

DESCRIPTION

Title of Invention

METHOD FOR MANUFACTURING OPTICAL SEMICONDUCTOR
PACKAGE

Technical Field

[0001] The present disclosure relates to a method for manufacturing an optical semiconductor package.

Background Art

[0002] Patent Literature 1 discloses a method for manufacturing a semiconductor package including a light receiving element. In the manufacturing method disclosed in Patent Literature 1, a connection wiring including a columnar electrode is formed on a glass substrate, a light receiving element (silicon substrate on which a photoelectric conversion device region (light receiving portion) is provided) is mounted on the connection wiring, and a first sealing film (underfill) made of a resin fills between the light receiving element and the glass substrate, and then the entire upper surface of the glass substrate is further covered with a second sealing film made of a resin.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Patent No. 4126389

Summary of Invention

Technical Problem

[0004] In the manufacturing method, since the light receiving portion is covered with the first sealing film, light receiving sensitivity may be

lowered. In addition, since an interface between the first sealing film and the second sealing film is in contact with the connection wiring, stress caused by a difference in thermal expansion coefficient between the first sealing film and the second sealing film or the like concentrates on the connection wiring, and the connection wiring may be damaged. As described above, there is room for improvement in the manufacturing method from the viewpoint of reliability of the semiconductor package.

[0005] An object of the present disclosure is to provide a method for manufacturing an optical semiconductor package capable of improving reliability.

Solution to Problem

[0006] A method for manufacturing an optical semiconductor package according to an aspect of the present disclosure includes a first step of temporarily bonding, to a substrate, a light receiving element having a first surface on which a light receiving portion and an electrode terminal electrically connected to the light receiving portion are provided and a first end portion of a metal member having a columnar shape, the light receiving element being temporarily bonded to the substrate such that the first surface faces the substrate in the first step, a second step of forming a resin portion covering the light receiving element and the metal member on the substrate, a third step of exposing a second surface of the light receiving element on a side opposite to the first surface of the light receiving element and a second end portion on a side opposite to the first end portion of the metal member by polishing or grinding the resin portion from a side facing the second surface, a fourth step of forming a first wiring layer including a first metal wiring electrically connected to

the second end portion on the second surface of the light receiving element and on an end surface of the resin portion continuous with the second surface, a fifth step of separating the substrate from the light receiving element, the metal member, and the resin portion, and a sixth step of forming a second wiring layer including a second metal wiring that electrically connects the first end portion and the electrode terminal on a side opposite to a side on which the first wiring layer is positioned with respect to the light receiving element and the resin portion after the fifth step.

[0007] In the manufacturing method, in the first step, the light receiving element is temporarily bonded to the substrate such that a gap is not formed between the substrate and the light receiving element. Accordingly, in the second step, it is possible to prevent the resin portion from flowing between the light receiving element and the substrate, that is, it is possible to prevent the resin portion from being formed at a position facing the light receiving portion. As a result, it is possible to avoid deterioration in light receiving sensitivity caused by the light receiving portion being covered with the resin portion. In addition, the light receiving element and the metal member are temporarily bonded to the substrate, and thus, the second step can be stably and accurately performed in a state where each member is stably fixed. As described above, according to the manufacturing method, the optical semiconductor package can be manufactured with high reliability.

[0008] The first step may include a step of positioning and supporting, by a support member, the metal member in a state of exposing the first end portion, and a step of temporarily bonding the first end portion to the

substrate by bringing a temporary bonding surface of the substrate into contact with the first end portion of the metal member supported by the support member. According to the above configuration, the metal member can be temporarily bonded to the substrate by a relatively simple operation of bringing the temporary bonding surface of the substrate into contact with the metal member positioned and supported by the support member.

