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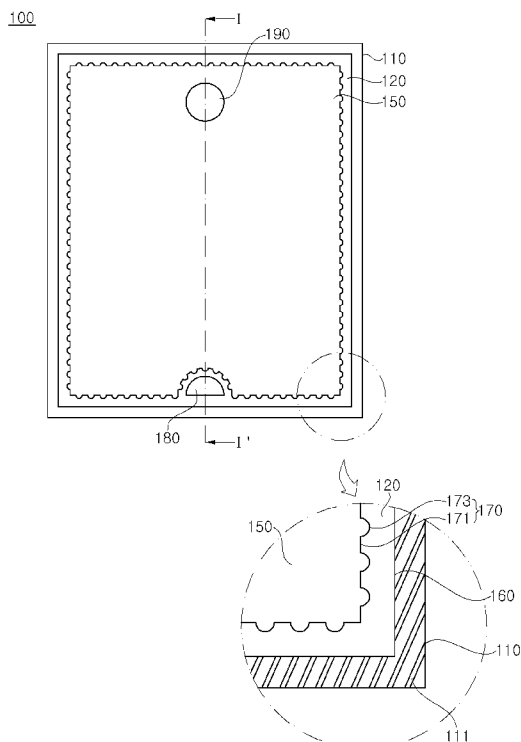
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(54) **Title:** LIGHT EMITTING DIODE CHIP



(57) **Abstract:** Disclosed herein is a light emitting diode chip. The light emitting diode chip includes a substrate, and a semiconductor stack, which is formed on the substrate and includes a first conductive type semiconductor layer, an active layer and a second conductive type semiconductor layer, the semiconductor stack having first side surface and second side surface disposed under the first side surface, wherein the first side surface is an outer side surface of the semiconductor stack to mesa-etching, the second side surface is an outer side surface of the first conductive type semiconductor layer, and at least one of the first side surface and second side surface has a convex pattern. Accordingly, the light emitting diode chip of the present invention can improve lateral light extraction by the convex pattern.



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GW, KM, ML, MR, NE, SN, TD, TG).

Description

Title of Invention: LIGHT EMITTING DIODE CHIP

Technical Field

- [1] The present invention relates to a light emitting diode chip and, more particularly, to a light emitting diode chip capable of improving luminous efficacy.

Background Art

- [2] A general light emitting diode chip includes a semiconductor stack formed on a substrate, such as a sapphire substrate, and electrodes formed on the semiconductor stack. In order to overcome light loss of the general light emitting diode chip due to total reflection of light generated in an active layer within the semiconductor stack, formation of a convex-concave pattern on the substrate has been proposed. However, this structure still has a problem of deterioration in light loss due to total reflection.

Disclosure of Invention

Technical Problem

- [3] It is an aspect of the present invention to provide a light emitting diode chip capable of improving luminous efficacy.

Solution to Problem

- [4] In accordance with one aspect of the present invention, a light emitting diode chip includes: a substrate; and a semiconductor stack formed on the substrate and including a first conductive type semiconductor layer, an active layer and a second conductive type semiconductor layer, the semiconductor stack having first side surface and second side surface disposed under first side surface, wherein the first side surface is an outer side surface of the semiconductor stack to mesa-etching, the second side surface is an outer side surface of the first conductive type semiconductor layer, and at least one of the first side surface and second side surface has a convex pattern. Accordingly, the light emitting diode chip of the present invention can improve lateral light extraction by the convex pattern.
- [5] At least one of the first side surface and second side surface further includes a concave pattern. The concave pattern comprises a flat shape, The concave pattern is arranged alternating with the convex pattern.
- [6] Each of the first side surface and second side surface further include a concave pattern. The concave pattern comprises a flat shape, The concave pattern is arranged alternating with the convex pattern.
- [7] At least one of the first side surface and second side surface includes a micro-lens pattern. The micro-lens pattern is arranged alternating with the convex pattern.
- [8] The convex pattern may include at least two of a rounded protrusion pattern, a

triangular protrusion pattern, and a rectangular protrusion pattern alternating with each other.

- [9] At least one of the first side surface and second side surface may further include a concave pattern. The concave pattern comprises a rounded groove shape, The concave pattern is arranged alternating with the convex pattern.
- [10] Each of the first side surface and second side surface may have a constant tilt angle.
- [11] The first conductive type semiconductor layer may further include a third side surface formed on the second side surface at an outer side surface thereof.
- [12] The convex pattern may include a first convex pattern placed on the first side surface; a second convex pattern placed on the second side surface; and a third convex pattern placed on the third side surface.
- [13] The first side surface may include a first planar pattern alternating with the first convex pattern, the second side surface may include a second planar pattern alternating with the second convex pattern, and the third side surface may include a third planar pattern alternating with the third convex pattern.
- [14] The light emitting diode chip may further include a transparent electrode layer on the second conductive type semiconductor layer. Here, an outer side surface of the transparent electrode layer is included in the first side surface.
- [15] The first side surface may correspond to a region formed by mesa-etching the transparent electrode layer and the semiconductor stack.
- [16] The first side surface may have a shape corresponding to an edge of a mask used for mesa-etching.
- [17] The second side surface may correspond to a region of the first conductive type semiconductor layer etched in a unit cell dividing process.
- [18] The second side surface may have a shape corresponding to an edge of a mask used for the unit cell dividing process.

Advantageous Effects of Invention

- [19] According to embodiments of the present invention, the light emitting diode chip reduces total reflection of light at a side surface thereof by a convex pattern, which is formed on at least one of a first side surface formed by mesa-etching a transparent electrode layer and a semiconductor stack, and a second side surface formed by etching a first conductive type semiconductor layer using a unit cell dividing process, thereby providing excellent light extraction efficiency.
- [20] In addition, the light emitting diode chip has a planar pattern alternating with the convex pattern, a concave pattern alternating with the convex pattern, a micro-lens pattern alternating with the convex pattern, or a triangular pattern alternating with the convex pattern on at least one of the first and second side surfaces, thereby providing

excellent light extraction efficiency.

