US008124994B2

(12) United States Patent
Yuan et al.

(10) **Patent No.: US 8,124,994 B2**
(45) **Date of Patent: Feb. 28, 2012**

(54) **ELECTRICAL CURRENT DISTRIBUTION IN LIGHT EMITTING DEVICES**

(75) Inventors: **Shu Yuan**, Shatin (HK); **Shiming Lin**, Beijing (CN)

(73) Assignee: **Tinggi Technologies Private Limited**, Singapore (SG)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **12/440,019**

(22) PCT Filed: **Sep. 4, 2007**

(86) PCT No.: **PCT/SG2007/000288**

§ 371 (c)(1),
(2), (4) Date: **Jan. 12, 2010**

(87) PCT Pub. No.: **WO2008/030188**

PCT Pub. Date: **Mar. 13, 2008**

(65) **Prior Publication Data**

US 2010/0117107 A1 May 13, 2010

(30) **Foreign Application Priority Data**

Sep. 4, 2006 (SG) 200606050-3

(51) **Int. Cl.**
H01L 33/00 (2010.01)
H01L 21/00 (2006.01)

(52) **U.S. Cl.** **257/98**; 257/E33.066; 438/29

(58) **Field of Classification Search** 257/E33.066, 257/E33.067, E33.068, 79–103; 438/29–32, 438/34

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,897,627	A	8/1975	Klatskin
4,107,720	A	8/1978	Pucel et al.
5,192,987	A	3/1993	Khan et al.
5,405,804	A	4/1995	Yabe
5,654,228	A	8/1997	Shieh et al.
5,719,433	A	2/1998	Delage et al.
5,811,927	A	9/1998	Anderson et al.
5,879,862	A	3/1999	Roh
6,020,261	A	2/2000	Weisman
6,091,085	A	7/2000	Lester
6,169,297	B1	1/2001	Jang et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1373522 A 10/2002

(Continued)

OTHER PUBLICATIONS

M.K. Kelly, et al., "Optical Process for Liftoff of Group III-Nitride Films," Physica Status Solidi (a), vol. 159, Issue 1, pp. R3-R4, (Nov. 28, 1996).

(Continued)

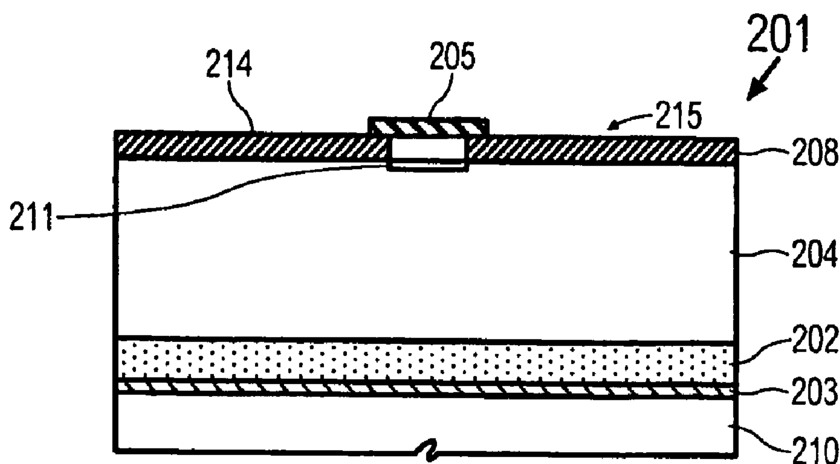
Primary Examiner — Tucker Wright

(74) *Attorney, Agent, or Firm* — Blakely, Sokoloff, Taylor & Zafman LLP

(57) **ABSTRACT**

A light emitting device is disclosed that has a plurality of epitaxial layers including an active layer, at least one of a reflective layer and an ohmic contact on a first side of the epitaxial layers; and a layer of a conductive metal on a second side of the epitaxial layers and having a light emitting surface. A terminal is on the light emitting surface, the terminal comprising an array for diffusing electrical current and minimizing its effect on light output. The array may have a bonding pad, an outer portion, and a joining portion connecting the bonding pad and the outer portion; the outer portion and the joining portion being for current dissipation.

8 Claims, 8 Drawing Sheets



U.S. PATENT DOCUMENTS

6,210,479 B1 4/2001 Bojarczuk et al.
6,259,156 B1 7/2001 Kohno et al.
6,303,405 B1 10/2001 Yoshida et al.
6,307,218 B1 10/2001 Steigerwald et al.
6,319,778 B1 11/2001 Chen et al.
6,365,429 B1 4/2002 Kneissl et al.
6,380,564 B1 4/2002 Chen et al.
6,420,242 B1 7/2002 Cheung et al.
6,420,732 B1 7/2002 Kung et al.
6,426,512 B1 7/2002 Ito et al.
6,448,102 B1 9/2002 Kneissl et al.
6,455,870 B1 9/2002 Wang et al.
6,492,661 B1 12/2002 Chien et al.
6,509,270 B1 1/2003 Held
6,562,648 B1 5/2003 Wong et al.
6,573,537 B1 6/2003 Steigerwald et al.
6,586,875 B1 7/2003 Chen et al.
6,589,857 B2 7/2003 Ogawa et al.
6,627,921 B2 9/2003 Wong et al.
6,627,989 B2 9/2003 Kohno et al.
6,649,437 B1 11/2003 Yang et al.
6,677,173 B2 1/2004 Ota
6,821,804 B2 11/2004 Thibeault et al.
7,338,822 B2 3/2008 Wu et al.
7,348,212 B2 3/2008 Schiaffino et al.
2001/0055324 A1 12/2001 Ota
2002/0022286 A1 2/2002 Nikolaev et al.
2002/0034835 A1 3/2002 Chen et al.
2002/0093023 A1 7/2002 Camras et al.
2002/0113279 A1 8/2002 Hanamaki et al.
2002/0117681 A1 8/2002 Weeks et al.
2002/0134985 A1 9/2002 Chen et al.
2002/0137243 A1 9/2002 Chen et al.
2002/0179910 A1 12/2002 Slater, Jr.
2003/0038284 A1 2/2003 Kurahashi et al.
2003/0064535 A1 4/2003 Kub et al.
2003/0111667 A1 6/2003 Schubert
2003/0151357 A1 8/2003 Uemura
2003/0178626 A1 9/2003 Sugiyama et al.
2003/0189212 A1 10/2003 Yoo
2003/0189215 A1 10/2003 Lee et al.
2003/0218179 A1 11/2003 Koide et al.
2004/0026709 A1 2/2004 Bader et al.
2004/0031967 A1 2/2004 Fudeta et al.
2004/0033638 A1 2/2004 Bader et al.
2004/0065889 A1 4/2004 Ueda et al.
2004/0104395 A1 6/2004 Hagimoto et al.
2004/0110395 A1 6/2004 Ueda et al.
2004/0130037 A1 7/2004 Mishra et al.
2004/0144991 A1 7/2004 Kikkawa
2004/0217362 A1 11/2004 Slater, Jr. et al.
2004/0235210 A1 11/2004 Tamura et al.
2005/0014303 A1 1/2005 Tsai et al.
2005/0026399 A1 2/2005 Chien et al.
2005/0035354 A1 2/2005 Lin et al.
2005/0082555 A1 4/2005 Chien et al.
2005/0087884 A1 4/2005 Stokes et al.
2005/0093002 A1 5/2005 Tsai et al.
2005/0098792 A1 5/2005 Lee et al.
2005/0127397 A1 6/2005 Borges et al.
2005/0142875 A1 6/2005 Yoo
2005/0164482 A1 7/2005 Saxlar
2005/0173692 A1 8/2005 Park et al.
2006/0006554 A1 1/2006 Yoo et al.
2006/0099730 A1 5/2006 Lee et al.
2006/0124939 A1 6/2006 Lee et al.
2006/0151801 A1 7/2006 Doan et al.
2006/0154390 A1 7/2006 Tran et al.
2006/0154391 A1 7/2006 Tran et al.
2006/0154392 A1 7/2006 Tran et al.
2006/0154393 A1 7/2006 Doan et al.
2006/0157721 A1 7/2006 Tran et al.
2006/0163586 A1 7/2006 Denbaars et al.
2006/0186418 A1 8/2006 Edmond et al.
2007/0029541 A1 2/2007 Xin et al.
2008/0164480 A1 7/2008 Kang et al.
2008/0210970 A1 9/2008 Kang et al.
2008/0265366 A1 10/2008 Guo et al.

