



- (51) International Patent Classification:
H01L 33/62 (2010.01) *H01L 33/48* (2010.01)
- (21) International Application Number:
PCT/US2013/033704
- (22) International Filing Date:
25 March 2013 (25.03.2013)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
13/436,247 30 March 2012 (30.03.2012) US
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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: CERAMIC-BASED LIGHT EMITTING DIODE (LED) DEVICES, COMPONENTS AND METHODS

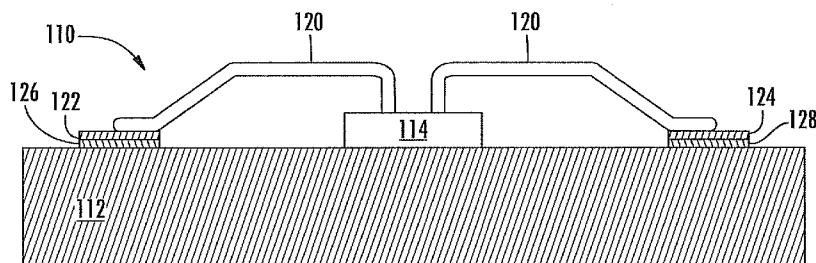


FIG. 1A

(57) Abstract: Devices, components and methods containing one or more light emitter devices, such as light emitting diodes (LEDs) or LED chips, are disclosed. In one aspect, a light emitter device component can include a ceramic body having a top surface, one or more light emitter devices mounted directly or indirectly on the top surface, and one or more electrical components mounted on the top surface and electrically coupled to the one or more light emitter devices, wherein the one or more electrical components can be spaced from the ceramic body by one or more non-metallic layers. Components disclosed herein can result in improved light extraction and thermal management.

DESCRIPTION
CERAMIC-BASED LIGHT EMITTING DIODE (LED) DEVICES,
COMPONENTS AND METHODS

5 CROSS REFERENCE TO RELATED APPLICATION

This application claims priority to U.S. Patent Application Serial No. 13/436,247, filed March 30, 2012, the disclosure of which is incorporated herein by reference in its entirety.

10 TECHNICAL FIELD

The subject matter disclosed herein relates generally to components, modules, and methods for light emitting diode (LED) lighting. More particularly, the subject matter disclosed herein relates to devices, components and methods for increasing brightness extracted from and improving the
15 manufacturability of light emitter devices, such as light emitting diodes (LEDs) or LED components.

BACKGROUND

Optoelectronic devices utilizing light emitters or light emitter devices,
20 such as light emitting diodes (LEDs) or LED components, have various applications in consumer electronics. One or more high brightness LED chips, for example, can be packaged within surface mount device (SMD) housings for use as light sources in space-limited applications where thermal management and size can be important. Some high brightness LED chips can be housed in
25 plastic, leaded chip carriers (PLCCs) or in or on ceramic-based housings or substrates, for example, housings comprising low temperature co-fired ceramic (LTCC) materials or high temperature co-fired ceramic (HTCC) materials. The LED chips and/or LED housings can be improved for display backlighting and illumination in automotive, signage, architectural, personal, and general-
30 illumination applications. Typical end-products for LED chips packaged within SMD housings include for example, but are not limited to, LED light bulbs, commercial/residential directional lighting, general indoor/outdoor illumination, commercial displays, indoor cabinet displays, flashes for cameras, retail and

window displays, emergency lighting and signs, household appliances, and television and automotive instrument panels.

One area of improvement of LED components includes the increasing amount of light, or brightness, extracted per package. Packages for high brightness LED chips can incorporate various design features for increasing the amount of light extracted per LED chip. Design features for increasing package brightness can include, for example, the type of phosphor(s) used, the method of bonding LED chips, and/or the selection of reflective materials surrounding the LED chips within the housing. Other areas of improvement for LED components include incorporation of design features which improve, for example, thermal properties and/or minimizing overall size, or footprint, of SMD housings to efficiently utilize space when mounted to an external source.

Accordingly, there remains a need for improved light emitter device components, modules, and methods that overcome or alleviate shortcomings of the prior art light emitter device components, modules and methods. Specifically, for example, there exists a need for high-efficiency LEDs and LED components that can be produced at reduced cost, higher manufacturability, and higher yield than existing devices.

SUMMARY

In accordance with this disclosure, light emitting diode (LED) devices, components, and methods are provided. It is, therefore, an object of the present disclosure to provide light emitter device components, modules and methods improving light extraction and thermal efficiency.

These and other objects as can become apparent from the disclosure herein are achieved, at least in whole or in part, by the subject matter described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

A full and enabling disclosure of the present subject matter including the best mode thereof to one of ordinary skill in the art is set forth more particularly in the remainder of the specification, including reference to the accompanying figures, in which:

Figures 1A and 1B illustrate cross-sectional side views of a light emitter device component according to embodiments of the present subject matter;

Figures 2A and 2B illustrate cross-sectional side views of a light emitter device component according to further embodiments of the present subject matter;

Figure 3 illustrates a top view of a light emitter device component according to the present subject matter;

Figure 4 illustrates a perspective view of a light emitter device component according to the present subject matter; and

Figure 5A illustrates a cross-sectional view of a light emitter device component along line 5-5 of Figure 3, and Figure 5B illustrates a cross-sectional view of another embodiment of the light emitter device component.

DETAILED DESCRIPTION

Reference will now be made in detail to possible aspects or embodiments of the subject matter herein, one or more examples of which are shown in the figures. Each example is provided to explain the subject matter and not as a limitation. In fact, features illustrated or described as part of one embodiment can be used in another embodiment to yield still a further embodiment. It is intended that the subject matter disclosed and envisioned herein covers such modifications and variations.

As illustrated in the various figures, some sizes of structures or portions are exaggerated relative to other structures or portions for illustrative purposes and, thus, are provided to illustrate the general structures of the present subject matter. Furthermore, various aspects of the present subject matter are described with reference to a structure or a portion being formed on other structures, portions, or both. As will be appreciated by those of skill in the art, references to a structure being formed "on" or "above" another structure or portion contemplates that additional structure, portion, or both may intervene. References to a structure or a portion being formed "on" another structure or portion without an intervening structure or portion are described herein as being formed "directly on" the structure or portion. Similarly, it will be understood that when an element is referred to as being "connected", "attached", or "coupled" to

another element, it can be directly connected, attached, or coupled to the other element, or intervening elements may be present. In contrast, when an element is referred to as being "directly connected", "directly attached", or "directly coupled" to another element, no intervening elements are present.

