



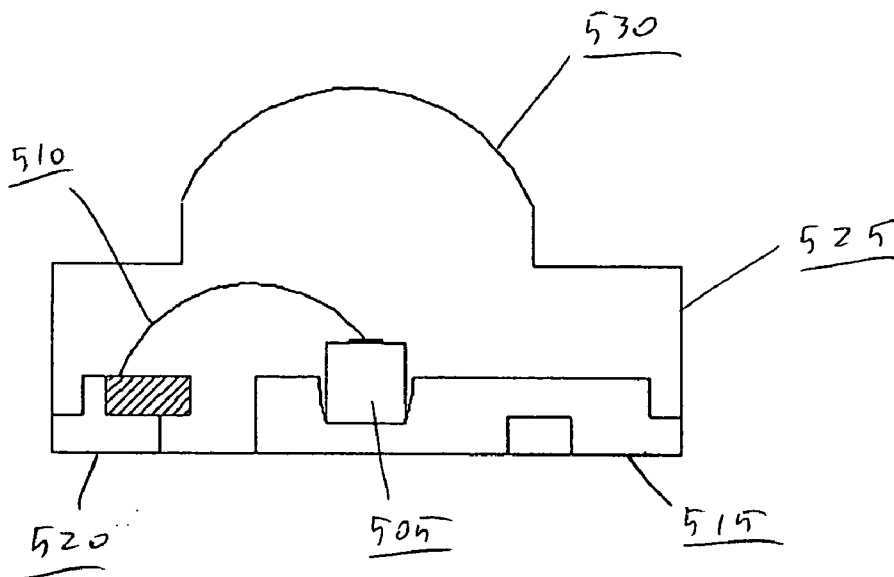
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(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2005/0151149 A1**
Chia et al. (43) **Pub. Date: Jul. 14, 2005**(54) **LIGHT EMISSION DEVICE**(22) Filed: **Jan. 8, 2004**(76) Inventors: **Chee Wai Chia, Penang (MY); Hui Peng Koay, Penang (MY); Lye Yee Wong, Penang (MY)****Publication Classification**(51) **Int. Cl.⁷ H01L 33/00**(52) **U.S. Cl. 257/99**

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Loveland, CO 80537-0599 (US)**(57) **ABSTRACT**

A light emission device. A lead frame comprises a first lead frame segment and a second lead frame segment. A light source is coupled to the first lead frame segment. A wire bond is coupled to the light source and coupled to the second lead frame segment. A translucent epoxy cast encases the light source, the wire bond and a portion of the lead frame.