FOREIGN PATENT DOCUMENTS

EP 1 061 590 A1 12/2000
EP 1 139 409 A2 10/2001
EP 1 326 290 A2 7/2003
EP 1 502 284 A2 2/2005
EP 1 693 891 A2 8/2006
JP 50-074876 6/1975
JP 52-055480 5/1977
JP 59-112667 6/1984
JP 63-095661 4/1988
JP 04-078186 3/1992
JP 05-291621 11/1993
JP 07-326628 12/1995
JP 10-117016 5/1998
JP 2000-164928 6/2000
JP 2000-183400 6/2000
JP 2000-277804 10/2000
JP 2000-294837 10/2000
JP 2001-035974 2/2001
JP 2001-036129 2/2001
JP 2001-049491 2/2001
JP 2001-168094 6/2001
JP 2001-168387 6/2001
JP 2001-237461 8/2001
JP 2001-274507 10/2001
JP 2001-313422 11/2001
JP 2003-152138 5/2003
JP 2003-218383 7/2003
JP 2003-303743 10/2003
JP 2003-309286 10/2003
JP 2003-318443 11/2003
JP 2003-347590 12/2003
JP 2004-072052 3/2004
JP 2004-088083 3/2004
JP 2004-319552 11/2004
JP 2005-012188 1/2005
JP 2005-236048 9/2005
JP 2005-260255 9/2005
JP 2005-286187 10/2005
JP 2006-253647 9/2006
KR 20010088931 9/2001
KR 10-0338180 5/2002
KR 10-2002-079659 10/2002
KR 20040058479 7/2004
KR 20040104232 12/2004
SG 200401424-7 3/2004
SG 200401964-2 4/2004
SG 200506301-1 9/2005
SG 200506897-8 10/2005
SG 200508210-2 12/2005
SG 200605500-8 8/2006
TW 419836 B 1/2001
TW 475276 B 2/2002
TW 540171 B 7/2003
WO WO 01/47039 A1 6/2001
WO WO 2004/102686 A1 11/2004
WO WO 2005/029572 A1 3/2005
WO WO 2005/029573 A1 3/2005
WO WO 2005/062745 A2 7/2005
WO WO 2005/064666 A1 7/2005
WO WO 2005/088743 A1 9/2005
WO WO 2005/096365 A1 10/2005
WO WO 2005/098974 A1 10/2005
WO WO 2005/104780 A2 11/2005
WO WO 2007/046773 A1 4/2007
WO WO 2007/037762 A1 5/2007
WO WO 2007/073354 A1 6/2007
WO WO 2008/020819 A1 2/2008

OTHER PUBLICATIONS

Tetsuzo Ueda, et al., "Vertical InGaN-Based Blue Light Emitting Diode with Plated Metal Base Fabricated using Laser Lift-Off Technique," Physica Status Solidi (c), vol. 0, Issue 7, pp. 2219-2222, (Oct. 20, 2003).

Chen-Fu Chu, et al., "Comparison of p-Side Down and p-Side Up GaN Light-Emitting Diodes Fabricated by Laser Lift-Off", Japan Journal of Applied Physics, vol. 42, Part 2, No. 2B, pp. L147-L150, (Feb. 15, 2003).

