. Accordingly, how to improve the light-emitting efficiency of light-emitting devices is an issue in this art.

Light-emitting device, such as a light-emitting diode (LED) can emit light due to the driving of electron current through the active layer of the light-emitting diode. However, if current density is not uniformly distributed to the whole light-emitting area, the light uniformity is reduced. Even further, the non-transparent top electrode, in conventional design, is usually positioned at the center region of the light-emitting area. In this manner, the current density under the top electrode is larger than the other region and can emit more light. However, the emitted light under the top electrode is blocked since the top electrode is not transparent to the light. The top electrode of the conventional LED blocks the emitted light at the central region with the highest intensity, resulting in reduction of the output light.

FIG. 1 is a schematic diagram illustrating a cross-sectional view of a conventional light-emitting device. Referring to FIG.1, the light-emitting device 100 is a vertical type light-emitting diode (LED), which includes electrodes 110 and 120, and a semiconductor stack of a semiconductor light-emitting layer 130, a first conductive-type semiconductor layer 132 and a second conductive-type semiconductor layer 134. The distribution of the current density is decreased gradually as the distance deviating from the electrodes 110 and 120 is increased. As shown in FIG. 1, the tight lines represent high current density, and the area with most number of lines is located between the electrodes 110 and 120. However, due to the congenital deficiency, the area with highest light-emitting efficiency is blocked by the electrode 110, such that the overall light-emitting efficiency of the light-emitting device 100 is affected.

FIG. 2 is a schematic diagram illustrating a top view of a conventional light-emitting device. Referring to FIG. 2, the light-emitting device 200 is a horizontal type LED, which includes electrodes 210 and 220. Because the current always transmits through a path with lowest resistance, the distribution of the current density is inhomogeneous between the electrodes 210 and 220, where the main distribution of the current density is along the central path between the electrodes 210 and 220. Therefore, in order to increase the amount of light emitted by the light-emitting device 200, the uniform current distribution area is needed to be enlarged, such that the size of the light-emitting device 200 is enlarged.

Based on aforesaid description, it is concluded that the light-emitting efficiency of the light-emitting device may be influenced by some factors, for example as follows.

The area between the electrodes of the light-emitting device is not only the area with highest current carrier density, but also the area producing most photons. However, the photons produced between the electrodes are mostly blocked by the opaque electrode, such that the light-emitting efficiency is hard to be enhanced.

A current always transmits through a path with lowest resistance, which

results in inhomogeneous luminance of the light-emitting device, such that the light-emitting efficiency and the size of the light-emitting device are also limited.

SUMMARY OF THE INVENTION

The present invention in an aspect provides a light-emitting device. The light-emitting device includes a light-emitting structure and a magnetic structure. The light-emitting structure includes a first doped structural layer, a second doped structural layer, an active layer between the two doped structural layers, a first electrode, and a second electrode, wherein the first electrode and the second electrode are respectively electrically coupled to the first doped structural layer and the second doped structural layer. The magnetic structure is adjacent to the light-emitting structure to produce a magnetic field in the light-emitting structure.

The present invention in an aspect provides a light-emitting device includes a light-emitting structure and a magnetic layer. The light-emitting structure includes a lower doped structural layer. An active layer is disposed on the lower doped structural layer. An upper doped structural layer is disposed on the active layer. A first electrode is disposed over the upper doped structural layer with electric coupling. A second electrode is disposed over the lower doped structural layer with electric coupling. The first electrode and the second electrode are at a same side or opposite side of the active layer. The magnetic layer is integrated with the light-emitting structure to produce a magnetic field with a direction substantially perpendicular and/or parallel to the active layer.

The present invention in an aspect provides a light-emitting device includes a light-emitting structure and a magnetic layer. The light-emitting structure includes a first doped structural layer, a second doped structural layer, an active layer between the two doped structural layers, a first electrode and a second electrode. The first electrode and the second electrode are electrically coupled to the first doped structural layer and the second doped

structural layer, respectively. The magnetic layer is coupled with the light-emitting structure on the first electrode and the second electrode by a package structure, to produce a magnetic field in the light-emitting structure.

The present invention in an aspect provides a light-emitting device includes a light-emitting structure, a first magnetic layer, and a second magnetic layer. The light-emitting structure has a first side and second side includes a first doped structural layer, a second doped structural layer, an active layer between the two doped structural layers, a first electrode disposed over the first doped structural layer with electric coupling, a second electrode, disposed over the second doped structural layer with electric coupling, and a first magnetic layer, disposed on the first electrode at the first side. The second magnetic layer is disposed over the second doped structural layer at the second side.

The present invention in an aspect provides a light-emitting device includes a light-emitting structure, a thermal conductive material layer, and a magnetic layer. The thermal conductive material layer is coupled with the light-emitting structure to dissipate a heat, generated by the light-emitting structure. The magnetic layer, coupled with the thermal conductive material layer to generate a magnetic filed in the light-emitting structure.

The present invention in an aspect provides a light-emitting device includes a heat sink, a structural carrier, and a light-emitting structure. The structural carrier stacks over the heat sink. The light-emitting structure stacks over the structural carrier. At least one portion of the structural carrier and the heat sink has magnetism to provide a magnetic field in the light-emitting structure.

The present invention in an aspect provides a light-emitting device includes a heat sink, a structural carrier, a light-emitting structure, and an encapsulant. The structural carrier stacks over the heat sink, wherein the structural carrier has a concave region with a sidewall. The light-emitting structure stacks over the structural carrier within the concave region. An encapsulant is filled in the space, wherein the encapsulant does contain magnetic material powders or doesn't contain the magnetic material powders.

The present invention in an aspect provides a light-emitting device includes a light-emitting structure, and a magnetic holding carrier, to hold the light-emitting structure with electric connection.

The present invention in an aspect provides a light-emitting device includes a light-emitting structure, a magnetic layer under the light-emitting structure, a holding carrier, to hold the magnetic layer with the light-emitting structure. An encapsulant wraps the light-emitting structure and a portion of the magnetic holding carrier.

The present invention in an aspect provides a light-emitting device includes a carrier, a magnetic layer disposed over the carrier to have a containing space; and a light-emitting structure, disposed over the carrier within the containing space.

It is to be understood that both the foregoing general description and the following detailed description are exemplary, and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. 1 is a schematic diagram illustrating a cross-sectional view of a conventional light-emitting device.

FIG. 2 is a schematic diagram illustrating a top view of a conventional light-emitting device.

FIG. 3 is schematic diagrams illustrating a cross-sectional view of a light-emitting device according to one embodiment of the present invention.

FIG. 4 is a top view of a light-emitting device according to another embodiment of the present invention.

FIG. 5 is a cross-sectional diagram illustrating a structure of a LED

according to one embodiment of the present invention.

FIG. 6 is a graph showing the output power of the light emitted by the LED having the magnetic substrate 424 according to one embodiment of the present invention.

FIG. 7 is a cross-sectional diagram illustrating a structure of a LED according to one embodiment of the present invention.

FIG. 8 is a cross-sectional diagram illustrating a structure of a LED according to one embodiment of the present invention.

FIG. 9 is a cross-sectional diagram illustrating a structure of a light-emitting device according to one embodiment of the present invention.

FIG. 10 is a cross-sectional diagram illustrating a structure of a light-emitting device according to one embodiment of the present invention.

FIG. 11 is a cross-sectional diagram illustrating a structure of a light-emitting device according to one embodiment of the present invention.

FIG. 12 is a cross-sectional drawing, schematically illustrating a structure of a light-emitting device according to embodiments of the present invention.

FIG. 13 is a cross-sectional diagram, schematically illustrating a structure of a light-emitting device according to one embodiment of the present invention.

FIG. 14 is a cross-sectional view, schematically illustrating a structure of light-emitting device, according to an embodiment of the present invention.

FIG. 15 is a cross-sectional view, schematically illustrating a structure of light-emitting device, according to an embodiment of the present invention.

FIG. 16 is a cross-sectional view, schematically illustrating a structure of light-emitting device, according to an embodiment of the present invention.

FIG. 17 is a cross-sectional view, schematically illustrating a structure of light-emitting device, according to an embodiment of the present invention.

FIG. 18 is a cross-sectional view, schematically illustrating the structure of a light-emitting device coupled with the magnetic layer by packaging, according to embodiments of the present invention.

FIG. 19 is a cross-sectional view, schematically illustrating another

structure of light-emitting devices integrated with the magnetic layer, according to an embodiment of the present invention.

FIG. 20 is a perspective view, schematically illustrating a structure with respect to FIG. 20.

FIG. 21 is a cross-sectional view, schematically illustrating the structure of a light-emitting device integrated with the magnetic layer by packaging, according to an embodiment of the present invention.

FIG. 22 is a cross-sectional view, schematically illustrating a structure of a light-emitting device with magnetic field being exerted, according to an embodiment of the present invention.

FIG. 23 is a cross-sectional view, schematically illustrating a structure of a light-emitting device with magnetic field, according to another embodiment of the present invention.

FIG. 24 is a cross-sectional view, schematically illustrating a structure of a light-emitting device with magnetic field, according to another embodiment of the present invention.

FIG. 25 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention.

FIG. 26 is a schematic cross-sectional view of the light-emitting device package according to an embodiment of the present embodiment.

FIG. 27 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present embodiment.

FIG. 28 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention.

FIG. 29 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention.

FIG. 30 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present embodiment.

FIG. 31 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present embodiment.

FIG. 32 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention.

FIG. 33 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention.

FIG. 34 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention.

FIG. 35 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention.

FIG. 36 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention.

FIG. 37 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of present invention.

FIG. 38 is a cross-sectional view of a light-emitting device package according to an embodiment of the present invention.

FIG. 39 is a cross-sectional view of a light-emitting device package according to an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention proposes a light-emitting device, in which a magnetic structure or a magnetic layer is included to improve the light outputting efficiency. The magnetic structure, such as a magnetic layer, can be film or bulk of magnetic material with a sufficient thickness, for example. The invention provides a light-emitting device with magnetic field, which uses the mechanism of Hall Effect to arrange the position of the electrode, so as to at least improve light outputting efficiency. In addition, the invention provides a light-emitting device with magnetic field, which uses the mechanism of magnetoresistance effect to match impedance to reduce inhomogeneous current spreading, so as to at least improve light outputting efficiency.

The magnetoresistance can be, for example, the ordinary magnetoresistance in semiconductor layer, such as GaN or GaAs, in ferromagnetic material such as Fe, Co, or Ni. The magnetoresistance can also be, for example, the giant magnetoresistance (GMR) in a stacked layer

of magnetic layer, such as Fe, Co, or Ni and non-magnetic layers, such as Cr, Cu, Ag, or Au.

Several embodiments are provided for describing the present invention. However, the present invention is not just limited to the embodiments. Further, the embodiments to each other can also be properly combined to have other embodiments.

FIG. 3 is schematic diagrams illustrating a cross-sectional view of a light-emitting device according to one embodiment of the present invention. Referring to FIG. 3(a), the light-emitting device 300 is a vertical type LED, which includes electrodes 310 and 320, and a stack of a semiconductor light-emitting layer 330, a first conductive-type layer 332 and a second conductive-type layer 334. The light-emitting device 300 is covered by a magnetic field, which is produced by a magnetic source 340 placed on the outside of the light-emitting device 300 and directed inward the cross-sectional plane of the light-emitting device 300. The magnetic force induced by the magnetic field pushes the electrons so as to make the current drift to the left. As shown in FIG. 3(a), the main distribution of the current density (represented by current lines) is moved from an area between the electrodes 310 and 320 to an area under the light-out plane, which indicates that the area having the highest light-emitting efficiency is no longer blocked by the electrode 310 and an overall light-emitting efficiency of the light-emitting device 300 can be substantially enhanced.

Referring to FIG. 3(b), the light-out plane of the light-emitting device 300 is expanded and disposed with plural electrodes 310, 350, and 360 thereon. As shown in FIG. 3(b), the distribution of the current density (represented by current lines) between the electrode 320 and each of the electrodes 310, 350, and 360 are all moved from the area between the electrodes to the area under the light-out plane, such that an overall light-emitting efficiency of the light-emitting device 300 is substantially enhanced. Moreover, the distributions of the current density under the light-out plane between two electrodes 310 and 350 and two electrodes 350 and 360 are the same. Therefore, the light-emitting device 300 of the present

invention is able to provide higher luminance without affecting the homogeneity of light.

As shown in FIG. 3, the magnetic filed in the embodiment is changing the electrons flow rather in longitudinal direction of the LED for the vertical type LED. However, from to lateral view, the magnetic filed can also affect the electron flow, transversely, on the electrode plane, particularly to a horizontal type LED. FIG. 4 is a top view of a light-emitting device according to another embodiment of the present invention. Referring to FIG.4, the light-emitting device 400 is a horizontal type LED, which includes electrodes 402 and 404. Similarly to the foregoing embodiment, as the magnetic field 406 drifts the electrons out of the paths between the electrodes 402 and 404, the distribution of current density is moved to the left part of the light-emitting device 400, for example. As shown in FIG. 4, the current path is spread to a larger area (left area), which creates a more homogeneous distribution of the current density.

FIG. 5 is a cross-sectional diagram illustrating a structure of a LED according to one embodiment of the present invention. Referring to FIG. 8, the LED 420 is a horizontal type LED, which includes electrodes 426 and 428, and a substrate 424, in which an active layer 430 is located between the electrodes 426 and 428 for generating light when a current flows through it. In more detail, the active layer 430 is located between a first doped structural layer 432 and a second doped structural layer 434, which are doped semiconductor layers, for example. The doped structural layer can be a semiconductor stacked layer or any other proper structure, as usually known. A magnetic substrate 422 is further disposed under the substrate 424 for providing the LED 800 with a magnetic field.

FIG. 6 is a graph showing the output power of the light emitted by the LED having the magnetic substrate 424 according to one embodiment of the present invention, where x coordinate refers to the current injected into the LED and y coordinate refers to the output power of light emitted by the LED. Referring to FIG. 6, the efficiency of optoelectronic transformation is raised by 0.04 mW/mA and an overall output power of light is enhanced by 22.6

percent as a 0.25T magnetic field is added to the LED, for example. On the other hand, the efficiency of optoelectronic transformation is raised by 0.025 mW/mA and an overall output power of light is enhanced by 15 percent as a 0.15T magnetic field is added to the LED. As shown in FIG. 9, apparently, the output power of light is enhanced when the strength of the external magnetic field is increased. Basically, the strength of the magnetic field can be 0.01T or greater.

