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LIGHT-EMITTING DEVICE

Abstract

A light-emitting device includes first and second semiconductor laser elements, first and second support members, first and second protective elements, and first to fourth wirings. One of ends of the third wiring is bonded to the first protective element. One of ends of the fourth wiring is bonded to the second protective element. In the top view, a distance between the first semiconductor laser element and the first protective element is shorter than a length of the third wiring when the other of the ends of the third wiring is bonded to the second support member, or a distance between the second semiconductor laser element and the second protective element is shorter than a length of the fourth wiring when the other of the ends of the fourth wiring is bonded to the first support member.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application is a continuation application of U.S. patent application Ser. No. 18/627,932, filed on Apr. 5, 2024, which is a continuation application of U.S. patent application Ser. No. 17/489,676, filed on Sep. 29, 2021, now U.S. Pat. No. 11,984,437, which claims priority to Japanese Patent Application No. 2020-166497, filed on Sep. 30, 2020, and Japanese Patent Application No. 2021-135011, filed on Aug. 20, 2021. The entire disclosures of U.S. patent application Ser. Nos. 18/627,932 and 17/489,676 and Japanese Patent Application Nos. 2020-166497 and 2021-135011 are hereby incorporated herein by reference in their entireties.

BACKGROUND
[0002] The present disclosure relates to a light-emitting device.
[0003] Japanese Patent Publication No. 2020-21761 discloses a light-emitting device including a plurality of light-emitting elements connected in series and driven by a constant current, and Zener diodes connected to the light-emitting elements in parallel, the Zener diodes being used for a bypass current path at the time of open-mode failure.
SUMMARY
[0004] However, Japanese Patent Publication No. 2020-21761 does not disclose a concrete form of connections between a plurality of light-emitting elements by wiring. Accordingly, there is room for improvement in the connection form of wiring in the case in which wiring is used.
[0005] A light-emitting device includes a plurality of semiconductor laser elements, a plurality of support members, a first protective element, a second protective element, a first wiring, a second wiring, a third wiring, and a fourth wiring. The semiconductor laser elements each has a p-electrode and an n-electrode. The semiconductor laser elements include a first semiconductor laser element and a second semiconductor laser element. The support members include a first support member bonded with the first semiconductor laser element and a second support member bonded with the second semiconductor laser element. The first protective element is bonded to the first support member, and configured to protect the first semiconductor laser element. The second protective element is bonded to the second support member, and configured to protect the second semiconductor laser elements. One of ends of the first wiring is bonded to the first semiconductor laser element or the first support member. One of ends of the second wiring is bonded to the first semiconductor laser element or the first support member, and the other of the ends of the second wiring is bonded to the second semiconductor laser element or the second support member. One of ends of the third wiring is bonded to the first protective element. One of ends of the fourth wiring is bonded to the first protective element. A current passes from the n-electrode of the first semiconductor laser element to the p-electrode of the second semiconductor laser element through a first current path running through the first wiring and the second wiring. A current passes from

the first protective element to the p-electrode of the second semiconductor laser element through a second current path running through the third wiring. A current passes from the first protective element to the second protective element through a third current path running through the third wiring and the fourth wiring but not through the first wiring or the second wiring. The first semiconductor laser element and the second semiconductor laser element are aligned in a first direction. The first semiconductor laser element and the second semiconductor laser element are each configured to emit light in a second direction perpendicular to the first direction in a top view. The first protective element and the second protective element are aligned in the first direction. The other of the ends of the third wiring is bonded to the second support member, or the other of the ends of the fourth wiring is bonded to the first support member. In the top view, a distance between the first semiconductor laser element and the first protective element is shorter than a length of the third wiring when the other of the ends of the third wiring is bonded to the second support member, or a distance between the second semiconductor laser element and the second protective element is shorter than a length of the fourth wiring when the other of the ends of the fourth wiring is bonded to the first support member.

[0006] A light-emitting device includes a plurality of semiconductor laser elements, a plurality of support members, a first protective element, a second protective element, a first wiring, a second wiring, a third wiring, and a fourth wiring. The semiconductor laser elements each has a first surface and a second surface opposite to the first surface. The semiconductor laser elements include a first semiconductor laser element and a second semiconductor laser element. The support members include a first support member bonded with the first surface of the first semiconductor laser element and a second support member bonded with the first surface of the second semiconductor laser element. The first protective element is bonded to the first support member, and configured to protect the first semiconductor laser element. The second protective element is bonded to the second support member, and configured to protect the second semiconductor laser element. One of ends of the first wiring is bonded to the second surface of the first semiconductor laser element. One of ends of the second wiring is bonded to the support member equipped with the first semiconductor laser element, and the other of the ends of the second wiring being bonded to the second surface of the second semiconductor laser element or the second support member. One of ends of the third wiring is bonded to the first protective element. One of ends of the fourth wiring is bonded to the second protective element. A current passes from the first semiconductor laser element to the second semiconductor laser element through a first current path running through the first wiring and the second wiring but not through the third wiring or the fourth wiring. A current passes from the first protective element to the second semiconductor laser element through a second current path running through the third wiring but not the first wiring. A current passes from the first protective element to the second protective element through a third current path running through the third wiring and the fourth wiring but not through the first wiring or the second wiring. The first semiconductor laser element and the second semiconductor laser element are aligned in a first direction. The first semiconductor laser element and the second semiconductor laser element are each configured to emit light in a second direction perpendicular to the first direction in a top view. The first protective element and the second protective element are aligned in the first direction. The other of the ends of the third wiring is bonded to the second support member, or the other of the ends of the fourth wiring is bonded to the first support member. In the top view, a distance between the first semiconductor laser element and the first protective element is shorter than a length of the third wiring when the other of the ends of the third wiring is bonded to the second support member, or a distance between the second semiconductor laser element and the second protective element is shorter than a length of the fourth wiring when the other of the ends of the fourth wiring is bonded to the first support member.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. **1** is a schematic perspective view of a light-emitting device according to a first embodiment.

[0008] FIG. **2** is a schematic top view corresponding to FIG. **1**.

[0009] FIG. **3** is a schematic cross-sectional view of the light-emitting device taken along the line III-III of FIG. **2**.

[0010] FIG. **4** is a schematic cross-sectional view of the light-emitting device taken along the line IV-IV of FIG. **2**.

[0011] FIG. **5** is a schematic top view illustrating the internal structure of the light-emitting device according to the first embodiment.

[0012] FIG. **6**A is a schematic top view of a portion of the light-emitting device according to the first embodiment for illustrating wiring connections.

[0013] FIG. **6**B is another schematic top view of a portion of the light-emitting device according to the first embodiment for illustrating wiring connections.

[0014] FIG. **6**C is another schematic top view of a portion of the light-emitting device according to the first embodiment for illustrating wiring connections.

[0015] FIG. **7** is a schematic top view of a light-emitting device according to Modified Example 1 for illustrating wiring connections.

[0016] FIG. **8** is a schematic top view of a light-emitting device according to Modified Example 2 for illustrating wiring connections.

[0017] FIG. **9** is a schematic top view of a light-emitting device according to Modified Example 3 for illustrating wiring connections.

[0018] FIG. **10** is a schematic top view of a light-emitting device according to Modified Example 4 for illustrating wiring connections.

[0019] FIG. **11** is a schematic top view of a light-emitting device according to Modified Example 5 for illustrating wiring connections.

[0020] FIG. **12** is a schematic top view of a light-emitting device according to Modified Example 6 for illustrating wiring connections.

[0021] FIG. **13** is a schematic perspective view of a light-emitting device according to a second embodiment.

[0022] FIG. **14** is a schematic top view of the light-emitting device according to the second embodiment.

[0023] FIG. **15** is a schematic top view illustrating the internal structure of the light-emitting device according to the second embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

[0024] In the present specification or the claims, shapes referred to as polygons such as triangles and quadrilaterals include polygons with rounded, chamfered, beveled, or concave beveled corners. Not only shapes with modified corners (ends of sides) but also shapes with intermediate portions of sides modified are referred to as polygons. That is, shapes partially modified on the basis of polygons are interpreted as “polygons” disclosed in the present specification and the claims.

[0025] The same applies to not only polygons but also terms describing specific shapes such as trapezoids, circles, and rugged shapes. The same also applies to the case of each side constituting such a shape. That is, even if an end or an intermediate portion of a certain side has been modified, the modified portion is also interpreted as a portion of the “side.” In the case in which a “polygon” or a “side” without partial modification is distinguished from modified shapes, the term “exact” is added, and a term such as an “exact quadrilateral” is used.

[0026] In the present specification or the claims, expressions such as up/down, right/left,

front/back, front/rear, toward/away merely indicate relationships such as relative positions, orientations, and directions and do not have to coincide with relationships during use.

[0027] In the present specification or the claims, in the case in which a plurality of members correspond to a certain component and are distinguished from one another, the components may be expressed with “first” and “second.” In the case in which objects or viewpoints of distinguishment are different between the present specification and the claims, the same ordinal number may not indicate the same object between the present specification and the claims.