W.H. Li, et al., "Electrochemical Deposition of Copper on Pattemed Cu/Ta(N)SiO2 Surfaces for Super Filling of Sub-Micron Features", Joumal of Applied Electrochemistry, vol. 31, pp. 1395-1397, (Aug. 20, 2001).
Zhifang Fan, et al., "Very Low Resistance Multilayer Ohmic Contact to n-Gan," Applied Physics Letters, vol. 68, Issue 12, pp. 1672-1674, (Mar. 18, 1996).
I. Schnitzer, et al., "30% External Quantum Efficiency from Surface Textured, Thin-Film Light-Emitting Diodes," Applied Physics Letters, vol. 63, Issue 16, pp. 2174-2176, (Oct. 18, 1993).
Shyi-Ming Pan, et al., "Improvement of InGaN-GaN Light-Emitting Diodies with Surface-Textured Indium-Tin-Oxide Transparent Ohmic Contacts," IEEE Photonics Technology Letters, vol. 15, Issue 5, pp. 649-651, (May 2003).
Chul Huh, et al., "Improved Light-Output and Electrical Performance of InGaN-Based Light-Emitting Diode by Microroughening of the *p*-GaN Surface," Journal of Applied Physics, vol. 93, Issue 11, pp. 9383-9385, (Jun. 1, 2003).
F.A. Kish, et al., "Very High-Efficiency Semiconductor Wafer-Bonded Transparent-Substrate $(Al_xGa_{1-x})_{0.5}In_{0.5}P/GaP$ Light-Emitting Diodes," Applied Physics Letters, vol. 64, Issue 21, pp. 2839-2841, (May 23, 1994).
R.H. Horng, et al., "AlGaInP Light-Emitting Diodes with Mirror Substrates Fabricated by Wafer Bonding," Applied Physics Letters, vol. 75, Issue 20, pp. 3054-3056, (Nov. 15, 1999).
H. Sugawara, et al., "Characteristics of a Distributed Bragg Reflector for the Visible-Light Spectral Region using InGaAIP and GaAs: Comparison of Transparent- and Loss-Type Structures," Journal of Applied Physics, vol. 74, Issue 5, pp. 3189-3193, (Sep. 1, 1993).
PCT International Search Report for PCT Application No. PCT/SG2003/000222 containing Communication relating to the Results of the Partial International Search Report, 3 pgs., (Dec. 9, 2003).
PCT International Search Report for PCT Application No. PCT/SG2003/000223 containing Communication relating to the Results of the Partial International Search Report, 3 pgs., (Dec. 9, 2003).
PCT International Search Report for PCT Application No. PCT/SG2005/000061 containing Communication relating to the Results of the Partial International Search Report, 2 pgs., (May 12, 2005).
PCT International Search Report for PCT Application No. PCT/SG2005/000062 containing Communication relating to the Results of the Partial International Search Report, 2 pgs., (May 12, 2005).
PCT International Search Report for PCT Application No. PCT/SG2006/000254 containing Communication relating to the Results of the Partial International Search Report, 4 pgs., (Nov. 16, 2006).
PCT International Search Report for PCT Application No. PCT/SG2006/000255 containing Communication relating to the Results of the Partial International Search Report, 3 pgs., (Nov. 6, 2006).
PCT International Search Report for PCT Application No. PCT/SG2006/000395 containing Communication relating to the Results of the Partial International Search Report, 3 pgs., (Feb. 26, 2007).
PCT International Search Report for PCT Application No. PCT/SG2005/000261 containing Communication relating to the Results of the Partial International Search Report, 3 pgs., (Oct. 12, 2007).
International Search Report for PCT/SG2007/000288, 4 pgs. (Oct. 30, 2007).
PCT International Preliminary Report on Patentability for PCT Counterpart Application No. PCT/SG2007/000288, 5 pgs., (Jul. 11, 2008).
PCT Written Opinion of the International Searching Authority for PCT Counterpart Application No. PCT/SG2007/000288, 5 pgs., (Nov. 9, 2007).
Supplementary European Search Report for European Application No. 05711220.3-2222, 3 pgs., (Nov. 30, 2010).
Supplementary European Search Report for European Application No. 06784267.4-1235, 4 pgs., (Feb. 4, 2011).
Supplementary European Search Report for European Application No. 03818739, 1 pg., (Jan. 19, 2011).