FIG. 7 is a cross-sectional diagram illustrating a structure of a LED according to one embodiment of the present invention. Referring to FIG. 7, the LED 450 is a vertical type LED, which includes electrodes 452 and 458, and a structural stack layer 454, in which an active layer 456 is in the structural stack layer 454 located between the electrodes 458 and 452, for generating light when a current flows through it. A magnetic substrate 460 is further disposed under the electrode 452 for providing the LED 450 with a magnetic field.

Moreover, the present invention may take use of an epitaxial lateral overgrowth (ELOG) structure for forming the LED, as illustrated in FIG. 8. Referring to FIG. 8, the magnetic substance is used as a mask and a semiconductor is grown on the substrate through an epitaxial process, such that the magnetic substance can be embedded in the LED chip to increase the effect for raising the luminance of the LED with the external magnetic field.

In an actual application, the light-emitting devices can be combined with magnetic material through various manners such as epoxy, metal bonding, wafer bonding, epitaxy embedding and coating. In addition, the magnetic material may be coupled to the light-emitting device itself and produced as a substrate, a submount, an electromagnet, a slug, a holder, or a magnetic heat sink or produced as a magnetic film or a magnetic bulk, so as to provide the magnetic field for the light-emitting device. The magnetic material may be ferromagnetic material such as Rb, Ru, Nd, Fe, Pg, Co, Ni, Mn, Cr, Cu, Cr2, Pt, Sm, Sb, Pt, or an alloy thereof. The magnetic material may also be ceramic material such as oxides of Mn, Fe, Co, Cu and V, Cr_2O_3, CrS, MnS, MnSe, MnTe, fluorides of Mn, Fe, Co or Ni, chlorides of V, Cr, Fe, Co, Ni

and Cu, bromides of Cu, CrSb, MnAs, MnBi, α-Mn, $MnCl_2 \cdot 4H_2O$, $MnBr_2 \cdot 4H_2O$, $CuCl_2 \cdot 2H_2O$, $Co(NH_4)x(SO_4)xCl_2 \cdot 6H_2O$, $FeCo_3$, and $FeCo_3 \cdot 2MgCO_3$. The light-emitting device can be an organic LED (OLED), an inorganic LED, a vertical type LED, a horizontal type LED, a thin film LED, or a flip chip LED. Embodiments of the light-emitting device adopting foregoing structures are described respectively below.

FIG. 9 is a cross-sectional diagram illustrating a structure of a light-emitting device according to one embodiment of the present invention. Referring to FIG. 9, the light-emitting device 500 of the present embodiment is a vertical type LED, which includes a light-emitting chip 510 and a magnetic submount 520. A transparent conductive layer (TCL) 562 is, for example is Ni/Au or Indium Tin Oxide (ITO), further disposed over a first doped layer 512, so as to enhance the current spreading. The light-emitting chip 510 is disposed on the magnetic submount 520 through an epoxy, a metal bonding, a wafer bonding, epitaxy embedding, or a coating process.

The light-emitting chip 510 includes, from top to bottom, a first electrode 511, a first doped layer 512, an active layer 513, a second doped layer 514, a substrate 515, and a second electrode 516, in which the first doped layer 512, the active layer 513, and the second doped layer 514 form a light-emitting stacking layer, which is disposed on the substrate 515. The first electrode 511 is disposed on the first doped layer 512 and electrically coupled to the first doped layer 512, and the second electrode 516 is disposed under the substrate 515 and electrically coupled to the second doped layer 514, so as to form a vertical type LED structure. The active layer 513 is disposed between first electrode 511 and the second electrode 516, and capable of generating light when a current flows through it. It should noted herein that the material of the substrate 515 may be Si, SiC, GaN, GaN, GaP, GaAs, sapphire, ZnO, or AlN, and the material of the light-emitting stacking layer may be inorganic semiconductor material such as GaAs, InP, GaN, GaP, AlP, AlAs, InAs, GaSb, InSb, CdS, CdSe, ZnS, or ZnSe, or organic semiconductor material such as polymer.

The magnetic field induced by the magnetic submount 520 is exerted on

the light-emitting chip 510, such that the main distribution of current density in the light-emitting chip 510 is moved from an area between the first electrode 511 and the second electrode 516 to an area under the light-out plane, so as to enhance the current homogeneity and increase an overall brightness of the light-emitting device 500.

Further in design option, the light-emitting device 500 may further include a reflection layer 560, such as a mirror layer, disposed between the substrate 515 and the second electrode 516 for reflecting the light emitted from the active layer 513, so as to increase the brightness of the light-emitting device. It should be noted herein that, in other embodiments, the reflection layer 560 may also be disposed between second doped layer 514 and the substrate 515 or between the second electrode 516 and the magnetic submount 520 for reflecting light, but not limited to the provided options.

FIG. 10 is a cross-sectional diagram illustrating a structure of a light-emitting device according to one embodiment of the present invention. Referring to FIG. 10, in this light-emitting device of the present embodiment, this light-emitting device of the present embodiment is a vertical type LED, which includes a light-emitting chip 564 and a magnetic submount 550, for example. The light-emitting chip 564 is disposed on the magnetic submount 550 through a usual manner, such as an epoxy, a metal bonding, a wafer bonding, epitaxy embedding, or a coating process.

In an example, the light-emitting chip 564 includes a first electrode 568, a substrate 561, a first doped layer 558, an active layer 556, a second doped layer 554, and a second electrode 552, in which the first doped layer 558, the active layer 556, and the second doped layer 554 form a light-emitting stacking structure, which is disposed under the substrate 561. The first electrode 568 is disposed over the first doped layer 558 and electrically coupled to the first doped layer 558, in which the substrate 561 may be a conductive substrate, such as a doped semiconductor layer. The second electrode 552 is disposed under the second doped layer 554 and electrically coupled to the second doped layer 554, so as to form a vertical type LED

structure. The active layer 556 is disposed between first electrode 568 and the second electrode 552, and capable of generating light when a current flows through it.

The magnetic field induced by the magnetic submount 550 is exerted on the light-emitting chip 564, such that the main distribution of current density in the light-emitting chip 564 is moved from an area between the first electrode 568 and the second electrode 552 to an area under the light-out plane, so as to enhance the current homogeneity and increase an overall brightness of the light-emitting device.

FIG. 11 is a cross-sectional diagram illustrating a structure of a light-emitting device according to one embodiment of the present invention. Further, a thin film LED having a vertical type structure is taken as another example. Referring to FIG. 11, the light-emitting device 600 of the present embodiment is a vertical type LED, which includes a light-emitting chip 610 and a magnetic submount 620. The light-emitting chip 610 is disposed over the magnetic submount 620 through, for example, an epoxy, a metal bonding, a wafer bonding, epitaxy embedding, a coating process, or any proper process.

The light-emitting chip 610 includes, for example, a first electrode 611, a first doped layer 612, an active layer 613, a second doped layer 614, and a second electrode 615, in which the first doped layer 612, the active layer 613, and the second doped layer 614 form a light-emitting stacking layer. Depending on the actual need, a reflection layer 660, can be formed as well, so that the backward light is reflected back. The first electrode 611 is disposed over the first doped layer 612 and electrically coupled to the first doped layer 612, and the second electrode 615 is disposed under the second doped layer 614 and electrically coupled to the second doped layer 614, so as to form a vertical type LED structure, in which the reflection layer 660 is, for example, a metal layer for also serving the electric connection. The active layer 613 is disposed between first electrode 611 and the second electrode 615, and capable of generating light when a current flows through it.

The magnetic field induced by the magnetic submount 620 is exerted on

the light-emitting chip 610, such that the main distribution of current density in the light-emitting chip 610 is moved from an area between the first electrode 611 and the second electrode 615 to an area under the light-out plane, so as to enhance the current homogeneity and increase an overall brightness of the light-emitting device 600.

In one embodiment of the present invention, a transparent conductive layer (TCL) is further disposed between the first doped layer 612 and the electrode 611 to enhance the brightness thereof. Even further, a reflection layer 660, such as the metal layer serving as mirror, is further disposed between the second doped layer 614 and the second electrode 615 for reflecting the light emitted from the active layer 613, so as to increase the brightness of the light-emitting device 600. It should be noted herein that, in other embodiments, the reflection layer 660 may also be disposed between the second electrode 615 and the magnetic submount 620 for reflecting light, but not limited to it.

FIG. 12 is a cross-sectional drawing, schematically illustrating a structure of a light-emitting device according to embodiments of the present invention. Referring to FIG. 12(a), the light-emitting device 700a of the present embodiment is a vertical type LED, which includes a light-emitting chip 710 and a magnetic material 720. The light-emitting chip 710 includes, for example, a first electrode 711, a first doped layer 712, an active layer 713, a second doped layer 714, and a second electrode 715, in which the first doped layer 712, the active layer 713, and the second doped layer 714 form a light-emitting stacking layer. The first electrode 711 is disposed on the first doped layer 712 and electrically coupled to the first doped layer 712. The second electrode 715 is disposed under the second doped layer 714 and electrically coupled to the second doped layer 714, so as to form a vertical type LED structure. The active layer 713 is disposed between first electrode 711 and the second electrode 716, and capable of generating light when a current flows through it.

The magnetic material 720 is disposed on the first electrode 711 and exerts a magnetic field on the light-emitting chip 710, such that the main

distribution of current density in the light-emitting chip 710 is moved from an area between the first electrode 711 and the second electrode 715 to an area under the light-out plane, so as to enhance the current homogeneity and increase an overall brightness of the light-emitting device 700a.

In other embodiment as shown in FIG. 12(b), based on the embodiment in FIG. 12(a), the magnetic layer 730 may be disposed on the light-emitting stacking layer and covers the first electrode 711. Alternatively as shown in FIG. 12(c), the magnetic layer 740 is disposed on an exposed region of the first doped layer 712. The exposed region of the first doped layer 712 is not covered by the first electrode 711.

FIG. 13 is a cross-sectional diagram, schematically illustrating a structure of a light-emitting device according to one embodiment of the present invention. Referring to FIG. 13, the magnetic material is fabricated into a submount 810 having a plurality of concaves, for example. Each of the concaves is disposed with one of the light-emitting chips 820 - 850. In further option, each of the concaves may have a reflective surface for reflecting light emitted by the corresponding light-emitting chip.

FIG. 14 is a cross-sectional view, schematically illustrating a structure of light-emitting device, according to an embodiment of the present invention. In FIG. 14, a light-emitting structure can include the basic structure 964, disposed on a substrate 952. The basic structure 964 can include, for example, a bottom doped layer 954, which can be organic/in-organic semiconductor or any suitable doped materials used for emitting light. The basic structure 964 may include, for example, a bottom doped stack layer 954, an active layer 956, an upper doped stack layer 958. Here, the bottom doped stack layer 954 and the upper doped stack layer 958 are in different conductive types. However, depending on the operation voltage, the bottom doped stack layer 954 or the upper doped stack layer 958 can be p-type or n-type. In addition, due to for example the relative poor contact between the electrode and the doped semiconductor material, the transparent conductive layer (TCL) 960 may also included, for example. In addition, in order to have better performance of light output in the light-emitting area 970,

a rough surface 962 can be formed, which is for example formed on the TCL 960 or on the upper doped stack layer 958. Actually, the rough surface 962 can be at any proper surface depending on the light output direction. The two electrodes 966 and 968, respectively disposed on the bottom doped stack layer 954 and the upper doped stack layer 958, are at the same side of the light-emitting structure, that is also called horizontal-type light-emitting device. In this horizontal design, there is a horizontal component of driving current in the upper doped stack layer 958 or even in the TCL 960 if the TCL is included. Particularly, the basic structure 964 is thin film design to reduce the thickness, and then the horizontal component of the driving current is relative large.

In the present invention, a magnetic layer 950 is additional added and is implemented on the substrate 952 at the other side. The magnetic layer 950 is used to produce a magnetic field so as to redistribute the current density of the horizontal component in the upper doped stack layer 958, based on the mechanism of FIG. 4. The magnetic layer 950 can, for example, be an artificial ferromagnetic layer with the magnetization to provide a magnetic field substantially perpendicular to the light-emitting area 970, so as to redistribute the current density of the horizontal component. The locations of the electrodes 966 and 968 are set in accordance the magnetic field be produced. It can be understood that the magnetic layer 950 is used to produce the intended magnetic field for shift the driving current, and any proper modified design can be implemented. The magnetic layer 950 can also serve as another substrate. Even for example, the magnetic layer 950 can be an external structure or unit without physically contact. In other words, magnetic layer 950 can be an external unit for applying the magnetic field or an integrated structure layer in the light-emitting structure.

FIG. 15 is a cross-sectional view, schematically illustrating a structure of light-emitting device, according to an embodiment of the present invention. In FIG. 15, the magnetic layer 984 can be implemented by bounding bump 980 and 982 by flip-chip packaging process, known in the art. Here, when considering the light output direction, which is toward the transparent

substrate 952, the rough surface 962 can be formed on the outer surface of the substrate 952 and a reflection layer 960', such as a metal layer, can be implemented in the basic structure 964'. However, it is not the only packaging manner to implement the magnetic layer 984.

Alternatively, for example, the bounding bump 980 and 982 can be omitted, and the electrodes 966 and 968 can be fabricated to have the same height by, for example, plating or any proper semiconductor fabrication process. Because the electrodes 966 and 968 have the same height, the magnetic layer 984 can then be directly adhered to the electrode, for example. In other words, the magnetic layer 284 can be formed by any proper manner.

Even further for example, the structure in FIG. 15 can be combined with FIG. 14 by adding the magnetic layer 950 at bottom, as well. As a result, two magnetic layers can be implemented.

FIG. 16 is a cross-sectional view, schematically illustrating a structure of light-emitting device, according to an embodiment of the present invention. In FIG. 16, alternatively, the magnetic layer 984 can also serve as the substrate. In this situation, the basic structure 964'' can be packaged with the magnetic layer 984 as previously described. Like FIG. 15, the reflection layer 960' is implemented in the basic structure 964''. In addition, the bottom doped layer 954 has the rough surface 962. As a result, the light can go through the rough surface 962 in better performance.

FIG. 17 is a top view, schematically illustrating structures of light-emitting device for setting the electrodes, according to an embodiment of the present invention. In FIG. 17, it is another design of electrodes 992 and 994, in which the electrode 992 is not located at the diagonal corner to the electrode 994. This kind of electrode design is based on the magnetic field to be applied. The strength and direction of the magnetic field may cause the different result. Particularly, if the magnetic field is applied, as similarly described in FIG. 4, the electrode 992 is not at the symmetric locations in accordance with the magnetic field.