(21) Appl. No.: **10/755,047**500

100

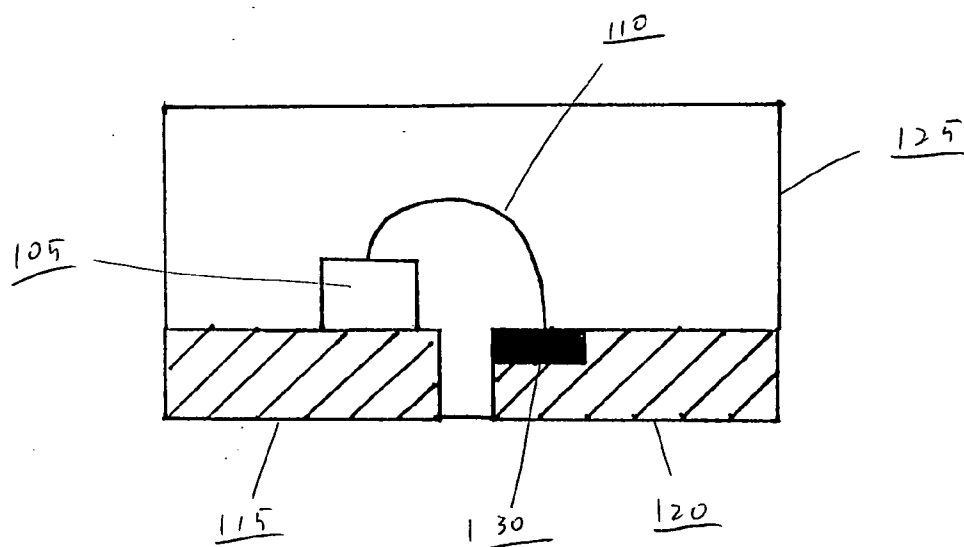


Figure 1

200

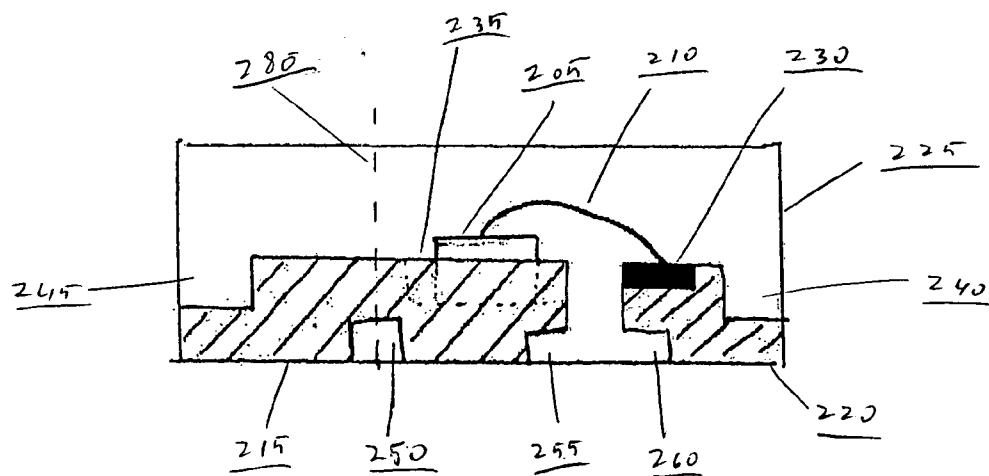


Figure 2

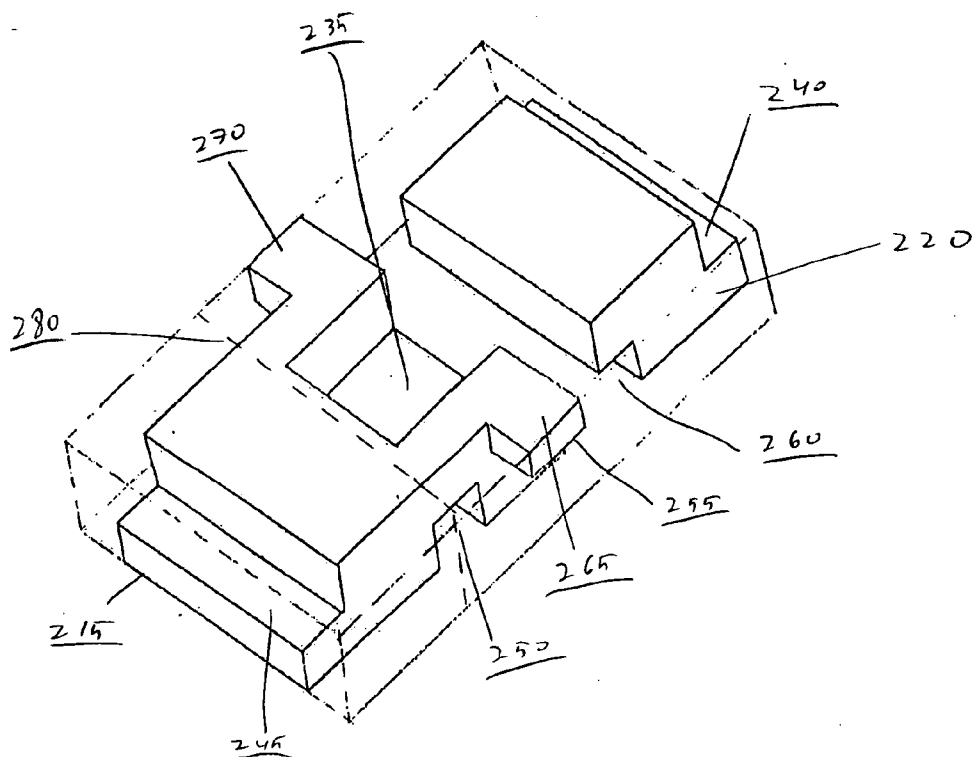


Figure 3

400

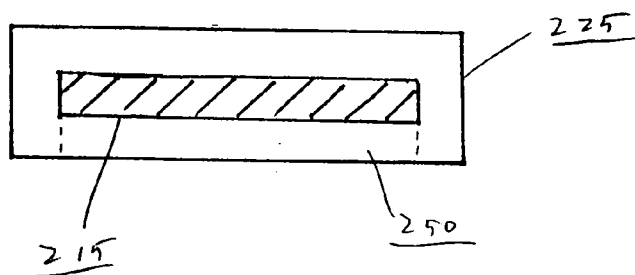


Figure 4