[0028] For example, in the case in which objects are distinguished by the ordinal numbers “first,” “second,” and “third” in the present specification and where only the “first” and “third” ones in the present specification are described in the claims, the ordinal numbers “first” and “second” may be used to achieve distinguishment in the claims for the ease of seeing. In this case, the “first” and “second” objects in the claims indicate the “first” and “third” objects in the present specification.

Embodiments of the present disclosure are described below referring to the accompanying drawings. The embodiments described below are concrete forms of the technical idea of the present invention but do not limit the present invention. In the description below, the same term or reference numeral represents the same member or a similar member, and repetitive descriptions may be omitted as appropriate. Sizes or positional relationships of components illustrated in the drawings may be exaggerated in order to clarify the descriptions.

First Embodiment

[0029] A light-emitting device according to a first embodiment is described. FIG. **1** is a schematic perspective view of a light-emitting device **1**, which is an example of the light-emitting device according to the first embodiment. FIG. **2** is a schematic top view of the light-emitting device **1**. FIG. **3** is a schematic cross-sectional view of the light-emitting device **1** taken along the line III-III of FIG. **2**. FIG. **4** is a schematic cross-sectional view of the light-emitting device **1** taken along the line IV-IV of FIG. **2**. FIG. **5** is a schematic top view illustrating the internal structure in which some of components of the light-emitting device **1** has been removed. FIG. **6**A is a schematic top view illustrating wiring connections for electrical connections between a plurality of light-emitting elements **20** aligned in a first direction in the light-emitting device **1**. The arrow “I” in FIG. **6**A indicates the direction in which a current flows.

[0030] The light-emitting device **1** includes a plurality of components including a base member **10**, the light-emitting elements **20**, a plurality of support members **30**, one or more light-reflective members **40**, a plurality of protective elements **50**, a plurality of wirings **60**, a sealing member **70**, and a lens member **80**. The light-emitting device **1** may further include other components.

[0031] Subsequently, each component is described.

Base Member **10**

[0032] The base member **10** includes a base portion **12** and a lateral wall **14** projecting upward from the base portion **12**. The base portion **12** and the lateral wall **14** form a recessed shape in which the inside of the lateral wall **14** is recessed. In other words, the base member **10** has a recessed portion **10***a* defining the recessed shape.

[0033] The base portion **12** has a projection **12***a*. The projection **12***a* is surrounded by the lateral wall **14**. The recessed portion **10***a* includes the projecting portion of the projection **12***a*. The uppermost surface of the projection **12***a* is located below the uppermost surface of the recessed portion **10***a*. The uppermost surface of the projection **12***a* serves as a mounting surface on which other components are mounted. With the base portion **12** having the projection **12***a*, a warp of the mounting surface can be reduced even in the case in which the base portion **12** and the lateral wall **14** are made of different materials. The shape of the base member **10** is not limited to the above shape but may be, for example, a flat plate shape.

[0034] The base member **10** includes a plurality of wiring portions **14***a*. The wiring portions **14***a* each include an inner wiring region inside the recessed portion **10***a* and an outer wiring region outside the recess. The inner wiring region and the outer wiring region of the wiring portion **14***a*

are electrically conductive. The inner wiring region is bonded to components disposed in the recessed portion **10***a*.

[0035] The wiring portion **14***a* is disposed through the lateral wall **14**. For example, the wiring portion **14***a* can be disposed using a lead pin penetrating through the lateral wall **14**. The base member **10** can include one or more wiring portions **14***a* in each of facing wall surfaces of the lateral wall **14**.

[0036] For example, the base member **10** can be formed of a metal material such as iron, an iron alloy, and copper. Alternatively, a ceramic material such as AlN, SiC, and SiN can be used. The base member **10** can be formed by forming the base portion **12** and the lateral wall **14** using different materials and bonding these members. Metal lead pins can be employed for the wiring portions **14***a*.

Light-Emitting Element **20**

[0037] The light-emitting elements **20** each have a light exit surface from which light is emitted. For example, a semiconductor laser element can be employed for the light-emitting element **20**. The light-emitting element **20** has an upper surface, a lower surface, and one or more lateral surfaces. One lateral surface of the light-emitting element **20** is a light exit surface. The light exit surface can be another surface of the light-emitting element **20**.

[0038] The light-emitting element **20** has a first surface **21** and a second surface **22** opposite to the first surface **21**. The first surface **21** or the second surface **22** can be a bonding surface bonded to another component. The lower surface of the light-emitting element **20** is the first surface **21**, and the upper surface of the light-emitting element **20** is the second surface **22**. The first surface **21** and the second surface **22** are not the light exit surface but may be the light exit surface.

[0039] The light-emitting element **20** includes a p-electrode and an n-electrode. For example, in the light-emitting element **20**, the p-electrode is disposed on the first surface **21**, and the n-electrode is disposed on the second surface **22**. Alternatively, for example, in the light-emitting element **20**, the n-electrode is disposed on the first surface **21**, and the p-electrode is disposed on the second surface **22**. Alternatively, for example, in the light-emitting element **20**, the p-electrode and the n-electrode are disposed on the first surface **21**.

[0040] The peak emission wavelength of the light-emitting element **20** falls within the range of 320 nm to 530 nm, typically within the range of 430 nm to 480 nm. For example, a semiconductor element containing a nitride semiconductor can be employed as such a light-emitting element **20**. For the nitride semiconductor, for example, GaN, InGaN, and AlGaN can be used. The peak emission wavelength of the light-emitting element **20** is not limited to the above wavelength range.

[0041] A semiconductor laser element, which is an example of the light-emitting element **20**, is described. Light (laser beam) radiated from the semiconductor laser element has divergence and forms an elliptic far-field pattern (hereinafter referred to as “FFP”) in a plane parallel to an emission end surface of the light. The FFP indicates the shape and light intensity distribution of emitted light at a position away from the emission end surface.

[0042] Light passing through the center of the elliptic FFP, in other words, light with the peak intensity in the light intensity distribution of the FFP, is referred to as light traveling on an optical axis. The optical path of the light traveling on an optical axis is referred to as the optical axis of the light. Light having an intensity of 1/e.sup.2 (e is the Napier's constant) or more of the peak intensity in the light intensity distribution of the FFP is referred to as the “main portion” of light.

[0043] As for the elliptic FFP of light emitted from the semiconductor laser element, the minor axis direction of the ellipse is referred to as the slow axis direction of the FFP, and the major axis direction is referred to as the fast axis direction of the FFP. A semiconductor laser element in which the direction of layering of a plurality of layers including an active layer constituting the semiconductor laser element coincides with the fast axis direction of the FFP can be employed for the light-emitting element **20**.

[0044] The angle at the intensity corresponding to 1/e.sup.2 of the peak intensity based on the light

intensity distribution of the FFP of the semiconductor laser element is referred to as a spread angle of light of the semiconductor laser element. As for the semiconductor laser element, the spread angle of light in the fast axis direction is larger than the spread angle of light in the slow axis direction.

Support Member **30**

[0045] The support members **30** each has a lower surface, an upper surface, and one or more lateral surfaces. The width of the support member **30** is the smallest in the upper-lower direction. The shape of the support member **30** is a rectangular parallelepiped. The shape is not limited to a rectangular parallelepiped.

[0046] The support member **30** can serve as a support member on which other components are mounted. The support member **30** can be used for electrical connections. The support member **30** includes a conducting region used for establishing electrical connections. The support member **30** includes a bonding region **31** and a conducting region **32** electrically connected to the bonding region **31**. The bonding region **31** and the conducting region **32** are formed on the same surface of the support member **30**. Other components can be mounted on this surface of the support member **30**. Other components are bonded to the bonding region **31**. The conducting region **32** can be electrically connected to the other components bonded to the bonding region **31**.

[0047] The bonding region **31** is continuous with the conducting region **32**. In other words, the bonding region **31** and the conducting region **32** can be defined as segments of a single region. The support member **30** may include a conducting region **32** not continuous with the bonding region **31**. In this case, for example, a conducting region **32** not continuous with the bonding region **31** and a conducting region **32** continuous with the bonding region **31** can be electrically connected by a wiring.

[0048] The support member **30** can include a plurality of bonding regions **31**. The bonding regions **31** are formed on the same surface of the support member **30**. The conducting region **32** can be electrically connected to a plurality of bonding regions **31**. The bonding regions **31** may include a bonding region **31** continuous with the conducting region **32** and a bonding region **31** not continuous with the conducting region **32**.

[0049] For example, the support member **30** is formed of, silicon nitride, aluminum nitride, or silicon carbide. Other materials may be used. For example, the conducting region **32** of the support member **30** can be formed by providing Ti/Pt/Au. For example, the bonding region **31** of the support member **30** can be formed by providing Pt/AuSn on a portion of the region provided with Ti/Pt/Au.

Light-Reflective Member **40**

[0050] The light-reflective members **40** each have a light-reflective surface **41**. For example, the light-reflective surface **41** has a reflectance of 90% or more with respect to a peak wavelength of irradiated light. The reflectance of light can be 100% or less or can be less than 100%.

