United States Patent Application Publication	20250255062
Kind Code	A1
Publication Date	August 07, 2025
Inventor(s)	ABE; Koji et al.

LIGHT EMITTING MODULE MANUFACTURING METHOD INCLUDING COVERING LATERAL FACES OF LIGHT EMITTING ELEMENTS WITH RESIN

Abstract

A light emitting module includes: a wiring board; a plurality of light emitting elements mounted on the wiring board, each of first and second adjacent ones of the light emitting elements having an upper face, a lower face located opposite to the upper face and facing an upper face of the wiring board, and an oblique lateral face between the upper face and the lower face spreading outwards from the lower face to the upper face; a first resin disposed between the upper face of the wiring board and the lower faces of the first and second light emitting elements, and between lateral faces of the first and second light emitting elements, the first resin containing a light reflecting substance; and a second resin containing a phosphor and covering the upper face of at least one of the light emitting elements and an upper face of the first resin.

Inventors: **ABE; Koji (Tokushima-shi, JP), NISHIUCHI; Kazusa (Anan-shi, JP)**

Applicant: **NICHIA CORPORATION** (Anan-shi, JP)

Family ID: **80683797**

Assignee: **NICHIA CORPORATION (Anan-shi, JP)**

Appl. No.: **19/191137**

Filed: **April 28, 2025**

Foreign Application Priority Data

JP	2021-060799	Mar. 31, 2021
JP	2022-015422	Feb. 03, 2022

Related U.S. Application Data

parent US division 17702245 20220323 parent-grant-document US 12317661 child US 19191137

Publication Classification

Int. Cl.: **H10H20/857** (20250101); **H01L25/075** (20060101); **H10H20/01** (20250101); **H10H20/854** (20250101); **H10H20/856** (20250101)

U.S. Cl.:

CPC **H10H20/857** (20250101); **H01L25/0753** (20130101); **H10H20/01** (20250101); **H10H20/854** (20250101); **H10H20/856** (20250101); H10H20/0362 (20250101); H10H20/0364 (20250101)

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application is a divisional application of U.S. patent application Ser. No. 17/702,245, filed on Mar. 23, 2022, which claims priority to Japanese Patent Application No. 2021-060799, filed on Mar. 31, 2021, and Japanese Patent Application No. 2022-015422, filed on Feb. 3, 2022. The disclosures of these applications are hereby incorporated by reference in their entireties.

BACKGROUND
[0002] The present disclosure relates to a light emitting module and a method of manufacturing such a light emitting module.
[0003] In recent years, a light emitting module has been proposed in which a large number of light emitting elements mounted on a single wiring board are individually controlled (see for example, Japanese Patent Publication No. 2020-74005). There is a need to improve the efficiency in extracting light from each light emitting element in such a light emitting module.
SUMMARY
[0004] One object of certain embodiments of the present disclosure is to provide a light emitting module having high light extraction efficiency, and a method of manufacturing such a light emitting module.
[0005] A method of manufacturing a light emitting module according to an embodiment includes: providing a wiring board having an upper face on which a plurality of light emitting elements are mounted; disposing a first resin in an area of the upper face of the wiring board and outward from a region in which the light emitting elements are mounted, wherein the first resin contains a light reflecting substance; and covering a lateral face of the light emitting elements with the first resin by spreading the first resin over the region.
[0006] A light emitting module according to an embodiment includes a wiring board, a plurality of light emitting elements mounted on the wiring board, a first resin containing a light reflecting substance, and a second resin containing a phosphor. At least one of the light emitting elements has an upper face, a lower face positioned opposite to the upper face, and oblique lateral faces between the upper face and the lower face spreading apart from the lower face to the upper face. The lower face of at least one of the light emitting elements faces the upper face of the wiring board. The first resin is disposed between an upper face of the wiring board and the lower face of the light emitting elements, and between the lateral faces of adjacent ones of the light emitting elements. The second resin covers the upper face of at least one of the light emitting elements and the upper face of the first resin. Between adjacent ones of the light emitting elements, the upper face of the first resin is positioned between the upper faces and the lower faces of the adjacent ones of the light emitting