Based on the electrodes in FIG. 17, the investigations have been done. The magnetic filed of 420 mT at perpendicular direction and a driving current

of 200mA are, for example, applied. Taking the electrode in FIG. 17, the improvement can also have about 5.6%, for example. From the investigation, the added magnetic field in the present invention can indeed improve the performance, in which the locations of the electrode are accordingly set.

FIG. 18 is a cross-sectional view, schematically illustrating the structure of a light-emitting device integrated with the magnetic layer by packaging, according to embodiments of the present invention. In FIG. 18, for example, a doped semiconductor structural layer 1002 is disposed on a substrate 1000. An active layer 1004 is formed on the doped semiconductor structural layer 1002. Another doped semiconductor structural layer 1006 is formed on the active layer 1004. Here, doped semiconductor structural layer can be a single layer or a stacked layer with a designed structure. However, the present invention is not to specifically limit the semiconductor structural layers. Even further, for example, a transparent conductive layer 1008 may further be formed on the semiconductor structural layer 1002. The TCL 1008 is in contact with the electrode 1012, so as to improve the light-emitting efficiency as conventionally known. Even further, depending on the light-emitting direction, a mirror can also be implemented. In this example, an electrode 1010 is disposed on the semiconductor structural layer 1002. Another electrode 1012 is disposed on the TCL layer 1008. Usually, this structural part is, for example, known as an LED. The present invention is not necessary to be limited to a specific non-magnetic-field LED.

In an embodiment, in order to implement the magnetic-source, a packaging structure, such flip chip package, can be employed to integrate the magnetic layer in the light-emitting device. The magnetic layer 1018 can be formed on a submount 1020. The magnetic layer 1018, for example, is a ferromagnetic layer with a magnetization in a desired direction. The material to form the ferromagnetic layer includes, for example, Fe, Co, Ni, Tb ... and so on. Further, in stead of artificial magnetic material, the natural magnet can also be used by adhering thereon. However, the direction the magnetic field should be properly arranged. The LED is then packaged

onto the submount 1020 with the magnetic layer 1018 by the bounding structure 1014 and 1016, such as the bounding bumps or directly bounding. As a result, the magnetic layer 1018 can produce the magnet field into the LED. In one example, if the magnetization direction of the magnetic layer 218 is coming out the drawing sheet then a magnetic field in the desired direction. The LED with the submount 1020 having the magnetic layer 1018 can be separately used, in which the intended magnetic field is self-supplying in a single chip.

FIG. 19 is a cross-sectional view, schematically illustrating another structure of light-emitting devices integrated with the magnetic layer, according to an embodiment of the present invention. FIG. 20 is a perspective view, schematically illustrating a structure with respect to FIG. 20. Bases on the same aspect, the magnetic layer can be integrated with the LED as the light-emitting device by various manners.

In FIG. 19, for alternative structure, the LED structure as described in other embodiment includes the doped semiconductor structural layer 1002, the active layer 1004, and another doped semiconductor structural layer 1006. Further, the TCL 1008 may also be included. The LED structure is also taken as the example for the following embodiments to implement the magnetic layer. The bottom electrode layer 1034 is formed on the doped semiconductor structural layer 1002 at one side and another electrode layer 1036 is formed on the TCL 1008 at the opposite side to the bottom electrode layer 1034. A light-emitting area 1040 is intended to form. In this structure as the base, the magnetic layer 1038 can be, for example, formed on the electrode layer 1036, and preferably just formed on the electrode layer 1036. The magnetic field in the LED with the direction 1042 can also be, for example, created. Another magnetic layer 1044 can be further formed on the electrode layer 1034.

As can be seen in FIG. 20 for example, the electrode layer 1036 and the magnetic layer 1038 can be in several sections with a pattern, such as strip pattern, to produce the intended magnetic field. In other words, the top electrode with the magnetic field can be in single piece or in several pieces

depending on how the magnetic field to be created for improving the light outputting efficiency.

Even further, when the LED is designed by arranging the two electrodes at the same side, the magnetic-source can also be integrated. Several examples are provided. FIG. 21 is a cross-sectional view, schematically illustrating the structure of a light-emitting device integrated with the magnetic layer by packaging, according to an embodiment of the present invention. In FIG. 21, based on the structure in FIG. 19, for example, the electrode 1034 can be formed on an extending region of the doped semiconductor structural layer 1002 but at the same side as the electrode 1036. The magnetic layer 1038 can also be formed on the electrode 1036. In addition, for example, another magnetic layer 1044 can be directly disposed on the doped semiconductor structural layer 1002.

FIG. 22 is a cross-sectional view, schematically illustrating a structure of a light-emitting device with magnetic field being exerted, according to an embodiment of the present invention. In FIG. 22, a basic structure of the light-emitting device with magnetic field includes a light-emitting structure 1100, a thermal conductive material layer 1102 and a magnetic layer 1104. The structure of the light-emitting device 1100 is, for example, as the usual LED, which can be for example the vertical structure in FIG. 1 with two electrodes at two opposite sides, or for example the horizontal structure in FIG. 3 with two electrodes at the same side. The light-emitting structure is conventionally known by the one in ordinary skill in the art and is not further described. The thermal conductive material layer 1102 and the light-emitting structure 1100 are coupled, so as to dissipate the generated heat from the light-emitting structure 1100. The magnetic layer 1104 is coupled with the thermal conductive material layer 1102 to generate a magnetic field on the light-emitting structure 1100, so as to have the effect to shift the distribution of the driving current.

The effect of thermal conductive material layer 1102 is to conduct the heat out and dissipate. The thermal conductive material can be, for example, copper, silver, gold, aluminum, platina, ceramic, oxide, or various

combinations thereof, which have large thermal conductive coefficient. The thermal conductive material can also take from paramagnetic material or ferromagnetic material, for example, according to the need of magnetic field. It can be the materials having metal from iron, cobalt, nickel, aluminum, platinum, tin, platina or and alloys thereof, or other compound. As a result, the magnetic field from the magnetic material can be easily exerted in the light-emitting device. If the thermal conductive material layer is antimagnetic or diamagnetic, such as gold, silver, copper, carbon or lead, then the thickness should be reduced to prevent the magnetic filed from being over reduced. In general, the area of the thermal conductive material layer 302 is larger than the magnetic layer, so as that the thermal dissipation route is not going through the magnetic material, then the thermal resistance is reduced, and thermal dissipation efficiency is improved.

For the embodiment in FIG. 22, the magnetic layer 1104 is embedded in the thermal magnetic layer 1102. In other words, the thermal magnetic layer 1102 surrounds the top surface and the side surface of the magnetic layer 1104. This structure allows the magnetic layer 1104 to be close to the light-emitting structure 1100.

FIG. 23 is a cross-sectional view, schematically illustrating a structure of a light-emitting device with magnetic field. In this embodiment, a silicon-on-insulator (SOI) substrate 1108 having a concave is used to adapt at least one light-emitting structure 1114. The concave is formed in the top silicon layer 1108c and the insulating layer 1108b to expose the bottom silicon layer 1108a. The electrodes 1116a, 1116b for connecting to the light-emitting structure 1114 can be, for example, the connection pads on the bottom silicon layer 1108a, then the packaging bumps are connected between the light-emitting structure 1114 and the electrodes 1116a, 1116b. In addition, the bottom silicon layer 1108a has multiple conductive plugs 1120 therein, so as to extend the electrodes 1116a, 1116b of connection pads to the lower surface of the bottom silicon layer 1108a. The lower surface of the bottom silicon layer 308a is formed with other electrode layers 1110a, 1110b, for electric connecting to the light-emitting structure 1114 by the plugs 1120.

The thermal conductive layer 1102 is further implemented to serve as the heat sink 1102 and surrounds the magnetic layer 1104. The heat sink 1102 has electrode layers 1202 and 1204 to connect to the electrode layer 1110a and 1110b. In other words, the operation voltages can be applied to the light-emitting structure 1114 from the electrode layers 1202 and 1204 on the heat sink 1102.

FIG. 24 is a cross-sectional view, schematically illustrating a structure of a light-emitting device with magnetic field, according to another embodiment of the present invention. In FIG. 24, alternatively, the light-emitting structure 1112 can also be packaged by wire bonding manner. The SOI layer 1108 is also taken. However, the concave is just formed in the top silicon layer 1108c to expose the insulating layer 1108b. The electrode layers 310a and 310b are formed on the sidewall and the bottom of the concave. The light-emitting structure 1112 is wire bounding to the electrode layers 1110a and 1110b. The electrode layers 1110a and 1110b are insulated by the insulating layer 1113. The electrode layers 1110a and 1110b can be metal and also serve as the additional reflection layer. Other lower concaves are formed in the bottom silicon layer 1108c and the insulating layer 1108b to expose the top silicon layer. Then, additional electrical conductive dissipating layer 1119 can be formed on the surface of the lower concaves. Additional thermal conductive layer 1121 may be further used with the electrical conductive dissipating layer 1119. The thermal conductive material layer 1102 surrounds the magnetic layer 1104 and is adhered to the electrical conductive dissipating layer 1119 over the bottom silicon layer 1108a. In addition, the electrode layers 1202 and 1204 may also be formed on top of the thermal conductive material layer 1102 in contact with the electrical conductive dissipating layer 1119. In one situation, the light-emitting structure 1112 may be not connected by bonding wire. Instead as an option, the electrical conductive dissipating layer 1119 can also serves as the electrodes to connect to the electrode layers 1110a and 1110b and then the light-emitting structure 1112 for supplying the operation voltages.

As previously stated, the provided embodiments can be combined to each other to have other embodiments. Various combinations are not described here but would be understood by the one in ordinary skill in the art.

Further, based on the same aspect, other embodiments are further provided. FIG. 25 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention. Referring to FIG. 25, the light-emitting device package 1400 of the present embodiment is similar to the foregoing light-emitting device package. The light-emitting device package 1400 of the present embodiment further includes a first carrier 1410, a second carrier 1420, and a heat sink 1430. The first carrier 1410 is disposed on the second carrier 1420, and the second carrier 1420 is disposed on the heat sink 1430. The first carrier 1410 is, for example, a submount, and the second carrier 1420 is, for example, a slug. In the present embodiment, at least one of the first carrier 1410, the second carrier 1420, and the heat sink 1430 has magnetism to from the magnetic source. In the present embodiment, the heat sink 1430 has a plurality of fins, for example. However, the heat sink 1430 may not have fins but be a block or otherwise shaped heat sink. Additionally, the shape of the fins of the heat sink 1430 is not limited in the present invention. Moreover, the heat sink 1430 may have heat conductivity and optionally have electrical conductivity.

In the present embodiment, a connection layer 1440a is disposed between the light-emitting structure 1310 and the first carrier 1410 for bonding the light-emitting structure 1310 and the first carrier 1410. In addition, a reflection layer 1450 is disposed between the light-emitting structure 1310 and the first carrier 1410 for reflecting light from the light-emitting structure 1310, so as to increase the light-emitting efficiency of the light-emitting device package 1400. However, in other embodiments, the reflection layer 1450 may also be disposed between the first carrier 1410 and the second carrier 1410. Additionally, in other embodiments, the light-emitting structure 1310 may be bonded directly on the first carrier 1410 without being bonded through the connection layer 1440a. In the present embodiment a connection layer 1440b is disposed between the first carrier

1410 and the second carrier 1410 for bonding the first carrier 1410 and the second carrier 1410. However, in other embodiments, the first carrier 1410 may be bonded directly on the second carrier 1410 without being bonded through the connection layer 1440b. In the present embodiment, a connection layer 1440c is disposed between the second carrier 1410 and the heat sink 1430 for bonding the second carrier 1410 and the heat sink 1430. However, in other embodiments, the second carrier 1410 may be bonded directly on or screwed on the heat sink 1430 without being bonded through the connection layer 1440c. Furthermore, in the present embodiment, the connection layers 1440a, 1440b, and 1440c is, for example, electrically conducting glue, insulating glue, heat dissipating glue, metal glue, non-metal glue, metal bump, or other appropriate material.

It should be noted that the light-emitting device package in the present invention is not limited to include the second carrier 1410 and the heat sink 1430. In other embodiments, the light-emitting device package may not include the heat sink 1430, and at least one of the first carrier 1410 and the second carrier 1410 has magnetism to form the magnetic source. Alternatively, the light-emitting device package may not include the second carrier 1410 and the heat sink 1430, and the first carrier 1410 has magnetism and is, for example, a submount or a slug.

FIG. 26 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present embodiment. Referring to FIG. 26, the light-emitting device package 1400a of the present embodiment is similar to the above light-emitting device package 1400 in FIG. 25, but the differences between them are as follows. It is not limited in the present invention that the at least one of the first carrier 1410, the second carrier 1410, and the heat sink 1430 wholly has magnetism. Alternatively, there may be a portion of the at least one of the first carrier 1410, the second carrier 1410, and the heat sink 1430 having magnetism to form the magnetic source.

For example, in the light-emitting device package 1400a of the present embodiment, a first carrier 1410a includes a first portion 1412 and a second

portion 1414 located on the first portion 1412, a second carrier 1410a includes a third portion 1422 and a fourth portion 1424 located on the third portion 1422, and a heat sink 1430a includes a fifth portion 1432 and a sixth portion 1434 located on the fifth portion 1432. One of the first portion 1412 and the second portion 1414 is a magnetic portion, and the other is a non-magnetic portion. Additionally, one of the third portion 1422 and the fourth portion 1424 is a magnetic portion, and the other is a non-magnetic portion. Moreover, one of the fifth portion 1432 and sixth portion 1434 is a magnetic portion, and the other is a non-magnetic portion.

In other embodiments, there may be two of the first carrier, the second carrier, and the heat sink each have a magnetic portion and a non-magnetic portion, while the other has a single portion with or without magnetism. Alternatively, there may be one of the first carrier, the second carrier, and the heat sink has a magnetic portion and a non-magnetic portion, and the others each have a single portion with or without magnetism.

FIG. 27 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present embodiment. Referring to FIG. 27, the light-emitting device package 1400b of the present embodiment is similar to the above light-emitting device package 1400 in FIG. 25, but the differences between them are as follows. In the light-emitting device package 1400b, a second carrier 1410b has a concave 1426, and the light-emitting structure 1310 and the first carrier 1410 is located in the concave 1426. In the present embodiment, the second carrier 1410b is, for example, a slug, and includes a bottom portion 1422b and a side wall portion 1424b. The side wall portion 1424b is disposed on the bottom portion 1422b and surrounds the light-emitting structure 1310 and the first carrier 1410. In the present embodiment, both the side wall portion 1424b and the first carrier 1410 have magnetism to form two magnetic sources, thus increasing the strength of the magnetic field applied to the light-emitting structure 1310, such that the light-emitting efficiency of the light-emitting device package 1400b is further improved. It should be noted that the shape of the concave 1426 is not limited to that shown in FIG. 27 in the present

invention, and may be otherwise shaped in other embodiments.