[0051] The main material constituting the outer shape of the light-reflective member **40** can be glass or metal. The main material is preferably resistant to heat. For example, a glass such as quartz and BK7 (borosilicate glass), a metal such as aluminum, or Si can be used. For example, the light-reflective surface can be constituted of a metal such as Ag and Al or a dielectric multilayer film such as Ta.sub.2O.sub.5/SiO.sub.2, TiO.sub.2/SiO.sub.2, and Nb.sub.2O.sub.5/SiO.sub.2. The term “main material” refers to the material accounting for the highest proportion in the case in which a plurality of materials are used, but in the case in which a single material is used, refers to that material.

Protective Element **50**

[0052] The protective elements **50** are circuit elements for preventing excessive currents from flowing through and breaking specific elements (such as the light-emitting elements **20**). The protective elements **50** each have an upper surface and a lower surface. Typical examples of the protective elements **50** include voltage regulator diodes such as Zener diodes. For example, Si

diodes can be used for the Zener diodes.

Wiring **60**

[0053] The wirings **60** are each constituted of a linear electric conductor with both ends serving as joints. In other words, the wiring **60** include joints bonded to other components at both ends of the linear portion. The wiring **60** is used to electrically connect two components. For example, a metal wiring can be used for the wiring **60**. Examples of the metal include gold, aluminum, silver, and copper.

Sealing Member **70**

[0054] The sealing member **70** has an upper surface and a lower surface. The sealing member **70** is light-transmissive from the upper surface to the lower surface. The term "light-transmissive" indicates that the transmittance of main incident light is 80% or more.

[0055] The sealing member **70** may be partially light-transmissive. For example, the sealing member **70** may include a frame and one or more light-transmissive members. The frame has one or more openings and is not light-transmissive. The one or more light-transmissive members cover the one or more openings of the frame.

[0056] For example, a light-transmissive material such as glass, sapphire, and quartz can be used for the main material of the sealing member **70**. For example, metal can be used for the main material of the frame, and the light-transmissive material described above can be used for the light-transmissive member.

Lens Member **80**

[0057] The lens member **80** has an upper surface and a lower surface. The lens member **80** has a plurality of lens surfaces. The lens surfaces are formed on the upper surface side of the lens member **80**. The upper surface of the lens member **80** includes a plurality of lens surfaces. A portion of the lens member **80** constituting each lens surface is referred to as a lens portion **81**.

[0058] The lens member **80** can have an array of a plurality of lens surfaces. The lens member **80** can have a plurality of lens surfaces arranged in a matrix. The lens surfaces include at least three lens surfaces. The lens surfaces include at least three lens surfaces aligned. The lens member **80** can be formed of a light-transmissive material such as glass and synthetic quartz.

Light-Emitting Device **1**

[0059] Subsequently, the light-emitting device **1** is described. In the light-emitting device **1**, the light-emitting elements **20** are each mounted on the support member **30**. One or more light-emitting elements **20** are mounted on a single support member **30**. The first surface **21** of each light-emitting element **20** is bonded to the bonding region **31** of the support member **30**. The conducting region **32** of the support member **30** is electrically connected to the light-emitting element **20** bonded to the bonding region **31**. In the example of the light-emitting device **1** shown in the drawings, a single light-emitting element **20** is mounted on each of the support members **30**. An edge-emitting semiconductor laser element in which a lateral surface serves as the light exit surface is employed as the light-emitting element **20**.

[0060] For example, the p-electrode of the light-emitting element **20** is bonded to the bonding region **31**. Alternatively, for example, the n-electrode of the light-emitting element **20** is bonded to the bonding region **31**. Alternatively, for example, the p-electrode and the n-electrode of the light-emitting element **20** are bonded to bonding regions **31** of different support members **30**.

[0061] In the light-emitting device **1**, the support members **30** equipped with the light-emitting elements **20** are disposed on the mounting surface of the base member **10**. The support members **30** are mounted on the mounting surface of the base member **10** using the surfaces opposite to the surfaces on which the light-emitting elements **20** have been mounted. A plurality of support members **30** are disposed on the mounting surface of the base member **10**.

[0062] The light-emitting device **1** can include three or more support members **30** equipped with light-emitting elements **20**. The light-emitting device **1** can include **10** or more support members **30** equipped with light-emitting elements **20**. In the example of the light-emitting device **1** shown in

the drawings, **20** support members **30** equipped with light-emitting elements **20** are disposed.
[0063] In the light-emitting device **1**, a plurality of light-emitting elements **20** are disposed on the mounting surface of the base member **10**. The light-emitting elements **20** are disposed on the mounting surface of the base member **10** via the support members **30**. A plurality of light-emitting elements **20** are disposed in the recessed portion **10***a*.
[0064] The light-emitting device **1** includes a plurality of support members **30** aligned in the first direction in a top view. The support members **30** are disposed at regular intervals in the first direction. The support members **30** aligned in the first direction are oriented in the same direction in a top view. In the example of the light-emitting device **1** shown in the drawings, the direction indicated by the reference numeral "**1**D" is the same as the first direction.
[0065] The light-emitting device **1** includes a plurality of support members **30** aligned in a second direction perpendicular to the first direction in a top view. The support members **30** are disposed at regular intervals in the second direction. The support members **30** aligned in the second direction are oriented in the same direction in a top view. In the example of the light-emitting device **1** shown in the drawings, the direction indicated by the reference numeral "**2**D" is the same as the second direction. In the example of the light-emitting device **1** shown in the drawings, **20** support members are arranged in a 4×5 matrix.
[0066] The light exit surfaces of the light-emitting elements **20** mounted on the support members **30** aligned in the first direction are oriented in the same direction. The light exit surfaces of the light-emitting elements **20** aligned in the first direction are located in the same imaginary plane. The light exit surfaces of the light-emitting elements **20** mounted on the support members **30** aligned in the second direction are oriented in the same direction. In the example of the light-emitting device **1** shown in the drawings, the optical axes of light emitted from the light exit surfaces of a plurality of light-emitting elements **20** (semiconductor laser elements) are parallel to the second direction.
[0067] A plurality of support members **30** are arranged in a matrix in the first direction and the second direction. The number of support members **30** aligned in the first direction can be two or more. The number of support members **30** aligned in the second direction can be one or more. In the case in which the number of support members **30** aligned in the second direction is one, the number of support members **30** aligned in the first direction can be three or more.
[0068] In the light-emitting device **1**, support members **30** not equipped with light-emitting elements **20** can be disposed. A pair of support members **30** not equipped with light-emitting elements **20** are disposed corresponding to a plurality of support members **30** aligned in the first direction. The support members **30** not equipped with light-emitting elements **20** are respectively disposed away in the first direction from the support members **30** located at both ends of the support members **30** aligned in the first direction. The support members **30** not equipped with light-emitting elements **20** are disposed outside the support members **30** arranged in a matrix.
[0069] In the light-emitting device, the light-reflective member(s) **40** are disposed on the mounting surface of the base member **10**. One or more light-reflective members **40** are disposed on the mounting surface of the base member **10**. The light-reflective members **40** are disposed such that the light-reflective surfaces **41** face the light exit surfaces of the light-emitting elements **20**.
[0070] The light-reflective members **40** can be respectively disposed for a plurality of light-emitting elements **20**. In this case, the light-emitting device **1** includes a plurality of light-reflective members **40**, and the number of light-reflective members **40** is equal to or larger than the number of the light-emitting elements **20**.
[0071] A single light-reflective member **40** may reflect light emitted from a plurality of light-emitting elements **20** aligned in the first direction. In this case, the distance between both ends of the light-reflective member **40** in the first direction is larger than the distance between the two light-emitting elements **20** located at both ends of a plurality of light-emitting elements **20** aligned in the first direction.