elements in a direction in which the wiring board faces the second resin. The portions of the lateral faces of the adjacent ones of the light emitting elements that are exposed from the first resin are covered by the second resin.
[0007] According to certain embodiments of the present disclosure, a light emitting module having high light extraction efficiency and a method of manufacturing such a light emitting module can be achieved.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0008] FIG. **1** is a perspective view of a light emitting module according to an embodiment when viewed diagonally from above.
[0009] FIG. **2** is a perspective view of the light emitting module according to the embodiment when viewed diagonally from below.
[0010] FIG. **3** is an enlarged plan view of the region III in FIG. **1**.
[0011] FIG. **4** is a cross-sectional view taken along line IV-IV in FIG. **1**.
[0012] FIG. **5**A is an enlarged cross-sectional view of the region VA in FIG. **4**.
[0013] FIG. **5**B is an enlarged cross-sectional view of the region VB in FIG. **5**A.
[0014] FIG. **6**A is a cross-sectional view showing a method of manufacturing a light emitting module according to an embodiment.
[0015] FIG. **6**B is a cross-sectional view showing the method of manufacturing a light emitting module according to the embodiment.
[0016] FIG. **6**C is a cross-sectional view showing the method of manufacturing a light emitting module according to the embodiment.
[0017] FIG. **7**A is a cross-sectional view showing the method of manufacturing a light emitting module according to the embodiment.
[0018] FIG. **7**B is a cross-sectional view showing the method of manufacturing a light emitting module according to the embodiment.
[0019] FIG. **7**C is a cross-sectional view showing the method of manufacturing a light emitting module according to the embodiment.
[0020] FIG. **8**A is a plan view showing the method of manufacturing a light emitting module according to the embodiment.
[0021] FIG. **8**B is a plan view showing the method of manufacturing a light emitting module according to the embodiment.
[0022] FIG. **9** is a perspective view of a nozzle used in the embodiment.
[0023] FIG. **10**A is an enlarged cross-sectional view showing a method of manufacturing a light emitting module according to the embodiment.
[0024] FIG. **10**B is an enlarged cross-sectional view showing a method of manufacturing a light emitting module according to the embodiment.
DETAILED DESCRIPTION
[0025] Certain embodiments will be explained below with reference to the accompanying drawings. Each drawing is a schematic view of an embodiment. As such, the sizes of and spacing or positional relationships between the members may be exaggerated or certain parts omitted. An end face view which only shows a cross section might be used as a cross-sectional view. In the drawings, the same constituents will be denoted by the same reference numerals.
Construction
[0026] First, the construction of a light emitting module according to one embodiment will be explained.
[0027] FIG. **1** is a perspective view of a light emitting module according to the embodiment when

viewed diagonally from above.
[0028] FIG. **2** is a perspective view of the light emitting module according to the embodiment when viewed diagonally from below.
[0029] FIG. **3** is an enlarged plan view of the region III in FIG. **1**.
[0030] FIG. **4** is a cross-sectional view taken along line IV-IV in FIG. **1**.
[0031] FIG. **5**A is an enlarged cross-sectional view of the region VA in FIG. **4**.
[0032] FIG. **5**B is an enlarged cross-sectional view of the region VB in FIG. **5**A.
[0033] As shown in FIG. **1** and FIG. **2**, the light emitting module **1** according to this embodiment includes a package substrate **10**, a wiring board **20**, a plurality of light emitting elements **30**, a first resin **40**, a second resin **50**, a plurality of wires **60**, and a third resin **70**. In FIG. **1**, for explanation purposes, a portion of the third resin **70** and a portion of the second resin **50** are omitted to make some of the wires **60**, some of the light emitting elements **30**, and the like visible.
[0034] The light emitting module **1** includes a large number of small-sized light emitting elements **30** as the light emitting elements **30**, and preferably includes even larger number of small-sized light emitting elements **30** densely arranged with a narrow pitch on the wiring board **20**. This can increase the number of divided emission ranges to be individually controlled to allow the light emitting module to be used as a light source for a high resolution lighting system. When used as an adaptive driving beam (ADB) headlight, for example, the light emitting module **1** can achieve higher definition and higher resolution emission by way of an advanced light distribution control.
[0035] A package substrate **10** includes, for example, a flat sheet shaped base **11** and wiring provided at least on the upper face of the base **11**. The material used for the base **11** preferably has high heat dissipation performance, more preferably further has a high light-shielding property and high strength. Specific examples include metals, such as aluminum (Al) and copper (Cu), ceramics, such as alumina, aluminum nitride, and mullite, resins, such as phenol resins, epoxy resins, polyimide resin, bismaleimide triazine (BT) resins and polyphthalamide (PPA) resin, and metal composite materials, and resin and ceramic composite materials. The package substrate **10** may be flat sheet shaped, or of a structure having a cavity in the upper face for placing a wiring board **20**. Examples of wiring materials include metals, such as copper (Cu), silver (Ag), gold (Au), aluminum (Al), platinum (Pt), titanium (Ti), tungsten (W), palladium (Pd), iron (Fe), and nickel (Ni), or their alloys.
[0036] As one example, the package substrate **10** is formed by stacking an insulation material, such as an epoxy resin, on a base formed of a metal, such as Al or Cu, in which wiring is provided on the surface and the interior. Portions of the wiring constitute a plurality of upper face pads **12** on the upper face **10***a* of the package substrate **10**, and other portions of the wiring constitute a plurality of lower face pads **13** on the lower face **10***b* of the package substrate **10**.
[0037] In the present specification, an XYZ orthogonal coordinate system is employed for explanation purposes. The longitudinal direction of the package substrate **10** is the “X direction,” the transverse direction is the “Y direction,” and the thickness direction is the “Z direction.” The Z direction from the lower face **10***b* to the upper face **10***a* of the package substrate **10** might also be referred to as “upward” and the reverse direction as “downward,” but these expressions are also used as a matter of convenience and have nothing to do with the direction of gravity.
[0038] The metal base is at least partially exposed from the insulating material on both the upper face **10***a* and the lower face **10***b* of the package substrate **10**, constituting a heat dissipation part **14**. In a plan view, the heat dissipation part **14** is positioned in the central portion of the package substrate **10**, and a plurality of upper face pads **12** and a plurality of lower face pads **13** are arranged on both sides of the heat dissipation part **14** so as to interpose the heat dissipation part **14**. The upper face pads **12** and the lower face pads **13** are arranged, for example, along the longer sides of the package substrate **10**.
[0039] A wiring board **20** is disposed on the heat dissipation part **14** of the package substrate **10**. The wiring board **20** is, for example, a silicon board in which an integrated circuit is embedded,