However, in other embodiment, the bottom portion 1422b may not have magnetism, and the side wall portion 1424b may have magnetism. Alternatively, the second carrier 1410b may have only one portion with or without magnetism. That is to say, the bottom portion 1422b and the side wall portion 1424b may be integrally formed. Additionally, the first carrier 1410 may not have magnetism.

FIG. 28 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention. Referring to FIG. 28, the light-emitting device package 1400c of the present embodiment is similar to the above light-emitting device package 1400b in FIG. 27, but the differences between them are as follows. The light-emitting device package 1400c of the present embodiment does not have the second carrier 1410b shown in FIG. 27. In addition, a first carrier 1410c has a concave 1416, and the light-emitting structure 1310 is located in the concave 1416. Moreover, the first carrier 1410c may be a submount or a slug, and have a bottom portion 1412c and a side wall portion 1414c. The side wall portion 1414c is disposed on the bottom portion 1412c, and surrounds the light-emitting structure 1310. In the present embodiment, the bottom portion 1412c or the side wall portion 1414c has magnetism. However, in other embodiments, the first carrier 1410c may have only one portion with or without magnetism. In the present embodiment, the connection layer1440b is disposed between the first carrier 1410c and the heat sink 1430 for bonding the first carrier 1410c and the heat sink 1430.

FIG. 29 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention. Referring to FIG. 29, the light-emitting device package 1400d of the present embodiment is similar to the above light-emitting device package 1400 in FIG. 25, but the differences are as follows. In the light-emitting device package 1400d, a heat sink 1430d includes a portion 1432d and another portion 1434d, which are the modifications of the portion 1432 and the portion 1434 in FIG. 26. The portion 1432d has a concave 1436 for containing the portion 1434d.

The second carrier 1410 is disposed on both the magnetic portion 1432d and the portion 1434d and crosses a boundary B between the portion 1432d and the portion 1434d. In the present embodiment, the portion 1432d is a non-magnetic portion, and the portion 1434d is a magnetic portion. The heat conductivity of the non-magnetic portion is greater than the heat conductivity of the magnetic portion, such that a heat conduction path P is formed from the light-emitting structure 1310 to the portion 1432d through the first carrier 1410 and the second carrier 1410. Since the major heat conduction path P does not passes through any magnetic material, such that the heat dissipation efficiency of the light-emitting device package 1400d in the present embodiment is better.

However, in other embodiment, the fifth portion 1432d and the sixth portion 1434d may be magnetic portion and non-magnetic portion, respectively. FIG. 30 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present embodiment. Referring to FIG. 30, the light-emitting device package 1400e of the present embodiment is similar to the above light-emitting device package 1400 in FIG. 25, but the differences between them are as follows. In the light-emitting device package 1400e, a heat conducting element 1460, such as copper, silver, aluminum, or ceramic, is disposed between the light-emitting structure 1310 and the first carrier 1410 for increasing heat dissipation rate from the light-emitting structure 1310, and the heat conducting element 1460 is, for example, a heat conducting layer.

FIG. 31 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present embodiment. Referring to FIG. 31, the light-emitting device package 1400f is similar to the above light-emitting device package 1400 in FIG. 25, but the differences between them are as follows. In the light-emitting device package 1400f, a magnetic element 1470 is disposed on the first carrier 1410, and the light-emitting structure 1310 is disposed on the magnetic element 1470. The magnetic element 1470 is, for example, a magnetic layer, and forms a magnetic source. All of the first carrier 1410, the second carrier 1420, and the heat sink 1430

may have no magnetism. Alternatively, at least a portion of at least one of the first carrier 1410, the second carrier 1420, and the heat sink 1430 may have magnetism.

FIG. 32 is a schematic cross-sectional view of a light-emitting device package 1400g according to an embodiment of the present invention. Referring to FIG. 32, the light-emitting device package 1400g of the present embodiment is similar to the above light-emitting device package 1400 in FIG. 25, but the differences between them are as follows. The light-emitting device package 1400g of the present embodiment further includes an encapsulant 1480 and a magnetic film 1490. The encapsulant 1480 wraps the light-emitting structure 1310 and the first carrier 1410. In the present embodiment, the material of the encapsulant 1480 is, for example, silicone resin or other resin. Moreover, the encapsulant 1480 may be doped with or not doped with phosphor. The magnetic film 1490 is disposed on the encapsulant 1480 for forming the magnetic source. In the present embodiment, the light-emitting device package 1400g further includes a lens 1510 disposed on the magnetic film 1490. Additionally, a second carrier 1410g has a concave 1426g for containing the light-emitting structure 1310 and the first carrier 1410 in the present embodiment.

In the present embodiment, all of the first carrier 1410, the second carrier 1410g, and the heat sink 1430 may have no magnetism. However, in other embodiments, at least a portion of at least one of the first carrier 1410, the second carrier 1420g, and the heat sink 1430 may have magnetism.

FIG. 33 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention. Referring to FIG. 33, the light-emitting device package 1400h of the present embodiment is similar to the above light-emitting device package 1400g in FIG. 32, but the differences between them are as follows. In the light-emitting device package 1400h, a plurality of magnetic powders 1482 are doped in the encapsulant 1480 to form the magnetic source. In other embodiments, the light-emitting device package may not include the magnetic film 1490, but may include the magnetic powders 1482.

FIG. 34 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention. Referring to FIG. 34, the light-emitting device package 1400i of the present embodiment is similar to the above light-emitting device package 1400b in FIG. 27, but the differences between them are as follows. In the light-emitting device package 1400i, a reflection layer 1520 is disposed on the bottom portion 1422b of the second carrier 1410b and the side wall portion 1424b of the second carrier 1410b, i.e. on the inner surface 1428 of the concave 1426, for reflecting light from the light-emitting structure 1310, thus increasing the light-emitting efficiency of the light-emitting device package 1400i.

FIG. 35 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention. Referring to FIG. 35, the light-emitting device package 1400j of the present embodiment is similar to the above light-emitting device package 1400c in FIG. 28, but the differences between them are as follows. In the light-emitting device package 1400j, a reflection layer 1530 is disposed on the bottom portion 1412c of the first carrier 1410c and the side wall portion 1414c of the first carrier 1410c, i.e. on an inner surface 1418 of a concave 1416. In the present embodiment, the connection layer 1440b bonds the first carrier 1410c and the heat sink 1430.

FIG. 36 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of the present invention. Referring to FIG. 36, the light-emitting device package 1400k is partly similar to the above light-emitting device package 1400g in FIG. 32, but the differences between them are as follows. In the light-emitting device package 1400k, a first carrier 1410k is a lead frame but not a submount as in FIG. 32. In the present embodiment, the first carrier 1410k has magnetism. In addition, an encapsulant 1480k wraps the light-emitting structure 1310 and a part of the first carrier 1410k. In the present embodiment, the material of the 1480k is, for example, epoxy resin, silicone resin or other resin.

FIG. 37 is a schematic cross-sectional view of a light-emitting device package according to an embodiment of present invention. Referring to FIG.

37, the light-emitting device package 1400l is similar to the above light-emitting device package 1400k in FIG. 36, but the differences between them are as follows. In the light-emitting device package 1400l, a plurality of magnetic powders 1482l are doped in an encapsulant 1480l. In addition, a magnetic element 1470l is disposed on the first carrier 1410k, and the light-emitting structure 1310 is disposed on the magnetic element 1470l. In the present embodiment, the magnetic element 1470l is, for example, a magnetic layer. In addition, a connection layer 1440d may be disposed between the light-emitting structure 1310 and the magnetic element 1470l, and another connection layer 1440e may be disposed between the magnetic element 1470l and the first carrier 1410k.

In other embodiments, the light-emitting device package may include the magnetic powder 1482l but not the magnetic element 1470l, and the first carrier 1410k has or does not have magnetism. Alternatively, the light-emitting device package may include the magnetic element 1470l but not the magnetic powder 1482l, and the first carrier 1410k has or does not have magnetism.

FIG. 38 is a cross-sectional view of a light-emitting device package according to an embodiment of the present invention. Referring to FIG. 38, the light-emitting device package 1400m of the present embodiment is similar to the above light-emitting device package 1400f in FIG. 31, but the differences therebetween are as follows. The light-emitting device package 1400m further includes a magnetic layer 1540 surrounding the light-emitting structure 1310 for forming the magnetic source. The carrier 1410 to have a containing space in a shape being, for example, round, elliptic, rectangular, trapezium, inverse trapezium, or cup. In the present embodiment, the first carrier 1410 may or may not have magnetism.

FIG. 39 is a cross-sectional view of a light-emitting device package according to an embodiment of the present invention. Referring to FIG. 39, the light-emitting device package 1400n is similar to the above light-emitting device package 1400m in FIG. 38, but the differences between them are as follows. In the light-emitting device package 1400n, a reflection layer

1450m is disposed on both the first carrier 1410 and the inner surface 1542 of the magnetic ring 1540, so as to increase the light-emitting efficiency of the light-emitting device package 1400n.

It should be noted that light-emitting structure 1310 in the above light-emitting device packages 1400 and 1400a-1400n can be vertical type or horizontal type. The light-emitting direction can be also chosen, accordingly.

To sum up, in the light-emitting device package according to the embodiments of the present invention, since the magnetic source is disposed beside the light-emitting device for applying a magnetic field to the light-emitting device, the paths of currents in the light-emitting device is changed into better paths by the magnetic field, thus increasing the light-emitting efficiency of the light-emitting device package.

When the light-emitting device package according to the embodiments of the present invention is a vertical type light-emitting device package, the magnetic field generates a Lorentz force on the currents in the light-emitting device to push the currents along a direction away from the region under the electrode. In this way, the currents are not concentrated under the electrode but spread along the direction away from the region under the electrode, such that more proportion of photons generated in the light-emitting layer are not blocked by the electrode, thus increasing the light-emitting efficiency of the light-emitting device package.

When the light-emitting device package according to the embodiments of the present invention is a horizontal type light-emitting device package, the magnetic field generates Lorentz force and magnetization resistance effect pushing currents out of the direct paths between the first electrode and the second electrode, such that the currents in the light-emitting device are more uniform, which makes photons emitted from the light-emitting layer more uniform.

In this way, the surface area of the light-emitting device may be relatively small even if a larger area for emitting uniform light is needed.

It will be apparent to those skilled in the art that various modifications

and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing descriptions, it is intended that the present invention covers modifications and variations of this invention if they fall within the scope of the following claims and their equivalents.

CLAIMS

1. A light-emitting device comprising:

a light-emitting structure, comprising a first doped structural layer, a second doped structural layer, an active layer between the two doped structural layers, a first electrode, and a second electrode, wherein the first electrode and the second electrode are respectively electrically coupled to the first doped structural layer and the second doped structural layer; and

a magnetic structure, adjacent to the light-emitting structure to produce a magnetic field in the light-emitting structure.

2. The light-emitting device of claim 1, wherein the magnetic structure is coupled to the light-emitting structure.

3. The light-emitting device of claim 1, wherein the first electrode and the second electrode are at a same side of the light-emitting structure, wherein the magnetic field transversely shifts a driving current of the light-emitting structure to re-distribute in the light-emitting structure.

4. The light-emitting device of claim 1, wherein the first electrode and the second electrode are at opposite two sides of the light-emitting structure and the magnetic layer is disposed at a bottom of the light-emitting structure, wherein the magnetic field longitudinally shifts a driving current of the light-emitting structure between the first electrode and the second electrode.

5. The light-emitting device of claim 1, wherein the light-emitting structure further comprises a substrate, wherein the magnetic structure is disposed on the substrate, and the second doped structural layer is disposed over the substrate and the magnetic structure.

6. The light-emitting device of claim 5, wherein the magnetic structure comprises a plurality of magnetic substance layers, distributed on the substrate.

7. The light-emitting device of claim 1, wherein the light-emitting structure further comprises:

a substrate, wherein the second doped structural layer is disposed over the substrate.

8. The light-emitting device of claim 7, wherein the light-emitting

structure further comprises a reflection layer, disposed on the second electrode, wherein the second electrode is disposed over the magnetic-structure.

9. The light-emitting device of claim 1, wherein the light-emitting structure further comprises a substrate, wherein the second doped structural layer is disposed over the substrate, wherein the second electrode also has a light reflection function.

10. The light-emitting device of claim 1, wherein the light-emitting structure further comprises a transparent conductive layer in contact with the first electrode.

11. The light-emitting device of claim 1, wherein the light-emitting structure further comprises a substrate disposed over the first doped structural layer, wherein the second electrode layer is disposed on the magnetic structure.

12. The light-emitting device of claim 10, wherein the light-emitting structure further comprises a transparent conductive layer between the substrate and the first electrode in contact.

13. The light-emitting device of claim 1, further comprising a reflection layer between the second electrode layer and the second doped structural layer.

14. The light-emitting device of claim 1, wherein the magnetic structure is just disposed on the first electrode, so that the first electrode is disposed between the magnetic structure and the first doped structural layer.

15. The light-emitting device of claim 1, wherein the magnetic- structure is disposed on the first electrode and an exposed portion of the first doped structural layer.

16. The light-emitting device of claim 1, wherein the magnetic- structure is disposed on an exposed portion of the first doped structural layer.

17. The light-emitting device of claim 1, wherein the magnetic- structure is a structural layer with a plurality of concave regions, wherein each of the concave regions is disposed with at least one of the light-emitting structure.

18. A light-emitting device, comprising:

a light-emitting structure, comprising:

a lower doped structural layer;

an active layer, disposed on the lower doped structural layer;

an upper doped structural layer, disposed on the active layer;

a first electrode, disposed over the upper doped structural layer with electric coupling; and

a second electrode, disposed over the lower doped structural layer with electric coupling, wherein the first electrode and the second electrode are at a same side of the active layer; and

a magnetic layer, coupled to the light-emitting structure to produce a magnetic field with a direction substantially perpendicular to the active layer.

19. The light-emitting device of claim 18, wherein the light-emitting structure further comprises a substrate being disposed with the lower doped structural layer, wherein the magnetic layer is coupled on the substrate.

20. The light-emitting device of claim 18, wherein the light-emitting structure further comprises a transparent conductive layer disposed on the upper doped structural layer.