5 Furthermore, relative terms such as "on", "above", "upper", "top", "lower", or "bottom" are used herein to describe one structure's or portion's relationship to another structure or portion as illustrated in the figures. It will be understood that relative terms such as "on", "above", "upper", "top", "lower" or "bottom" are intended to encompass different orientations of the device in addition to the
10 orientation depicted in the figures. For example, if the device in the figures is turned over, structure or portion described as "above" other structures or portions would now be oriented "below" the other structures or portions. Likewise, if devices in the figures are rotated along an axis, structure or portion described as "above", other structures or portions would now be oriented "next
15 to" or "left of" the other structures or portions. Like numbers refer to like elements throughout.

Unless the absence of one or more elements is specifically recited, the terms "comprising," "including," and "having" as used herein should be interpreted as open-ended terms that do not preclude the presence of one or
20 more elements.

Light emitters or light emitting devices according to embodiments described herein can comprise group III-V nitride (e.g., gallium nitride (GaN)) based light emitting diode (LED) chips or lasers that can be fabricated on a growth substrate, for example, a silicon carbide (SiC) substrate, such as those
25 devices manufactured and sold by Cree, Inc. of Durham, North Carolina. Other growth substrates are also contemplated herein, for example and not limited to sapphire, silicon (Si) and GaN. In one aspect, SiC substrates/layers can be 4H polytype silicon carbide substrates/layers. Other SiC candidate polytypes, such as 3C, 6H, and 15R polytypes, however, can be used. Appropriate SiC
30 substrates are available from Cree, Inc., of Durham, N.C., the assignee of the present subject matter, and the methods for producing such substrates are set forth in the scientific literature as well as in a number of commonly assigned U.S. patents, including but not limited to U.S. Patent No. Re. 34,861; U.S.

Patent No. 4,946,547; and U.S. Patent No. 5,200,022, the disclosures of which are incorporated by reference herein in their entireties. Any other suitable growth substrates are contemplated herein.

As used herein, the term "Group III nitride" refers to those
5 semiconducting compounds formed between nitrogen and one or more elements in Group III of the periodic table, usually aluminum (Al), gallium (Ga), and indium (In). The term also refers to binary, ternary, and quaternary compounds such as GaN, AlGa_N and AlInGa_N. The Group III elements can combine with nitrogen to form binary (e.g., GaN), ternary (e.g., AlGa_N), and
10 quaternary (e.g., AlInGa_N) compounds. These compounds may have empirical formulas in which one mole of nitrogen is combined with a total of one mole of the Group III elements. Accordingly, formulas such as Al_xGa_{1-x}N where 1>x>0 are often used to describe these compounds. Techniques for epitaxial growth of Group III nitrides have become reasonably well developed and reported in
15 the appropriate scientific literature.

Although various embodiments of LED chips disclosed herein comprise a growth substrate, it will be understood by those skilled in the art that the crystalline epitaxial growth substrate on which the epitaxial layers comprising an LED chip are grown can be removed, and the freestanding epitaxial layers
20 can be mounted on a substitute carrier substrate or substrate which can have different thermal, electrical, structural and/or optical characteristics than the original substrate. The subject matter described herein is not limited to structures having crystalline epitaxial growth substrates and can be used in connection with structures in which the epitaxial layers have been removed
25 from their original growth substrates and bonded to substitute carrier substrates.

Group III nitride based LEDs or LED chips according to some embodiments of the present subject matter, for example, can be fabricated on growth substrates (e.g., Si, SiC, or sapphire substrates) to provide horizontal
30 devices (with at least two electrical contacts on a same side of the LED chip). Moreover, the growth substrate can be maintained on the LED after fabrication or removed (e.g., by etching, grinding, polishing, etc.). The growth substrate can be removed, for example, to reduce a thickness of the resulting LED chip

and/or to reduce a forward voltage through a vertical LED chip. A horizontal device (with or without the growth substrate), for example, can be flip chip bonded (e.g., using solder) to a carrier substrate or printed circuit board (PCB), or wire bonded. Examples of horizontal LED chip structures are discussed by way of example in U.S. Publication No. 2008/0258130 to Bergmann et al. and in U.S. Publication No. 2006/0186418 to Edmond et al., the disclosures of which are hereby incorporated by reference herein in their entireties.

One or more LED chips can be at least partially coated with one or more phosphors. The phosphors can absorb a portion of the LED chip light and emit a different wavelength of light such that the LED device or package emits a combination of light from each of the LED chip and the phosphor. In one embodiment, the LED device or package emits what is perceived as white light resulting from a combination of light emission from the LED chip and the phosphor. One or more LED chips can be coated and fabricated using many different methods, with one suitable method being described in U.S. Patent Application Serial Nos. 11/656,759 and 11/899,790, both entitled "Wafer Level Phosphor Coating Method and Devices Fabricated Utilizing Method", and both of which are incorporated herein by reference in their entireties. Other suitable methods for coating one or more LED chips are described in U.S. Patent Application Serial No. 12/014,404 entitled "Phosphor Coating Systems and Methods for Light Emitting Structures and Packaged Light Emitting Diodes Including Phosphor Coating" and the continuation-in-part application U.S. Patent Application Serial No. 12/717,048 entitled "Systems and Methods for Application of Optical Materials to Optical Elements", the disclosures of which are hereby incorporated by reference herein in their entireties. LED chips can also be coated using other methods such electrophoretic deposition (EPD), with a suitable EPD method described in U.S. Patent Application Serial No. 11/473,089 entitled "Close Loop Electrophoretic Deposition of Semiconductor Devices", which is also incorporated herein by reference in its entirety. It is understood that LED devices, systems, and methods according to the present subject matter can also have multiple LED chips of different colors, one or more of which can be white emitting. As understood by those of skill in the art, an encapsulant can be used, such as by dispensing, in association with an LED

component or substrate to cover one or more of the LED chips. In this case, any suitable type and color of phosphor can be added to the encapsulant in order to achieve desired light output of a desired color. This type use of phosphor can be instead of or in addition to any phosphor coating of the one or
5 more LED chips.