such as an application specific integrated circuit (ASIC) board. The lower face of the wiring board **20** is bonded to the upper face of the heat dissipation part **14** via a bonding material. An example of the bonding material is silicone silver paste. The central portion of the upper face **21** of the wiring board **20** is provided with a first pad as a region **38** on and to which the light emitting elements **30** are mounted and connected. A second pad is disposed in the periphery of and electrically connected to the first pad.

[0040] Wires **60** are members for electrically connecting the package substrate **10** and the wiring board **20**. The wires **60** are connected to the upper face pads **12** of the package substrate **10** and the second pad of the wiring board **20**. For example, the wires **60** are formed of gold (Au). For example, as many wires **60** as the upper face pads **12** are provided.

[0041] As shown in FIG. **1** and FIG. **3** to FIG. **5**B, the light emitting elements **30** are mounted in the central portion of the upper face **21** of the wiring board **20**. The light emitting elements **30** are substantially quadrangular when viewed from above. The light emitting elements **30** are arranged in a matrix, for example. In one example, light emitting elements **30** each having substantially a square upper face are arranged in four segments, 64 rows by 64 columns per segment, 16,384 pieces in total. In one example, the light emitting elements **30** are arranged per 50 μm, and each light emitting element **30** has substantially square shape whose each side is 45 μm. Accordingly, the space between adjacent light emitting elements **30** is 5 μm. The light emitting elements **30** are connected to the first pad on the upper face **21** of the wiring board **20**. The light emitting elements **30** are, for example, light emitting diodes (LEDs), and emit blue light, for example.

[0042] The shape and the size of each light emitting element **30** in the light emitting module **1** are preferably substantially quadrangular and 20 μm to 100 μm per side, more preferably substantially quadrangular and 30 μm to 100 μm per side, in a top view, considering the mounting accuracy of the light emitting elements **30** and the high definition quality of the module. The number of light emitting elements **30** in the light emitting module **1** is preferably 5,000 to 100,000, more preferably 15,000 to 30,000, considering the size reduction and the high definition quality of the light emitting module.

[0043] The distance between adjacent light emitting elements **30** is preferably narrower in order to enhance the high definition quality of the light emitting module **1**. Considering the efficiency in disposing the first resin **40** described later, moreover, the distance between adjacent light emitting elements **30** is preferably set in a range of 2 μm to 10 μm, more preferably 3 μm to 7 μm.