21. The light-emitting device of claim 20, wherein the transparent conductive layer has a roughen surface.

22. The light-emitting device of claim 18, wherein the light-emitting structure further comprises a substrate being disposed with the lower doped structural layer, wherein the magnetic layer is coupled to the first electrode and the second electrode by a package structure.

23. The light-emitting device of claim 22, wherein the light-emitting structure further comprises a reflection layer disposed between the upper doped structural layer and the first electrode.

24. The light-emitting device of claim 18, wherein the magnetic layer is coupled to the first electrode and the second electrode by a package structure, wherein the magnetic layer also servers as a substrate.

25. The light-emitting device of claim 18, wherein the first electrode and the second electrode are located at two positions in accordance with the applied magnetic field.

26. The light-emitting device of claim 25, wherein the light-emitting structure has a light-emitting region in rectangular or square shape, and one of the two electrodes is located at a corner of the light-emitting region and another of the two electrodes is located at a side of the light-emitting region in accordance with the applied magnetic field.

27. A light-emitting device comprising:

a light-emitting structure, comprising:

a first doped structural layer;

a second doped structural layer;

an active layer between the two doped structural layers; and

a first electrode and a second electrode, electrically coupled to the first doped structural layer and the second doped structural layer, respectively; and

a magnetic layer, coupled to the light-emitting structure on the first electrode and the second electrode by a package structure, to produce a magnetic field in the light-emitting structure.

28. The light-emitting device of claim 27, wherein the magnetic layer comprises:

a submount layer; and

a magnetic film on the submount layer,

wherein the first electrode and the second electrodes are connected to the magnetic film by the package structure.

29. The light-emitting device of claim 28, wherein the package structure comprises packaging bumps.

30. A light-emitting device comprising:

a light-emitting structure has a first side and second side, comprising:

a first doped structural layer;

a second doped structural layer;

an active layer between the two doped structural layers;

a first electrode, disposed over the first doped structural layer with electric coupling; and

a second electrode, disposed over the second doped structural layer

with electric coupling; and

a first magnetic layer, disposed on the first electrode at the first side;

a second magnetic layer, disposed over the second doped structural layer at the second side.

31. The light-emitting device of claim 30, further comprising a transparent conductive layer, disposed on the first doped structural layer.

32. The light-emitting device of claim 30, wherein the first magnetic layer and the first electrode form a plurality of stack layers distributed over the first doped structural layer.

33. The light-emitting device of claim 30, wherein the second electrode is disposed on the second doped structural layer at the second side and the second magnetic layer is disposed on the second electrode.

34. The light-emitting device of claim 30, wherein the second electrode is disposed on an exposed portion of the second doped structural layer facing to the first side, and the second magnetic layer is disposed on the second doped structural layer.

35. A light-emitting device, comprising:

a light-emitting structure;

a thermal conductive material layer, coupled with the light-emitting structure to dissipate a heat, generated by the light-emitting structure; and

a magnetic layer, coupled with the thermal conductive material layer to generate a magnetic filed in the light-emitting structure.

36. The light-emitting device of claim 35, wherein the light-emitting structure is on the thermal conductive material layer, and the magnetic layer is indented in the thermal conductive material layer.

37. The light-emitting device of claim 35, wherein

the magnetic layer is disposed on the light-emitting structure at a first side;

the thermal conductive material layer is disposed over the light-emitting structure at the first side and encloses the magnetic layer; and

a first electrode layer and a second electrode layer are disposed on the thermal conductive material layer to electrically connect the light-emitting

structure.

38. The light-emitting device of claim 37, wherein the light-emitting structure comprises:

a silicon-on-insulator (SOI) layer of a lower silicon layer, an insulating layer, and an upper silicon layer, wherein the top silicon and the insulating layer have a concave to expose a portion of lower silicon layer; and

at least one light-emitting unit, implemented on the lower silicon layer within the concave.

39. The light-emitting device of claim 38, wherein the light-emitting structure comprises:

a plurality of conductive plugs, formed in the lower silicon layer; and

a conductive pattern layer on a lower surface of the lower silicon layer,

wherein the conductive plugs and the conductive pattern layer form an interconnect structure for connecting the at least one light-emitting unit to the first electrode layer and the second electrode layer on the thermal conductive material layer.

40. The light-emitting device of claim 37, wherein the light-emitting structure comprises:

a silicon-on-insulator (SOI) layer of a lower silicon layer, an insulating layer, and an upper silicon layer, wherein the top silicon has a first concave to expose the insulating layer, and a plurality of second concaves in the insulating layer and the lower silicon layer to expose the upper silicon layer;

a first metal layer and a second metal layer are formed on a periphery of the first concave;

a light-emitting unit, disposed over the insulating layer within the first concave on the first electrode and the second electrode;

a thermal conductive layer, formed on the second concave in the insulating layer and the lower silicon layer and having a portion in contacting with the first electrode layer and the second electrode layer on the thermal conductive material layer.

41. A light-emitting device, comprising:

a heat sink;

a structural carrier, stacking over the heat sink; and

a light-emitting structure, stacking over the structural carrier,

wherein at least one portion of the structural carrier and the heat sink has magnetism to provide a magnetic field in the light-emitting structure.

42. The light-emitting device of claim 41, wherein the heat sink is also a magnetic material.

43. The light-emitting device of claim 41, wherein the structural carrier has a first carrier and a second carrier in stack and the first carrier is between the light-emitting structure and the second carrier.

44. The light-emitting device of claim 43, wherein at least one of the first carrier, the second carrier, and the heat sink has a magnetic portion.

45. The light-emitting device of claim 43, wherein the second carrier has a planar layer portion and a protruding portion at a periphery of the planar layer portion to surround the light-emitting structure, so that the second carrier forms a concave.

46. The light-emitting device of claim 45, wherein the second carrier comprises a reflection layer disposed on an inner surface of the concave.

47. The light-emitting device of claim 45, wherein at least one of the planar layer portion and protruding portion of the second carrier has a magnetic portion.

48. The light-emitting device of claim 41, wherein the structural carrier is a single carrier layer.

49. The light-emitting device of claim 48, wherein at least one of the carrier and the heat sink has a magnetic portion.

50. The light-emitting device of claim 48, wherein the carrier has a planar layer portion and a protruding portion at a periphery of the planar layer portion to surround the light-emitting structure, so that the second carrier forms a concave.

51. The light-emitting device of claim 50, wherein the second carrier comprises a reflection layer disposed on an inner surface of the concave.

52. The light-emitting device of claim 41, further comprising a thermal conductive layer between the light-emitting structure and the structure carrier.

53. The light-emitting device of claim 41, further comprising a magnetic layer between the light-emitting structure and the structure carrier.

54. The light-emitting device of claim 41, further comprising a magnetic layer between the heat sink and the structure carrier.

55. A light-emitting device, comprising:

a heat sink;

a structural carrier, stacking over the heat sink, wherein the structural carrier has a concave region with a sidewall;

a light-emitting structure, stacking over the structural carrier within the concave region; and

an encapsulant, filled in the space, wherein the encapsulant does contain magnetic material powders or doesn't contain the magnetic material powders.

56. The light-emitting device of claim 55, light-emitting device comprises:

a lens cap, disposed on a top of the sidewall of the structural carrier to cover the concave region and therefore form a space; and

a magnetic cap with the lens cap, disposed on a top of the sidewall of the structural carrier for the encapsulant.

57. The light-emitting device of claim 56, wherein the encapsulant do contain the magnetic material powders and a magnetic cap with the lens cap disposed on the top of the sidewall of the structural carrier.

58. The light-emitting device of claim 56, wherein at least one portion of the structural carrier with the heat sink further has magnetic material; or the structural carrier with the heat sink has no magnetic material.

59. The light-emitting device of claim 55, wherein at least one portion of the structural carrier with the heat sink further has a magnetic portion.

60. The light-emitting device of claim 55, wherein the structural carrier comprises a first carrier and a second carrier, the first carrier is between the light-emitting structure and the second carrier, wherein the sidewall is on the second carrier.

61. The light-emitting device of claim 55, wherein a reflection layer is disposed at least on the sidewall of the structural carrier.

62. A light-emitting device, comprising:

a light-emitting structure; and

a magnetic holding carrier, to hold the light-emitting structure.

63. The light-emitting device of claim 62, further comprising an encapsulant, wrapping the light-emitting structure and a portion of the magnetic holding carrier.

64. A light-emitting device, comprising:

a light-emitting structure;

a magnetic layer under the light-emitting structure;

a holding carrier, to hold the magnetic layer with the light-emitting structure ; and

an encapsulant, wrapping the light-emitting structure and a portion of the magnetic holding carrier.

65. The light-emitting device of claim 64, wherein the encapsulant contains magnetic powders, and the holding carrier is a magnetism material.

66. The light-emitting device of claim 64, wherein the encapsulant contains magnetic powders, and the holding carrier is not a magnetism material.

67. The light-emitting device of claim 64, wherein the encapsulant contains no magnetic powders, and the holding carrier is a magnetism material.

68. The light-emitting device of claim 64, wherein the encapsulant contains no magnetic powders, and the holding carrier is not a magnetism material.

69. A light-emitting device , comprising:

a carrier;

a magnetic layer, disposed over the carrier to have a containing space; and

a light-emitting structure, disposed over the carrier within the containing space.

70. The light-emitting device of claims 69, wherein the carrier has magnetism.

71. The light-emitting device of claims 69, wherein the carrier has no magnetism.

72. The light-emitting device of claims 69, further comprising a reflection layer between the carrier and the light-emitting structure.

73. The light-emitting device of claims 72, wherein the reflection layer further extends on an inner surface of the magnetic ring.

74. The light-emitting device of claims 69, further comprising a magnetic layer between the carrier and the light-emitting structure.

75. The light-emitting device of claims 69, wherein the carrier has a containing space in a shape being round, elliptic, rectangular, trapezium, inverse trapezium, or cup.

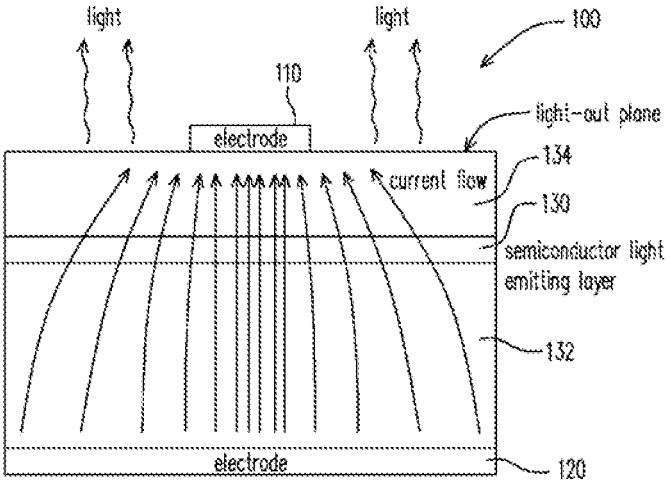


FIG. 1 (PRIOR ART)

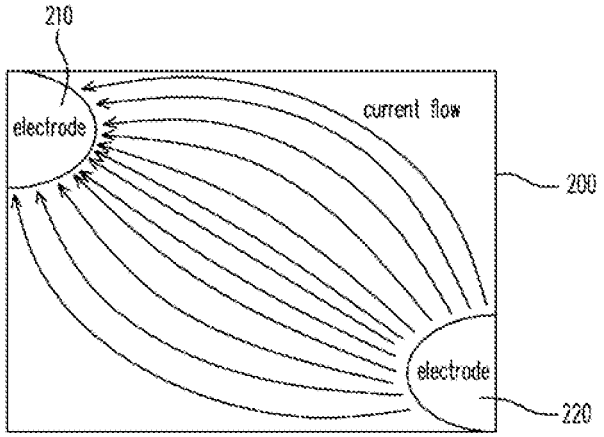


FIG. 2 (PRIOR ART)

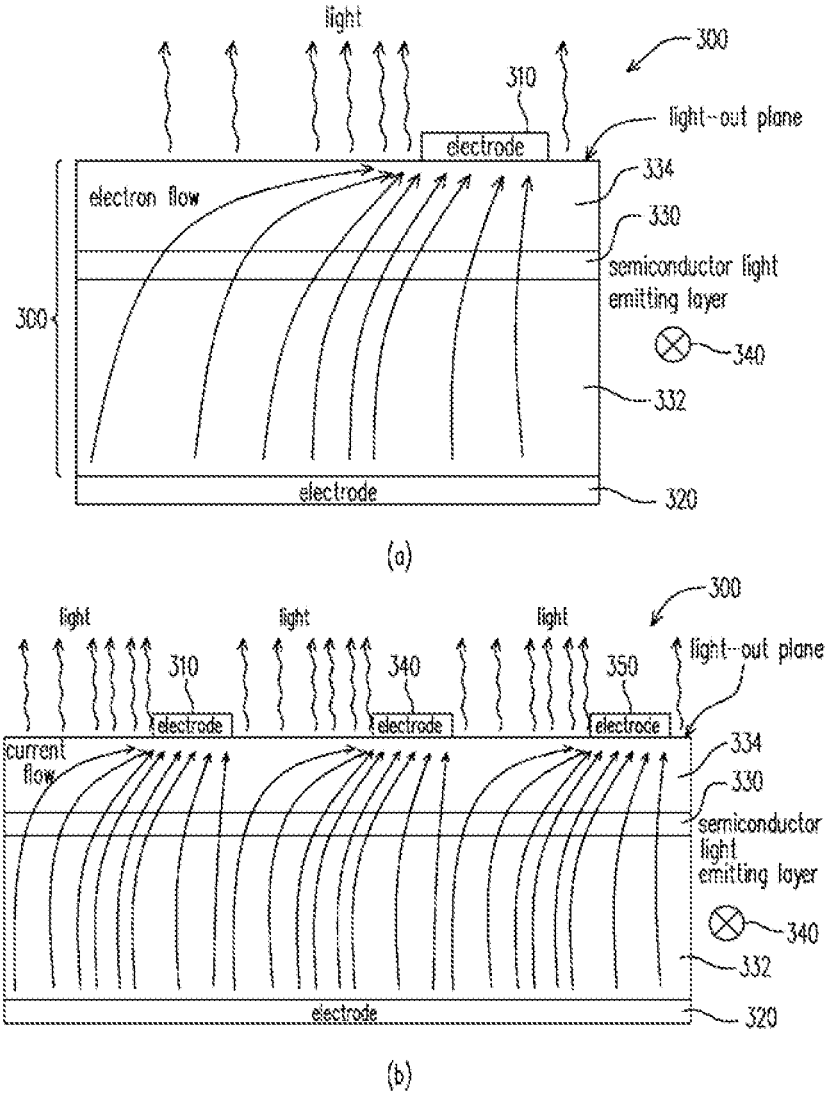

light
300
310
light-out plane
electrode
334
electron flow
330
semiconductor light emitting layer
300
340
332
electrode
320
(a)
light
light
light
300
310
340
350
light-out plane
electrode
electrode
electrode
current flow
334
330
semiconductor light emitting layer
340
332
electrode
320
(b)