[0072] In the case in which the number of support members **30** aligned in the second direction is two or more, a plurality of light-emitting elements **20** and a plurality of light-reflective members **40** are alternately aligned in the second direction. That is, a light-reflective member **40** is disposed between two light-emitting elements **20** aligned in the second direction, and a light-emitting element **20** is disposed between two light-reflective members **40** aligned in the second direction.
[0073] The main portion of light emitted from the light-emitting elements **20** is reflected by the light-reflective surfaces **41**. The reflected light travels in a different direction, such as the upward direction. The light-reflective members **40** allow light to upwardly exit from the light-emitting device **1** using the light-emitting elements **20** in which the lateral surfaces serve as the light exit surfaces. For example, in the case in which the light-emitting elements **20** are end-face emitting semiconductor laser elements, the light exit surfaces of the light-emitting elements **20** can be main sources of heat emitted from the light-emitting elements **20**, and the heat dissipation performance can be improved by bringing the light exit surfaces close to the support members **30** or the base member **10**.
[0074] In the light-emitting device **1**, protective elements **50** are disposed on the mounting surface of the base member **10**. A plurality of protective elements **50** are disposed on the mounting surface. The protective elements **50** are not directly mounted on the mounting surface. However, the protective elements **50** can be directly disposed on the mounting surface. The protective elements **50** can be mounted on the support members **30**.
[0075] A plurality of protective elements **50** respectively correspond to a plurality of light-emitting elements **20**. Each protective element **50** is disposed near the corresponding light-emitting element **20**. For example, each protective element **50** is disposed on the support member **30** equipped with the corresponding light-emitting element **20**. In the case in which the protective element **50** is disposed near the corresponding light-emitting element **20**, the corresponding one of a plurality of light-emitting elements **20** is the closest to this protective element **50**. In the example of the light-emitting device **1** shown in the drawings, a single protective element **50** is mounted on each of the support members **30**.
[0076] The protective element **50** is bonded to the bonding region **31** of the support member **30**. This bonding region **31** differs from the bonding region **31** bonded to the light-emitting element **20**. The conducting region **32** of the support member **30** is electrically connected to the protective element **50** bonded to the bonding region **31**. The conducting region **32** of the support member **30** is electrically connected to the bonding region **31** bonded to the protective element **50** and the bonding region **31** bonded to the light-emitting element **20**.
[0077] In the example of the light-emitting device **1** shown in the drawings, the protective element **50** is aligned with the light-emitting element **20** in the first direction. The length of the protective element **50** in the second direction is shorter than the length of the light-emitting element **20** in the second direction. The protective element **50** is disposed between two imaginary straight lines respectively passing through both ends of the light-emitting element **20** in the second direction and parallel to the first direction in a top view.
[0078] The number of protective elements **50** in the light-emitting device **1** is the same as the number of light-emitting elements **20** aligned in the first direction. The light-emitting device **1** may include other protective elements than the protective elements **50**. In the example of the light-emitting device **1** shown in the drawings, the light-emitting device **1** does not include other protective elements than the protective elements **50**, and the number of the protective elements **50** in the light-emitting device **1** is equal to the number of light-emitting elements **20** in the light-emitting device **1**.
[0079] In the light-emitting device **1**, a plurality of wirings **60** are used to supply the light-emitting elements **20** with power from an external device. The wirings **60** electrically connect the light-emitting elements **20** to the wiring portions **14***a*. The wirings **60** include one or more wirings **60**, one of the ends of each wiring **60** being bonded to the inner wiring region.

[0080] A plurality of wirings **60** electrically connect a plurality of light-emitting elements **20** in series. A plurality of wirings **60** electrically connect a plurality of light-emitting elements **20** aligned in the first direction in series. A plurality of light-emitting elements **20** aligned in the first direction among a plurality of light-emitting elements **20** are electrically connected to each other in series. A plurality of light-emitting elements **20** aligned in the second direction are not electrically connected to each other in series. The light-emitting elements **20** aligned in the second direction are electrically connected to each other in parallel.
[0081] A plurality of wirings **60** electrically connect a plurality of protective elements **50** in series. A plurality of wirings **60** electrically connect a plurality of protective elements **50** aligned in the first direction in series. A plurality of protective elements **50** aligned in the first direction among a plurality of protective elements **50** are electrically connected to each other in series. A plurality of protective elements **50** aligned in the second direction are not electrically connected to each other in series. The protective elements **50** aligned in the second direction are electrically connected to each other in parallel.
[0082] In a top view, the distance between a light-emitting element **20** mounted on a support member **30** and a protective element **50** corresponding to the light-emitting element **20** is shorter than the distance between the support member **30** and an adjacent support member **30**. For example, the longer distance can be twice or more as long as the shorter distance. For example, the longer distance can be **50** times or less as long as the shorter distance.
[0083] The shorter the wirings **60** are, the smaller the loads applied to the wirings **60** when a current is applied are. Accordingly, in the case in which the protective element **50** is close to the corresponding one of the light-emitting elements **20**, the light-emitting element **20** may be electrically connected to the protective element **50** by wirings. On the other hand, in the example of the light-emitting device **1** shown in the drawings, no wirings are bonded to both the light-emitting element **20** and the protective element **50** to electrically connect the light emitting element **20** and the protective element **50**.
[0084] In a top view, the distance between a light-emitting element **20** mounted on a support member **30** and a protective element **50** corresponding to the light-emitting element **20** is shorter than the length of a wiring **60** bonded to the protective element **50**. For example, the length of the wiring **60** can be twice or more as long as the distance between the light-emitting element **20** and the protective element **50**. For example, the length of the wiring **60** can be three times or more as long as the distance between the light-emitting element **20** and the protective element **50**. For example, the length of the wiring **60** can be **50** times or less as long as the distance between the light-emitting element **20** and the protective element **50**.
[0085] A plurality of wirings **60** electrically connect a plurality of light-emitting elements **20** aligned in the first direction also to the corresponding protective elements **50**. A plurality of wirings **60** provide one of two adjacent light-emitting elements **20** with a current path passing through the other light-emitting element **20** and a current path bypassing the other light-emitting element **20** but passing through the protective element **50** corresponding to the other light-emitting element **20**. With this structure, even in the case in which any of a plurality of light-emitting elements **20** is defective, power feeding to the other light-emitting elements **20** can be maintained by the current path passing through the protective element **50** corresponding to the defective light-emitting element **20**. A specific arrangement of a plurality of wirings **60** is described below.
[0086] A plurality of wirings **60** include one or more wirings **60**A each having both ends, one of the ends being located inside one of two adjacent support members **30** in the first direction, and the other end being located inside the other support member **30** in a top view. One of the ends of the wiring **60**A is bonded to the support member **30** or the light-emitting element **20**. The other end is bonded to the support member **30** or the light-emitting element **20**.
[0087] A plurality of wirings **60** include one or more wirings **60**B each having both ends, one of the ends being located inside one of two adjacent support members **30** in the first direction, and the

other end being located inside the other support member **30** in a top view. One of the ends of the wiring **60**B is bonded to the support member **30** or the protective element **50**. The other end is bonded to the support member **30**.

[0088] A plurality of wirings **60** include one or more wirings **60**C each bonded to a wiring portion **14***a* and a support member **30** not equipped with a light-emitting element **20**. A plurality of wirings **60** include one or more wirings **60**D each bonded to a support member **30** not equipped with a light-emitting element **20** and a support member **30** equipped with a light-emitting element **20**, the light-emitting element **20** mounted on the support member **30**, or a protective element **50**.

[0089] The example of the light-emitting device **1** shown in the drawings includes: wirings **60**C bonded to one of a pair of wiring portions **14***a* and a support member **30** not equipped with a light-emitting element **20**; wirings **60**D bonded to the support member **30** not equipped with a light-emitting element **20** and the conducting region **32** of a support member **30** equipped with a light-emitting element **20**; one or more wirings **60**A bonded to the second surface **22** of a light-emitting element **20** mounted on one of two adjacent support members **30**, the one being on the near side of the current path, and the conducting region **32** of the support member **30** on the far side of the current path; wirings **60**D bonded to the second surface **22** of a light-emitting element **20** and a support member **30** not equipped with a light-emitting element **20**; and wirings **60**C bonded to the support member **30** not equipped with a light-emitting element **20** and the other one of the pair of wiring portions **14***a* along the current path.

[0090] The example of the light-emitting device **1** shown in the drawings also includes: one or more wirings **60**B bonded to the upper surface of a protective element **50** mounted on one of two adjacent support members **30**, the one being on the near side of the current path, and the conducting region **32** of the support member **30** on the far side of the current path; and a wiring **60**D bonded to the upper surface of a protective element **50** and a support member **30** not equipped with a light-emitting element **20**. This structure secures, as a path of a current from the one support member **30** to the other support member **30**, a path passing through the light-emitting element **20** mounted on the one support member **30** and a path passing through the protective element **50** mounted on the one support member **30**.

[0091] In the example of the light-emitting device **1** shown in the drawings, a plurality of wirings **60**A are respectively bonded to the second surfaces **22** of a plurality of light-emitting elements **20**. The number of wirings **60** bonded to the light-emitting elements **20** is larger than the number of wirings **60** bonded to the corresponding protective elements **50**. The wirings **60** bonded to the corresponding protective elements **50** are thicker than the wirings **60** bonded to the light-emitting elements **20**. In the case in which a light-emitting element **20** is defective, a current passes through the protective element **50**, instead of the light-emitting element **20**. The current path can be stably secured by using a thick wiring **60** to compensate for the lack in the number of wirings **60**.

[0092] For connections, two wirings **60**, i.e., a first wiring and a second wiring, may be used instead of a single wiring **60** connecting the light-emitting element **20** mounted on one support member **30** and the conducting region **32** of the other support member **30**. The first wiring may connect the two support members **30**, while the second wiring may connect the support member **30** and the light-emitting element **20**. In the light-emitting device **1**, a wiring **60**A can connect two adjacent support members **30**, one end of the wiring **60**A being bonded to one of the support members **30**, and the other end being bonded to the other support member **30** or the light-emitting element **20** mounted on the other support member **30**.

[0093] In the example of the light-emitting device **1** shown in the drawings, the protective element **50** bonded to one end of the wiring **60**B is located closer to the support member **30** bonded to the other end of the wiring **60**B than the light-emitting element **20** mounted on the support member **30** equipped with the protective element **50**. The wiring **60**B bonded to the protective element **50** mounted on the support member **30** is shorter than the wiring **60**A bonded to the light-emitting element **20** mounted on this support member **30** in a top view. By making the wiring **60** for the

protective element **50** shorter than the wiring **60** for the light-emitting element **20**, the current load applied to the wiring **60** for the protective element **50** can be reduced.