[0044] For the light emitting elements **30**, those emitting light of any wavelength can be selected. For example, for blue or green light emitting elements, those using ZnSe, nitride semiconductors (In.sub.XAl.sub.YGa.sub.1-X-YN (0≤X, 0≤Y, X+Y≤1)), or GaP can be selected. For red light emitting elements **30**, semiconductors expressed as GaAlAs or AlInGaP can be suitably used. Furthermore, semiconductor light emitting elements formed of materials other than these can also be used. The composition or emission color of the light emitting elements **30** to be employed can be suitably selected in accordance with the purpose.

[0045] As shown in FIG. **5**A, the light emitting elements **30** each have an upper face **31**, a lower face **32** that opposes the upper face **31**, and lateral faces **33** between the upper face **31** and the lower face **32**. The lateral faces **33** are oblique so as to spread from the lower face **32** to the upper face **31**. The upper face **31** and the lower face **32** of each light emitting element **30** are quadrangular in a plan view, for example. The four lateral faces are contiguous with the upper face **31** and the lower face **32**. In other words, the shape of each light emitting element **30** is substantially an inverted truncated square pyramid. The lower face **32** of each light emitting element **30** opposes the upper face **21** of the wiring board **20**. Each light emitting element **30** is connected to the first pad via a conductive bonding material **39**. For this reason, the lower face **32** of each light emitting element **30** is distant from the upper face **21** of the wiring board **20**. An example of the bonding material **39** is copper (Cu). The bonding material **39** can be applied by electroplating, for example.

[0046] A first resin **40** has light reflecting property and is disposed between the upper face **21** of the wiring board **20** and the lower faces **32** of the light emitting elements **30**, and between the facing lateral faces **33** of adjacent light emitting elements **30**. In other words, the first resin **40** is disposed such that the upper faces of the light emitting elements **30** are exposed while covering the lower portions of the lateral faces **33** and the lower faces **32** of the light emitting elements. This can extract more light from the light emitting elements **30** through the upper face **21**. The first resin **40** includes a base material **41** formed of a light transmissive resin and a light reflecting substance **42** contained in the base material **41**. Increasing the amount of the light reflecting substance **42** contained in the first resin **40** can increase the efficiency in extracting the light from the light emitting elements **30**. The concentration of the light reflecting substance **42** in the first resin **40** is preferably in a range of 50% to 70% by mass, and is set for example, as about 60% by mass.
[0047] For the light transmissive resin for the base material **41**, for example, a silicone resin, modified silicone resin, epoxy resin, modified epoxy resin, acrylic resin, or a hybrid resin containing at least one of these resins can be used. Among them, the use of a silicone resin which is highly heat resistant and light resistant is preferable, a dimethyl silicone resin is more preferable. Dimethyl silicon resins are highly reliable as they are resistant to high temperature or the like, which are suited in automotive applications.
[0048] For the light reflecting substance, for example, titanium oxide, aluminum oxide, zinc oxide, barium carbonate, barium sulfate, boron nitride, aluminum nitride, glass filler, or the like can be suitably used.
[0049] In one example, the base material **41** is a dimethyl silicone resin, and the light reflecting substance is titanium oxide. The first resin **40** is white in appearance.
[0050] A second resin **50** has light transmissivity and covers the upper faces **31** of the light emitting elements **30** and the upper face **43** of the first resin **40**. The second resin **50** is in contact with the upper faces **31** and the upper portions of the lateral faces **33** of the light emitting elements **30**, and the upper face **43** of the first resin **40**. The upper portions and the lower portions of the lateral faces **33** refer to, for example, the regions of the lateral faces **33** on the upper face side and the lower face side, respectively, in the height direction from the lower faces **32** to the upper faces **32**. The second resin **50** contains at least a base material **51** formed of a light transmissive resin, and may contain a phosphor **52** contained in the base material **51**.
[0051] For the base material **51**, the same or a similar material to that for the base material **41** of the first resin **40** described above can be used. For the phosphor **52**, for example, yttrium aluminum garnet based phosphors (e.g., Y.sub.3(Al,Ga).sub.5O.sub.12:Ce), lutetium aluminum garnet based phosphors (e.g., Lu.sub.3(Al,Ga).sub.5O.sub.12:Ce), terbium aluminum garnet based phosphors (e.g., Tb.sub.3(Al,Ga).sub.5O.sub.12:Ce), CCA-based phosphors (e.g., Ca.sub.10(PO.sub.4).sub.6Cl.sub.2:Eu), SAE-based phosphors (e.g., Sr.sub.4Al.sub.14O.sub.25:Eu), chlorosilicate based phosphors (e.g., Ca.sub.8MgSi.sub.4O.sub.16Cl.sub.2:Eu), nitride based phosphors, such as β-SiAION based phosphors (e.g., (Si,Al).sub.3(O,N).sub.4:Eu), α-SiAION based phosphors (e.g., Ca(Si,Al).sub.12(O,N).sub.16:Eu), SLA based phosphors (e.g., SrLiAl.sub.3N.sub.4:Eu), CASN-based phosphors (e.g., CaAlSiN.sub.3:Eu), or SCASN-based phosphors (e.g., (Sr,Ca)AlSiN.sub.3:Eu), fluoride based phosphors, such as KSF-based phosphors (e.g., K.sub.2SiF.sub.6:Mn), KSAF-based phosphors (e.g., K.sub.2(Si,Al)F.sub.6:Mn), or MGF-based phosphors (e.g., 3.5MgO.Math.0.5MgF.sub.2.Math.GeO.sub.2:Mn), phosphors having a Perovskite structure (e.g., CsPb(F,Cl,Br,I).sub.3), or quantum dot phosphors (e.g., CdSe, InP, AgInS.sub.2 or AgInSe.sub.2) can be used.
[0052] As shown in FIG. **5**B, between adjacent light emitting elements **30**, the upper face **43** of the first resin **40** is positioned between the upper faces **31** and the lower faces **32** of the light emitting elements **30** in the Z direction, i.e., in the direction in which the wiring board **20** faces the second resin **50**. In this manner, the lower portions and the upper portions of the lateral faces **33** of the light