- [21] With such structures of the first and second side surfaces, the light emitting diode chip of the present invention has improved light extraction efficiency, thereby improving luminous efficacy.

[22]

Brief Description of Drawings

- [23] Figure 1 is a schematic plan view of a light emitting diode chip according to a first embodiment of the present invention.

- [24] Figure 2 is a sectional view of the light emitting diode chip taken along line I-I' of Figure 1.

- [25] Figure 3 is a schematic plan view of a light emitting diode chip according to a second embodiment of the present invention.

- [26] Figure 4 is a sectional view of the light emitting diode chip taken along line I-I' of Figure 3.

- [27] Figure 5 is a schematic plan view of a light emitting diode chip according to a third embodiment of the present invention.

- [28] Figure 6 is a sectional view of the light emitting diode chip taken along line I-I' of Figure 5.

- [29] Figure 7 is a schematic plan view of a light emitting diode chip according to a fourth embodiment of the present invention.

- [30] Figure 8 is a sectional view of the light emitting diode chip taken along line I-I' of Figure 7.

- [31] Figure 9 to Figure 11 are views of light emitting diode chips according to other embodiments of the present invention.

Best Mode for Carrying out the Invention

- [32] Hereinafter, exemplary embodiment of the invention will be described with reference to the accompanying drawings. It should be understood that the following embodiments are given by way of illustration only to provide thorough understanding of the invention to those skilled in the art. Therefore, the present invention is not limited to the following embodiments and may be embodied in different ways. In addition, like components will be denoted by like reference numerals throughout the specification, and the widths, lengths, and thicknesses of certain elements, layers or features may be exaggerated for clarity.

- [33] Figure 1 is a schematic plan view of a light emitting diode chip according to a first embodiment of the present invention, and Figure 2 is a sectional view of the light emitting diode chip taken along line I-I' of Figure 1.

- [34] Referring to Figures 1 and 2, a light emitting diode chip 100 according to the first

embodiment of the invention includes a substrate 110, a semiconductor stack, a transparent electrode layer 150, a first electrode 180, and a second electrode 190.

[35] The substrate 110 may be a growth substrate for growth of a gallium nitride-based compound semiconductor layer, such as a sapphire substrate, a spinel substrate, a gallium nitride substrate, a silicon carbide substrate, or a silicon substrate, without being limited thereto.

[36] The substrate 110 includes a convex-concave pattern 111 formed on an upper surface thereof. The convex-concave pattern 111 serves to improve luminous efficacy. The convex-concave pattern 111 refracts light, which is directed toward the surface of the substrate 110, to the outside of the substrate. The convex-concave pattern 111 is formed in a protruding stripe type semi-cylindrical shape.

[37] Although the convex-concave pattern 111 is illustrated as having the protruding stripe type semi-cylindrical shape, it should be understood that the present invention is not limited thereto. Alternatively, the convex-concave pattern 111 may have an island type semi-spherical shape, or other polygonal shapes.

[38] The semiconductor stack includes a first conductive type semiconductor layer 120, an active layer 130, and a second conductive type semiconductor layer 140.

[39] The active layer 130 is interposed between the first conductive type semiconductor layer 120 and the second conductive type semiconductor layer 140, and may have a single quantum well structure or a multi-quantum well structure. The compositional elements and ratio of the active layer 130 are determined to emit light having a desired wavelength, for example, UV or visible light.

[40] The first conductive type semiconductor layer 120 may include n-type GaN, and the second conductive type semiconductor layer 140 may include p-type GaN. Alternatively, the first and second conductive type semiconductor layers may be formed of p-type and n-type GaN, respectively. Each of the first and second conductive type semiconductor layers 120, 140 may be formed as a single layer or multiple layers.

[41] The active layer 130, and the first and second conductive type semiconductor layers 120, 140 may be formed by MOCVD or MBE.

[42] The transparent electrode layer 150 is formed on the second conductive type semiconductor layer 140. The transparent electrode layer 150 may be formed of a transparent oxide, such as ITO, ZnO, FTO, AZO, and GZO, graphene, CNT, Ni/Au, and the like, and form ohmic contact with the second conductive type semiconductor layer 140. Although not shown in the drawings, a current blocking layer (not shown) may be formed between the transparent electrode layer 150 and the second conductive type semiconductor layer 140. The current blocking layer serves to enhance current spreading between the transparent electrode layer 150 and the second conductive type semiconductor layer 140.

- [43] In the light emitting diode chip 100, the first conductive type semiconductor layer 120 is partially etched together with the transparent electrode layer 150, the second conductive type semiconductor layer 140 and the active layer 130 by mesa etching to expose the first conductive type semiconductor layer 120. An outer side surface of the transparent electrode layer 150 and the semiconductor stack subjected to mesa etching is defined as a first side surface 170. The first side surface 170 is formed with a convex pattern 173 and a concave pattern 171, which enhance lateral light extraction efficiency.
- [44] The convex pattern 173 and the concave pattern 171 are alternately formed along the first side surface 170, and the convex pattern 173 has a rounded protrusion shape. The convex pattern 173 and the concave pattern 171 may be formed in a mask process using photoresist. In other words, an outer side surface of the mask (not shown) has the same shape as those of the convex pattern 173 and the concave pattern 171.
- [45] The light emitting diode chip 100 is divided into unit cells on the substrate 110 and the unit cells are divided from each other by scribing, thereby providing unit light emitting diode chips 100, as shown in Figures 1 and 2.
- [46] Here, in the process of dividing the light emitting diode chip 100 into the unit cells, the first conductive type semiconductor layer 120 is also divided into the unit cells by etching, so that an upper surface of the substrate 110 can be exposed at an edge thereof.
- [47] The outer side surface of the first conductive type semiconductor layer 120 divided into the unit cells is defined as a second side surface 160. The second side surface 160 has a flat structure.
- [48] In the light emitting diode chip 100 according to the first embodiment of the invention described above, the convex pattern 173 and the concave pattern 171 are alternately formed on the first side surface 170 of the transparent electrode layer 150 and the semiconductor stack, whereby total reflection is reduced at the side surface of the light emitting diode chip 100, thereby enabling excellent light extraction of the light emitting diode chip.
- [49] Figure 3 is a schematic plan view of a light emitting diode chip according to a second embodiment of the present invention and Figure 4 is a sectional view of the light emitting diode chip taken along line I-I' of Figure 3.
- [50] As shown in Figures 3 and 4, a light emitting diode chip 200 according to the second embodiment of the invention has the same structure as the light emitting diode chip 100 (see Figure 1) according to the first embodiment except for a second side surface 260. Thus, the same components will be denoted by the same reference numerals, and detailed descriptions thereof will be omitted.
- [51] The first side surface 170 includes a first convex pattern 173 and a first concave

pattern 171. The first convex pattern 173 and the first concave pattern 171 are alternately formed along the first side surface 170.