[0094] In the example of the light-emitting device **1** shown in the drawings, the wirings **60**B do not overlap with the light-emitting elements **20** in a top view. Accordingly, the wirings **60**B do not pass directly above the light-emitting elements **20**. In the case in which the light-emitting element **20** and the protective element **50** are mounted on the support member **30**, for example, a wiring **60**B that is bonded to the protective element **50** and passes directly above the light-emitting element **20** can be damaged or broken when the light-emitting element **20** is defective. Such a situation can be suppressed by preventing the wiring **60**B from overlapping with the light-emitting element **20** in a top view.

[0095] The wirings **60**A can be bonded so as not to overlap with the protective element **50** in a top view. FIG. **6**B is a top view illustrating a state in which the wirings are connected. As shown in FIG. **6**B, none of the wirings **60**A connected to the light-emitting element **20** overlap with the protective element **50** in a top view. Accordingly, the wirings **60**A do not pass directly above the protective element **50**.

[0096] The protective element **50** is located in a region between an imaginary line passing through one end of the wiring **60**A while being parallel to the second direction and another imaginary line passing through the other end of this wiring **60**A while being parallel to the second direction. The wirings **60** include a wiring **60**A in which one of the both ends is connected to the light-emitting element **20** while the distance between the other end and the protective element **50** corresponding to this light-emitting element **20** is shorter than the distance between the other end and this light-emitting element **20**.

[0097] In the case in which a portion of the wiring **60**A is located at a position overlapping with the outer edge of the protective element **50** in a top view, false recognition by the wiring **60**A may occur at the visual inspection that checks whether the protective element **50** is appropriately disposed. In other words, overlapping of the wiring **60**A with the protective element **50** may cause false recognition that the protective element **50** is inappropriately mounted despite that the protective element **50** is mounted at the appropriate position. Accordingly, positioning the wiring **60**A so as not to overlap with the protective element **50** in a top view may suppress such a false recognition.

[0098] In the example of the light-emitting device **1** shown in the drawings, the protective element **50** is disposed at a position close to the light exit surface of the light-emitting element **20**. The protective element **50** is disposed at a position closer to the lateral surface serving as the light exit surface (hereinafter referred to as a “first lateral surface”) of the light-emitting element **20** than to the lateral surface (hereinafter referred to as a “second lateral surface”) located opposite to the first surface. This may connect the wiring **60**A to the light-emitting element **20** at a position sufficiently far from the first lateral surface, resulting in suppression of catastrophic failure of the light-emitting element **20**.

[0099] The wirings **60**A connected to the light-emitting element **20** are located closer to the second lateral surface than the protective element **50** in a top view. Among the wirings **60**A, one connected to the light-emitting element **20** at a position closest to the first lateral surface is located away with the distance of **250** μm or more from the first lateral surface.

[0100] In the case in which the wirings **60**A connected to the light-emitting element **20** are located too close to the first lateral surface, an occurrence of a catastrophic failure may be increased, however in the case in which the wirings **60**A connected to the light-emitting element **20** are located too far from the first lateral surface, luminance characteristic or temperature characteristic may be reduced. Accordingly, the wiring **60**A closest to the first lateral surface is preferably located away from the first lateral surface with a distance in a range of 250 μm to 550 μm. FIG. **6**C is an example of the light-emitting device **1** in which the wirings **60**A are located closer to the second lateral surface side than FIG. **6**B, however this example also satisfies the above-described range of

distance.
[0101] The wirings **60**A are connected to the light-emitting element **20** with a predetermined interval. The wirings **60**A include at least three wirings **60**A. Among the wirings **60**A, one located closest to the first lateral surface is located at a greater distance from the first lateral surface than the predetermined interval of the wirings **60**A while being located at a greater distance than a distance between one closest to the second lateral surface and the second lateral surface.
[0102] Viewing the support member **30** by dividing the upper surface using an imaginary line that passes the midpoint between the first and second lateral surfaces of the light-emitting element **20** and is parallel to the first direction in a top view, the protective element **50** corresponding to the light-emitting element **20** is located in a divided area closer to the first lateral surface. The protective element **50** is not located in a divided area closer to the second lateral surface, and connection portion of at least one of the wirings **60**A connected to the light-emitting element **20** is located in this divided area.
[0103] A current may flow in the reverse direction in the light-emitting device **1**. In this case, the example of the light-emitting device **1** shown in the drawings includes: wirings **60**C bonded to one of a pair of wiring portions **14***a* and a support member **30** not equipped with a light-emitting element **20**; wirings **60**D bonded to the support member **30** not equipped with a light-emitting element **20** and the second surface **22** of a light-emitting element **20**; one or more wirings **60**A bonded to the conducting region **32** of one of two adjacent support members **30**, the one being on the near side of the current path, and the second surface **22** of a light-emitting element **20** mounted on the support member **30** on the far side of the current path; wirings **60**D bonded to the conducting region **32** of a support member **30** equipped with a light-emitting element **20** and a support member **30** not equipped with a light-emitting element **20**; and wirings **60**C bonded to the support member **30** not equipped with a light-emitting element **20** and the other one of the pair of wiring portions **14***a* along the current path.
[0104] The example of the light-emitting device **1** shown in the drawings also includes: one or more wirings **60**B bonded to the conducting region **32** of one of two adjacent support members **30**, the one being on the near side of the current path, and bonded to the upper surface of a protective element **50** mounted on the support member **30** on the far side of the current path; and a wiring **60**D bonded to the conducting region **32** of the support member **30** equipped with a protective element **50** and a support member **30** not equipped with a light-emitting element **20**.
[0105] The form of electrical connections by a plurality of wirings **60** is described on the basis of two light-emitting elements **20** among a plurality of light-emitting elements **20** aligned in the first direction. The two light-emitting elements **20** are referred to as a first light-emitting element and a second light-emitting element, a support member **30** equipped with the first light-emitting element is referred to as a first support member, and a support member **30** equipped with the second light-emitting element is referred to as a second support member. Two protective elements **50** among a plurality of protective elements **50** are respectively referred to as a first protective element and a second protective element. In this case, the followings can be stated regarding the light-emitting device **1**.
[0106] A plurality of wirings **60** include a first wiring, one of the ends of the first wiring being bonded to the second surface **22** of one of the first light-emitting element and the second light-emitting element. The wirings **60** include a second wiring, one of the ends of the second wiring being bonded to the support member **30** equipped with one of the light-emitting elements **20** and the other end being bonded to the second surface **22** of the other one of the first light-emitting element and the second light-emitting element. The wirings **60** include a third wiring, one of the ends of the third wiring being bonded to the first protective element. The wirings **60** include a fourth wiring having, one of the ends of the fourth wiring being bonded to the second protective element.
[0107] Bonding the wirings **60** constitutes a current path passing through the first wiring and the

second wiring and not passing through the third wiring or the fourth wiring. Through the current path, a current flows from the first light-emitting element to the second light-emitting element.
[0108] Bonding the wirings **60** also constitutes a current path passing through the third wiring. Through the current path, a current flows from the first protective element to the second light-emitting element. This current path does not pass through one of the first wiring and the second wiring bonded to the second surface **22** of the first light-emitting element. This current path can pass through one of the first wiring and the second wiring bonded to the second surface **22** of the second light-emitting element.
[0109] Further, a current path passing through the third wiring and the fourth wiring and not passing through the first wiring or the second wiring is formed. Through the current path, a current flows from the first protective element to the second protective element.
[0110] In the light-emitting device **1**, the sealing member **70** is bonded to the base member **10**. The lower surface of the sealing member **70** is bonded to the upper surface of the base member **10**. The sealing member **70** is bonded to the upper surface of the recessed portion **10***a* of the base member **10**. The sealing member **70** is bonded to the uppermost surface of the base member **10**.
[0111] A sealed space is formed by bonding the base member **10** and the sealing member **70** together. The light-emitting elements **20** are confined in the sealed space. A hermetically sealed space can be formed by bonding the base member **10** and the sealing member **70** together in an atmosphere of a predetermined gas. By confining the light-emitting elements **20** in the sealed space as described above, dust collection on the light exit surfaces of the light-emitting elements **20** can be reduced, so that a decrease in the luminous efficacy can be reduced.
[0112] Light reflected by the light-reflective members **40** passes through the sealing member **70**. The main portion of light passes through a light-transmissive portion of the sealing member **70** and is emitted from the sealing member **70**.
[0113] In the light-emitting device **1**, the lens member **80** is located above a plurality of light-emitting elements **20**. The lens member **80** is disposed on or above the sealing member **70**. The lens member **80** is bonded to the sealing member **70**. For example, the lens member **80** is bonded using a UV-curable adhesive. Use of a UV-curable adhesive allows the position of mounting of the lens member **80** to be adjusted before bonding at a desired position.
[0114] The lens member **80** is disposed such that beams of light emitted from the light-emitting elements **20** respectively pass through and are emitted from individual lens surfaces.
[0115] The light-emitting device **1** that emits a plurality of beams of light can be manufactured as described above. A light-emitting device in which power can be supplied to light-emitting elements other than defect one of a plurality of light-emitting elements electrically connected in series can be provided.