emitting elements **30** are covered by the first resin **40** and the second resin **50**, respectively. In other words, the light emitting module **1** has recessed parts between adjacent light emitting elements **30**, the recessed parts being defined by the lateral faces **33** of the light emitting elements **30** and the upper face **43** of the first resin **40**, and the second resin **50** is disposed in the recessed parts.

[0053] A third resin **70** protects the wires that connect the package substrate **10** and the wiring board **20**.

[0054] The plan view shape of the third resin **70** is a quadrangular frame formed along the outline of the wiring board **20**. The third resin **70** is disposed to extend from the upper face of the package substrate **10** to the upper face of the wiring board **20** to cover the upper face pads **12** of the package substrate **10**, the wires **60**, and the external connection pads of the wiring board **20**.

[0055] As shown in FIG. **4**, the third resin **70** includes an outer resin frame **71** disposed on the package substrate **10**, an inner resin frame **72** disposed on the wiring board **20**, and a protective resin **73** disposed between the outer resin frame **71** and the inner resin frame **72**. The third resin **70** may have light transmissivity or light shielding property. The third resin **70** includes at least a base material formed of a light transmissive resin, and may contain a light reflecting substance and/or a light absorbing substance. For the base material, the same or a similar material to that for the base material **41** of the first resin **40** described above can be used. For the light reflecting substance, the same or a similar material to that for the light reflecting substance in the first resin **40** described above can be used. Examples of the light absorbing substance include carbon black, graphite, and the like.

[0056] In one example, the outer resin frame **71** and the inner resin frame **72** have light transmissivity, while the protective resin **73** has light reflecting property (light shielding property). The protective resin **73** appears, for example, white, black, or gray.

[0057] The first resin **40**, the second resin **50**, and the third resin **70** may each contain a coloring agent, diffuser, viscosity adjusting filler, or the like as needed.

Manufacturing Method

[0058] Next, a method of manufacturing a light emitting module **1** according to an embodiment will be explained.

[0059] FIG. **6**A to FIG. **6**C and FIG. **7**A to FIG. **7**C are cross-sectional views showing a method of manufacturing a light emitting module according to the embodiment.

[0060] FIG. **8**A and FIG. **8**B are plan views showing the method of manufacturing a light emitting module of the embodiment.

[0061] FIG. **9** is a perspective view of a nozzle used in the embodiment.

[0062] FIG. **10**A and FIG. **10**B are enlarged cross-sectional views showing the method of manufacturing a light emitting module of the embodiment.

[0063] In FIG. **6**A to FIG. **7**C, a smaller number of light emitting elements **30** than actual are shown to simplify the drawings.