FIG. 3

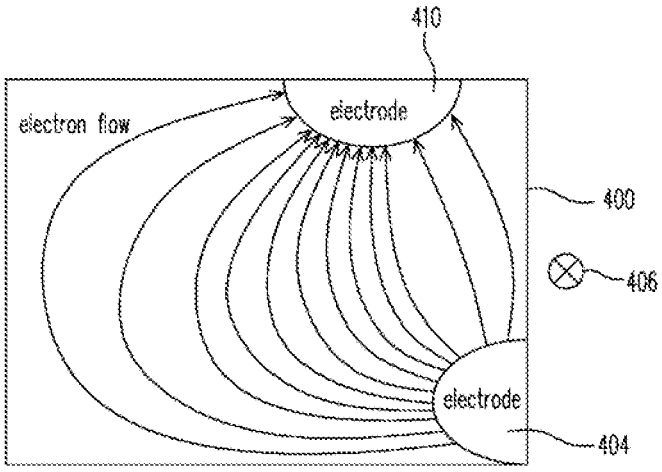

410
electrode
electron flow
400
406
electrode
404

FIG. 4

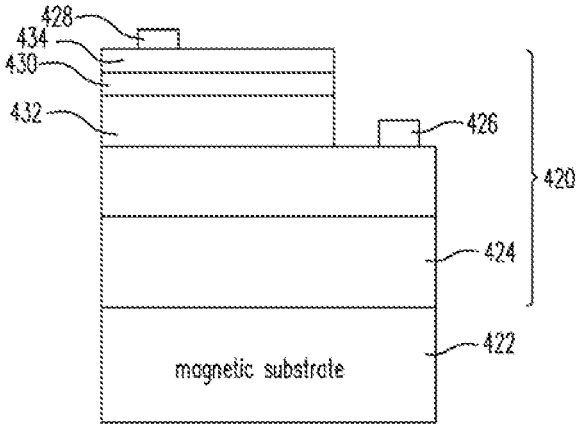

428
434
430
432
426
420
424
422
magnetic substrate

FIG. 5

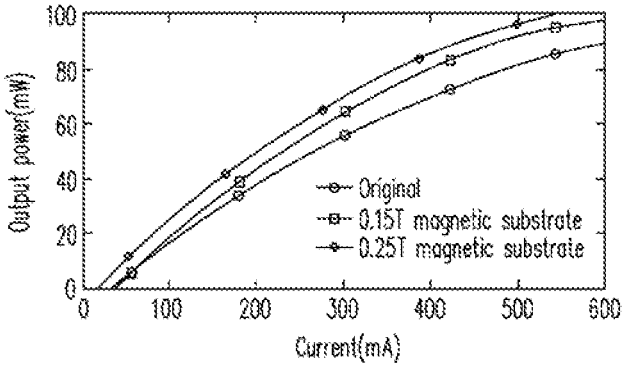

100
80
60
40
20
0
Output power(mW)
0
100
200
300
400
500
600
Current(mA)
Original
0.15T magnetic substrate
0.25T magnetic substrate

FIG. 6

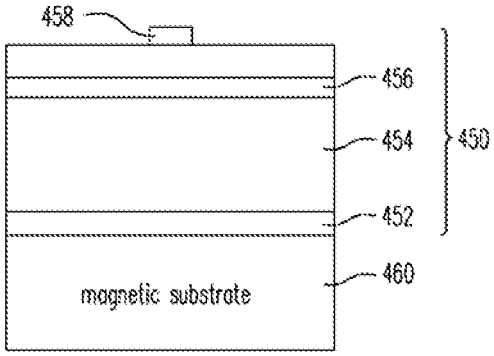

458
456
454
450
452
460
magnetic substrate

FIG. 7

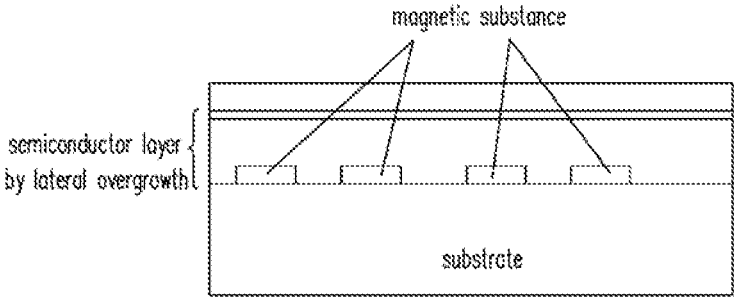

magnetic substance
semiconductor layer by lateral overgrowth
substrate

FIG. 8

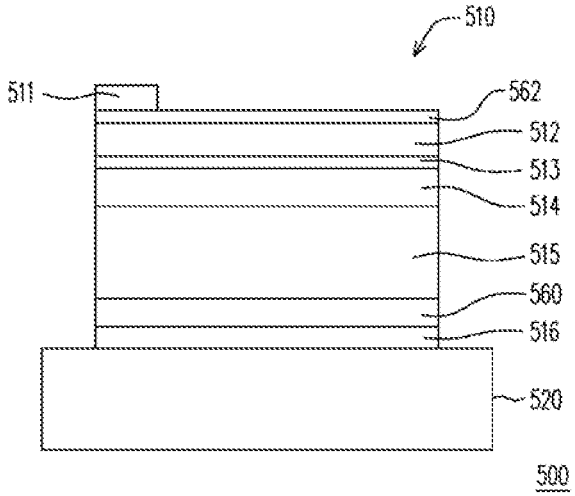

510
511
562
512
513
514
515
560
516
520
500

FIG. 9

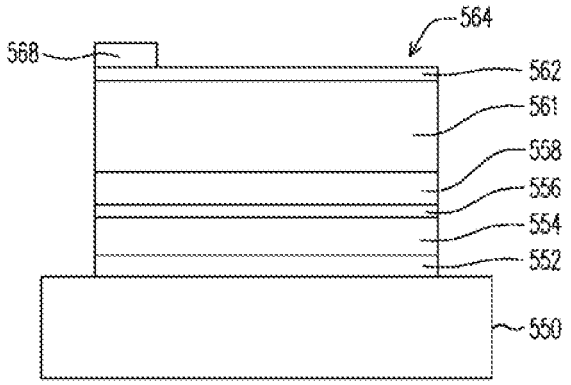

564
568
562
561
558
556
554
552
550

FIG. 10

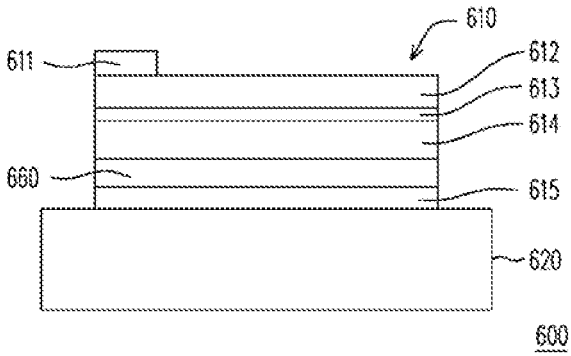
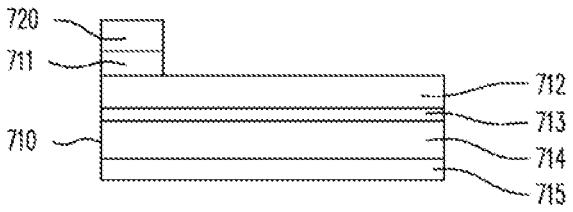
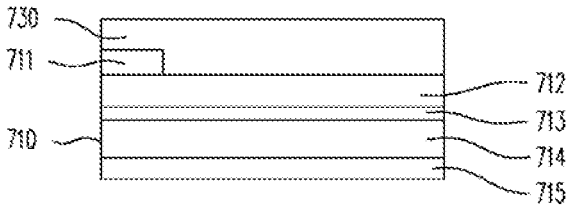

610
611
612
613
614
660
615
620
600

FIG. 11



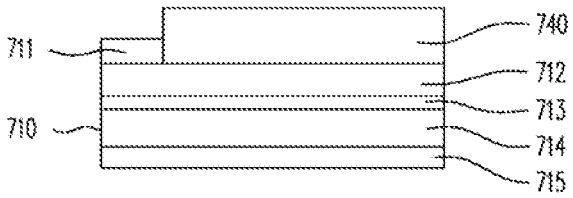
700a

(a)



700b

(b)



700c

(c)