Embodiments of the present subject matter will be described with reference to Figures 1A-5B. Referring now to Figures 1A and 1B, a light emitter device component can comprise light emitter device components or LED components that can be mounted over a non-metallic substrate (e.g.,
10 ceramic) without metal layers at the die attach interface. Generally, it is desirable for the substrate to be highly reflective to visible light (e.g., greater than about 90%) and provide conduction of heat and mechanical support. For example, ceramic materials containing alumina are among the materials that contain these desirable qualities. Figures 1A and 1B each illustrate a light
15 emitter package or LED component, generally designated **110**, mounted in this manner. LED component **110** as shown for example in Figure 1A can comprise a ceramic substrate or body **112** that can be of any suitable shape and configuration. In comparison to conventional configurations for light emitter device components or LED components that use metal as a reflector (e.g.,
20 silver or aluminum), it is believed that ceramic-based LED components can provide improved reflection and thus improved efficiency. Whereas metal reflectors usually produce only about 95% total reflection (i.e., diffuse plus specular), ceramic-based reflectors can produce upwards of 99% or higher total reflection. To further improve the total reflection, at least portions of
25 ceramic body **112** can be designed to have increased porosity to further increase the amount of diffuse reflection. Ceramic materials can further be desirable for use in LED components because of thermal management properties. For example, Alumina materials (Al_2O_3) have relatively low thermal resistance, low moisture sensitivity, superior reliability at high temperature
30 environments, and the superior ability to dissipate heat.

In one aspect, ceramic body **112** can comprise a ceramic body cast using low temperature co-fired ceramic (LTCC) materials and processes. Specifically, for example, ceramic body **112** can comprise a substrate cast from

a thin green ceramic tape. The ceramic tape can comprise any ceramic filler material known in the art, for example, glass ceramics such as aluminum oxide (Al_2O_3) or aluminum nitride (AlN) having 0.3 to 0.5 weight percent of glass frits.

The glass frits can be used as a binder and/or sintering inhibitor within the ceramic tape when the tape is fired. A green tape can be formed by casting a thick layer of a slurry dispersion of the glass frit, ceramic filler, one or more additional binders, and a volatile solvent. The cast layer can be heated at low temperatures to remove the volatile solvent. A green ceramic tape used for ceramic body **112** can advantageously comprise any thickness desired, thus contributing to a thinner size when desired. In another aspect, HTCC can be used. Ceramic body **112** can further comprise a ceramic material having any of a variety of scattering particle contained therein. Examples of suitable scattering particles can for example comprise particles of Al_2O_3 , TiO_2 , BaSO_4 , and/or AlN. In one particular embodiment, Al_2O_3 particles can be selected based on cost considerations, along with its mechanical, optical, electrical, and thermal properties. In still another aspect, the substrate can be a comparatively simple structure without intervening layers such as those produced by thin- or thick-film processes (e.g., bare substrates produced CoorsTek and several others). Such substrates can be fired along with other materials (e.g., Zirconia) to improve optical and mechanical properties.

Referring again to Figures 1A and 1B, ceramic body **112** can for example be formed without any cavity or recess so that one or more LED chips **114** are disposed on and can mount to ceramic body **112**. As one example, body **112** can comprise a surface, such as an upper surface, that can but does not have to be disposed along a single plane. The one or more LED chip(s) such as LED chip **114** can be mounted directly to the surface of body **112** with only a thin adhesive layer (e.g., silicone or epoxy) between body **112** and LED chip **114** (i.e., without any intervening layer, such as a metal or other layer, as shown for example in Figure 1A). Alternatively, the one or more LED chip(s) such as LED chip **114** can be mounted indirectly to the surface of ceramic body **112** as shown for example in Figure 1B where LED chip **114** is mounted to a first intervening layer **116** that can be a non-metallic layer. One or more than

one intervening layer can be used and all of them can be non-metallic layers. For example and without limitation, a second intervening layer **118** can also be disposed between body **112** and LED chip **114** as shown in Figure 1B where second intervening layer **118** is below and against first intervening layer **116**.

- 5 The one or more intervening layer(s) can be of a width that is identical to, less than or greater than the width of LED chip **114**. As an example, second intervening layer **118** is shown with a width that is wider than that of LED chip **114**, and arrows **A1** in Figure 1B indicate broken lines to illustrate where second intervening layer **118** could extend to instead as one example where
- 10 second intervening layer **118** would have a width that is less than the width of LED chip **114**.

In either arrangement, LED chip **114** can be electrically connected, such as by wirebonds **120** or any other suitable technique, to one or more electrical components. As used herein, electrical components can, for example and

15 without limitation, comprise electrical traces, leads, electrical pads, contact or bond pads, or any other suitable electrical component. For example, first and second electrical components **122** and **124** can each comprise a copper foil having wire-bondable gold or silver portions provided thereon. One of the first and second electrical components **122** and **124** can serve as a cathode and

20 the other as an anode for supplying LED chips **114** with current to illuminate an active layer within the LED chip. Alternatively, LED chip **114** may be flip-chip bonded to the first and second electrical components. Any other suitable bonding techniques could be used as well. Regardless of the specific connection, first and second electrical components **122** and **124** can be

25 separated from ceramic body **112** by one or more non-metallic layers. For instance, as shown in Figures 1A and 1B, adhesive layers **126** and **128** can be positioned between ceramic body **112** and first and second electrical components **122** and **124**, respectively. For example, adhesive layers **126** and **128** can each comprise an organic-based adhesive, a pressure-sensitive

30 adhesive (PSA), and/or an epoxy or silicone adhesive.

By connecting LED chips **114** and first and second electrical components **122** and **124** to ceramic body **112** using non-metallic layers (e.g.,

first and second intervening layers **116** and **118**, adhesive layers **126** and **128**), the manufacturability of LED component **110** can be greatly improved. Specifically, for example, prior art methods require resource-intensive processes in which a seed layer is deposited on the substrate by physical vapor
5 deposition or the like, and copper is plated on the seed layer to produce electrical traces on the substrate. Other metals are typically plated on the copper to make them wire-bondable. Such methods can require a number of additional processing steps with respect to ceramic body **112**, and these additional processing steps can leave contaminants on the ceramic surface,
10 which can be difficult to remove and can negatively impact the performance (e.g., brightness) and reliability of the device. In contrast, using one or more intervening non-metallic layers as discussed herein, first and second electrical components **122** and **124** can be adhered to ceramic body **112** in a comparatively simpler process. In such a configuration, the trace pattern can
15 be formed separate from substrate **112** and applied using a lamination technique, such as for example a heat press and/or an overpressure chamber (i.e., autoclave) lamination technique with an adhesive film known to those having skill in the art in the multi-layer printed circuit board industry.

Further in this regard, in an alternative configuration shown in Figure 2A,
20 LED component **110** can comprise an additional dielectric layer **127** positioned between ceramic body **112** and first electrical component **122**. Likewise, although not shown in Figures 2A or 2B, a similar dielectric layer can be positioned between ceramic body **112** and any other electrical components (e.g., second electrical component **128**). Dielectric layer **127** can be any of a
25 variety of material layers known in the art, such as a copper clad laminate (CCL) (e.g., glass-reinforced FR-4, CEM-3, CEM-4, or other related composite materials, such as CS-3965 from Risho). In one particular embodiment, for example, dielectric layer **127** can be a flexible printed circuit board ("flextape" PCB) comprising a polymer-like film having at least one conductive layer within
30 one or more layers of a flexible plastic resin (e.g., polyimide, Kapton from DuPont,). In this exemplary configuration, adhesive layer **126** can comprise a tape-like adhesive provided on the flextape for easy connection to ceramic

body **112**. It should be recognized, however, that dielectric layer **127** can comprise any material used in multilayer PCBs or flex PCBs, including prepreg materials, reinforced laminates (e.g., glass-reinforced epoxy, materials using carbon fiber), and non-reinforced materials.