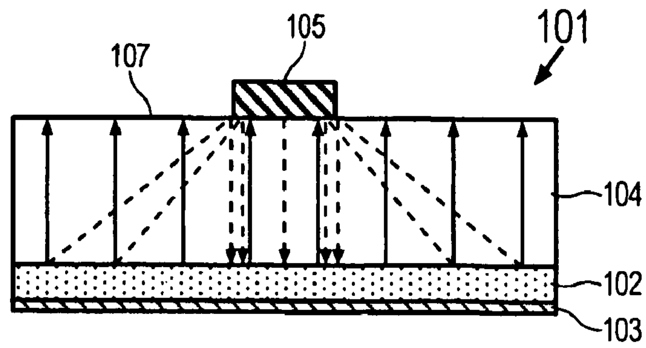


FIGURE 1

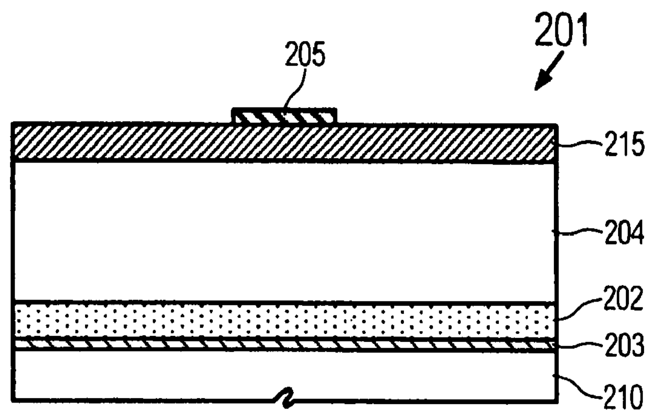


FIGURE 2

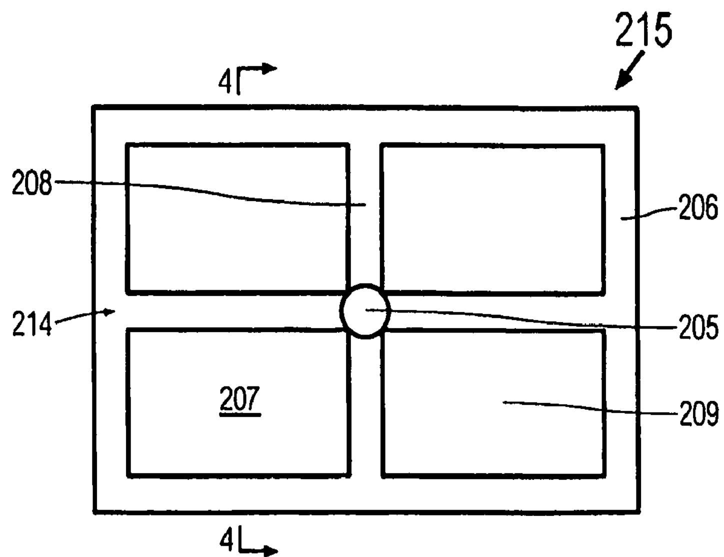


FIGURE 3

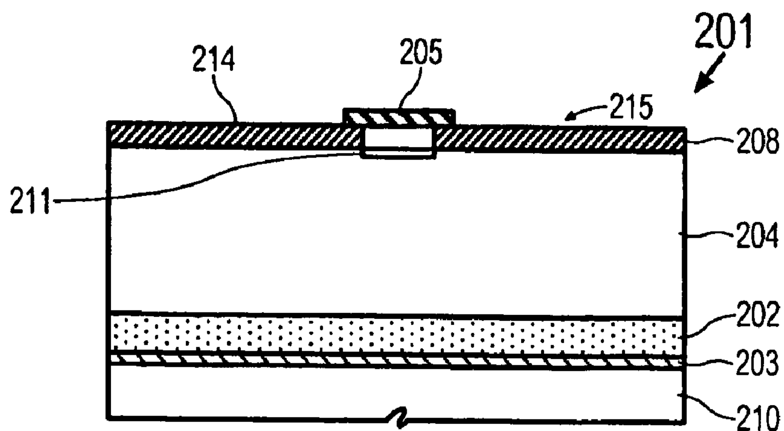


FIGURE 4

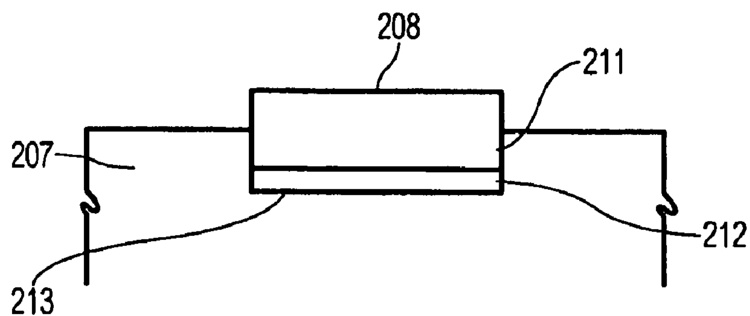


FIGURE 5

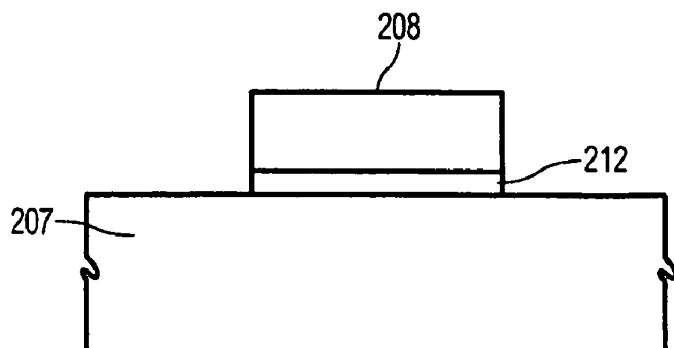


FIGURE 6

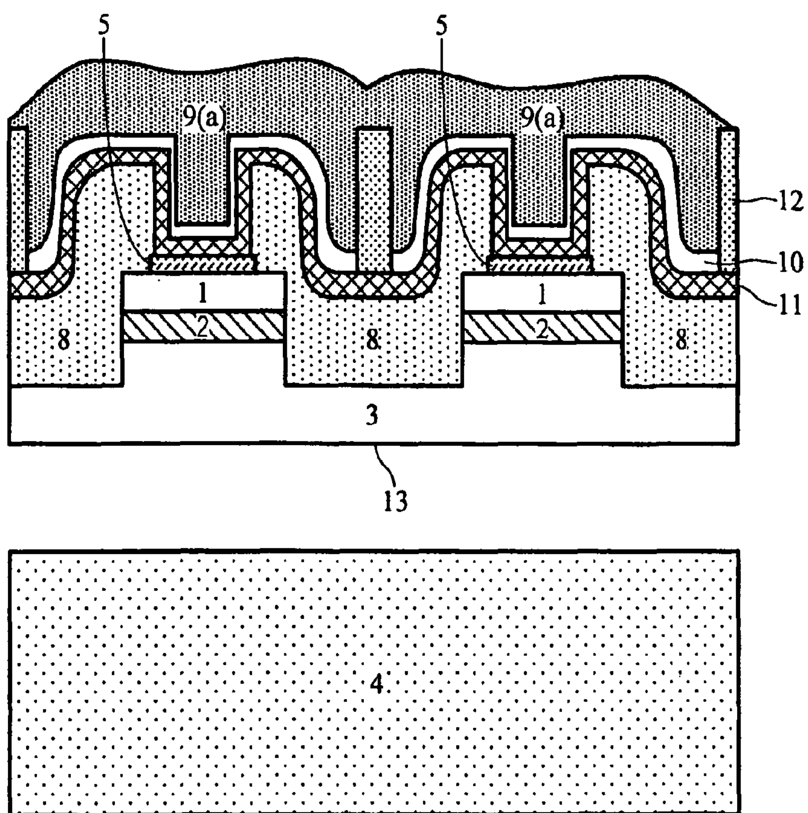


FIGURE 7

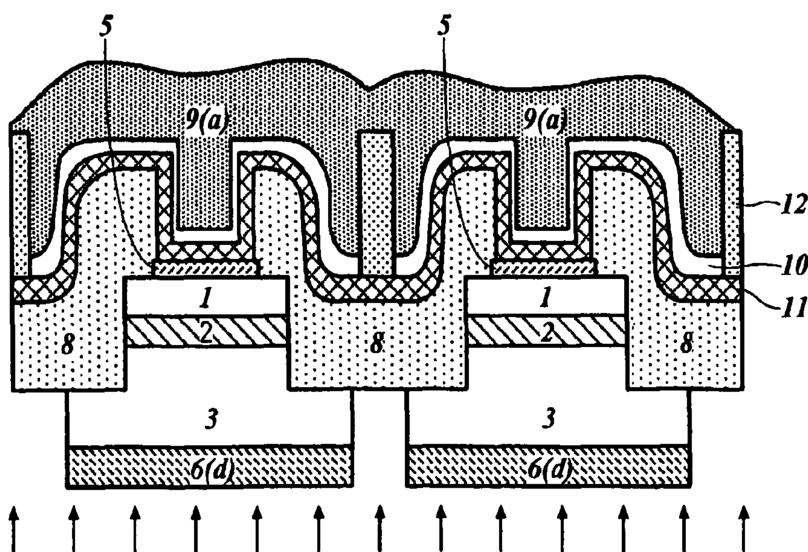


FIGURE 8

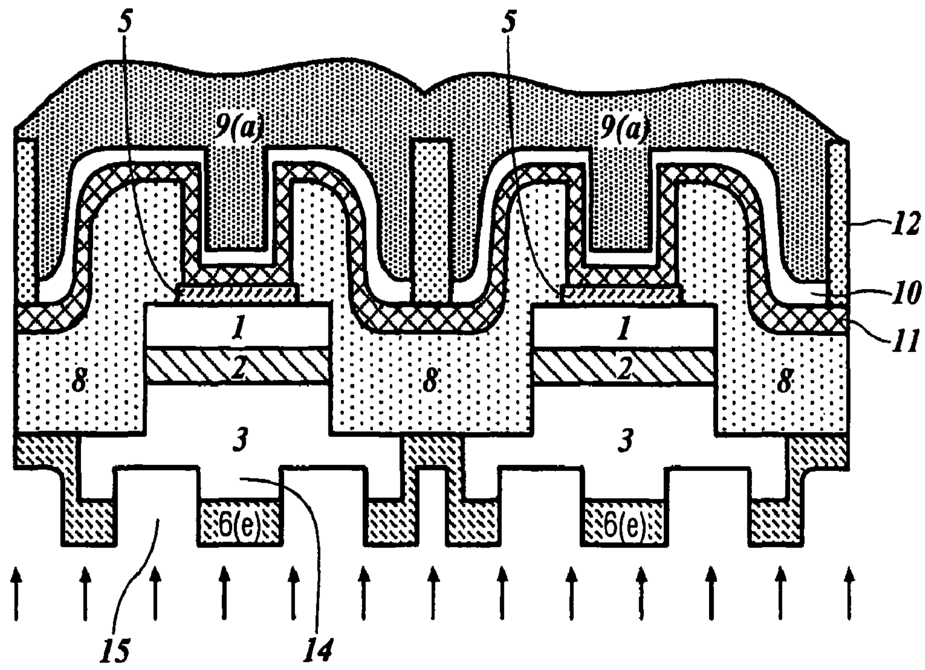


FIGURE 9A

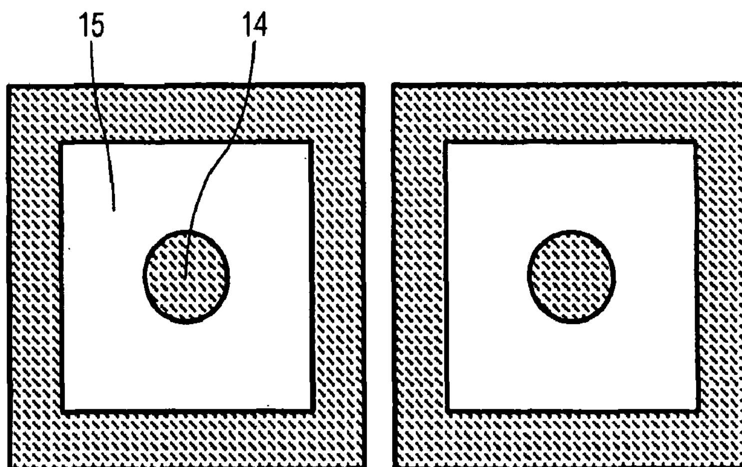


FIGURE 9B

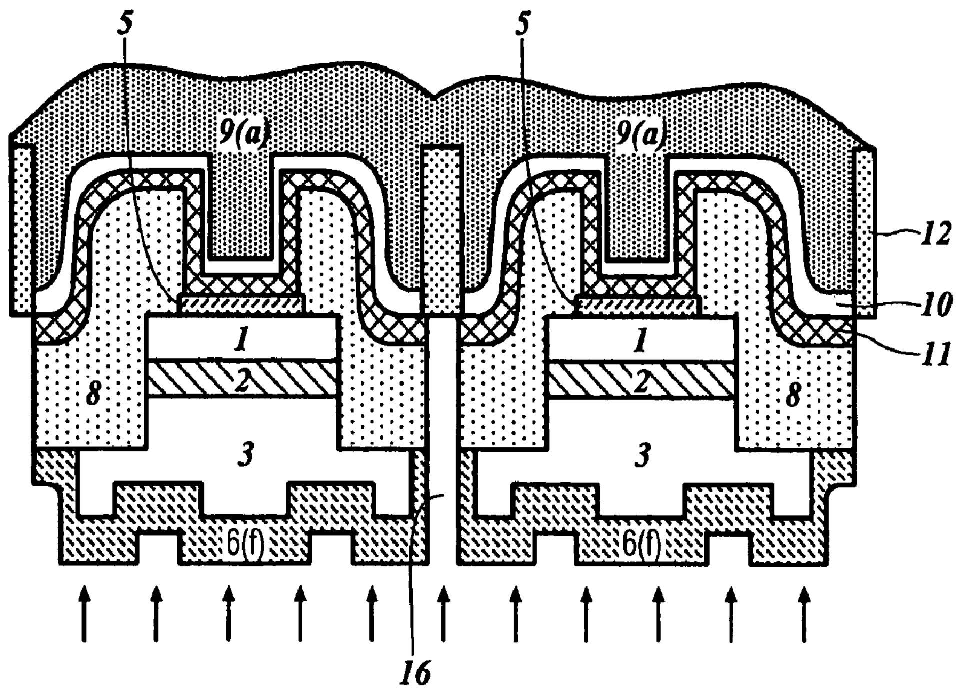


FIGURE 10A

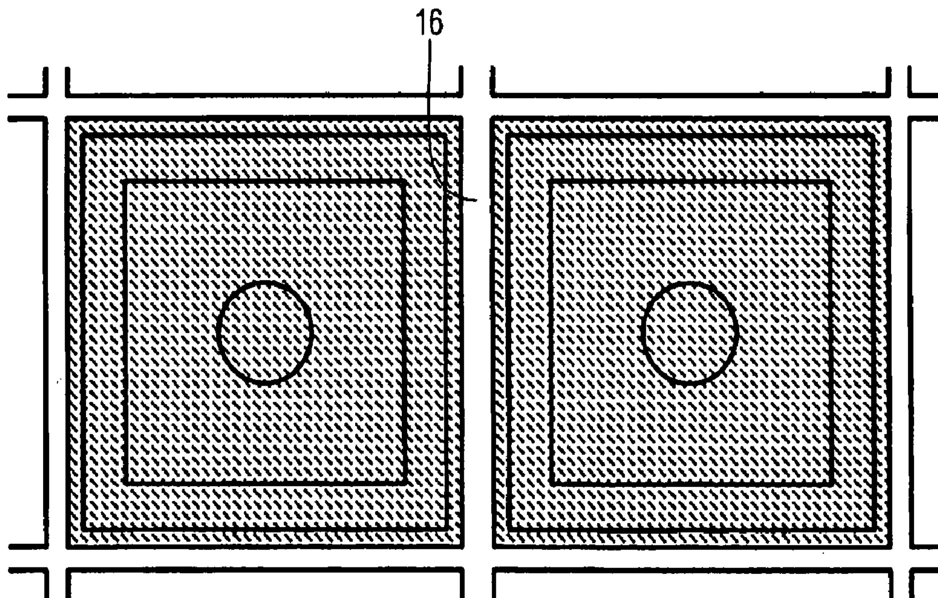


FIGURE 10B

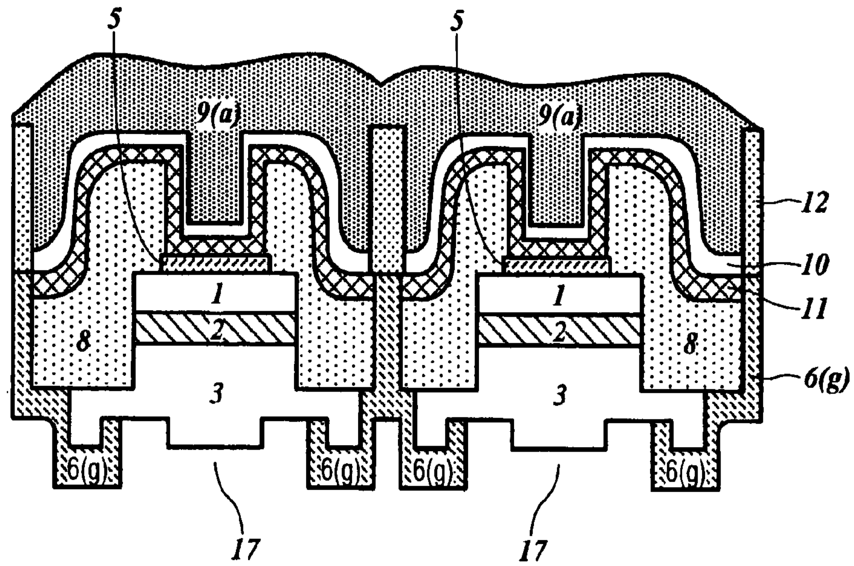


FIGURE 11A

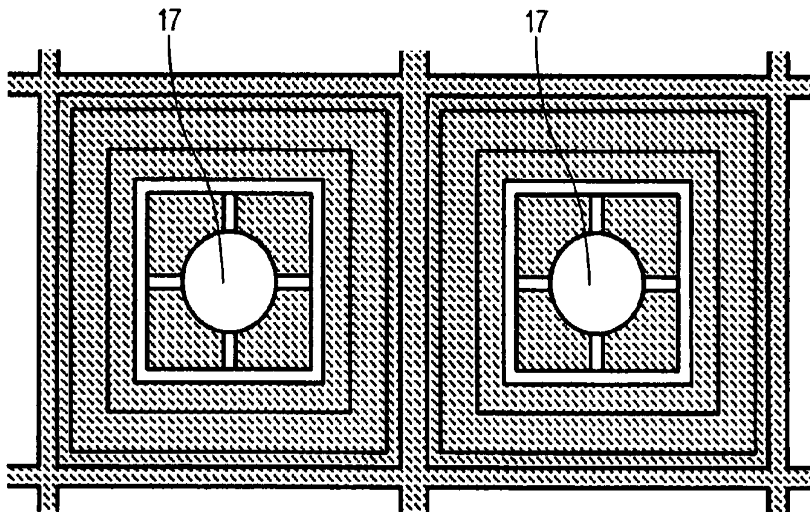


FIGURE 11B

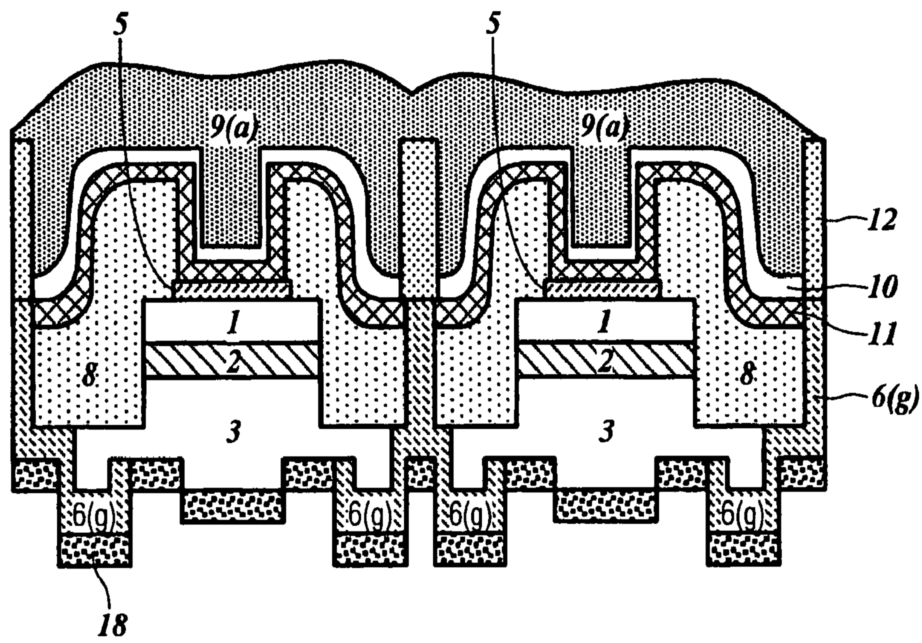


FIGURE 12

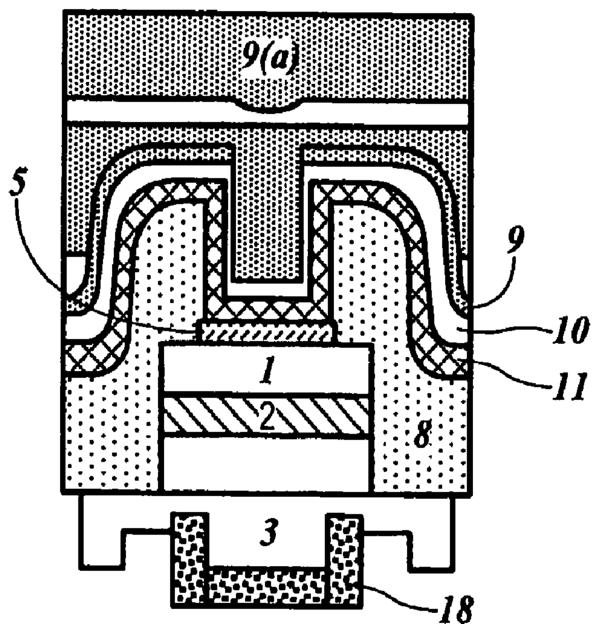


FIGURE 13A

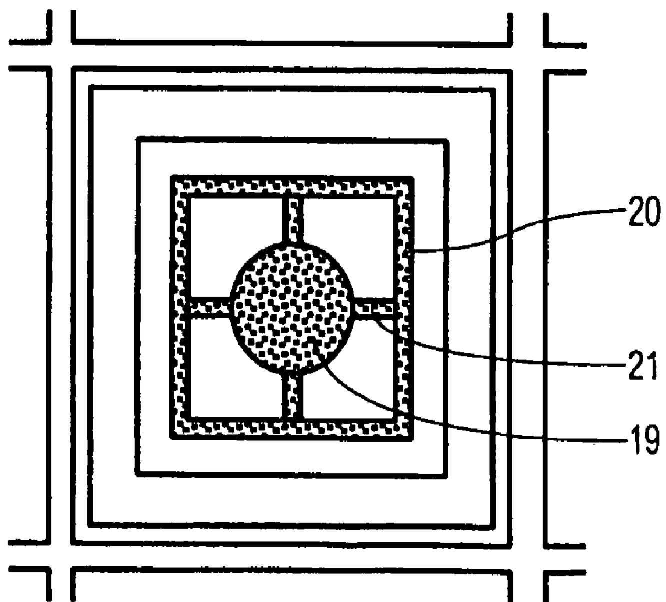


FIGURE 13B

ELECTRICAL CURRENT DISTRIBUTION IN LIGHT EMITTING DEVICES

CROSS REFERENCE TO RELATED APPLICATIONS

This patent application is a U.S. National Phase application under 35 U.S.C. §371 of International Application No. PCT/SG2007/000288, filed on Sep. 4, 2007, entitled ELECTRICAL CURRENT DISTRIBUTION IN LIGHT EMITTING DEVICES, which claims priority to Singapore patent application number 200606050-3, filed Sep. 4, 2006.

FIELD OF THE INVENTION

This invention relates to electrical current distribution in light emitting devices and refers particularly, through not exclusively, to apparatus for spreading the electrical current so as to maximize light output.

REFERENCE TO RELATED APPLICATION

Reference is made to earlier Singapore patent application 200506301-1 filed 29 Sep. 2005, the contents of which are incorporated herein by reference as if disclosed herein in their entirely.

BACKGROUD OF THE INVENTION

In most light emitting devices such as for example, light emitting diodes and laser diodes, bonding pads occupy about 15% of the surface area of the light emitting surface. Where the bonding pad is located, light cannot be emitted.