FIG. 12

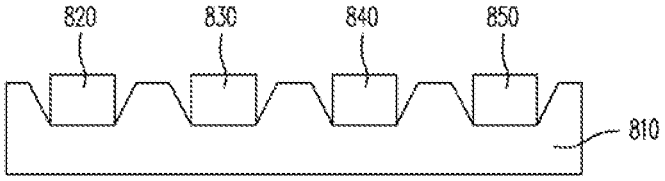


FIG. 13

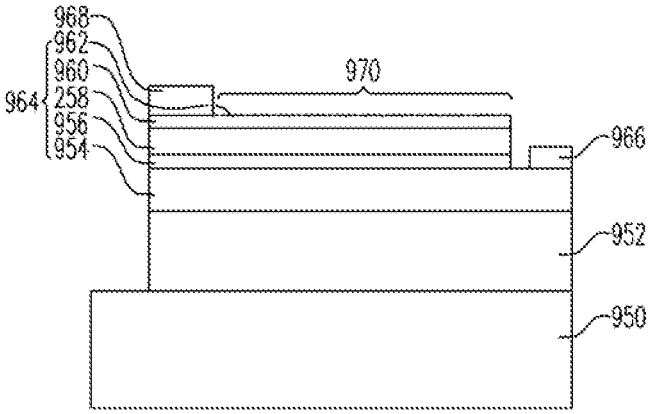


FIG. 14

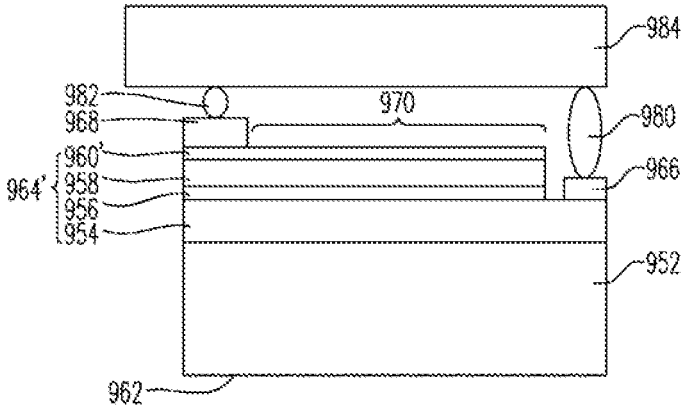

984
982
970
968
980
960'
966
964'
958
956
954
952
962

FIG. 15

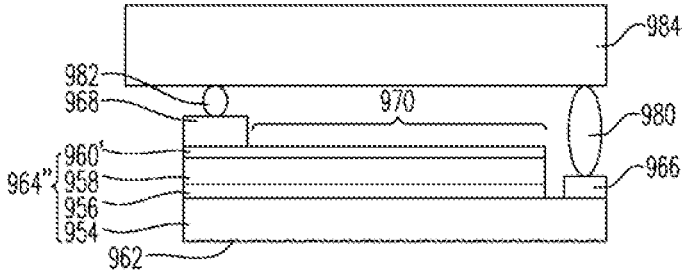

984
982
968
970
980
960'
966
964"
958
956
954
962

FIG. 16

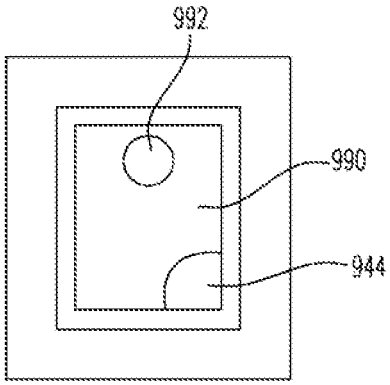

992
990
944

FIG. 17

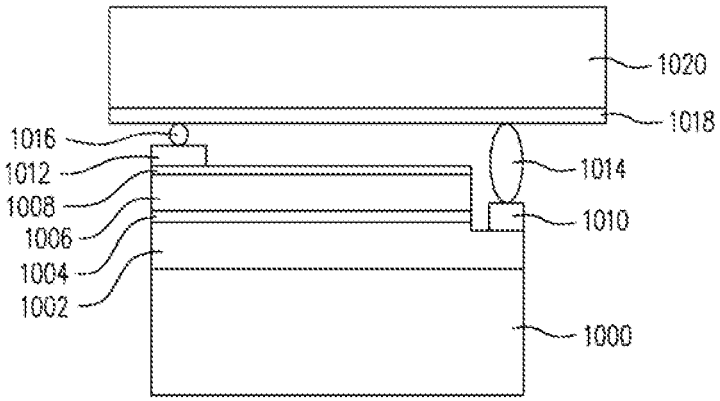

1020
1018
1016
1012
1008
1006
1004
1002
1014
1010
1000

FIG. 18

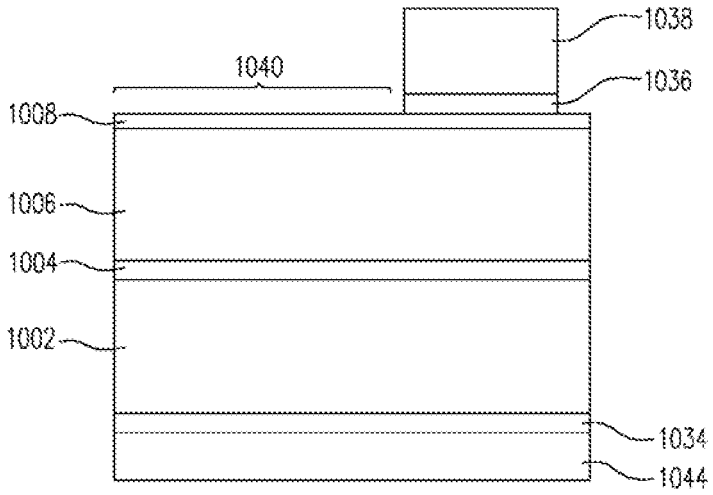

1038
1040
1036
1008
1006
1004
1002
1034
1044

FIG. 19

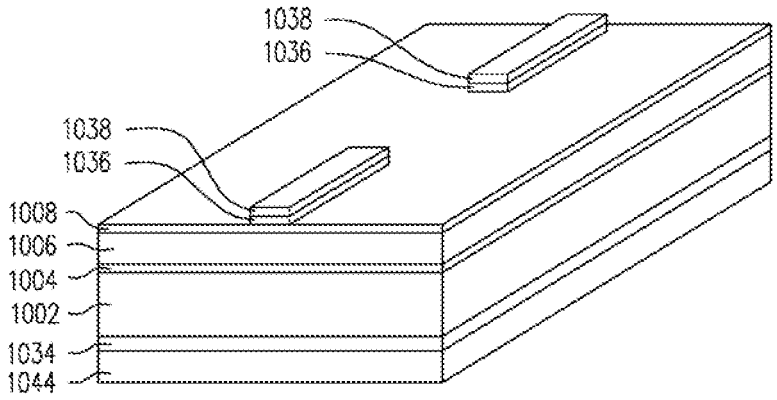

1038
1036
1038
1036
1008
1006
1004
1002
1034
1044

FIG. 20

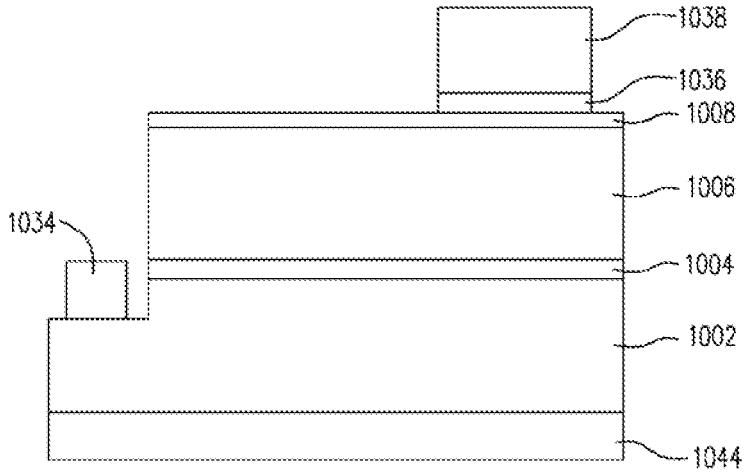


FIG. 21

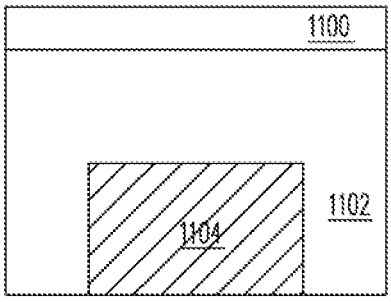


FIG. 22

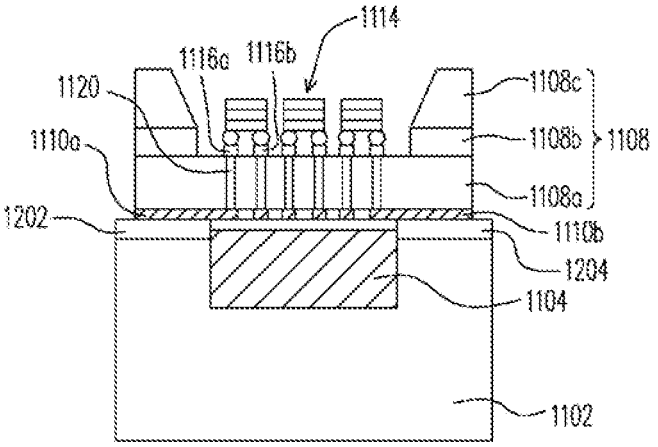

1114
1116a
1116b
1120
1108c
1110a
1108b
1108
1108a
1202
1110b
1204
1104
1102

FIG. 23

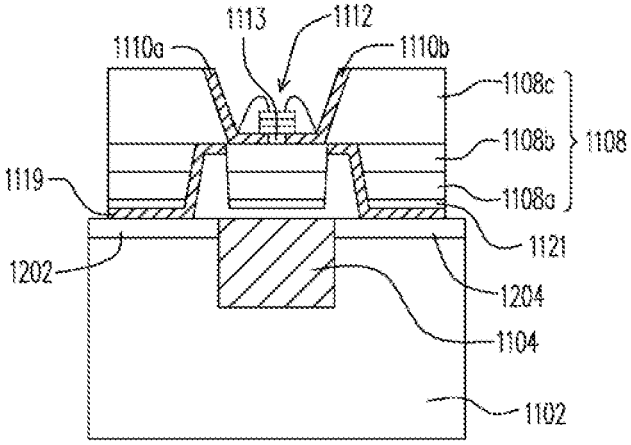

1113
1112
1110a
1110b
1108c
1108b
1108
1119
1108a
1121
1202
1204
1104
1102

FIG. 24

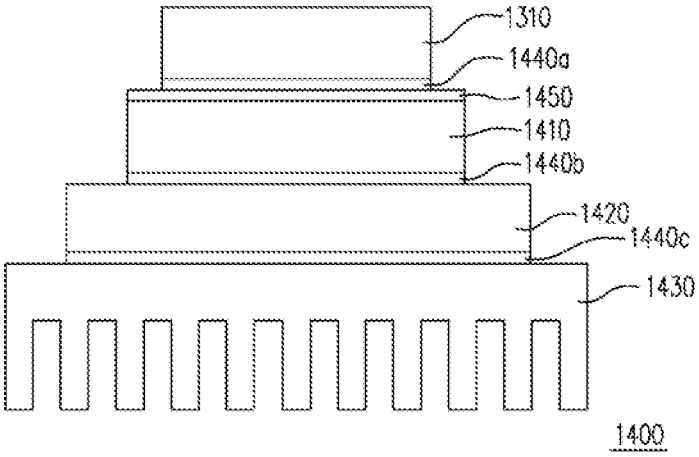

1310
1440a
1450
1410
1440b
1420
1440c
1430
1400

FIG. 25

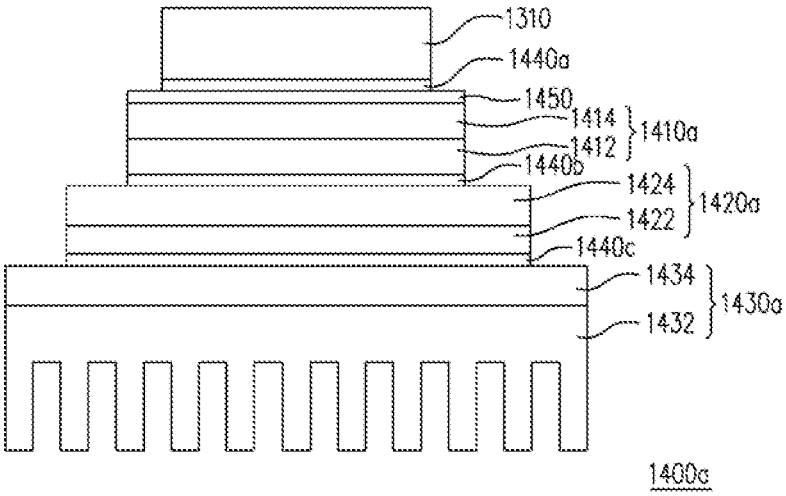

1310
1440a
1450
1414
1412
1410a
1440b
1424
1422
1420a
1440c
1434
1432
1430a
1400a