5 As further illustrated in Figure 2A, additional components can be integrated into LED component **110** to improve the performance and manufacturability thereof. For example, LED component **110** can further comprise an electrically insulating solder mask **130**, which can be disposed on dielectric layer **127** and at least partially on electrical components **122** and **124**
10 such that when solder is used to attach one or more wires to an electrical solder pad (not shown), the solder will be contained within the predefined area. Choosing a white solder mask can improve the overall reflectivity of LED component **110**. Similarly, a fillet **134** can be provided around a perimeter of a light emitting area defined above the top surface of ceramic body **112**, which
15 can be either transparent or reflective (e.g., white). For example, fillet **134** can be made white by incorporating TiO₂ particles therein or by forming fillet **134** of silicone or epoxy materials. Regardless of the specific configuration, fillet **134** can improve reflection of the sidewall portions of LED component **110**, thereby compensating in configurations where dielectric layer **127** has a comparatively
20 lesser reflectivity (e.g., where dielectric layer **127** comprises FR-4). Exemplary configurations for LED component **110** having such a fillet **134** can be found in commonly owned U.S. Patent Application Serial No. 13/435,912, filed March 30, 2012, the disclosure of which is incorporated by reference in its entirety herein.

25 LED component **110** can further comprise a retention material **132** disposed at least partially about an emission area in which LED chip **114** is positioned, where retention material **132** can be referred to as a dam. After placement of retention material **132**, an encapsulant **E** can be disposed within the recess formed thereby. Encapsulant **E** can contain one or more phosphors
30 such that light emitted from the one or more LED chips **114** can produce an emission of a desired wavelength. Encapsulant **E** can be selectively filled to any suitable level within the space disposed between one or more inner walls of

retention material **132**. For example, encapsulant **E** can be filled to a level equal to the height of retention material **132** or to any level above or below the retention material. The level of encapsulant **E** can be planar or curved in any suitable manner, such as concave or convex.

5 LED component **110** can also comprise a reflective layer **113** that can, for example and without limitation, be positioned and disposed within ceramic body **112** as shown in Figure 2A. In another aspect, reflective layer **113'** can as shown in Figure 2A in broken lines optionally instead only be positioned and disposed on a bottom surface of ceramic body **112** (i.e., a surface opposing the
10 top surface on which one or more LED chips **114** are disposed). Reflective layers **113** or **113'** can, for example, comprise a metal reflector (e.g., a silver layer), a white thermal compound, or any other material known to limit loss through the bottom surface of ceramic body **112**, thereby further improving total reflection of LED component **110**. Reflective layers **113** or **113'** can comprise
15 metal or a dielectric material and can for example be two ceramic or other reflective materials bonded together.

Furthermore, additional material layers can be provided in combination with ceramic body **112** to define a multi-layer substrate. As shown in Figure 2B, for example, at least one additional substrate layer **115** can be provided in
20 combination with ceramic body **112**. In this configuration, the combination of material layers can define a gradient in which ceramic body **112** can comprise a comparatively denser layer with optimized thermal conductivity (e.g., a sapphire layer), whereas substrate layer **115** can exhibit comparatively improved reflection. In this regard, substrate layer **115** can have a
25 comparatively higher degree of porosity with respect to ceramic body **112** such that substrate layer **115** exhibits a higher degree of diffuse reflectivity. This configuration can allow heat to dissipate away from the die while still producing a high degree of total reflection. In addition, light produced by LED chip **114** can penetrate farther into the multi-layer substructure before being reflected
30 back into the epi-layers that can re-absorb the light. This configuration can also comprise a reflective layer **113** that can, for example and without limitation, be positioned and disposed within ceramic body **112**. In another aspect, reflective

layer **113'** can as shown in broken lines in Figure 2B optionally instead only be positioned and disposed on a bottom surface of substrate layer **115**. Reflective layers **113** or **113'** can for example comprise a metal reflector (e.g., a silver layer), a white thermal compound, or any other material known to limit loss, thereby further improving total reflection of LED component **110**. Reflective layers **113** or **113'** can comprise metal or a dielectric material and can for example be two ceramic or other reflective materials bonded together.

Referring now to Figures 3 to 5B, further alternative configurations for a light emitter device component comprising a ceramic-based LED configuration such as those discussed above can incorporate a recess that can be defined by walls forming an opening. Figures 3 and 4 illustrate a light emitter package or LED component, generally designated **140**, comprising a package body **141** formed by outer walls **142**, **143**, **144**, and **145**. Package body **141** can comprise any material known in the art. For example, body **141** can comprise molded plastic, ceramic, thermoset, silicone and/or thermoplastic materials or any combination of these or other materials. Similarly to the configurations described above, body **141** can comprise a ceramic body cast using low temperature co-fired ceramic (LTCC) materials and processes, or HTCC can be used.

Outer walls **142** to **145** of LED component **140** can, for example only and without limitation, form a substantially square body **141**. The shape can also be any other shape or configuration, such as a rounded shape or configuration. Outer walls **142** to **145** can comprise one or more notches **N** at the corners of body **141**. LED component **140** can comprise a top surface **146** and a bottom surface **148**. One corner of LED component **140** can comprise a mark **150** for identifying electrical characteristics for a particular side of LED component **140**. For example, mark **150** can designate the side of the component comprising the anode or cathode.

LED component **140** can further comprise one or more inner walls defining a recess generally designated **R**. Here, inner walls **152**, **153**, **154**, and **155** define recess **R** within body **141**. Inner walls **152** to **155** can comprise substantially squared or rounded corners where the inner walls meet.

Optionally, component **140** may comprise a single inner wall defining a substantially circular recess therein. Optionally, inner walls **152** to **155** can be coated with a reflective material, such as silver, to further increase the amount of light extracted per LED component **140**.