[52] The second side surface 260 is defined by an outer side surface of the first conductive type semiconductor layer 120 and includes a second convex pattern 263 and a second concave pattern 261. The second convex pattern 263 and the second concave pattern 261 are alternately formed along the second side surface 260. The second convex pattern 263 and the second concave pattern 261 serve to enhance lateral light extraction of the light emitting diode chip 200. The second convex pattern 263 has a rounded protrusion shape. The second convex pattern 263 and the second concave pattern 261 may be formed in a mask process using photoresist. In other words, an outer side surface of the mask (not shown) has the same shape as those of the second convex pattern 263 and the second concave pattern 261. The second convex pattern 263 and the second concave pattern 261 are formed by the unit cell dividing process.

[53] In the light emitting diode chip 200 according to the second embodiment of the invention described above, the first convex pattern 173 and the first concave pattern 171 are alternately formed on the first side surface 170, which is formed by mesa etching the transparent electrode layer 150 and the semiconductor stack, and the second convex pattern 263 and the second concave pattern 261 are alternately formed on the second side surface 260 of the first conductive type semiconductor layer 120 etched by the unit cell dividing process, whereby total reflection is reduced at the side surface of the light emitting diode chip 200, thereby enabling excellent light extraction of the light emitting diode chip.

[54] Figure 5 is a schematic plan view of a light emitting diode chip according to a third embodiment of the present invention, and Figure 6 is a sectional view of the light emitting diode chip taken along line I-I' of Figure 5.

[55] As shown in Figures 5 and 6, a light emitting diode chip 300 according to the third embodiment of the invention has the same structure as the light emitting diode chip 100 (see Figure 1) according to the first embodiment except for second and third side surfaces 260, 360. Thus, the same components will be denoted by the same reference numerals and detailed descriptions thereof will be omitted.

[56] The first side surface 170 includes a first convex pattern 173 and a first concave pattern 171. The first convex pattern 173 and the first concave pattern 171 are alternately formed along the first side surface 170.

[57] The second side surface 260 is defined as an outer side surface of the first conductive type semiconductor layer 120, and includes a second convex pattern 263 and a second concave pattern 261. The second convex pattern 263 and the second concave pattern 261 are alternately formed along the second side surface 260. The second convex pattern 263 and the second concave pattern 261 serve to enhance lateral light ex-

traction of the light emitting diode chip 300. The second convex pattern 263 has a rounded protrusion shape.

- [58] The third side surface 360 is defined as an outer side surface of the first conductive type semiconductor layer 120 and is placed on the second side surface 260. The third side surface 360 includes a third convex pattern 363 and a third concave pattern 361. The third convex pattern 363 and the third concave pattern 361 are alternately formed along the third side surface 360. The third convex pattern 363 and the third concave pattern 361 serve to enhance lateral light extraction of the light emitting diode chip 300. The third convex pattern 363 has a rounded protrusion shape.
- [59] The second convex pattern 263, the second concave pattern 261, and the third convex pattern 363 and the third concave pattern 361 may be formed in a mask process using photoresist. In other words, an outer side surface of the mask (not shown) has the same shape as those of the second convex pattern 263, the second concave pattern 261, the third convex pattern 363, and the third concave pattern 361. The second convex pattern 263, the second concave pattern 261, the third convex pattern 363, and the third concave pattern 361 are formed by the unit cell dividing process. Here, the second convex pattern 263, the second concave pattern 261, the third convex pattern 363, and the third concave pattern 361 may be formed by a single mask process. In other words, the second convex pattern 263, the second concave pattern 261, the third convex pattern 363, and the third concave pattern 361 may be formed using a diffraction mask or a halftone mask.
- [60] In the light emitting diode chip 300 according to the third embodiment of the invention described above, the first convex pattern 173 and the first concave pattern 171 are alternately formed on the first side surface 170, which is formed by mesa etching the transparent electrode layer 150 and the semiconductor stack, the second convex pattern 263 and the second concave pattern 261 are alternately formed on the second side surface 260 of the first conductive type semiconductor layer 120 etched by the unit cell dividing process, and the third convex pattern 363 and the third concave pattern 361 are alternately formed on the third side surface 360, whereby total reflection is reduced at the side surface of the light emitting diode chip 300, thereby enabling excellent light extraction of the light emitting diode chip.
- [61] Figure 7 is a schematic plan view of a light emitting diode chip according to a fourth embodiment of the present invention, and Figure 8 is a sectional view of the light emitting diode chip taken along line I-I' of Figure 7.
- [62] As shown in Figures 7 and 8, a light emitting diode chip 400 according to the fourth embodiment of the invention has the same structure as the light emitting diode chip 200 (see Figure 3) according to the second embodiment except for first and second side surfaces 470, 460. Thus, the same components will be denoted by the same reference

numerals and detailed descriptions thereof will be omitted.

[63] The first side surface 470 includes a first convex pattern 473 and a first concave pattern 471. The first convex pattern 473 and the first concave pattern 471 are alternately formed along the first side surface 470. The first side surface 470 has a constant tilt angle.

[64] The second side surface 460 includes a second convex pattern 463 and a second concave pattern 461. The second convex pattern 463 and the second concave pattern 461 are alternately formed along the second side surface 460. The second side surface 460 has a constant tilt angle.