500

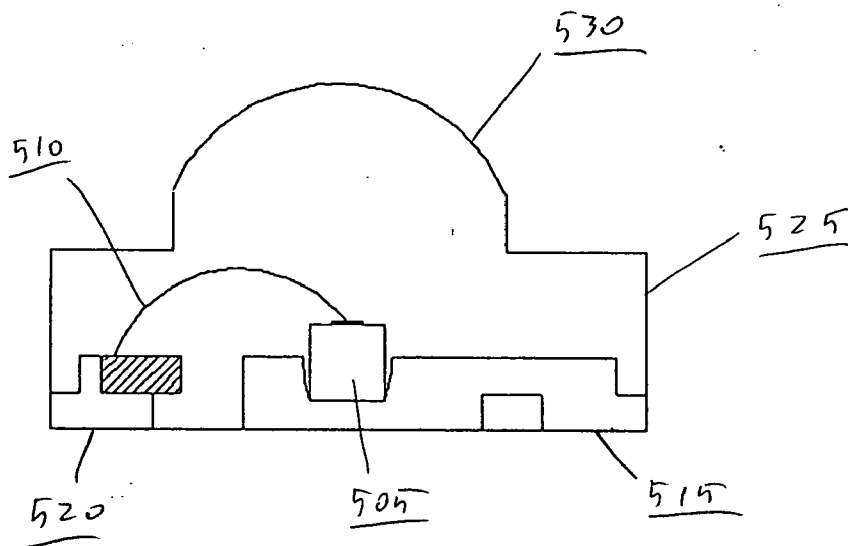


Figure 5A

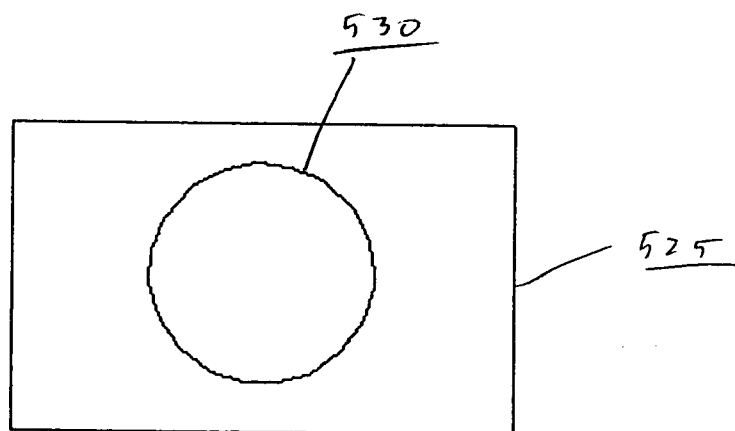


Figure 5B

600

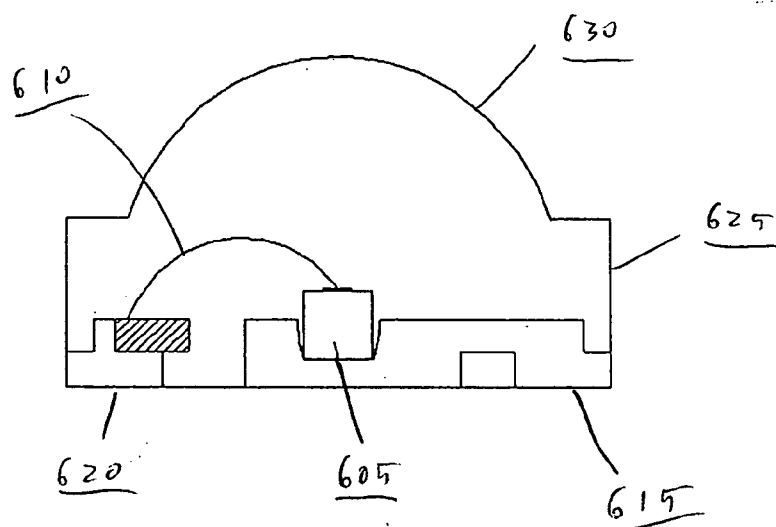


Figure 6A

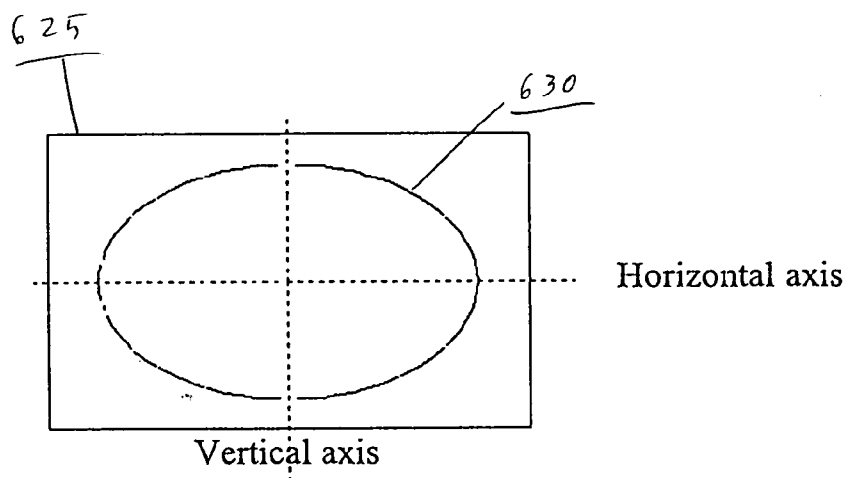


Figure 6B

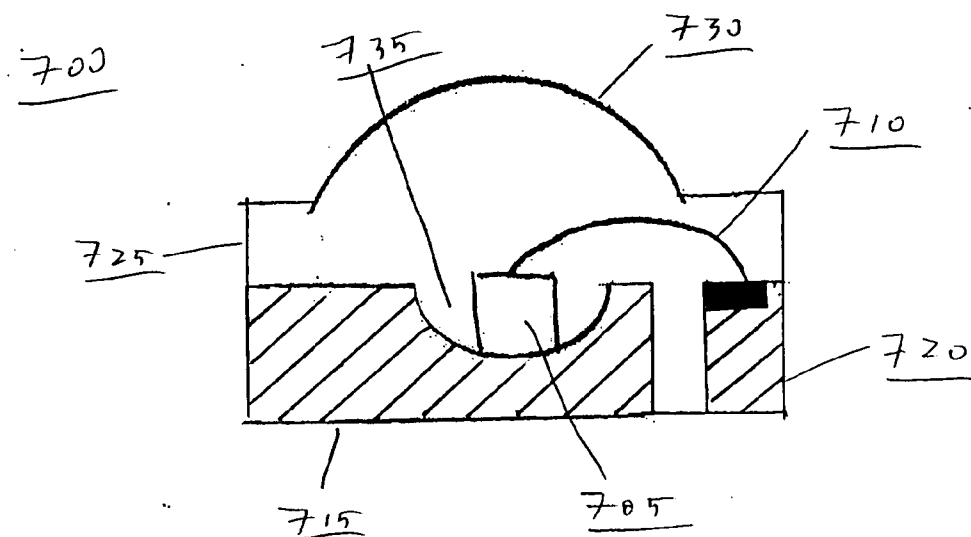