5 One or more light emitters such as LEDs or LED chips **158** can mount to or be disposed above lower surface **156**. An LED chip **158** can mount upon one or more intervening layers as shown for example in Figure 5A, or alternatively an LED chip can mount directly upon lower surface **156** without any intervening layer or layers as shown for example in Figure 5B. Lower
10 surface **156** of LED component **140** can comprise a first electrical component **162** and a second electrical component **164** separated from lower surface **156** by first and second non-metallic layers **163** and **165**, respectively. First and second electrical components **162** and **164** can each comprise a conductive material (e.g., silver metal) that is coupled to but physically separated from
15 lower surface **156** by first and second non-metallic layers **163** and **165**, respectively. The one or more LED chips **158** can electrically connect to first and second electrical components **162** and **164** using conductive wires **160** formed using a wirebonding process. One of the first and second electrical components **162** and **164** serves as a cathode and the other as an anode for
20 supplying the LED chips **158** with current to illuminate an active layer within the LED chip. Alternatively, the LED chips **158** may be flip-chip bonded to the first and second electrical components. Any other suitable bonding techniques could be used as well.

LED component **140** can further comprise a thermal component **166**.
25 Thermal component **166** can assist with managing thermal properties of LED component **140** by spreading and conducting heat away from the one or more LED chips **158**. Thermal component **166** can comprise one or more additional layers **168** to further improve heat spreading and thermal management capabilities of LED component **140**. For example, additional layers **168** can
30 comprise a die-attach layer. Using HTCC or any other suitable thermally conducting substrate may reduce any need to use added thermal components.

Referring now to the cross-sectional view of Figure 5A, taken along line 5-5 of Figure 3, features of LED component **140** are further illustrated. In this view recess **R** is defined by inner and outer walls **152**, **154**, **142**, and **144**, respectively. The opening of recess **R** can be as large as possible without extending all the way to the edge of the outer walls **142** and **144**. Encapsulant **E** can be disposed within the recess, and can contain one or more phosphors such that light emitted from the one or more LED chips **158** produces an emission of a desired wavelength. Encapsulant **E**, with or without phosphor included or later added, can be filled to any level within recess **R**, for example, flush with the top surface **146** of LED component **140**.

One or more LED chips **158** can electrically connect to first and second electrical components **162** and **164**, respectively, by wirebonding using electrically conductive wire **160**. LED chips **158** can mount within recess **R** upon one or more thermal components **166** comprising one or more additional thermally conductive layers **168**. One or more intervening layers such as, for example, conductive layer **168**, can then be deposited by any suitable technique upon the thermal components.

At least one thermally conductive via **170** can be disposed, or buried, within body **141** and further disposed between thermal component **166** and a thermal pad **172** extending from bottom surface **148** of LED component **140**. Thermal pad **172** can further spread the heat dissipated from LED component **140** and can conduct the heat into an external heat sink. Thermal pad **172** can comprise any suitable shape, size, and/or geometry known in the art. In one aspect, multiple conductive thermal vias **170** can be used to dissipate the heat released from the one or more LED chips **158**. Conductive thermal vias **170** can conduct heat away from LED component **140** by causing heat to flow on a path out from the one or more LED chips **158**, into to thermal element **166** and any intervening layers, such as conductive layer **168**, through body **141**, out from thermal pad **172**, and into an external heat sink (not shown). The external heat sink can comprise a printed circuit board (PCB) or other external element upon to which the LED component **140** may thermally and electrically connect. Conductive thermal vias **170** can comprise any thermally conductive material

known in the art, for example silver metal, which can assist in minimizing junction temperature difference between the LED chip(s) and the external sink, thus prolonging the life of LED component **140**.

As shown for example and without limitation in Figure 5B, one or more
5 LED chip **158** can mount within recess **R** directly upon lower surface **156** without any intervening layer. As one example, LED chip **158** can be mounted directly upon lower surface **156** without an intervening layer or structure such as thermal component **166** or a conductive layer **168**. LED component **140** shown in Figure 5B can but does not have to comprise a conductive thermal via
10 **170** or thermal pad **172** or a protruding layer **174** shown in Figure 5A. Otherwise, LED component **140** as shown in Figure 5B can comprise identical features and structures to the embodiment shown in Figure 5A.

Embodiments of the present disclosure shown in the drawings and described above are exemplary of numerous embodiments that can be made
15 within the scope of the appended claims. It is contemplated that the configurations of LED components such as those disclosed herein can comprise numerous configurations other than those specifically disclosed.

CLAIMS

What is claimed is:

1. A light emitter device component comprising:
a non-metallic body having a top surface;
one or more light emitter devices mounted on the top surface;
and
one or more electrical components mounted on the top surface and electrically coupled to the one or more light emitter devices, wherein the one or more electrical components are spaced from the non-metallic body by one or more non-metallic layers.
2. The light emitter device component according to claim 1, wherein the non-metallic body comprises a ceramic material.
3. The light emitter device component according to claim 2, wherein the non-metallic body comprises a thick-film ceramic substrate.
4. The light emitter device component according to claim 2, wherein the non-metallic body comprises a thin-film ceramic substrate.
5. The light emitter device component according to claim 1, wherein no metal is in direct contact with the non-metallic body.
6. The light emitter device component according to claim 1, wherein the non-metallic body comprises a plurality of scattering particles contained therein.
7. The light emitter device component according to claim 6, wherein the plurality of scattering particles comprise TiO_2 particles.
8. The light emitter device component according to claim 1, wherein the non-metallic body comprises a low-temperature co-fired ceramic (LTCC) material.

9. The light emitter device component according to claim 8, wherein LTCC materials comprise aluminum oxide (Al_2O_3) having 0.3 to 0.5 weight percent glass frits.
10. The light emitter device component according to claim 1, wherein the non-metallic body comprises a high temperature co-fired ceramic (HTCC) body.
11. The light emitter device component according to claim 1, wherein the one or more light emitter devices comprise light emitting diode (LED) chips.
12. The light emitter device component according to claim 1, wherein the one or more light emitter devices is mounted indirectly on the top surface with one or more intervening layer between the one or more light emitter devices and the top surface.
13. The light emitter device component according to claim 12, wherein the one or more intervening layer is non-metallic.
14. The light emitter device component according to claim 12, comprising a plurality of intervening layers.
15. The light emitter device component according to claim 1, wherein the one or more light emitter devices is mounted directly on the top surface without any intervening layer other than a thin adhesive layer.
16. The light emitter device component according to claim 1, wherein the one or more non-metallic layers comprise an adhesive.
17. The light emitter device component according to claim 16, wherein the adhesive comprises an epoxy.