Step of Providing Wiring board **20**

[0064] As shown in FIG. **6**A, a wiring board **20** is provided first. Then a plurality of light emitting elements **30** are mounted on the upper face **21** of the wiring board **20** in the central portion excluding the peripheral portion. The light emitting elements **30** are bonded to the wiring board **20** via a bonding material **39**. A resist film **101** is disposed in the peripheral portion of the upper face **21** of the wiring board **20**. The resist film **101** is disposed on the wiring board **20** to surround the region **38** in which the light emitting elements **30** are mounted. The resist film **101** is, for example, quadrangular frame shaped, and the thickness of the resist film **101** is set to be about the same as the sum of the thicknesses of the bonding material **39** and the light emitting elements **30**. In this manner, a wiring board **20** having the upper face **21** on which a resist film **101** and light emitting elements **30** are disposed is provided.

Step of Disposing First Resin **40**

[0065] As shown in FIG. **6**B and FIG. **8**A, an uncured first resin **40** is disposed in the area of the

upper face **21** of the wiring board **20** outward from the region **38** in which the light emitting elements **30** are mounted. As described above, in the first resin **40**, a light reflecting substance **42** is contained in the base material **41** formed of a light transmissive resin. For example, the region **38** is rectangular in a plan view, and the first resin **40** is disposed on the resist film **101** on one side of the region **38** in the Y direction along the long side of the region **38**. The length of the first resin **40** disposed in the X direction is equal to or larger than the length L of the long sides of the region **38**.
[0066] Here, as described above, the first resin **40** contains a high concentration of light reflecting substance. For this reason, the uncured first resin **40** disposed on the wiring board **20** hardly wet-spreads on the wiring board **20**, and is likely to maintain the shape as placed on the surface. For example, the viscosity of the first resin **40** disposed on the upper face of the wiring board **20** is preferably 50 Pa.Math.s or higher, but under 200 Pa.Math.s at room temperature (20±5° C.). This can reduce unintended spreading of the first resin **40** into the region **38** when being disposed on the wiring board **20**, thereby facilitating the control of movement of the first resin into the region **38** in the step of covering with the first resin **40** described below.
Step of Covering with First Resin **40**
[0067] By spreading the uncured first resin **40** into the region **38**, the first resin **40** is disposed between the wiring board **20** and the light emitting elements **30**. At this point, the upper faces of the light emitting elements **30** are also covered with the first resin. The lateral faces of the light emitting elements **30** are covered with the first resin **40** as the first resin flows into the gaps between adjacent light emitting elements **30**.
[0068] More specifically, as shown in FIG. **9**, a nozzle **200** which has an opening having a width W is provided. The shape of the opening of the nozzle **200** (opening shape) is quadrangular and the width W is set to be equal to or larger than the length L of the long sides of the region **38**.
[0069] Then, as shown in FIG. **6**C and FIG. **10**A, the nozzle **200** is moved in the Y direction, i.e., in the direction in which the short sides of the region **38** extend, while allowing the nozzle **200** to jet a gas **300** substantially perpendicularly to the upper face of the wiring board **20**. Jetting the gas **300** against the upper face **21** of the wiring board **20** in this manner can spread the uncured first resin **40** along the Y direction. The movement of the nozzle **200** may be repeated multiple times, for example. This can spread the first resin **40** over the region **38** as shown in FIG. **8**B.
[0070] At this time, the first resin **40** penetrates the gaps between adjacent light emitting elements **30** while moving on the upper faces **31** of the light emitting elements **30** in the Y direction, and further penetrates the gaps between the wiring board **20** and the light emitting elements **30**. Slowly moving the nozzle **200** along one direction while allowing the nozzle **200** to jet a gas **300** substantially perpendicularly to the upper face of the wiring board **20** can reduce the generation of voids in the first resin **40** spread over the region **38**.
[0071] In this embodiment, by jetting a gas **300** against the wiring board **20** substantially perpendicularly, the gas **300** substantially perpendicularly jetted can hit the first resin **40** along the upper face(s) of the resist film **101** and/or the wiring board **20**. In this manner, the surface shape of the first resin **40** that has remained on the resist film **101** by the surface tension can be changed, more specifically, the contact angle formed by the first resin **40** and the upper face of the resist film **101** can be increased. This can reduce the wettability to gently spread the first resin in the Y direction. As the first resin **40** reaches the region **38** and comes into contact with the light emitting elements **30**, the first resin **40** is allowed to wet-spread between the light emitting elements **30** and the gaps under the light emitting elements **30** by capillary action.
[0072] Spreading the first resin **40** in this manner can reduce the generation of voids. This can also reduce the thickness of the first resin **40** covering the upper faces of the light emitting elements **30**, thereby facilitating the removal of the first resin **40** in the step of removing the first resin **40** described below. In this manner, the first resin **40** is disposed between the wiring board **20** and the light emitting elements **30** and between adjacent light emitting elements **30**, and covers the upper faces **31** of the light emitting elements **30**. Subsequently, the first resin **40** is hardened by treating

with heat, for example. As one example, the thickness of the first resin **40** covering the upper faces of the light emitting elements **30** is about 20 μm. The upper faces of the light emitting elements **30** may be partially exposed from the first resin **40**, but all outer edges of each upper face are preferably covered by the first resin **40**.