Figure 7

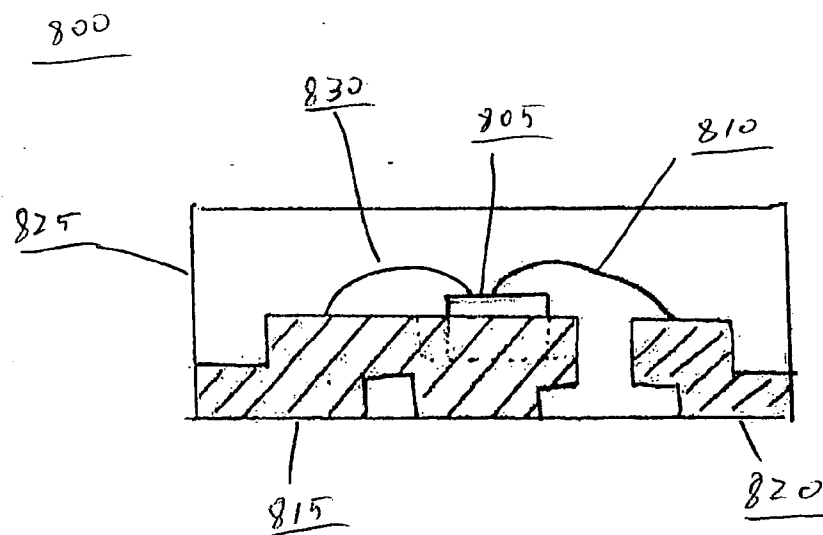
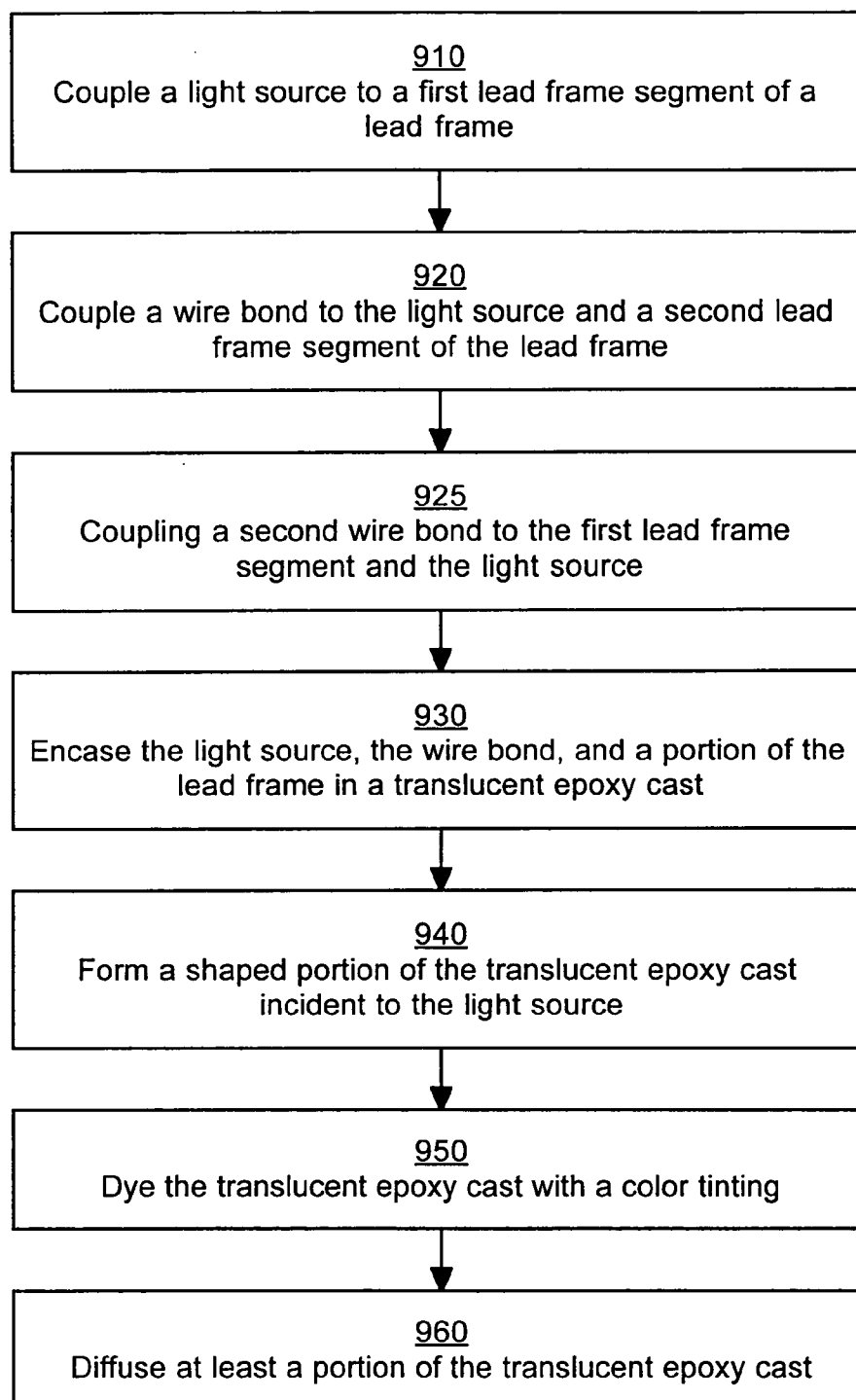


Figure 8

900Figure 9

LIGHT EMISSION DEVICE

FIELD OF INVENTION

[0001] Various embodiments of the present invention relate to the field of light emission devices.