Also, as the electrical current flows from the bonding pad to the active region and will follow the path of least resistance (normally the shortest path, in uniform materials) the maximum current flow, and thus maximum light output, is beneath the bonding pad. This results in a significant reduction in the light output.

SUMMARY OF THE INVENTION

In accordance with a first preferred aspect there is provided a light emitting device comprising a plurality of epitaxial layers including an active layer; at least one of a reflective layer and an ohmic contact on a first side of the epitaxial layers; and a layer of a conductive metal on a second side of the epitaxial layers and having a light emitting surface. A terminal is on the light emitting surface. The terminal has an array for diffusing electrical current and minimizing its effect on light output.

The array may comprise a bonding pad, an outer portion, and a joining portion connecting the bonding pad and the outer portion; the outer portion and the joining portion being for current dissipation. The outer portion may be at or adjacent a periphery of the light emitting surface. The joining portion may comprise a plurality of spokes joining the bonding pad and the outer portion.

There may be a second reflective layer between the array and the light emitting surface. Alternatively, the second reflective layer may be at a bottom of a trench in the light emitting surface.

In accordance with a second preferred aspect there is provided a method of fabricating a light emitting device. The light emitting device has a plurality of epitaxial layers including an active layer, a reflective layer on a first side of the epitaxial layers, and a conductive metal on a second side of the epitaxial layers. The method includes forming a terminal on a light emitting surface of the conductive metal, the terminal having an array for diffusing electrical current and minimizing its effect on light output.