[0073] In the step of covering with the first resin **40**, the rate of moving the nozzle **200** in the Y direction that jets the air **300** is preferably in a range of 0.1 to 0.5 mm/sec., and is preferably set, for example, as 0.2 mm/sec. The gas pressure is preferably in a range of 0.3 to 0.5 MPa, and is preferably set as 0.45 MPa, for example. The movement of the nozzle **200** is preferably repeated 1 to 5 times, and is preferably set as three times, for example. The gas **300** is preferably air, nitrogen gas, or oxygen gas, and is set as air, for example.

Step of Removing First Resin **40**

[0074] Subsequently, as shown in FIG. **7**A and FIG. **10**B, a nozzle **400** is allowed to jet solid carbon dioxide **500** against the upper face of the first resin **40**. The solid carbon dioxide **500** sublimates near the interfaces between the light emitting elements **30** and the first resin **40** to separate the first resin **40** from the upper faces **31** of the light emitting elements **30**. This can remove the first resin **40** from the upper faces **31** of the light emitting elements **30**. At this point, the upper portions of the first resin **40** disposed between the light emitting elements **30** can also be removed to expose the upper portions of the lateral faces **33** of the light emitting elements **30**.

[0075] The particle size of the solid carbon dioxide **500** is preferably set as 5 to 50 μm. The rate of movement of the nozzle **400** is preferably in a range of 20 to 100 mm/sec., and is preferably set as 50 mm/sec., for example. The pressure applied in jetting the solid carbon dioxide **500** is preferably 0.1 to 0.35 MPa, and is preferably set as 0.3 MPa, for example. The movement of the nozzle **400** is preferably repeated 1 to 5 times, and may be three times, for example.

[0076] Then the resist film **101** is removed. The resist film **101** can be removed, for example, by wet etching. As shown in FIG. **7**B, the intermediate body **90** composed of the wiring board **20**, the light emitting elements **30**, the resist film **101**, and the first resin **40** is dipped in the resist stripper **102**. This can remove the resist film **101** as shown in FIG. **7**C.

Step of Mounting Wiring board **20**

[0077] Subsequently, as shown in FIG. **1** and FIG. **4**, the wiring board **20** is mounted on the package substrate **10**. The package substrate **10** can be secured to the wiring board **20** via a known adhesive material, such as metal paste. An example of the adhesive material is silicone silver paste.

Step of Disposing Second Resin **50**

[0078] Then an uncured or semi-cured second resin **50** is disposed on the light emitting elements **30** and the first resin **40**. As described above, in the second resin **50**, a phosphor **52** is contained in the base material **51**. The second resin **50** is disposed inward of a frame-shaped third resin **70**, i.e., in the region **38** in which the light emitting elements **30** are disposed. The second resin **50** may be disposed by spraying or potting, or by placing one that has been processed in the shape of a sheet.

Step of Hardening Second Resin **50**

[0079] Then the second resin **50** is hardened by heating. At this time, heating the second resin **50** to a first temperature, for example, 100° C., the second resin **50** liquifies to penetrate the gaps between the light emitting elements **30** on the first resin **40**. This allows the second resin **50** to come into contact with the upper portions of the lateral faces **33** of the light emitting elements **30**. Then the second resin **50** is hardened by heating to a second, main hardening temperature which is higher than the first temperature such as 150° C. In the manner described above, a light emitting module **1** according to the embodiment can be manufactured.

[0080] The steps of disposing and hardening the second resin **50** may be performed between the step of stripping the resist film **101** shown in FIG. **7**B and the step of mounting the wiring board **20** on the package substrate **10**.

[0081] The method of manufacturing a light emitting module **1** according to the embodiment may further include, as a step of electrically connecting the wiring board **20** and the package substrate

10, a step of connecting the upper face pads **12** of the package substrate **10** and the external connection pad of the wiring board **20** using wires **60**, as a step of protecting the wires **60**, a step of disposing an outer resin frame **71** on the package substrate **10**, an inner resin frame **71** on the wiring board **20**, and a protective resin **73** between the outer resin frame **71** and the inner resin frame **72**, and other steps.