BACKGROUND OF THE INVENTION

[0002] Light emitting diodes (LEDs) are display devices that use a semiconductor diode that emits light when charged with electricity. LEDs provide light in a wide array of electronic devices. For example, LEDs are used as on/off indicators in electronic devices, are used to provide LCD or keypad backlighting in handheld devices, such as personal digital assistants (PDAs) and cellular telephones, and are used for digital display readouts, such as electronic signs. Typically, LEDs are manufactured into an electronic chip (e.g., LED chips) that provide for easy integration into electronic devices.

[0003] Conventional LED chips employ surface mount technology (SMT) using a printed circuit board (PCB) as a base, with the LED die encapsulated into an epoxy resin. The encapsulating process typically used is transfer molding, which utilizes high temperature and pressure to melt the mold compound and force it into the mold cavity. Due to the use of SMT and transfer molding epoxy encapsulation, there are a number of problems inherent to the used of conventional LED chips.

[0004] Typical LED chips are subject to thermal breakdown as a result of the poor thermal dissipation properties of a typical PCB. Due to the poor heat dissipation of a typical PCB, an LED used in a high power or high brightness application, may fail. Therefore, typical LED chips are restricted to low power or brightness, or have short life spans.

[0005] Furthermore, an encapsulating process using transfer molding creates an epoxy molding over an LED on top of a PCB. An LED chip subjected to the elements is prone to delamination caused by moisture absorption. Delamination causes the epoxy molding to separate from the PCB, exposing the LED die to moisture, and eventually leading to failure. Due to the wide number of electronic devices using LEDs that are exposed to the elements, delamination is a wide problem. Moreover, transfer molding requires expensive tools, machines and materials, requiring a substantial investment that is not typically viable for small- and medium-scale production.

SUMMARY OF THE INVENTION

[0006] Various embodiments of the present invention, a light emission device and a method for generating a light emission device, are described herein. In one embodiment, the light emission device comprises a lead frame comprising a first lead frame segment and a second lead frame segment. A light source is coupled to the first lead frame segment. A wire bond is coupled to the light source and coupled to the second lead frame segment. A translucent epoxy cast encases the light source, the wire bond and a portion of the lead frame.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The accompanying drawings, which are incorporated in and form a part of this specification, illustrate

embodiments of the invention and, together with the description, serve to explain the principles of the invention:

[0008] FIG. 1 illustrates a side view of a light emission device in accordance with an embodiment of the present invention.

[0009] FIG. 2 illustrates a side view of a light emission device in accordance with another embodiment of the present invention.

[0010] FIG. 3 illustrates an isometric view of a lead frame of a light emission device in accordance with an embodiment of the present invention.

[0011] FIG. 4 illustrates a cut-away cross-sectional view of a light emission device in accordance with an embodiment of the present invention.

[0012] FIG. 5A illustrates a cut-away side view of a light emission device including a round shape epoxy dome in accordance with an embodiment of the present invention.

[0013] FIG. 5B illustrates a top view of a light emission device including a round shape epoxy dome in accordance with an embodiment of the present invention.

[0014] FIG. 6A illustrates a cut-away side view of a light emission device including an oval shape epoxy dome in accordance with an embodiment of the present invention.

[0015] FIG. 6B illustrates a top view of a light emission device including an oval shape epoxy dome in accordance with an embodiment of the present invention.

[0016] FIG. 7 illustrates a side view of a light emission device including a hemispherical reflector cup in accordance with an embodiment of the present invention.

[0017] FIG. 8 illustrates side view of a light emission device including a flat top epoxy surface and including a first wire bond and a second wire bond in accordance with an embodiment of the present invention.

[0018] FIG. 9 is a flow chart illustrating a process for generating a light emission device in accordance with an embodiment of the present invention.

BEST MODE(S) FOR CARRYING OUT THE INVENTION

[0019] Reference will now be made in detail to various embodiments of the invention, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with various embodiments, it will be understood that they are not intended to limit the invention to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and the scope of the invention as defined by the appended claims. Furthermore, in the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, structures and devices have not been described in detail so as to avoid unnecessarily obscuring aspects of the present invention.

[0020] FIG. 1 illustrates a side view of an exemplary light emission device 100 in accordance with an embodiment of the present invention. Light emission device 100 comprises light source 105, wire bond 110, and a lead frame comprising first lead frame segment 115 and second lead frame segment 120. Light source 105, wire bond 110 and at least a portion of the lead frame are encased in epoxy cast 125. It should be appreciated that a lead frame refers to a type of chip package that uses conductive leads that extend outside of a housing. In the present embodiment, a portion of first lead frame segment 115 and a portion of second lead frame segment 120 are not encased within epoxy cast 125, allowing for the transmission of power signals to light source 105.

[0021] In one embodiment, the lead frame is comprised of copper, however, it should be appreciated that any other conductive material, such as another metal, may be implemented. In one embodiment, the lead frame is covered in a plating to improve various properties of the lead frame. For example, plating may be used to improve the bonding strength between light source 105 and first lead frame segment 115 and between wire bond 110 and second lead frame segment 120, may enhance the adhesiveness of epoxy cast 125 to the lead frame, may prevent oxidization of a metal lead frame, may enhance to solderability of pads of first lead frame segment 115 and second lead frame segment 120, and can improve the surface reflectivity to enhance flux extraction. In one embodiment, the plating is nickel/palladium/gold (NiPdAu). In another embodiment, the plating is silver (Ag). It should be appreciated that any other plating material may be implemented depending on the design requirements of light emission device 100.