[65] In the light emitting diode chip 400 according to the fourth embodiment of the invention described above, the first convex pattern 473 and the first concave pattern 471 are alternately formed on the first side surface 470, which is formed by mesa etching the transparent electrode layer 150 and the semiconductor stack, the second convex pattern 463 and the second concave pattern 461 are alternately formed on the second side surface 460 of the first conductive type semiconductor layer 120 etched by the unit cell dividing process, and the first and second side surfaces 470, 460 have constant tilt angles, thereby further improving lateral light extraction of the light emitting diode chip 400.

[66] Figure 9 to Figure 11 are views of light emitting diode chips according to other embodiments of the present invention.

[67] Referring to Figure 9, a first side surface 570 of a transparent electrode layer and a semiconductor stack includes a first convex pattern 573 and a first concave pattern 571, and a second side surface 560 of a first conductive type semiconductor layer etched by the unit cell dividing process includes a second convex pattern 563 and a second concave pattern 561.

[68] The first and second convex patterns 573, 563 have rounded protrusion shapes, and the first and second concave patterns 571, 561 have rounded groove shapes. That is, the first and second side surfaces 570, 560 have wavy patterns.

[69] The first and second side surfaces 570, 560 can improve lateral light extraction of the light emitting diode chip by the wavy patterns.

[70] In this embodiment, the wavy patterns are illustrated as being formed on the first and second side surfaces 570, 560. However, the present invention is not limited thereto, and the wavy pattern may be formed on at least one of the first and second side surfaces 570, 560.

[71] Referring to Figure 10, a first side surface 670 of a transparent electrode layer and a semiconductor stack includes a first convex pattern 673 and a first micro-lens pattern 671, and a second side surface 660 of a first conductive type semiconductor layer etched by the unit cell dividing process includes a second convex pattern 663 and a

second micro-lens pattern 661.

[72] With the first convex pattern 673 and the first micro-lens pattern 671 formed on the first side surface 670, and the second convex pattern 663 and the second micro-lens pattern 661 formed on the second side surface 660, the light emitting diode chip has improved lateral light extraction.

[73] In this embodiment, although the first convex pattern 673 and the first micro-lens pattern 671 are illustrated as being formed on the first side surface 670 and the second convex pattern 663 and the second micro-lens pattern 661 are illustrated as being formed on the second side surface 660, the present invention is not limited thereto, and these patterns may be formed only on one of the first and second side surfaces 670, 660.

[74] Referring to Figure 11, a first side surface 770 of a transparent electrode layer and a semiconductor stack includes first and second convex patterns 773, 771, and a second side surface 760 of a first conductive type semiconductor layer etched by the unit cell dividing process includes third and fourth convex patterns 763, 761.

[75] The first and third convex patterns 773, 763 have rounded protrusion shapes, and the second and fourth convex patterns 771, 761 have triangular protrusion shapes.

[76] With the first and second convex patterns 773, 771 and the third and fourth convex patterns 763, 761 formed on the first and second side surfaces 770, 760, the light emitting diode chip has improved lateral light extraction.

[77] In this embodiment, although the first and second convex patterns 773, 771 and the third and fourth convex patterns 763, 761 are illustrated as being respectively formed on the first and second side surfaces 770, 760, the present invention is not limited thereto, and these patterns may be formed only on one of the first and second side surfaces 770, 760. In addition, although the convex pattern is illustrated as having a round shape or a triangular shape, the shape of the convex pattern may be modified in various ways so long as the convex pattern can provide a function of light extraction.

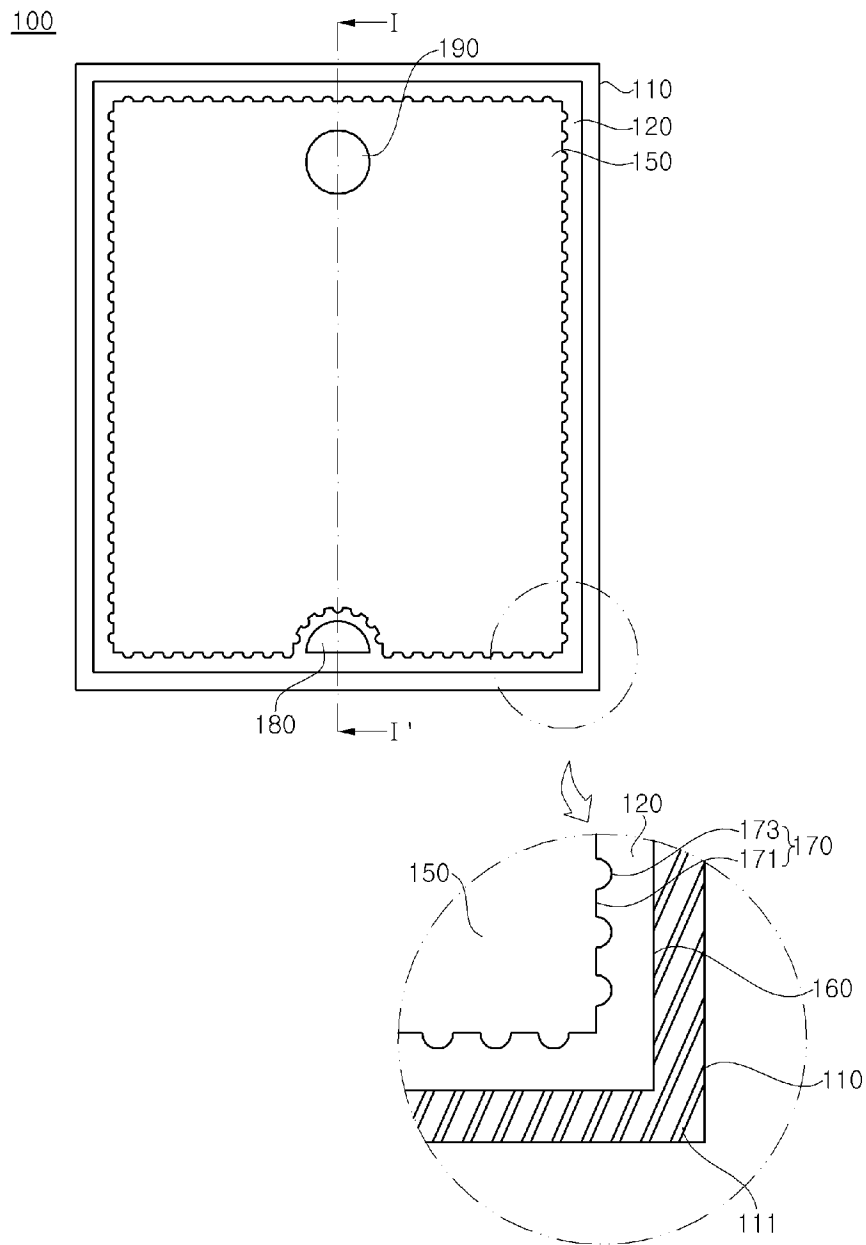
[78] Although some embodiments and features of the present invention have been described above, the present invention is not limited thereto, and may be modified in various ways without departing from the scope of the present invention.