The forming of the array may be by forming a bonding pad, an outer portion, and a joining portion electrically connecting the bonding pad and the outer portion; the outer portion and the joining portion being for current dissipation. The outer portion may be at or adjacent a periphery of the light emitting surface. The joining portion may comprise a plurality of spokes joining the bonding pad and the outer portion.

The method may further comprise forming second reflective layer on the light emitting surface before forming the array on the second reflective layer.

Alternatively, the method may further comprise forming trench in the tight emitting surface, forming a second reflective layer at a bottom of the trench, the array being formed on the second reflective layer.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the present invention may be fully understood and readily put into practical effect, there shall now be described by way of non-limitative example only preferred embodiments of the present invention, the description being with reference to the accompanying illustrative drawings.

In the drawings:

FIG. **1** is a schematic side view of a light emitting device;

FIG. **2** is a schematic side view of a preferred embodiment of a light emitting device;

FIG. **3** is a stop pan view of the device of FIG. **2**;

FIG. **4** is a vertical cross-section along the lines and in the direction of arrows **4-4** on FIG. **3**; and

FIG. **5** is an enlarged view of the trench of FIG. **4**;

FIG. **6** is an alternative to the arrangement of FIG. **5**;

FIGS. **7** to **13** are series of views corresponding to FIG. **4** showing the fabrication of the device of FIGS. **2** to **4**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