[0022] A lead frame provides improved thermal dissipation over the use of a PCB substrate, due to the lower thermal resistance. Light emission device 100 can be subjected to higher operating current due to the better heat dissipation properties of the lead frame. Therefore, the luminous intensity of light emission device 100 can be increased. Furthermore, light emission device 100 may have a lower profile due to a lead frame being thinner than a PCB substrate.

[0023] Light source 105 is coupled to first lead frame segment 115. In one embodiment, a power signal is received at light source 105 from first lead frame segment 115. In one embodiment, light source 105 is a light emitting diode (LED) die. While embodiments of the invention are described using an LED, it should be appreciated that other types of light sources may be implemented, such as an infrared emitting diode (IRED) or a laser diode. Wire bond 110 is coupled to light source 105 and second lead frame segment 120. Light source 105 receives positive and negative power signals via first lead frame segment 115 and wire bond 110, and emits light in response to such signals. In one embodiment, wire bond 110 is a gold wire. However, it should be appreciated that any conductive material may be implemented at wire bond 110. In one embodiment, first lead frame segment 115 operates as a cathode for transmitting a negative power signal, and second lead frame 120 operates as an anode for transmitting a positive power signal, as indicated at anode mark 130.

[0024] Epoxy cast 125 is formed over light source 105, wire bond 110, a portion of first lead frame segment 115 and a portion of second lead frame segment 120 using an epoxy

casting process. The use of a conductive lead frame substrate provides for the use of a conventional casting process in forming epoxy cast 125. In one embodiment, epoxy cast 125 is comprised of substantially half epoxy resin and substantially half epoxy hardener. However, it should be appreciated that any combination of epoxy resin and epoxy hardener may be used. Epoxy cast 125 is translucent, allowing for the passage of light. In one embodiment, epoxy cast 125 comprises a color tinting for filtering the wavelength of light passing through epoxy cast 125. In one embodiment, epoxy cast 125 is operable to diffuse light passing through epoxy cast 125. Using a casting process to generate epoxy cast 125 provides a substantial cost savings over transfer molding process due to the high volume per run with high density lead frame design as well as lower initial tooling costs. Furthermore, epoxy cast 125 provides improved moisture absorption resistivity compared to molding compound which is more sensitive to moisture.

[0025] FIG. 2 illustrates a side view of light emission device 200 in accordance with another embodiment of the present invention. Light emission device 200 comprises light source 205, wire bond 210, and a lead frame comprising first lead frame segment 215 and second lead frame segment 220. Light source 205, wire bond 210 and at least a portion of the lead frame are encased in epoxy cast 225. Light emission device 200 is similar to light emission device 100 of FIG. 1, while providing additional features.

[0026] Light emission device 200 comprises recess 235 for receiving light source 205 such that light source 205 resides at least partially within recess 235. Placing light source 205 within recess 235 assists in providing a low profile for light emission device 200, thereby allowing wider applicability. Light source 205 is coupled to first lead frame segment 215 and wire bond 210, and wire bond 210 is also coupled to second lead frame segment 220. Light source 205 receives positive and negative power signals via first lead frame segment 215 and wire bond 210, and emits light in response to such signals. In one embodiment, first lead frame segment 215 operates as a cathode for transmitting a negative power signal, and second lead frame 220 operates as an anode for transmitting a positive power signal, as indicated at anode mark 230.

[0027] With reference to FIG. 3, an isometric view of the lead frame of light emission device 200 is illustrated, in accordance with an embodiment of the present invention. Recess 235 is configured for receiving a light source (e.g., light source 205 of FIG. 2).

[0028] With reference to FIG. 2, the lead frame of light emission device 200 also comprises at least one anchoring recess for allowing epoxy cast 225 to be anchored to first lead frame segment 215 and second lead frame segment 220. In one embodiment, first lead frame segment 215 comprises anchoring recess 250, such that during epoxy casting, anchoring recess 250 is filled such that epoxy cast 225 is anchored to first lead frame segment 215.

[0029] FIG. 4 illustrates a cut-away cross-sectional view of light emission device 200 of FIG. 2, in accordance with an embodiment of the present invention. The cut-away cross-sectional view of FIG. 4 shows the cross-sectional area of light emission device 200 at dotted line 280 of FIGS. 2 and 3. As shown in FIG. 4, the illustrated portion of first

lead frame segment **215** is completely surrounded by epoxy cast **225**. In particular, anchoring recess **250** is completely filled with epoxy cast **225**.

[0030] With reference to **FIG. 2**, first lead frame segment **215** also comprises anchoring recesses **245** and **255**, and second lead frame segment **220** comprises anchoring recesses **240** and **260**. Anchoring recesses **240**, **245**, **255** and **260** provide additional anchoring functionality to the lead frame, thereby providing increased anchorage between the lead frame and epoxy cast **225**. With reference to **FIG. 3**, first lead frame segment **215** also comprises anchoring extensions **265** and **270**, providing additional anchoring functionality by locking epoxy casting **225** to first lead frame segment **215**. It should be appreciated that first lead frame segment **215** and second lead frame segment **220** may comprise any number of anchoring recesses and anchoring extensions, and that those illustrated in **FIGS. 2, 3** and **4** are exemplary. Improving the anchorage between the lead frame and epoxy cast **225** prevents delamination due to operation of light emission device **200** under a wide range of environmental conditions.