Claims

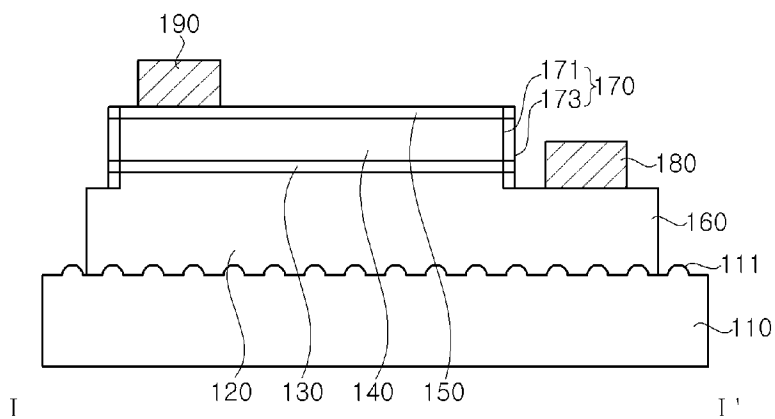
- [Claim 1] light emitting diode chip comprising:
a substrate; and
a semiconductor stack formed on the substrate and comprising a first conductive type semiconductor layer, an active layer and a second conductive type semiconductor layer, the semiconductor stack having a first side surface and a second side surface disposed under the first side surface,
wherein the first side surface is an outer side surface of the semiconductor stack to mesa-etching, the second side surface is an outer side surface of the first conductive type semiconductor layer, and at least one of the first side surface and the second side surface has a convex pattern.
- [Claim 2] The light emitting diode chip of claim 1, wherein at least one of the first side surface and the second side surface further comprises a concave pattern, the concave pattern comprises a flat shape, the concave pattern is arranged alternating with the convex pattern.
- [Claim 3] The light emitting diode chip of claim 1, wherein each of the first side surface and the second side surface further comprise a concave pattern, the concave pattern comprises a flat shape, the concave pattern is arranged alternating with the convex pattern .
- [Claim 4] The light emitting diode chip of claim 1, wherein at least one of the first side surface and the second side surface comprises a micro-lens pattern, the micro-lens pattern is arranged alternating with the convex pattern.
- [Claim 5] The light emitting diode chip of claim 1, wherein the convex pattern comprises at least two of a rounded protrusion pattern, a triangular protrusion pattern, and a rectangular protrusion pattern alternating with each other.
- [Claim 6] The light emitting diode chip of claim 1, wherein at least one of the first side surface and second side surface further comprises a concave pattern, the concave pattern comprises a rounded groove shape, the concave pattern is arranged alternating with the convex pattern.
- [Claim 7] The light emitting diode chip of claim 1, wherein both the first surface and the second side surface have a constant tilt angle.
- [Claim 8] The light emitting diode chip of claim 1, wherein the first conductive type semiconductor layer further comprises a third side surface formed

- on the second side surface at an outer side surface thereof.
- [Claim 9] The light emitting diode chip of claim 7, wherein the convex pattern comprises:
- a first convex pattern placed on the first side surface;
 - a second convex pattern placed on the second side surface; and
 - a third convex pattern placed on the third side surface.
- [Claim 10] The light emitting diode chip of claim 9, wherein the first side surface comprises a first concave pattern alternating with the first convex pattern, the second side surface comprises a second concave pattern alternating with the second convex pattern, and the third side surface comprises a third concave pattern alternating with the third convex pattern.
- [Claim 11] The light emitting diode chip of claim 1, further comprising:
- a transparent electrode layer formed on the second conductive type semiconductor layer, an outer side surface of the transparent electrode layer being included in the first side surface.
- [Claim 12] The light emitting diode chip of claim 11, wherein the first side surface corresponds to a region formed by the mesa-etching the transparent electrode layer and the semiconductor stack.
- [Claim 13] The light emitting diode chip of claim 12, wherein the first side surface has a shape corresponding to an edge of a mask used for mesa-etching.
- [Claim 14] The light emitting diode chip of claim 1, wherein the second side surface corresponds to a region of the first conductive type semiconductor layer etched by a unit cell dividing process.
- [Claim 15] The light emitting diode chip of claim 13, wherein the second side surface has a shape corresponding to an edge of a mask used for the unit cell dividing process.