Modified Examples

[0116] Subsequently, modified examples of the light-emitting device **1** are described. FIG. **7** to FIG. **11** are schematic top views of respective modified examples of the light-emitting device **1**. As with FIG. **6**A, the schematic top views illustrate wiring connections for electrical connections between a plurality of light-emitting elements **20** aligned in the first direction. The arrow “I” in each drawing indicates the direction in which a current flows.
[0117] Each modified example differs from the first embodiment in the arrangements and positions of the light-emitting elements and the protective elements for electrical connections, form of wiring connections, and the like. The modified examples also have features in common with the first embodiment. The other features of the light-emitting device **1** in each modified example are the same as described above. Differences of each modified example from the first embodiment are described below.

Modified Example 1

[0118] FIG. **7** is a drawing according to Modified Example 1. In Modified Example 1 of the light-emitting device **1** shown in the drawing, the conducting region **32** of the support member **30**

connected to an end of the wiring **60**A or the wiring **60**B is larger than in the light-emitting device **1** of the first embodiment. The large conducting region **32** facilitates bonding of the wiring **60**.

[0119] In Modified Example 1 of the light-emitting device **1** shown in the drawing, the protective element **50** bonded to one end of the wiring **60**B is located farther from the support member **30** bonded to the other end of the wiring **60**B than the light-emitting element **20** mounted on the support member **30** equipped with this protective element **50**. The wiring **60**B bonded to the protective element **50** mounted on the support member **30** is longer than the wiring **60**A bonded to the light-emitting element **20** mounted on this support member **30** in a top view. This arrangement can secure a larger region of bonding of the wiring **60** to the support member **30**. In Modified Example 1 of the light-emitting device **1** shown in the drawing, the wirings **60**B overlap with the light-emitting elements **20** in a top view.

Modified Example 2

[0120] FIG. **8** is a drawing according to Modified Example 2. Modified Example 2 of the light-emitting device **1** shown in the drawing differs from the light-emitting device **1** of the first embodiment in that support members **302** are further included. The number of the support members **302** disposed is equal to the number of the protective elements **50** in the light-emitting device **1**. The support members **302** respectively correspond to the protective elements **50**. As with Modified Example 1, the conducting region **32** of the support member **30** connected to an end of the wiring **60**A or the wiring **60**B is larger than in the light-emitting device **1** of the first embodiment.

[0121] In both of the first embodiment and Modified Example 2, one of the ends of the wiring **60**B is bonded to the support member **30** or the protective element **50**. In Modified Example 2, the other end is bonded to the support member **302** not equipped with the light-emitting element **20** or the protective element **50**, while, in the first embodiment, the other end is bonded to the support member **30** equipped with the light-emitting element **20** and the protective element **50**.

[0122] In Modified Example 2, a plurality of wirings **60** do not include wirings **60**D each bonded to the support member **30** not equipped with the light-emitting element **20** and the protective element **50** mounted on the support member **30** equipped with the light-emitting element **20**. Instead, a plurality of wirings **60** include wirings **60**D each bonded to the support member **30** not equipped with the light-emitting element **20** and the support member **302** not equipped with the light-emitting element **20** or the protective element **50**.

[0123] A plurality of wirings **60** include one or more wirings **60**E each having one of the ends located inside the support member **302** in a top view. The other end of the wiring **60**E is located inside the support member **30** in a top view. One of the ends of the wiring **60**E is bonded to the support member **302**. The other end is bonded to the support member **30**.

[0124] Modified Example 2 of the light-emitting device **1** shown in the drawing includes one or more wiring sets each including: a wiring **60**B bonded to the upper surface of a protective element **50** mounted on one of two adjacent support members **30**, the one being on the near side of the current path, and a support member **302** corresponding to the protective element **50**; and one or more wirings **60**E bonded to this support member **302** and the conducting region **32** of the support member **30** on the far side of the current path.

[0125] The one or more wiring sets, a wiring **60**B bonded to the upper surface of a protective element **50** mounted on a support member **30** and the conducting region **32** of a support member **302** corresponding to the protective element **50**, and a wiring **60**D bonded to this support member **302** and a support member **30** not equipped with a light-emitting element **20** are disposed along the current path.

[0126] In Modified Example 2, the wirings **60** bonded to the protective elements **50** can be shorter than in the first embodiment. Accordingly, in Modified Example 2, the wirings **60** bonded to the protective elements **50** can be thinner than in the first embodiment. Accordingly, the wirings **60** bonded to the protective elements **50** can have a thickness equal to or less than the thickness of the wirings **60** bonded to the light-emitting elements **20**.

[0127] In Modified Example 2, as with the first embodiment, the wiring **60**B does not overlap with the light-emitting element **20** in a top view, and, as with Modified Example 1, the conducting region **32** of the support member **30** connected to an end of the wiring **60**A or the wiring **60**B is larger than in the light-emitting device **1** of the first embodiment.
[0128] A current may flow in the reverse direction in the light-emitting device **1** of Modified Example 2. In this case, the wiring set is constituted of: a wiring **60**B bonded to the upper surface of a protective element **50** mounted on one of two adjacent support members **30**, the one being on the near side of the current path, and a support member **302** corresponding to the protective element **50**; and one or more wirings **60**E bonded to this support member **30** and a support member **302** corresponding to a protective element **50** mounted on the support member **30** on the far side of the current path. A wiring **60**D bonded to the support member **302** and a support member **30** not equipped with a light-emitting element **20**, the one or more wiring sets, a wiring **60**B bonded to the upper surface of a protective element **50** mounted on a support member **30** and the conducting region **32** of a support member **302** corresponding to the protective element **50** are disposed along the current path.
[0129] A plurality of wirings **60** include a fifth wiring in addition to the first wiring to the fourth wiring. One of the ends of the fifth wiring is bonded to a support member **302** corresponding to the first protective element. Further, the plurality of wirings **60** include a sixth wiring. One of the ends of the sixth wiring is bonded to a support member **302** corresponding to the second protective element.
[0130] Bonding the wirings **60** constitutes a current path passing through the first wiring and the second wiring and not passing through the third wiring, the fourth wiring, the fifth wiring, or the sixth wiring. Through the current path, a current flows from the first light-emitting element to the second light-emitting element.
[0131] Bonding the wirings **60** also constitutes a current path passing through the third wiring and the fifth wiring. Through the current path, a current flows from the first protective element to the second light-emitting element. The current path does not pass through one of the first wiring and the second wiring bonded to the second surface **22** of the first light-emitting element. The current path can pass through one of the first wiring and the second wiring bonded to the second surface **22** of the second light-emitting element.
[0132] Further, a current path passing through the third wiring, the fourth wiring, the fifth wiring, and the sixth wiring and not passing through the first wiring or the second wiring is formed. Through the current path, a current flows from the first protective element to the second protective element.

Modified Example 3

[0133] FIG. **9** is a drawing according to Modified Example 3. Modified Example 3 of the light-emitting device **1** shown in the drawing differs from the light-emitting device **1** of the first embodiment in that the protective elements **50** mounted on the support members **30** in the light-emitting device **1** of Modified Example 2 are mounted on the corresponding support members **302**. The light-emitting elements **20** and the protective elements **50** are mounted on different support members in the light-emitting device **1** of Modified Example 3, so that the yield can be improved.
[0134] Differences from the light-emitting device **1** of the first embodiment are described below, but many of the differences between the Modified Example 3 and the first embodiment overlap with the differences described above between Modified Example 2 and the first embodiment. The differences overlapping with the differences in description of Modified Example 2 are obvious from comparison between Modified Example 3 shown in the drawing and the description of Modified Example 2 above, and the differences are not described again.
[0135] In Modified Example 3, one of the ends of the wiring **60**B is bonded to the support member **30**, and the other end is bonded to the protective element **50** mounted on the support member **302**.
[0136] Modified Example 3 of the light-emitting device **1** shown in the drawing includes one or

more wiring sets each including: a wiring **60**B bonded to one of two adjacent support members **30**, the one being on the near side of the current path, and a protective element **50** that corresponds to a light-emitting element **20** mounted on the support member **30** and is mounted on a support member **302**; and one or more wirings **60**E bonded to this support member **302** and the conducting region **32** of the support member **30** on the far side of the current path.

[0137] The one or more wiring sets, a wiring **60**B bonded to the conducting region **32** of a support member **30** equipped with a light-emitting element **20** and the upper surface of a protective element **50** corresponding to this light-emitting element **20**, and a wiring **60**D bonded to a support member **302** equipped with this protective element **50** and a support member **30** not equipped with a light-emitting element **20** are disposed along the current path.

[0138] A current may flow in the reverse direction in the light-emitting device **1** of Modified Example 3. In this case, the wiring set is constituted of: a wiring **60**B bonded to the conducting region **32** of one of two adjacent support members **30**, the one being on the near side of the current path, and the upper surface of a protective element **50** corresponding to a light-emitting element **20** mounted on this support member **30**; and one or more wirings **60**E bonded to the support member **30** and a support member **302** equipped with a protective element **50** corresponding to a light-emitting element **20** mounted on the support member **30** on the far side of the current path. The one or more wiring sets, a wiring **60**B bonded to the conducting region **32** of a support member **30** equipped with a light-emitting element **20** and the upper surface of a protective element **50** corresponding to this light-emitting element **20**, and a wiring **60**D bonded to the conducting region **32** of a support member **30** equipped with a light-emitting element **20** and a support member **30** not equipped with a light-emitting element **20** are disposed along the current path.