[0031] In various embodiments of the present invention, a portion of the epoxy cast may be formed into a shape, such as a dome, for directing light. **FIG. 5A** illustrates a cut-away side view of a light emission device **500** including a round shape epoxy dome in accordance with an embodiment of the present invention. Light emission device **500** comprises light source **505**, wire bond **510**, and a lead frame comprising first lead frame segment **515** and second lead frame segment **520**. Light source **505**, wire bond **510** and at least a portion of the lead frame are encased in epoxy cast **525**. Epoxy cast **525** comprises epoxy shaped portion **530**. In the illustrated embodiment, shaped portion **530** is a round shape dome. It should be appreciated that epoxy shaped portion **530** may be any shape (e.g., rectangular, triangular, cylindrical), and is not limited to the illustrated embodiment.

[0032] **FIG. 5B** illustrates a top view of light emission device **500** including a round shape epoxy dome in accordance with an embodiment of the present invention. As shown in **FIG. 5B**, epoxy shaped portion **530** is seen to provide for symmetric viewing angles of emitted light in all directions.

[0033] **FIG. 6A** illustrates a cut-away side view of a light emission device **600** including an oval shape epoxy dome in accordance with an embodiment of the present invention. Light emission device **600** comprises light source **605**, wire bond **610**, and a lead frame comprising first lead frame segment **615** and second lead frame segment **620**. Light source **605**, wire bond **610** and at least a portion of the lead frame are encased in epoxy cast **625**. Epoxy cast **625** comprises epoxy shaped portion **630**. In the illustrated embodiment, shaped portion **630** is an oval shape dome. As described at **FIG. 5A**, it should be appreciated that epoxy shaped portion **630** may be any shape, and is not limited to the illustrated embodiment.

[0034] **FIG. 6B** illustrates a top view of light emission device **600** including an oval shape epoxy dome in accordance with an embodiment of the present invention. As shown in **FIG. 6B**, epoxy shaped portion **630** is seen to provide for asymmetric viewing angles of emitted light in all directions. Using an oval shape dome, the viewing angle on the horizontal axis is greater than the viewing angle on the vertical axis.

[0035] **FIG. 7** illustrates a side view of light emission device **700** including a reflector cup **735** in accordance with an embodiment of the present invention. Light emission device **700** comprises light source **705**, wire bond **710**, and a lead frame comprising first lead frame segment **715** and second lead frame segment **720**. Light source **705**, wire bond **710** and at least a portion of the lead frame are encased in epoxy cast **725**. Light emission device **700** is similar to light emission device **100** of **FIG. 1**, while providing additional features.

[0036] Light emission device **700** comprises reflector cup **735** for receiving light source **705** and for reflecting light emitted from light source **705**. In one embodiment, light source **705** resides at least partially within reflector cup **735**. Placing light source **705** within reflector cup **735** allows for enhancing and directing the light emitted by light source **705**. Furthermore, placing light source **705** within reflector cup **735** assists in providing a low profile for light emission device **700**, thereby allowing wider applicability.

[0037] Epoxy cast **725** comprises epoxy shaped portion **730**. In the illustrated embodiment, shaped portion **730** is a round shape dome. It should be appreciated that epoxy shaped portion **730** may be any shape and is not limited to the illustrated embodiment. The use of reflector cup **735** in conjunction with epoxy shaped portion **730** allows for directing the light emitted in a desired radiation pattern and viewing angle.

[0038] As described above, embodiments of the present invention are configured to implement different types of light sources. For example, embodiments of the present invention may implement a double wire bonded light source (e.g., a double wire bonded LED). A double wire bonded light source is operable to receive positive and negative power signals through two wire bonds, respectively, rather than through one wire bond and through coupling the light source to a lead frame.

[0039] **FIG. 8** illustrates a side view of light emission device **800** including first wire bond **810** and second wire bond **830** in accordance with an embodiment of the present invention. Light emission device **800** comprises light source **805**, first wire bond **810**, second wire bond **830** and a lead frame comprising first lead frame segment **815** and second lead frame segment **820**. Light source **805**, wire bond **810** and at least a portion of the lead frame are encased in epoxy cast **825**. In one embodiment, epoxy cast **825** has a flat top surface. It should be appreciated that a lead frame refers to a type of chip package that uses conductive leads that extend outside of a housing. First wire bond is coupled to light source **805** and second lead frame segment **820** and second wire bond **830** is coupled to light source **805** and first lead frame segment **815**.

[0040] **FIG. 9** is a flow chart illustrating a process **900** for generating a light emission device in accordance with an embodiment of the present invention. For purposes of clarity, the following discussion will refer to **FIG. 2** to more clearly describe the present invention. However, it should be appreciated that other embodiments of the present invention may be generated according to process **900**. Although specific steps are disclosed in process **900**, such steps are exemplary. That is, the embodiments of the present invention are well suited to performing various other steps or variations of the steps recited in **FIG. 9**.