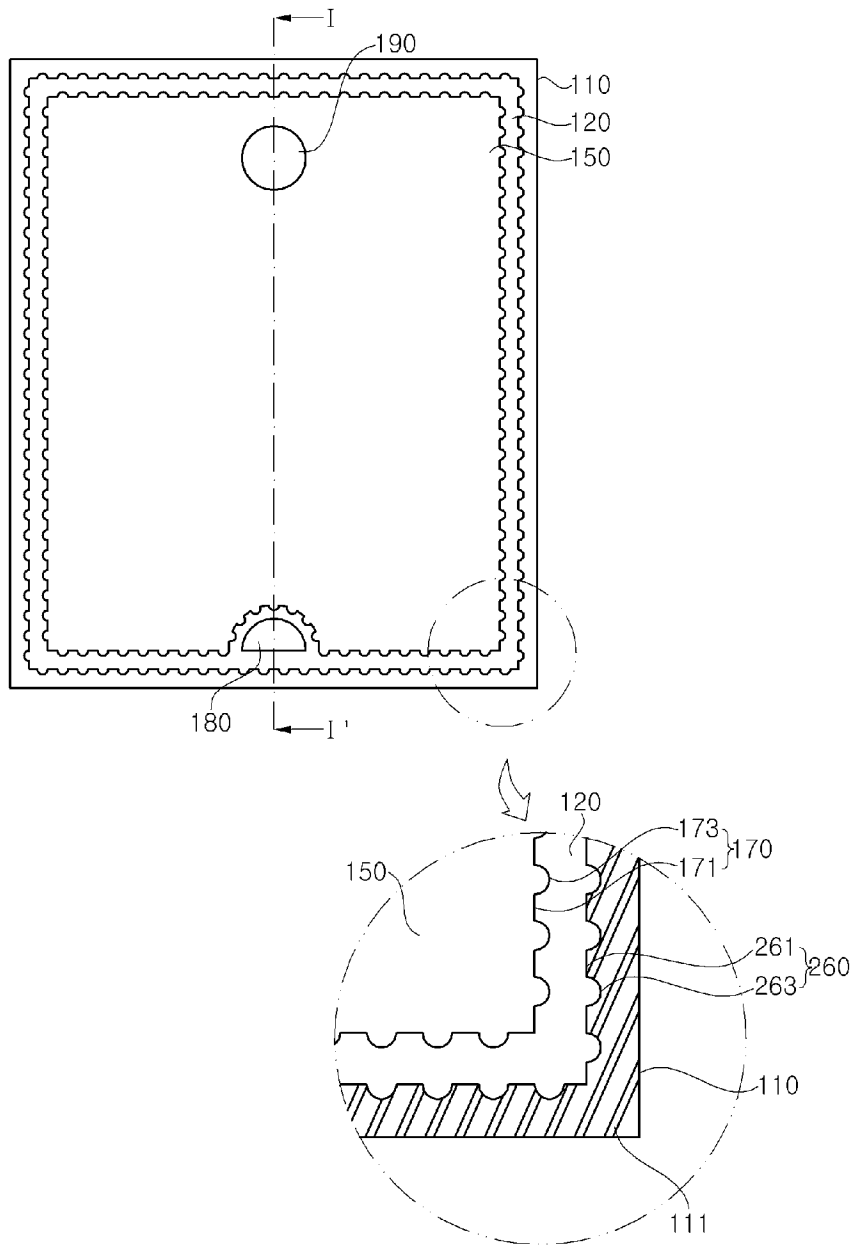
[Fig. 1]



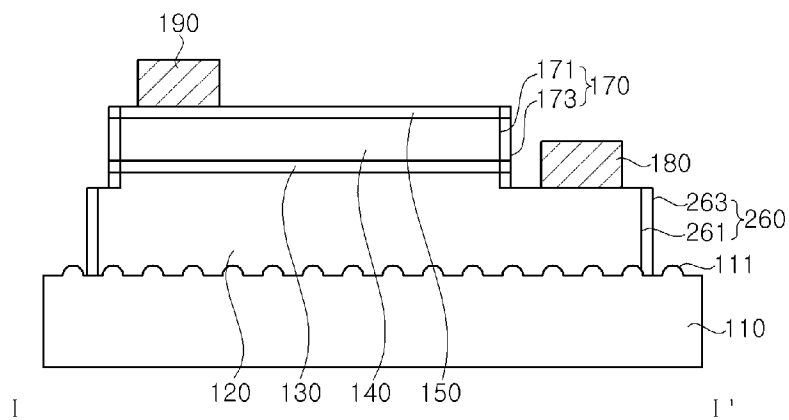
[Fig. 2]



[Fig. 3]