18. The light emitter device component according to claim 16, wherein the adhesive comprises a silicone adhesive.
19. The light emitter device component according to claim 1, wherein the one or more non-metallic layers comprise one or more dielectric layers.
20. The light emitter device component according to claim 19, wherein the one or more dielectric layers comprise a polyimide-based polymer.
21. The light emitter device component according to claim 19, wherein the one or more dielectric layers comprise a printed circuit board (PCB).
22. The light emitter device component according to claim 21, wherein the printed circuit board comprises FR-4, CEM-3, CEM-4, or a related composite material.
23. The light emitter device component according to claim 1, comprising one or more intervening substrate layer having a comparatively higher thermal conductivity than the non-metallic body.
24. The light emitter device component according to claim 1, comprising one or more reflective layers positioned on a bottom surface of the non-metallic body opposing the top surface or within the non-metallic body.
25. The light emitter device component according to claim 24, wherein the one or more reflective layers comprise a metallic reflective layer.
26. The light emitter device component according to claim 24, wherein the one or more reflective layers comprise a white thermal compound.
27. The light emitter device component according to claim 1, comprising a fillet applied around a perimeter of a light-emitting area.

28. The light emitter device component according to claim 27, wherein the fillet comprises silicone.
29. The light emitter device component according to claim 27, wherein the fillet comprises a plurality of scattering particles contained therein.
30. The light emitter device component according to claim 29, wherein the plurality of scattering particles comprise TiO_2 particles.
31. A method of forming a light emitter device component having increased brightness, the method comprising:
 - mounting one or more light emitter devices on a top surface of a non-metallic body without metal layers at a die attach interface;
 - depositing one or more non-metallic layers on the top surface of the non-metallic body; and
 - mounting one or more electrical components to the one or more non-metallic layers, wherein the one or more electrical components are spaced from the non-metallic body by the one or more non-metallic layers.
32. The method of claim 31, wherein the non-metallic body comprises a ceramic body.
33. The method of claim 32, wherein the ceramic body comprises thick-film ceramic substrate.
34. The method of claim 32, wherein the ceramic body comprises thin-film ceramic substrate.
35. The method of claim 31, wherein mounting one or more light emitter devices on a top surface of a non-metallic body comprises depositing one or more intervening layer on the top surface of the non-metallic

body and mounting the one or more light emitter devices on the one or more intervening layer.

36. The method of claim 31, wherein mounting one or more light emitter devices on a top surface of a non-metallic body comprises mounting the one or more light emitter devices directly on the top surface without any intervening layer.
37. The method of claim 31, wherein depositing one or more non-metallic layers on the top surface of the non-metallic body comprises applying an adhesive on the top surface of the non-metallic body.
38. The method of claim 37, wherein applying an adhesive on the top surface of the non-metallic body comprises applying an epoxy.
39. The method of claim 37, wherein applying an adhesive on the top surface of the non-metallic body comprises applying a silicone adhesive.
40. The method of claim 37, wherein applying an adhesive comprises using lamination by heat press or autoclave.
41. The method of claim 31, wherein depositing one or more non-metallic layers on the top surface of the non-metallic body comprises depositing one or more dielectric layers on the top surface of the non-metallic body.
42. The method of claim 41, wherein depositing one or more dielectric layers on the top surface of the non-metallic body comprises depositing a polyimide-based polymer.
43. The method of claim 41, wherein depositing one or more dielectric layers on the top surface of the non-metallic body comprises depositing a printed circuit board (PCB).

44. The method of claim 43, wherein the printed circuit board comprises FR-4, CEM-3, CEM-4, or a related composite material.
45. The method of claim 41, wherein depositing one or more dielectric layers comprises using lamination by heat press or autoclave.
46. The method of claim 31, wherein no metal is in direct contact with the non-metallic body.
47. The method of claim 31, comprising attaching one or more intervening substrate layer to the non-metallic body, the one or more intervening substrate layer having a thermal conductivity that is comparatively higher than a thermal conductivity of the non-metallic body.
48. The method of claim 31, comprising providing one or more reflective layers on a bottom surface of the non-metallic body opposing the top surface or within the non-metallic body.
49. The method of claim 31, comprising providing a plurality of scattering particles within the non-metallic body.
50. The method of claim 49, wherein the plurality of scattering particles comprise TiO_2 particles.
51. The method of claim 31, comprising providing a fillet around a perimeter of a light-emitting area of the top surface of the non-metallic body.
52. The method of claim 51, wherein the fillet comprises silicone.
53. The method of claim 51, wherein the fillet comprises a plurality of scattering particles contained therein.

54. The method of claim 53, wherein the plurality of scattering particles comprise TiO_2 particles.

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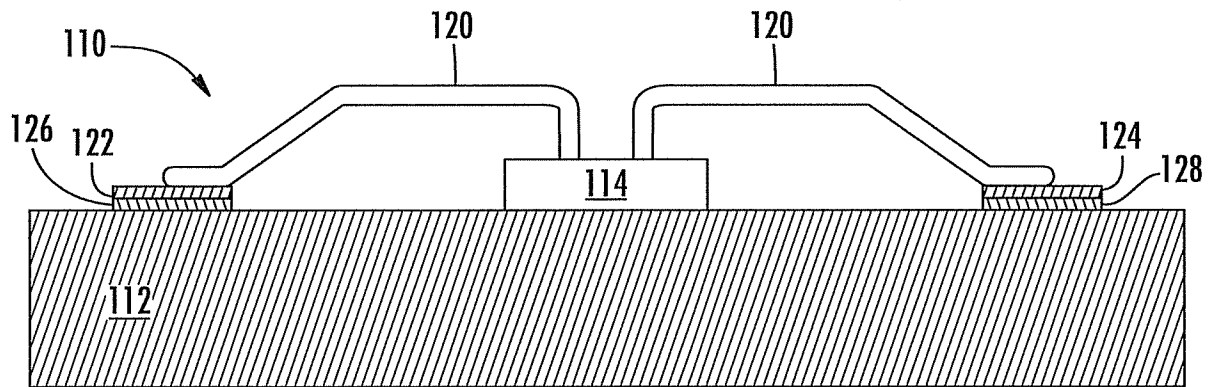