To first refer to FIG. **1** there is shown a light emitting device **101** such as, for example, a light emitting diode or a laser diode, and having a reflective layer and/or ohmic contact **103** on a first side of a plurality of epitaxial layers including an active region **102**. A conductive metal layer **104** is on a second side of the epitaxial layers. The reflective layer **103** may be on the epitaxial layers and the ohmic contact on the reflective layer, or vice versa. There may be only one of them. A bonding pad **105** is provided on the light output surface **107**. The electrical current flows in the metal layer **104** to the active layer **102** by the paths as shown with the dotted lines on FIG. **1**. As can be seen, the maximum electrical current is concentrated under the bond pad **105**. That means the maximum light emitted by the active layer **102** (as shown by the sold lines) will also be concentrated under the bonding pad **105**. Such light will be reflected back into layer **104** by the bonding pad **105**. This significantly reduces the light output.

FIGS. **2** to **4** show a preferred embodiment where like reference numerals are used for like components but the prefix number "1" is changed to "2". Here, the bonding pad **105** is replaced by a terminal layer **215**.

The terminal layer **215** comprises an array **214** of electrically conductive material, preferably the same material as the bonding pad **205**, and which is electrically connected to both the bonding pad **205** and the light output surface **207**. The array **214** is distributed over the surface **207** so that electrical

current will flow from the terminal layer **215** to the active region **202** in a diffused or distributed manner.

The array **214** preferably has the bonding pad **205** as its center so the distribution of the array **214** is relatively uniform over the surface **207**. Also, it is preferred for the array **214** to be of reduced height when compared with the bonding pad **205**.