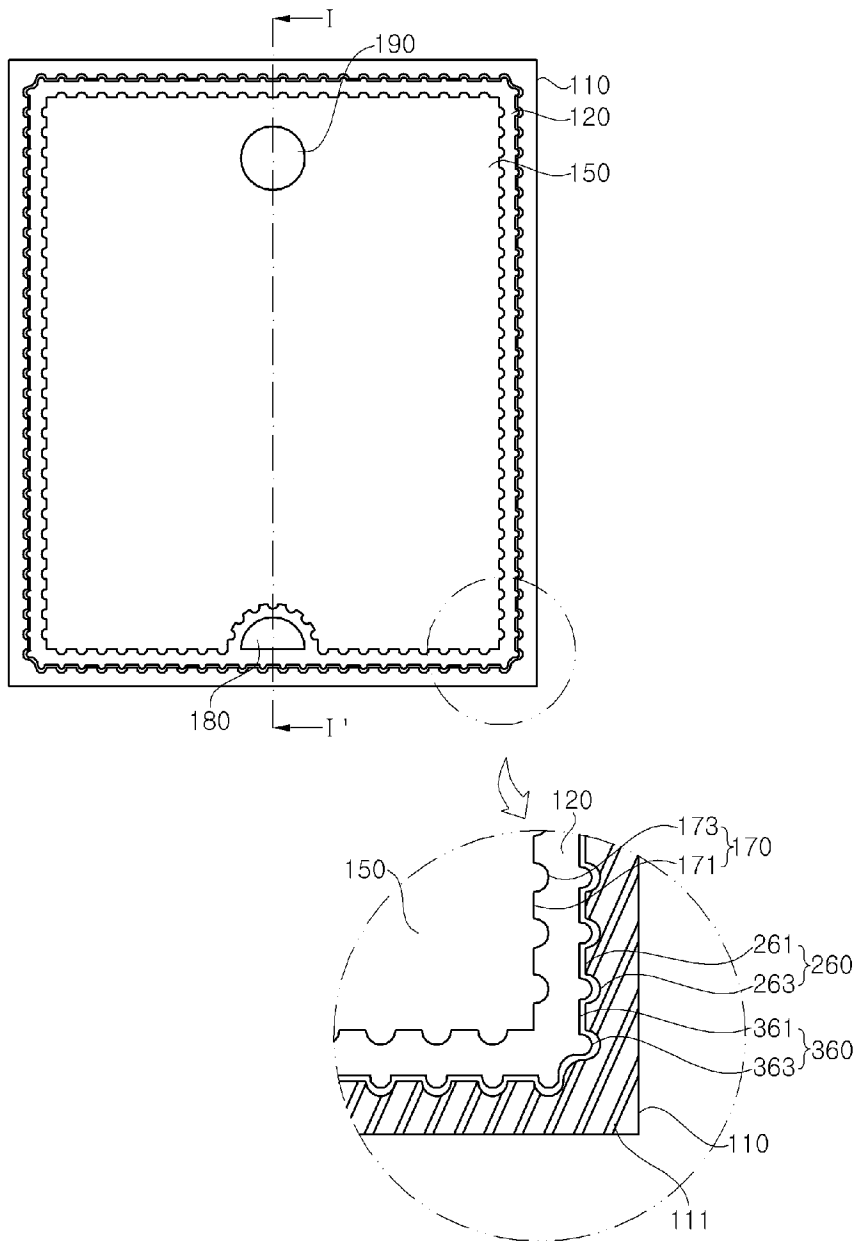
200

[Fig. 4]

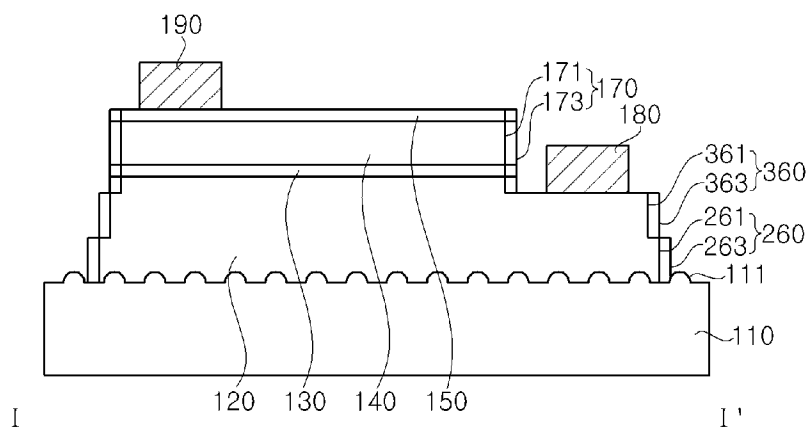


[Fig. 5]

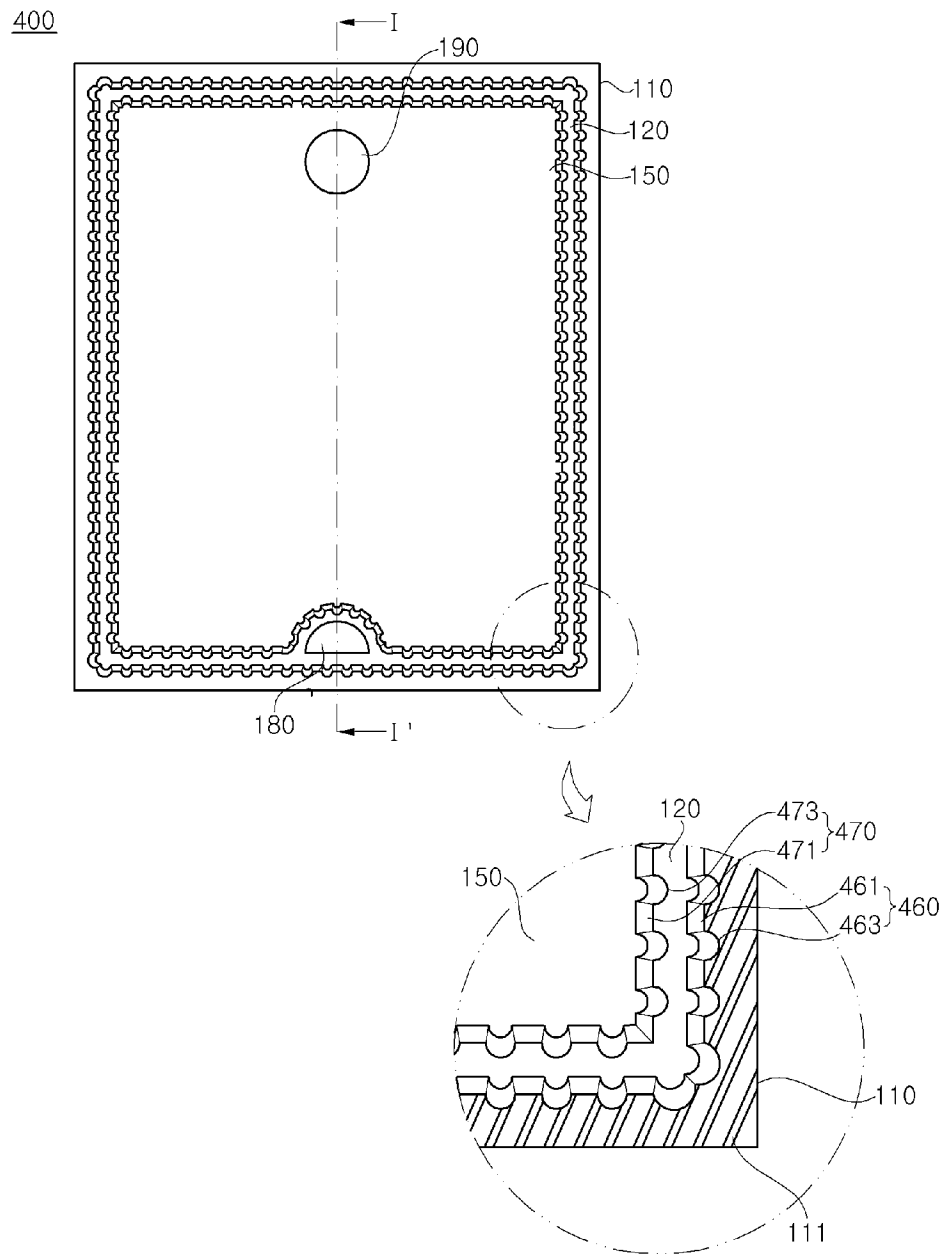
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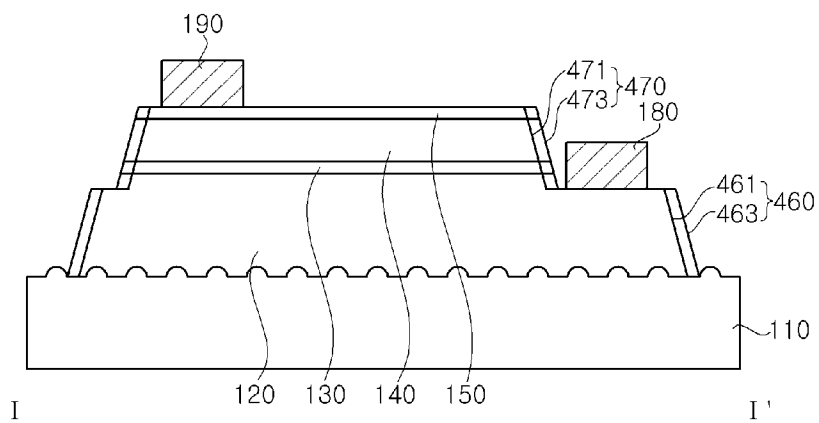
[Fig. 6]