Modified Example 4

[0139] FIG. **10** is a drawing according to Modified Example 4. In Modified Example 4 of the light-emitting device **1** shown in the drawing, the protective elements **50** each include both electrodes located on the lower surface, and the electrodes are respectively bonded to two bonding regions **31** of the support member **30**. This structure leads to the difference from the light-emitting device **1** of the first embodiment that the wiring **60** is not bonded to the upper surface of the protective element **50**.

[0140] In Modified Example 4 of the light-emitting device **1** shown in the drawing, a plurality of wirings **60** include one or more wirings **60**B each having one of the ends located inside one of two support members **30** in a top view. The other end of the wiring **60**B is located inside the other support member **30** in a top view. These two support members **30** are adjacent to each other in the first direction. One of the ends of the wiring **60**B is bonded to a conducting region **32** of the support member **30**, the conducting region **32** being electrically connected to the bonding region **31** bonded to one of both electrodes of the protective element **50**. The other end is bonded to a conducting region **32** of the support member **30**, the conducting region **32** being electrically connected to the bonding region **31** bonded to the other one of both electrodes of the protective element **50**.

[0141] The example of the light-emitting device **1** shown in the drawing also includes: one or more wirings **60**B bonded to the conducting region **32** electrically connected to the bonding region **31** bonded to one of the electrodes of a protective element **50** mounted on one of two adjacent support members **30**, the one being on the near side of the current path, and the conducting region **32** electrically connected to the bonding region **31** bonded to the other electrode of a protective element **50** mounted on the support member **30** on the far side of the current path; and a wiring **60**D bonded to the conducting region **32** electrically connected to the bonding region **31** bonded to one of the electrodes of the protective element **50** and a support member **30** not equipped with a light-emitting element **20**. The conducting region **32** electrically connected to the bonding region **31** bonded to the other electrode of the protective element **50** is also electrically connected to the bonding region **31** bonded to the light-emitting element **20**.

[0142] A current may flow in the reverse direction in the light-emitting device **1**. In this case, the conducting region **32** electrically connected to the bonding region **31** bonded to the one electrode of the protective element **50** is also electrically connected to the bonding region **31** bonded to the light-emitting element **20**.

[0143] The first wiring and the second wiring included in a plurality of wirings **60** are substantially the same as in the light-emitting device **1** of the first embodiment, and the third wiring and the fourth wiring are different as described below. A plurality of wirings **60** include a third wiring. One of the ends of the third wiring is bonded to the conducting region **32** electrically connected to the bonding region **31** bonded to one of the electrodes of the first protective element. A plurality of wirings **60** include a fourth wiring. One of the ends of the fourth wiring is bonded to the conducting region **32** electrically connected to the bonding region **31** bonded to one of the electrodes of the second protective element.

Modified Example 5

[0144] FIG. **11** is a drawing according to Modified Example 5. In Modified Example 5 of the light-emitting device **1** shown in the drawing, the protective element **50** is mounted on the support member **30** at a position farther from the light exit surface of the light-emitting element **20** mounted on the support member **30** in the second direction than a lateral surface opposite to the light exit surface. The position of the protective element **50** mounted on the support member **30** relative to the light-emitting element **20** differs from the position in the light-emitting device **1** of the first embodiment.

[0145] Disposing the protective element **50** at such a position allows the size of the support member **30** in the first direction to be reduced. The wiring **60** can be bonded such that the wiring **60** bonded to the protective element **50** does not pass directly above the light-emitting element **20**.

Modified Example 6

[0146] FIG. **12** is a drawing related to Modified Example 6. In Modified Example 6 of the light-emitting device **1** shown in the drawing, in the support member **30** equipped with the light-emitting element **20** and the protective element **50**, a plurality of wirings **60** include one or more wirings **60**F having one end bonded to the light-emitting element **20** and the other end bonded to the conducting region **32**. In the support member **30** equipped with the light-emitting element **20** and the protective element **50**, the plurality of wirings **60** include at least one wiring **60**G having one end bonded to the protective element **50** and the other end bonded to the conducting region **32**. The plurality of wirings **60** include wiring(s) **60**H connecting the support members **30** adjacent to each other.

[0147] In Modified Example 6, the first wiring(s) of the wirings **60** is bonded to two support members **30**, and the second wiring(s) of the wirings **60** is bonded to the support member **30** and the light-emitting element **20**. Accordingly, the light-emitting element **20** and the adjacent support member **30** are electrically connected. Similarly, the first wiring(s) of the wirings **60** is bonded to two support members **30**, and the second wiring(s) of the wirings **60** is bonded to the support member **30** and the protective element **50**. Accordingly, the protective element **50** and the adjacent support member **30** are electrically connected.

[0148] As compared to the light-emitting device **1** of the first embodiment, in the light-emitting device **1** of Modified Example **6**, the length of the wiring **60** bonded to the light-emitting element **20** and the length of the wiring **60** bonded to the protective element **50** can be shorter. Accordingly, the current load applied to the wiring **60** can be reduced.

Second Embodiment

[0149] Subsequently, a light-emitting device according to a second embodiment is described. FIG. **13** is a schematic perspective view of a light-emitting device **2**, which is an example of the light-emitting device according to the second embodiment. FIG. **14** is a schematic top view of the light-emitting device **2**. FIG. **15** is a schematic top view illustrating the internal structure in which some of components of the light-emitting device **2** has been removed. Descriptions overlapping with the

descriptions of the light-emitting device according to the first embodiment described above may be omitted as appropriate. Features of the light-emitting device **2** shown in the drawing that are consistent with the descriptions of the first embodiment described above are applicable to the light-emitting device of the second embodiment.

[0150] The light-emitting device **2** includes a plurality of components including the base member **10**, a plurality of light-emitting elements **20**, a plurality of support members **30**, one or more light-reflective members **40**, a plurality of protective elements **50**, a plurality of wirings **60**, the sealing member **70**, and the lens member **80**. The light-emitting device **2** may further include other components.

[0151] In the light-emitting device **2**, the base member **10** has one or more stepped portions **16** in the recessed portion **10***a*. The stepped portions **16** are portions defining the recessed shape of the base member **10**. The stepped portions **16** each refer to a portion constituted of only an upper surface and an inner lateral surface intersecting with the upper surface and extending downward. The stepped portions **16** can be interpreted as portions of the lateral wall **14**. The mounting surface of the base member **10** is located inside the stepped portions **16** in a top view.

[0152] In the base member **10** of the light-emitting device **2**, the wiring portions **14***a* are disposed on the upper surfaces of the stepped portions **16**. The inner wiring regions of the wiring portions **14***a* are disposed on the upper surfaces of the stepped portions **16**. The outer wiring regions of the wiring portions **14***a* are disposed on the lower surface of the base member **10**. The inner wiring regions and the outer wiring regions are electrically connected by via holes running through the base member **10**.

[0153] In the base member **10** of the light-emitting device **2**, the stepped portions **16** are formed along the inner lateral surfaces of the lateral wall **14** opposite to each other in the first direction. Further, in the base member **10** of the light-emitting device **2**, no stepped portions **16** are formed along the inner lateral surfaces of the lateral wall **14** opposite to each other in the second direction.

[0154] The light-emitting device **2** does not include the support members **30** that do not equip light-emitting elements **20** and are bonded with the wirings **60**. Accordingly, a plurality of wirings **60** include, instead of the wiring **60**C and the wiring **60**D in the first embodiment, one or more wirings **60**C each bonded to the wiring portion **14***a* and the support member **30** equipped with the light-emitting element **20**, or the light-emitting element **20** or the protective element **50** mounted on the support member **30**. This structure allows for reduction in the size of the light-emitting device **2**.

[0155] In the light-emitting device **2**, connections of the wirings **60** are substantially the same as in description of the first embodiment except that the wiring **60**C in the second embodiment replaces the wiring **60**C and the wiring **60**D in the first embodiment. Accordingly, as with the first embodiment, each modified example can apply to the light-emitting device according to the second embodiment.

[0156] The features below are common to the first embodiment, the second embodiment, and the modified examples of these embodiments described above.

[0157] A plurality of wirings **60** in the light-emitting device according to each embodiment include the first wiring, one of the ends of the first wiring being bonded to one of the first light-emitting element and the second light-emitting element or the support member equipped with the one light-emitting element. Further, the plurality of wirings **60** include the second wiring, one of the ends of the second wiring being bonded to one of the first light-emitting element and the second light-emitting element or the support member equipped with the one light-emitting element and the other end being bonded to the other light-emitting element or the support member equipped with the other light-emitting element. Furthermore, the plurality of wirings **60** include the third wiring and the fourth wiring. One of the ends of the third wiring is bonded to the first protective element or the support member equipped with the first protective element. One of the ends of the fourth wiring being bonded to the second protective element or the support member equipped with the second protective element.