[0041] At step 910 of process 900, light source 205 is coupled to first lead frame segment 215 of a lead frame, wherein the lead frame also includes second lead frame segment 220. In one embodiment, light source 205 is an LED die. In one embodiment, first lead frame segment 215 comprises a first recess 235 such that light source 205 resides at least partially within first recess 235. In one embodiment, first recess 235 is a reflector cup (e.g., reflector cup 735 of FIG. 7).

[0042] At step 920, a wire bond is coupled to light source 205 and second lead frame segment 220. In one embodiment, as shown at step 925, a second wire bond (e.g., second wire bond 830 of FIG. 8) is coupled to first lead frame 215 and light source 205. It should be appreciated that step 925 is used when light source 205 is a double wire bonded light source. Accordingly, step 925 is optional.

[0043] At step 930, light source 205, wire bond 210, and a portion of lead frame are encased in translucent epoxy cast 225. In one embodiment, as shown at step 940, a shaped portion (e.g., shaped portion 530 of FIG. 5) of translucent epoxy cast 225 is formed. In one embodiment, the shaped portion is formed incident light source 205. In one embodiment, as shown at step 950, translucent epoxy cast 225 is dyed with a color tinting. In one embodiment, translucent epoxy cast 225 is configured to act as a diffuser.

[0044] Embodiments of the invention provide a light emission device that provides higher operating conditions with better heat dissipation. Furthermore, the light emission device has improved reliability and package robustness due to the use of a lead frame and an epoxy casting process, as well as providing better anchorage between the lead frame and the epoxy cast. Moreover, the lead frame can be etched or stamped into a desirable shape, and can provide a thinner package profile. The described embodiments also provide a light emission device that provides higher light output due to the improved heat dissipation, as well as a higher reflective surface, a reflector cup, and a shaped epoxy dome.

[0045] Various embodiments of the present invention, a light emission device, are thus described. While the present invention has been described in particular embodiments, it should be appreciated that the present invention should not be construed as limited by such embodiments, but rather construed according to the below claims.

What is claimed is:

1. A light emission device comprising:
 - a lead frame comprising a first lead frame segment and a second lead frame segment;
 - a light source coupled to said first lead frame segment;
 - a wire bond coupled to said light source and coupled to said second lead frame segment; and
 - an epoxy cast encasing said light source, said wire bond, and a portion of said lead frame.
2. The light emission device as recited in claim 1 wherein said first lead frame segment comprises a first recess such that said light source resides at least partially within said first recess.

3. The light emission device as recited in claim 1 wherein said first lead frame segment comprises a second recess such that said epoxy cast is anchored to said first lead frame segment.

4. The light emission device as recited in claim 2 wherein said first recess is a reflector cup.

5. The light emission device as recited in claim 1 wherein said epoxy cast comprises a shaped epoxy portion.

6. The light emission device as recited in claim 1 wherein said lead frame comprises plating.

7. The light emission device as recited in claim 1 wherein said epoxy cast comprises a color tinting.

8. The light emission device as recited in claim 1 wherein said epoxy cast is operable to diffuse light from said light source.

9. The light emission device as recited in claim 1 further comprising a second wire bond coupled to said first lead frame segment and said light source.

10. The light emission device as recited in claim 5 wherein said shaped epoxy portion is a dome shape.

11. The light emission device as recited in claim 1 wherein said light source is a light emitting diode die.

12. A method for generating a light emission device, said method comprising:

coupling a light source to a first lead frame segment of a lead frame, said lead frame further comprising a second lead frame segment;

coupling a wire bond to said light source and said second lead frame segment; and

encasing said light source, said wire bond, and a portion of said lead frame in an epoxy cast.

13. The method as recited in claim 12 wherein said first lead frame segment comprises a first recess such that said light source resides at least partially within said first recess.

14. The method as recited in claim 13 wherein said first recess is a reflector cup.

15. The method as recited in claim 12 wherein said encasing comprises forming a shaped portion of said epoxy cast.

16. The method as recited in claim 12 further comprising dyeing said epoxy cast with a color tinting.

17. The method as recited in claim 12 further comprising diffusing at least a portion of said translucent epoxy cast.

18. The method as recited in claim 12 further comprising coupling a second wire bond to said first lead frame segment and said light source.

19. The method as recited in claim 12 wherein said light source is a light emitting diode die.

20. A light emission device comprising:

a lead frame comprising a first lead frame segment and a second lead frame segment;

a light emitting diode coupled to said first lead frame segment, said first lead frame segment comprising a first recess such that said light source resides at least partially within said first recess;

a wire bond coupled to said light source and coupled to said second lead frame segment; and

an epoxy cast encasing said light emitting diode, said wire bond, and a portion of said lead frame, said epoxy cast comprising a shaped epoxy portion.

21. The light emission device as recited in claim 20 wherein said first lead frame segment comprises a second recess such that said epoxy cast is anchored to said first lead frame segment.

22. The light emission device as recited in claim 20 wherein said first recess is a reflector cup.

23. The light emission device as recited in claim 20 wherein said shaped epoxy portion is incident to said light source.

24. The light emission device as recited in claim 20 wherein said lead frame comprises plating.

25. The light emission device as recited in claim 20 wherein said epoxy cast comprises a color tinting.

26. The light emission device as recited in claim 20 wherein said epoxy cast is operable to diffuse light from said light source.

27. The light emission device as recited in claim 20 further comprising a second wire bond coupled to said first lead frame segment and said light source.

28. The light emission device as recited in claim 20 wherein said shaped epoxy portion is a dome shape.

* * * * *