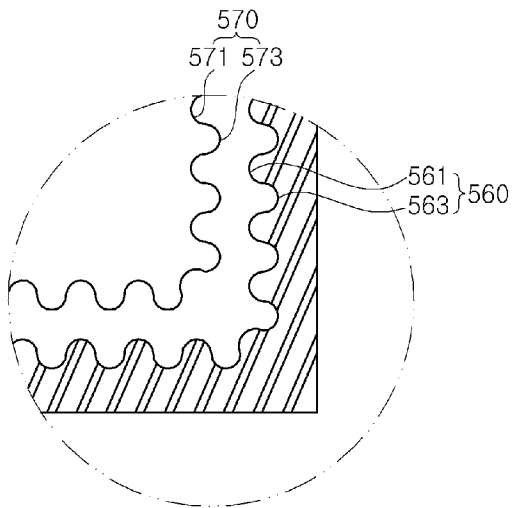
[Fig. 7]



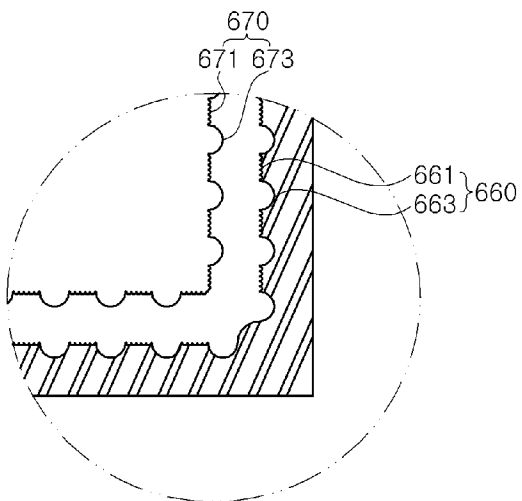
[Fig. 8]



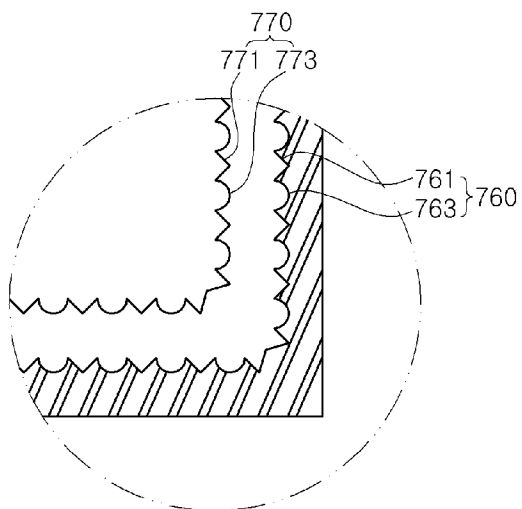
[Fig. 9]



[Fig. 10]



[Fig. 11]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2014/005482**A. CLASSIFICATION OF SUBJECT MATTER****H01L 33/22(2010.01)i, H01L 33/20(2010.01)i**

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)

H01L 33/22; H01L 33/20; H01L 33/10; H01L 33/36; H01L 33/00

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: light emitting diode, mesa-etching, convex, concave, side

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2010-0095134 A (LG INNOTEK CO., LTD.) 30 August 2010 See abstract, paragraphs 17-19, 35-36, 65, claim 1 and figures 1, 5.	1-15
Y	US 2011-0284894 A1 (HEE YOUNG BEOM et al.) 24 November 2011 See abstract, paragraphs 45-49, 53, 102, claims 1, 19 and figures 1, 2D.	1-15
A	KR 10-2011-0103608 A (LG INNOTEK CO., LTD.) 21 September 2011 See abstract, paragraphs 27-33, 62-67, claim 1 and figures 1, 11-12.	1-15
A	KR 10-2012-0005662 A (LG INNOTEK CO., LTD.) 17 January 2012 See abstract, paragraphs 10-22, 67-80, claims 1, 4 and figures 4-5.	1-15
A	JP 2007-258338 A (ROHM CO., LTD.) 04 October 2007 See abstract, paragraphs 19-27, 44-53, claim 1 and figures 1, 4-8.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2014/005482

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR 10-2010-0095134 A	30/08/2010	CN 101814563 A CN 101814563 B EP 2221887 A1 US 2010-0213488 A1 US 8552443 B2	25/08/2010 06/11/2013 25/08/2010 26/08/2010 08/10/2013
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