FIG. 26

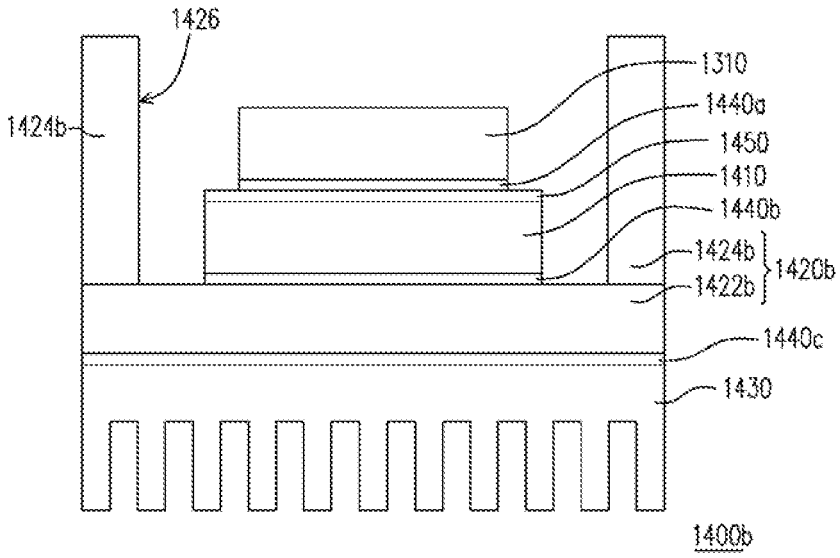

1426
1424b
1310
1440a
1450
1410
1440b
1424b
1422b
1420b
1440c
1430
1400b

FIG. 27

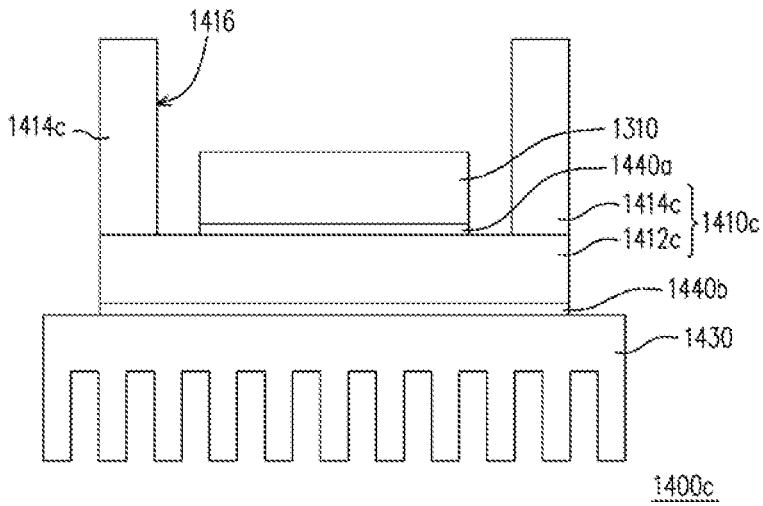

1416
1414c
1310
1440a
1414c
1412c
1410c
1440b
1430
1400c

FIG. 28

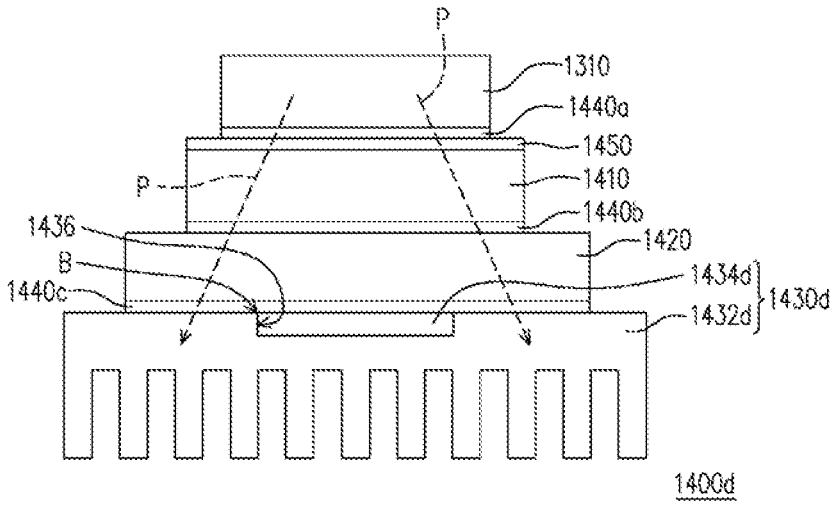

P
1310
1440a
1450
P
1410
1440b
1436
1420
B
1434d
1430d
1440c
1432d
1400d

FIG. 29

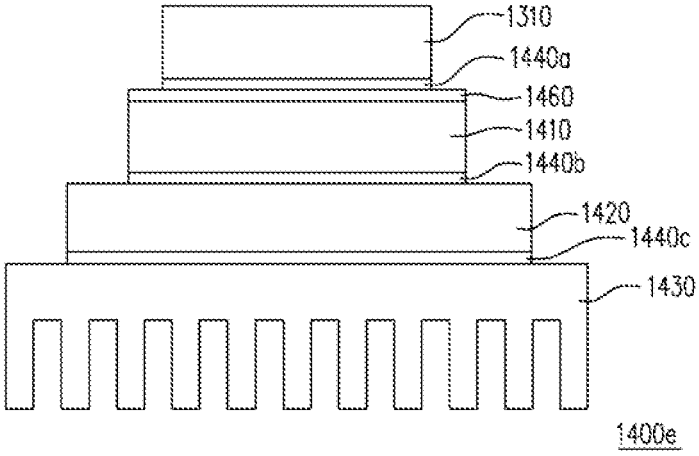

1310
1440a
1460
1410
1440b
1420
1440c
1430
1400e

FIG. 30

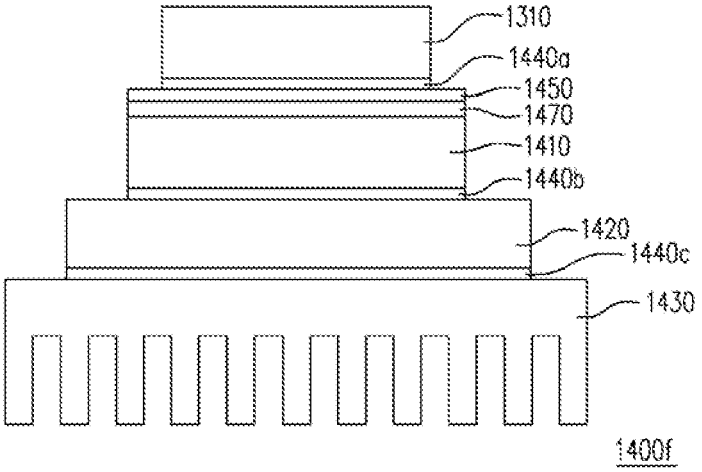


FIG. 31

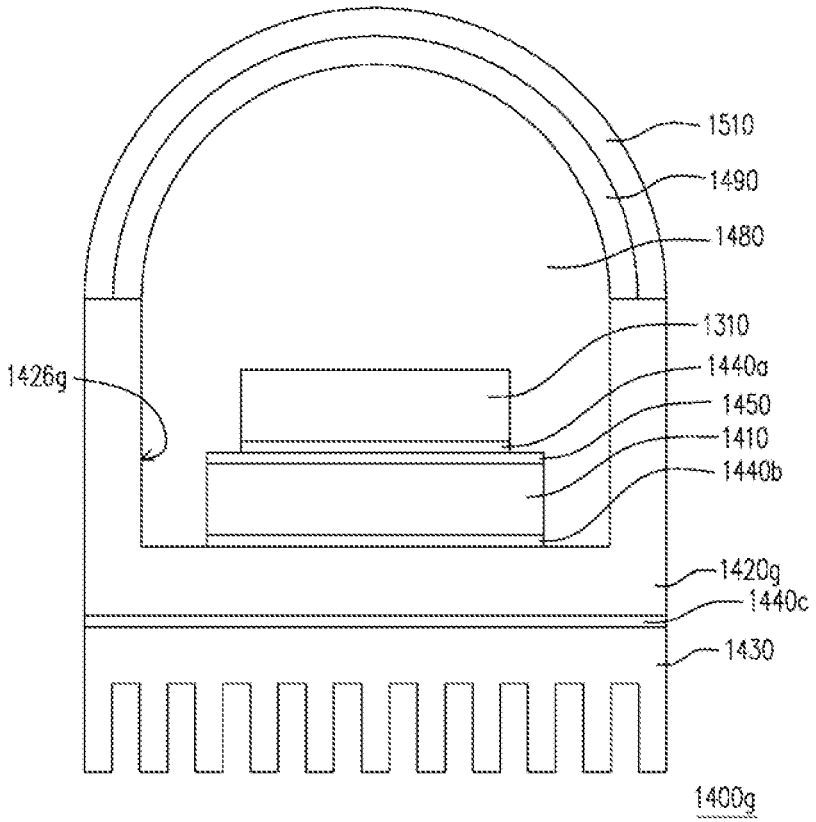

1510
1490
1480
1310
1426g
1440a
1450
1410
1440b
1420g
1440c
1430
1400g

FIG. 32

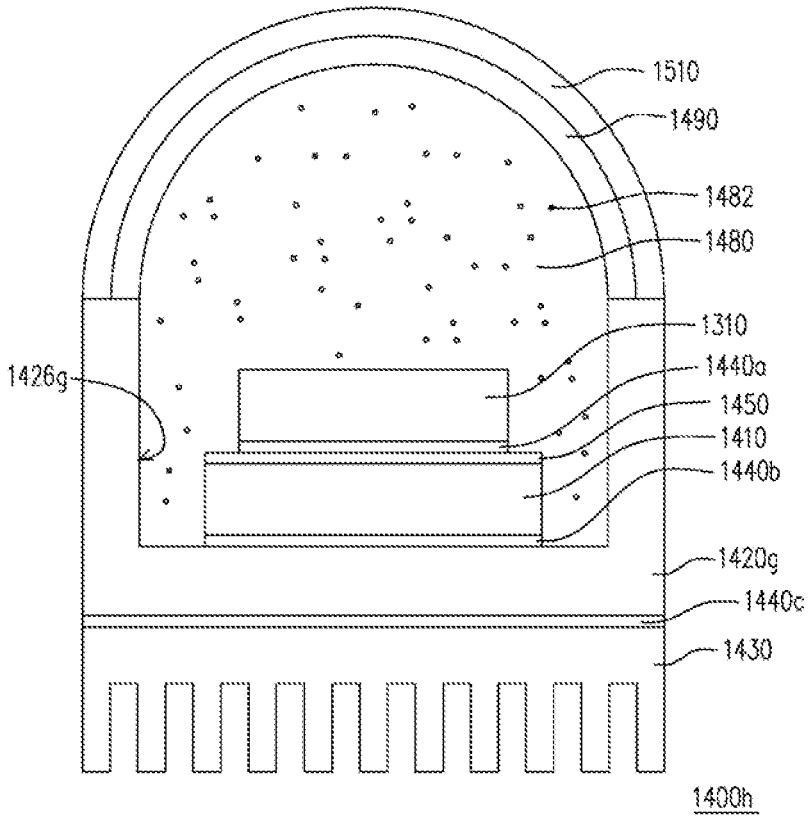

1510
1490
1482
1480
1310
1426g
1440a
1450
1410
1440b
1420g
1440c
1430
1400h

FIG. 33

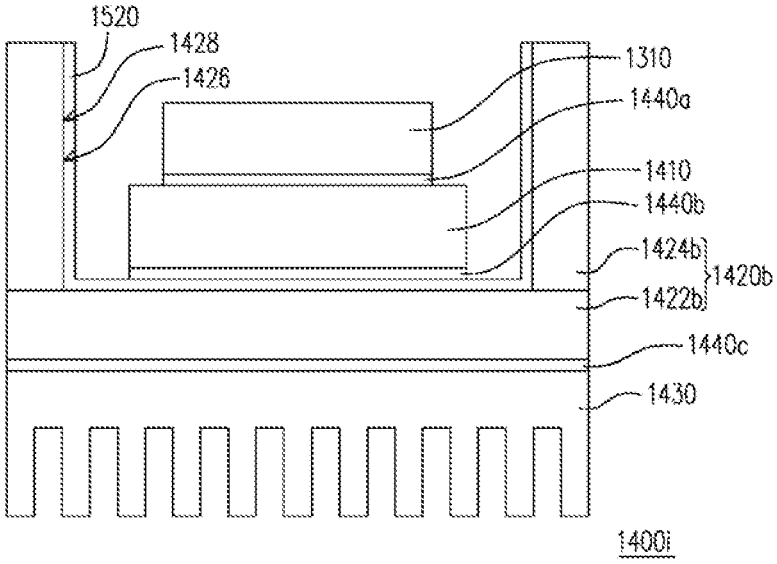

1520
1428
1426
1310
1440a
1410
1440b
1424b
1420b
1422b
1440c
1430
1400i

FIG. 34

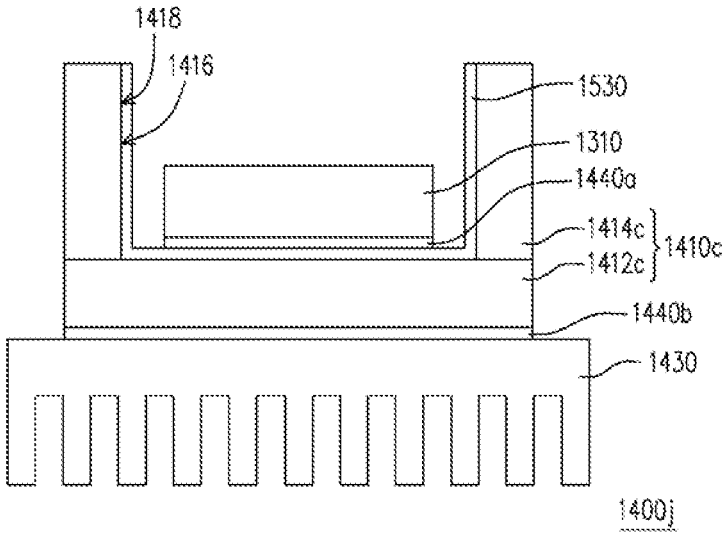

1418
1416
1530
1310
1440a
1414c
1410c
1412c
1440b
1430
1400j

FIG. 35

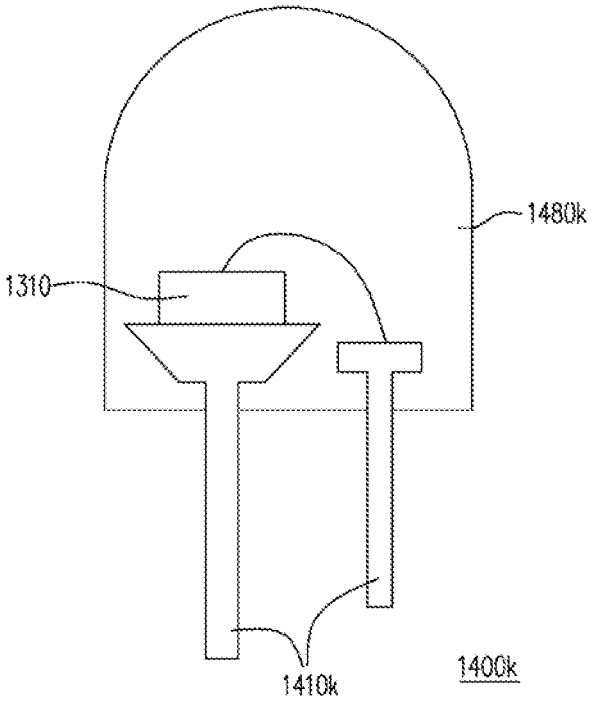


FIG. 36

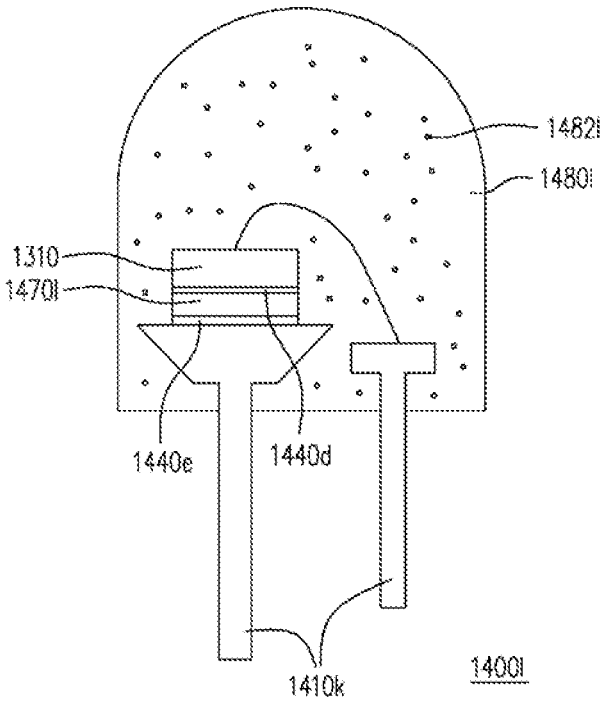


FIG. 37

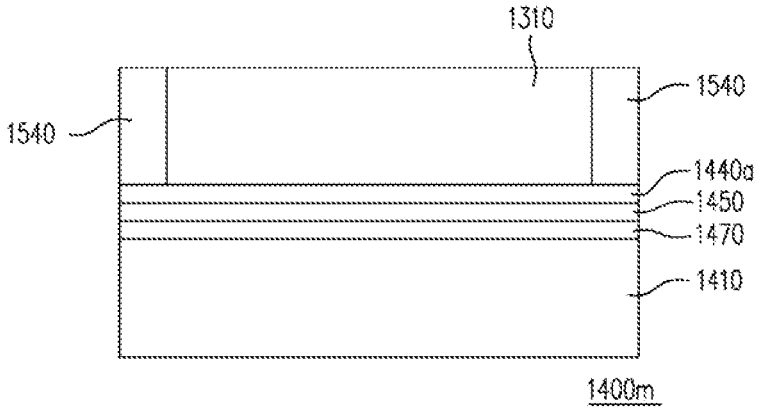

1310
1540
1540
1440a
1450
1470
1410
1400m

FIG. 38

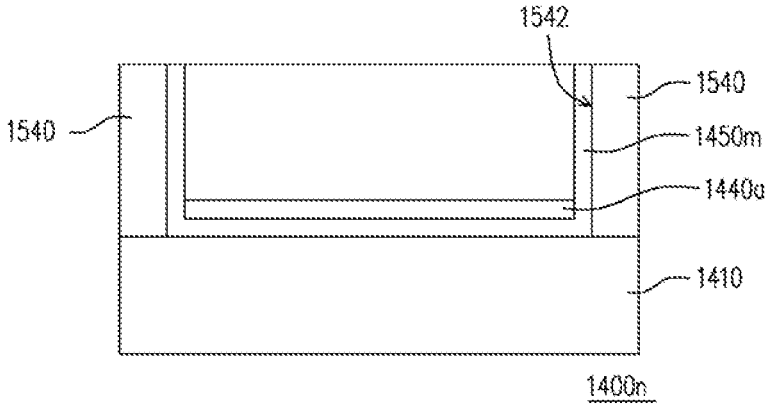

1542
1540
1540
1450m
1440a
1410
1400n

FIG. 39

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2008/073758

A. CLASSIFICATION OF SUBJECT MATTER

See extra sheet

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)

IPC: H01L 33/00; H01L 51/50; H01S 3/-; H01S 5/-; F21V 17/-

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) CNPAT; CNKI; WPI; EPODOC; PAJ; ELSEVIER: LED, magnetic w field, flux, magnetism, light w emit+, ferromagnetic, encapsu+, spintronic, emission

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP-9-219564A(HITACHI LTD)19 Aug. 1997(19.08.1997) description paragraphs [0024]-[0030], Fig.1	1-3,7,9,18-19,25,35,69,71-72
X	JP-9-83074A(NIKON CORP)28 Mar. 1997(28.03.1997) description paragraphs[0009]-[0060], Figs.1-2	4
X	WO2006/044027A2(GELCORE LLC et al.)27 Apr. 2006(27.04.2006) description page 4 line 24-page 5 line 6, Fig.2	41,62-63
X	US2006/0124953A1(CREE INC et al.)15 Jun. 2006(15.06.2006) description paragraphs[0127]-[0128], Fig.29	55,61

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"E" earlier application or patent but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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	Date of mailing of the international search report
17 Mar.2009(17.03.2009)	**02 Apr. 2009 (02.04.2009)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer TIAN,Xiqing Telephone No. (86-10)62414326

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2008/073758

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP2005-108609A(ASAHI GLASS CO LTD et al.)21Apr.2005(21.04.2005)the whole document	1-75
A	US3986194A(KAGAKU GIJUTSU-CHO KINZ et al.)12 Oct. 1976(12.10.1976) the whole document	1-75
A	US2001/0031547A1(UNIV TOHOKU)18 Oct. 2001(18.10.2001) the whole document	1-75
A	US4450460A(UNIV KYOTO)22 May 1984(22.05.1984)the whole document	1-75
A	T.Manago and H.Akinaga Spin-polarized Light-emitting Diode Using Metal/Insulator/Semiconductor Structures. APPLIED PHYSICS LETTERS. 22 Jul.2002,vol.81,No. 4, pages 694-696 the whole document	1-75

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2008/073758

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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		GB2087644B	24.10.1984

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2008/073758

A. CLASSIFICATION OF SUBJECT MATTER

H01L 33/00 (2009.01) i

H01L 51/50 (2006.01) i