[0158] The current path passing through the first wiring and the second wiring is formed in which a current flows from the n-electrode of the first light-emitting element to the p-electrode of the second light-emitting element. The current path passing through the third wiring is further formed in which a current flows from the first protective element to the p-electrode of the second light-emitting element. The current path passing through the third wiring and the fourth wiring and not passing through the first wiring or the second wiring is further formed in which a current flows from the first protective element to the second protective element.
[0159] Descriptions have been provided above, but the present invention having the technical feature disclosed in the specification is not limited to the structures described referring to each embodiment in the specification. For example, the present invention can apply to a light-emitting device including a component that is not disclosed in the embodiments, and the difference from the disclosed structure does not constitute grounds for inability in application of the present invention. In view of the minimum components for achieving the present invention, the components included in the light-emitting devices disclosed referring to the embodiments can include unnecessary components.
[0160] In short, the light-emitting devices disclosed referring to the embodiments in the present specification have the viewpoint of disclosure of rational constitutions based on an assumed use in addition to the viewpoint of achievement of the present invention. The application of the present invention is not limited to the illustrative use, but there is another aspect that application to that use is effective.
[0161] In the above viewpoints, it is possible that the present invention (claims) does not need to include all the components disclosed referring to one embodiment. For example, in the case in which part of the components of the light-emitting devices disclosed referring to the embodiments is not disclosed in the claims, the components are not limited to the components disclosed referring to the present embodiments. Application of the present invention disclosed in the claims is claimed while accepting design flexibility such as substitution, omission, and changes in shapes and materials made by a person skilled in the art.
[0162] The light-emitting devices and the optical members described referring to the embodiments can be used for projectors. That is, a projector is one of the uses to which the present invention applies. The present invention is not limited to this use and can be used for light sources for lightings, vehicle headlights, head-mounted displays, backlights for other displays, or the like.

Claims

1. A light-emitting device comprising: a plurality of semiconductor laser elements each having a p-electrode and an n-electrode, the plurality of semiconductor laser elements including a first semiconductor laser element and a second semiconductor laser element; a plurality of support members including a first support member bonded with the first semiconductor laser element and a second support member bonded with the second semiconductor laser element; a first protective element bonded to the first support member, and configured to protect the first semiconductor laser element; a second protective element bonded to the second support member, and configured to protect the second semiconductor laser elements; a first wiring, one of ends of the first wiring being bonded to the first semiconductor laser element or the first support member; a second wiring, one of ends of the second wiring being bonded to the first semiconductor laser element or the first support member, and the other of the ends of the second wiring being bonded to the second semiconductor laser element or the second support member; a third wiring, one of ends of the third wiring being bonded to the first protective element; and a fourth wiring, one of ends of the fourth wiring being bonded to the first protective element, wherein a current passes from the n-electrode of the first semiconductor laser element to the p-electrode of the second semiconductor laser element through a first current path running through the first wiring and the second wiring, a

current passes from the first protective element to the p-electrode of the second semiconductor laser element through a second current path running through the third wiring, a current passes from the first protective element to the second protective element through a third current path running through the third wiring and the fourth wiring but not through the first wiring or the second wiring, the first semiconductor laser element and the second semiconductor laser element are aligned in a first direction, the first semiconductor laser element and the second semiconductor laser element are each configured to emit light in a second direction perpendicular to the first direction in a top view, the first protective element and the second protective element are aligned in the first direction, the other of the ends of the third wiring is bonded to the second support member, or the other of the ends of the fourth wiring is bonded to the first support member, and in the top view, a distance between the first semiconductor laser element and the first protective element is shorter than a length of the third wiring when the other of the ends of the third wiring is bonded to the second support member, or a distance between the second semiconductor laser element and the second protective element is shorter than a length of the fourth wiring when the other of the ends of the fourth wiring is bonded to the first support member.

2. The light-emitting device according to claim 1, wherein the distance between the first semiconductor laser element and the first protective element is shorter than a distance between the first support member and the second support member, and the distance between the second semiconductor laser element and the second protective element is shorter than the distance between the first support member and the second support member.

3. The light-emitting device according to claim 1, wherein in the top view, the third wiring is shorter than the first wiring, and the fourth wiring is shorter than the second wiring.

4. The light-emitting device according to claim 1, wherein the third wiring is thicker than the first wiring.

5. The light-emitting device according to claim 1, further comprising the plurality of semiconductor laser elements include three or more semiconductor laser elements including the first and second semiconductor laser elements, the three or more semiconductor laser elements being electrically connected in series.

6. The light-emitting device according to claim 5, wherein the three or more semiconductor laser elements electrically connected in series are aligned, and the first semiconductor laser element and the second semiconductor laser element are adjacent to each other.

7. The light-emitting device according to claim 6, wherein the first semiconductor laser element or the second semiconductor laser element is located at an end of the three or more semiconductor laser elements aligned.

8. The light-emitting device according to claim 1, wherein the third wiring does not pass directly above the first semiconductor laser element.

9. The light-emitting device according to claim 1, wherein the first wiring does not pass directly above the first protective element, and the second wiring does not pass directly above the second protective element.

10. The light-emitting device according to claim 1, wherein the first semiconductor laser element has a first surface and a second surface located opposite to the first surface, and the first surface serves as a light exit surface, the first protective element is located closer to the first surface than to the second surface, and the first wiring is bonded to the first semiconductor laser element at a position with a distance of 250 μm or more from the light exit surface of the first semiconductor laser element.

11. A light-emitting device comprising: a plurality of semiconductor laser elements each having a first surface and a second surface opposite to the first surface, the plurality of semiconductor laser elements including a first semiconductor laser element and a second semiconductor laser element; a plurality of support members including a first support member bonded with the first surface of the first semiconductor laser element and a second support member bonded with the first surface of the

second semiconductor laser element; a first protective element bonded to the first support member, and configured to protect the first semiconductor laser element; a second protective element bonded to the second support member, and configured to protect the second semiconductor laser element; a first wiring, one of ends of the first wiring being bonded to the second surface of the first semiconductor laser element; a second wiring, one of ends of the second wiring being bonded to the support member equipped with the first semiconductor laser element, and the other of the ends of the second wiring being bonded to the second surface of the second semiconductor laser element or the second support member; a third wiring, one of ends of the third wiring being bonded to the first protective element; and a fourth wiring, one of ends of the fourth wiring being bonded to the second protective element, wherein a current passes from the first semiconductor laser element to the second semiconductor laser element through a first current path running through the first wiring and the second wiring but not through the third wiring or the fourth wiring, a current passes from the first protective element to the second semiconductor laser element through a second current path running through the third wiring but not the first wiring, a current passes from the first protective element to the second protective element through a third current path running through the third wiring and the fourth wiring but not through the first wiring or the second wiring, the first semiconductor laser element and the second semiconductor laser element are aligned in a first direction, the first semiconductor laser element and the second semiconductor laser element are each configured to emit light in a second direction perpendicular to the first direction in a top view, the first protective element and the second protective element are aligned in the first direction, the other of the ends of the third wiring is bonded to the second support member, or the other of the ends of the fourth wiring is bonded to the first support member, and in the top view, a distance between the first semiconductor laser element and the first protective element is shorter than a length of the third wiring when the other of the ends of the third wiring is bonded to the second support member, or a distance between the second semiconductor laser element and the second protective element is shorter than a length of the fourth wiring when the other of the ends of the fourth wiring is bonded to the first support member.

12. The light-emitting device according to claim 11, wherein the distance between the first semiconductor laser element and the first protective element is shorter than a distance between the first support member and the second support member, and the distance between the second semiconductor laser element and the second protective element is shorter than the distance between the first support member and the second support member.

13. The light-emitting device according to claim 11, wherein in the top view, the third wiring is shorter than the first wiring, and the fourth wiring is shorter than the second wiring.

14. The light-emitting device according to claim 11, wherein the third wiring is thicker than the first wiring.

15. The light-emitting device according to claim 11, further comprising the plurality of semiconductor laser elements include three or more semiconductor laser elements including the first and second semiconductor laser elements, the three or more semiconductor laser elements being electrically connected in series.

16. The light-emitting device according to claim 15, wherein the three or more semiconductor laser elements electrically connected in series are aligned, and the first semiconductor laser element and the second semiconductor laser element are adjacent to each other.

17. The light-emitting device according to claim 16, wherein the first semiconductor laser element or the second semiconductor laser element is located at an end of the three or more semiconductor laser elements aligned.

18. The light-emitting device according to claim 11, wherein the third wiring does not pass directly above the first semiconductor laser element.

19. The light-emitting device according to claim 11, wherein the first wiring does not pass directly above the first protective element, and the second wiring does not pass directly above the second

protective element.

20. The light-emitting device according to claim 11, wherein the first semiconductor laser element has a first surface and a second surface located opposite to the first surface, and the first surface serves as a light exit surface, the first protective element is located closer to the first surface than to the second surface, and the first wiring is bonded to the first semiconductor laser element at a position with a distance of 250 μm or more from the light exit surface of the first semiconductor laser clement.