[0082] In the light emitting module **1** according to this embodiment, a first resin **40** is disposed between the wiring board **20** and the light emitting elements **30**. Accordingly, the light emitted downward from the light emitting elements **30** can be reflected upwards. Therefore, the light extraction efficiency of the light emitting module **1** is high.

[0083] The first resin **40** has a high light reflectance because of the high concentration of the light reflecting substance **42** in the first resin **40**, i.e., 50 to 70% by mass. Therefore, the light extraction efficiency of the light emitting module **1** is high.

[0084] In the light emitting module **1**, moreover, the second resin **50** is in contact with the light emitting elements **30**, i.e., there is no adhesive layer or the like between the light emitting elements **30** and the second resin **50**. Therefore, the light utilization is high.

[0085] In the light emitting module **1**, furthermore, the upper portions of the lateral faces **33** of the light emitting elements **30** are in contact with the second resin **50**. Exposing the upper portions of the lateral faces **33** of the light emitting elements **30** from the first resin **40** can increase the efficiency in extracting light from the light emitting elements **30**. Moreover, the contact areas between the light emitting elements **30** and the second resin **50** is large, thereby being able to achieve good adhesion.

[0086] According to the method of manufacturing a light emitting module **1** of this embodiment, the first resin **40** can be securely disposed between the wiring board **20** and the light emitting elements **30**, and between the light emitting elements **30** by jetting a gas against the upper face of the wiring board **20** on which the first resin **40** is disposed while reducing the generation of voids. This makes it possible to dispose a first resin **40** containing a high concentration of a light reflecting substance between narrower gaps between the light emitting elements **30**, thereby facilitating the size reduction in the light emitting module **1**. Furthermore, the reflectance of the first resin **40** can be increased.

[0087] Moreover, as shown in FIG. **9**, the width W of the opening of the nozzle **200** is set to be equal to or larger than the length L of the long sides of the region **38**. This can move the first resin **40** across the region **38** in one pass in the transverse direction, thereby efficiently and uniformly spreading the first resin **40** while reducing the generation of voids.

[0088] Repeating the movement of the nozzle **200** multiple times can reduce the thickness of the first resin **40** disposed on the upper faces **31** of the light emitting elements **30**. This allows the solid carbon dioxide jetted against the surface to remove the first resin **40** from the upper faces **31** of the light emitting elements **30**. Because solid carbon dioxide is soft, it is less likely to damages the light emitting elements **30**. Allowing the solid carbon dioxide to sublimate near the interfaces between the light emitting elements **30** and the first resin **40** can easily remove the first resin **40**. Furthermore, jetting solid carbon dioxide against the surface can also remove the upper portions of the first resin **40** located between the light emitting elements **30**, thereby exposing the upper portions of the lateral faces **33** of the light emitting elements **30**.

[0089] The embodiments described in the foregoing are examples that give shape to the present invention, and the present invention is not limited to these embodiments. For example, those resulting from adding to, removing from, or modifying certain constituent elements or steps in the embodiments described above are also encompassed by the present invention.

[0090] The present disclosure can be utilized in automotive headlights, light sources for display devices, and the like.

Claims

1. A light emitting module comprising: a wiring board; a plurality of light emitting elements mounted on the wiring board, the plurality of light emitting elements including first and second adjacent light emitting elements, each of the first and second light emitting elements having an upper face, a lower face located opposite to the upper face and facing an upper face of the wiring board, and an oblique lateral face between the upper face and the lower face spreading outwards from the lower face to the upper face; a first resin disposed between the upper face of the wiring board and the lower faces of the first and second light emitting elements, and between lateral faces of the first and second light emitting elements, the first resin containing a light reflecting substance; and a second resin containing a phosphor and covering the upper face of at least one of the light emitting elements and an upper face of the first resin; wherein, between the first and second light emitting elements, the upper face of the first resin is positioned between the upper faces and the lower faces of the first and second light emitting elements in a direction in which the wiring board faces the second resin, and portions of the lateral faces of the first and second light emitting elements that are exposed from the first resin are covered by the second resin.
2. The light emitting module according to claim 1 wherein the light reflecting substance comprises titanium oxide.
3. The light emitting module according to claim 1 wherein a concentration of the light reflecting substance in the first resin is 50% to 70% by mass.