As shown, the array **214** comprises an outer portion **206** that is at or adjacent the periphery of surface **207**. This is to provide for light emission from at, and adjacent to, the periphery of active region **202**. Electrically and physically connecting the outer portion **206** and the bonding pad **205** is a joining portion **208** that is, in this case, four equally-spaced radial "spokes" extending from the bonding pad **205** to the outer portion **206**. All spokes **208** are preferably identical, and are more preferably of the same height and width as the outer portion **206**. Although four spokes **208** are shown in a cruciform shape, there may be any suitable number of spokes such as, for example, one, two, three, four, five, six, and so forth.

Between the spokes **208** and the outer portion **206** are light-emitting openings **209** for emission of light from light output surface **207**.

The outer portion **206** and/or each spoke **208** or array **214** may be located in a trench **211** formed in the light output surface **207**. The trench **211** may have a reflective layer **212** at its bottom **213** so that light propagated by active region **202** under the array **214** will be more efficiently reflected by reflective layer **212**. The reflective layer **212** may have a diffusing surface so that light will be reflected from it an angle other than perpendicular. The reflective layer **212** is electrically conductive to enable electric current to pass from array **214** to the active region **202**. The reflecting layer **212** is preferably of the same shape and dimensions on surface **207** as the array **214**.

As shown in FIG. **6**, the trench **211** may not be used and the reflective layer **212** may be applied directly to the light output surface **207** beneath array **214**.

FIGS. **7** to **13** show the process. These are FIGS. **11** to **17** of the related application, and are the process step after the original sapphire substrate **4** is removed.

As shown in FIG. **8**, after removal of the sapphire substrate **4**, the devices are isolated from each other by trench etching from the newly exposed surface **13** along the edges of the mesa, as shown in FIGS. **8** to **10**, with a photoresist layer **6**(*d*) protecting the regions of the n-type GaN layer **3** during the etching process.

Alternatively, the lowermost surface **13** of the n-type layer **3** may be cleaved at locations in alignment with the photoresists **12** and the dies separated. This is of advantage for laser diodes as the exposed side surfaces of the n-type layer **3** are substantially parallel, thus causing a large amount of total internal reflection. This acts as a light amplification system for improved, and directed light, output.

Pad etching takes place after applying a fifth resist layer **6**(*e*) over the exposed surfaces of SiO_2 layer **8**, the sides of the n-type GaN layer **3**, and the center of the n-type GaN layer **3** [FIGS. **9**(*a*) and (*b*)] thus forming projecting portions **14** and recess portions **15** of n-type GaN layer **3**.

The resist **6**(*e*) is the removed and a further resist **6**(*f*) applied over the exposed surfaces of the n-type GaN layer **3** and the outer periphery of the SiO_2 layer **8** to thus leave a gap **16** for die isolation. Etching takes place (FIG. **10**) through the gap **16** and the SiO_2 layer **8**, and seed layer **11** until the ends of the thick photoresists **12** are exposed. The resist **6**(*f*) is removed.

A final resist layer **6**(*g*) is applied over all exposed lower-surfaces from the edge of the SiO_2 layer **8** through to adjacent the center of the n-type GaN layer **3**, where a central gap **17** remains (FIG. **11**).

An array **214** of layer or layers **18** of n-type metals are then applied over the resist **6**(*g*) with the layer **18** at the gap **17** at the center of the n-type GaN layer **3** being applied directly to the GaN layer **3** (FIG. **12**). The resist layer **6**(*g*) with the layer **18** attached, is removed leaving the layer **18** attached to the center **17** of the n-type GaN layer **3** where gap **17** was previously located.

In this way the seed layers **11**, **10**, **9** and the copper layer **9**(*a*) act as reflectors to increase light output, with copper layer **9**(*a*) being one terminal, thus not interfering with light output. The second terminal is layer **18** in array **214** on the n-type layer **3** of GaN and this is an array at and/or around the center of that layer **3**, thus minimizing its effect on light output, and increasing the diffusion of current.

Whilst there has been described in the foregoing description preferred embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations or modifications in details of design or construction may be made without departing from the present invention.

What is claimed is:

1. A light emitting device comprising:

a plurality of epitaxial layers including an active layer;

a reflective layer on a first side of the epitaxial layers;

a layer of a conductive metal on a second side of the epitaxial layers and having a light emitting surface;

a terminal comprising an array on the light emitting surface, the array being for diffusing electrical current and minimizing its effect on light output; and

a second reflective layer of a same shape and dimensions as the array, the second reflective layer being beneath the array on the light emitting surface or at a bottom of a trench in the light emitting surface, the second reflective layer being for reflecting light propagated by the active layer under the array and being electrically conductive to enable electric current to pass from the array to the active layer, the second reflective layer including a diffusing surface to reflect the light propagated by the active layer at an angle other than perpendicular to the reflective layer.

2. The light emitting device as claimed in claim **1**, wherein the array comprises a bonding pad, an outer portion, and a joining portion connecting the bonding pad and the outer portion; the outer portion and the joining portion being for current dissipation.

3. The light emitting device as claimed in claim **2**, wherein the outer portion is at or adjacent a periphery of the light emitting surface.

4. The light emitting device as claimed in claim **2**, wherein the joining portion comprises a plurality of spokes joining the bonding pad and the outer portion.

5. A method of fabricating a light emitting device comprising a plurality of epitaxial layers including an active layer, a reflective layer on a first side of the epitaxial layers and a conductive metal on a second side of the epitaxial layer, the conductive metal having a light emitting surface; the method comprising:

forming a second reflective layer on the light emitting surface or at a bottom of a trench in the light emitting surface; and

forming a terminal comprising an array on the second reflective layer, the array being for diffusing electrical current and minimizing its effect on light output;

the second reflective layer being of a same shape and dimensions as the array, the second reflective layer also for reflecting light propagated by the active layer under the array and being electrically conductive to enable electric current to pass from the array to the active layer, and the second reflective layer including a diffusing surface to reflect light propagated by the active layer at an angle other than perpendicular to the reflective layer.

6. The method in claim **5**, wherein the forming of the array is by forming a bonding pad, an outer portion, and a joining portion electrically connecting the bonding pad and the outer portion; the outer portion and the joining portion being for current dissipation.

7. The method as claimed in claim **6**, wherein the outer portion is at or adjacent a periphery of the light emitting surface.

8. The method as claimed in claim **6**, wherein the joining portion comprises a plurality of spokes joining the bonding pad and the outer portion.

* * * * *