FIG. 1A

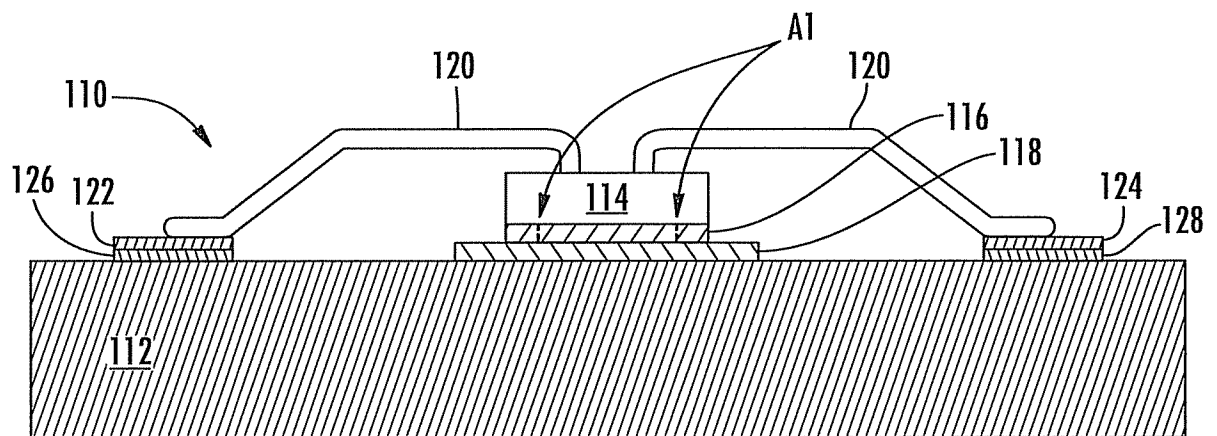


FIG. 1B

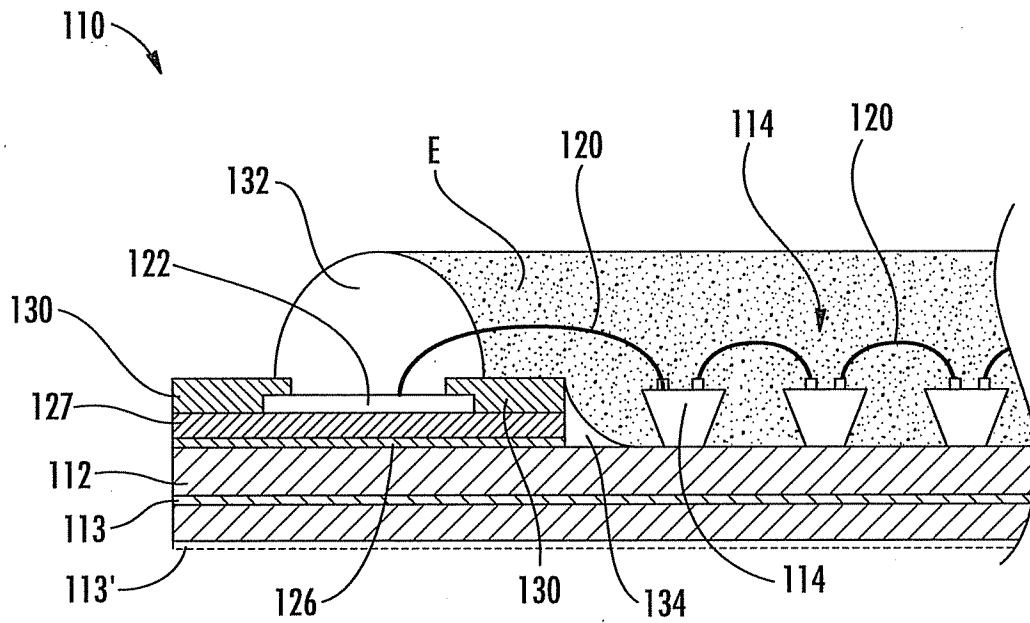


FIG. 2A

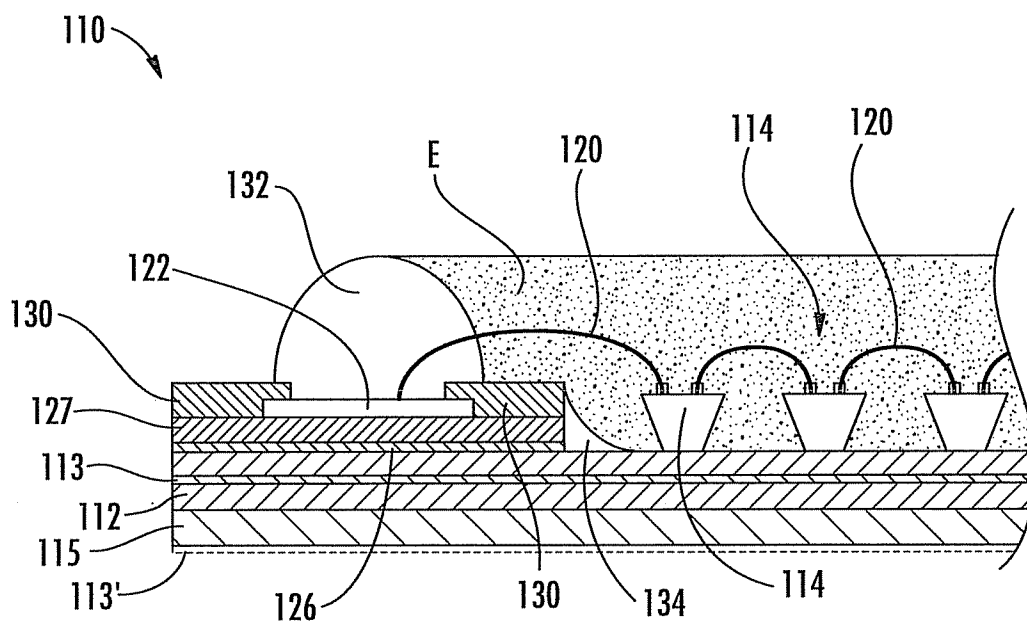


FIG. 2B

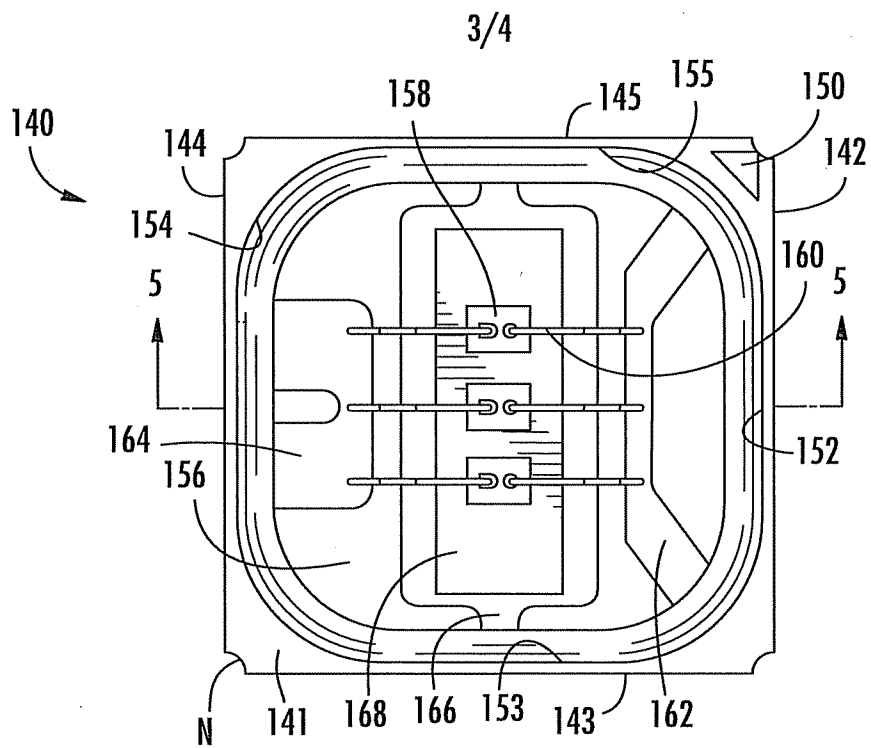


FIG. 3

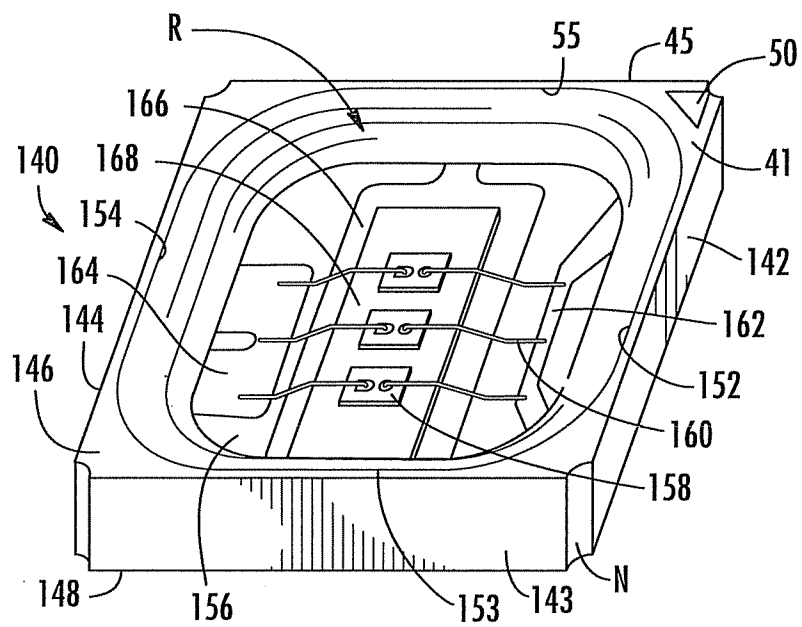


FIG. 4

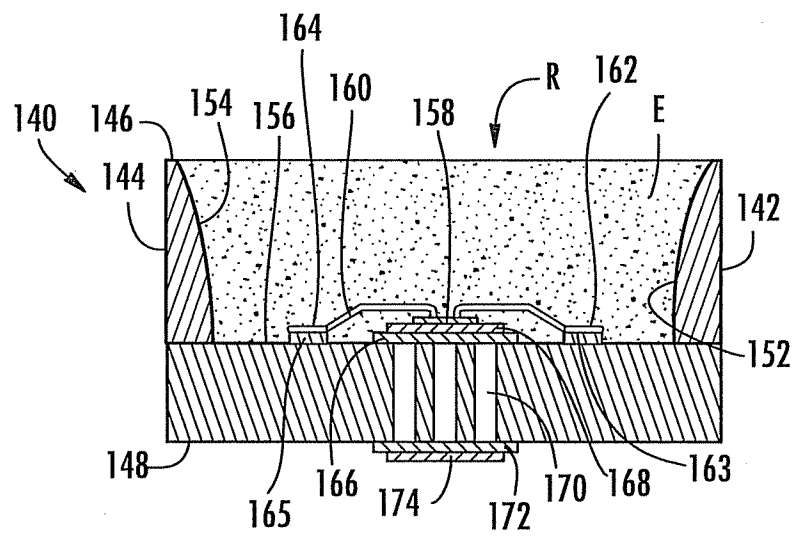


FIG. 5A

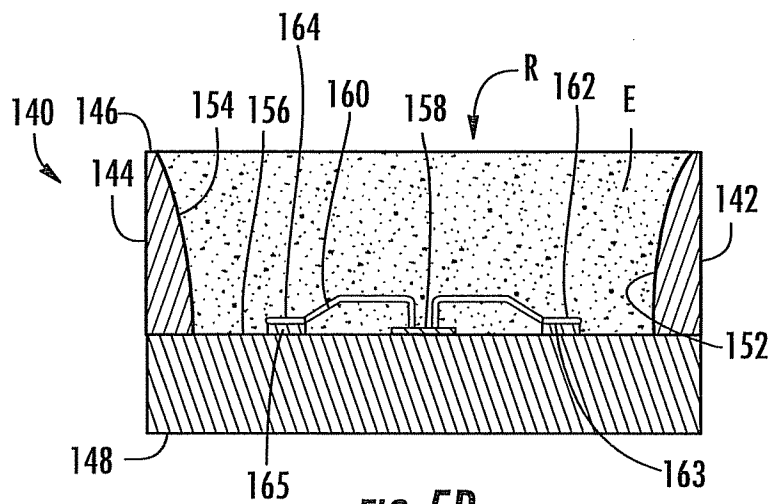


FIG. 5B

A. CLASSIFICATION OF SUBJECT MATTER**H01L 33/62(2010.01)i, H01L 33/48(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 33/62; C09J 163/00; H01L 23/42; C08G 59/40; H01L 23/12; H01L 23/50; H01L 23/495; H01L 33/48

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: LED, ceramic, non-metallic, substrate, alumina, LTCC, adhesive

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y A	JP 2001-131517 A (HITACHI LTD.) 15 May 2001 See paragraphs [0116], [0123], claim 3 and figure 2.	1-4, 8-9, 11, 16-18 , 31-34 5-7, 10, 12-15, 19-30 , 35-54
A	US 2002-0047189 A1 (YOSHINORI MIYAKI et al.) 25 April 2002 See abstract, claim 1 and figure 1A.	1-54
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A	KR 10-0505838 B1 (SEIKO EPSON CORP.) 21 October 2005 See abstract, claim 1 and figure 1.	1-54



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"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

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"&" document member of the same patent family

Date of the actual completion of the international search

26 June 2013 (26.06.2013)

Date of mailing of the international search report

26 June 2013 (26.06.2013)

Name and mailing address of the ISA/KR

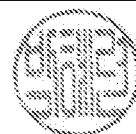
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Authorized officer

PARK, Hye Lyun

Telephone No. 82-42-481-3463



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/033704

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