[0009] The support member may have a plate-shaped member in which a through-hole having a width larger than a width of the metal member is formed, and a support substrate that the second end portion is placed on and is supported by, the metal member may be positioned by being inserted into the through-hole of the plate-shaped member and may be supported by the support substrate, and the first end portion may protrude to a side opposite to the support substrate side with respect to the plate-shaped member in a state where the metal member is supported by the support member. According to the above configuration, since the metal member is supported by the support member in a state where the first end portion of the metal member protrudes more than the plate-shaped member, when the temporary bonding surface of the substrate is brought into contact with the first end portion, it is possible to prevent the temporary bonding surface of the substrate from coming into contact with the plate-shaped member. That is, it is possible to accurately prevent the temporary bonding surface of the substrate from adhering to the plate-shaped member.

[0010] The metal member may have a shaft including the second end portion and a flange including the first end portion and formed to be wider

than the shaft, the support member may be a plate-shaped member in which a through-hole having a width larger than a width of the shaft and smaller than a width of the flange, and the metal member may be supported by the support member by inserting the shaft into the through-hole and bringing an inner surface on the second end portion side of the flange into contact with a peripheral edge portion of the through-hole of the support member. According to the above configuration, the flange can be hooked and supported by the peripheral edge portion of the through-hole of the plate-shaped member. That is, since the support substrate for supporting the second end portion is unnecessary, the support member can be simplified. In addition, the flange is provided, and thus, a posture (perpendicularity) of the metal member erected on the substrate can be further stabilized.

[0011] In the fourth step, the first wiring layer may be formed such that a wiring width of a portion of the first metal wiring connected to the second end portion is larger than a width of the second end portion of the metal member. According to the above configuration, it is possible to absorb the positional deviation of the metal member that may occur in the second step (resin portion forming step). That is, the wiring width of the first metal wiring is increased, and thus, even though the position of the metal member is slightly deviated in the second step, the first metal wiring and the metal member (second end portion) can be more reliably brought into contact with each other.

[0012] In the fourth step, the first wiring layer may be formed such that a wiring width of a portion of the first metal wiring connected to the second end portion is smaller than a width of the second end portion of

the metal member. According to the above configuration, the first metal wiring can be formed without being affected by a size (width) of the metal member. For example, in a case where the width of the first metal wiring is set to be larger than the width of the metal member in a case where the width of the metal member (second end portion) is relatively large, there may be a problem that the first metal wiring easily interferes with another wiring provided in the first wiring layer. According to the above configuration, occurrence of such a problem can be avoided.

[0013] In the sixth step, the second wiring layer may be formed such that the wiring width of the portion of the second metal wiring connected to the first end portion is larger than the width of the first end portion of the metal member. According to the above configuration, it is possible to absorb the positional deviation of the metal member that may occur in the second step (resin portion forming step). That is, the wiring width of the second metal wiring is increased, and thus, even though the position of the metal member is slightly deviated in the second step, the second metal wiring and the metal member (first end portion) can be more reliably brought into contact with each other.

[0014] In the sixth step, the second wiring layer may be formed such that a wiring width of a portion of the second metal wiring connected to the first end portion is smaller than a width of the first end portion of the metal member. According to the above configuration, the second metal wiring can be formed without being affected by the size (width) of the metal member. For example, in a case where the width of the metal member (first end portion) is relatively large, when the width of the second metal wiring is set to be larger than the width of the metal member,

there may be a problem that the second metal wiring easily interferes with another wiring provided in the second wiring layer. According to the above configuration, occurrence of such a problem can be avoided.

[0015] The fifth step may be performed after at least the third step. The fourth step may be performed after the third step, and the fifth step may be performed after the fourth step. According to the above configuration, the substrate is attached also in the third step (or the third step and the fourth step), and thus, the third step (alternatively, the third step and the fourth step) can be performed with high reliability in a state where the support stability of each member is improved.

[0016] The light receiving element may have a light receiving surface on the first surface. According to the above configuration, the optical semiconductor package in which a front surface of a front surface incidence type light receiving element is the first surface can be manufactured with high reliability.

[0017] A method for manufacturing an optical semiconductor package according to another aspect of the present disclosure includes a first step of forming, on a substrate, a first wiring layer which includes a first metal wiring and in which an opening portion for exposing the substrate is provided, a second step of forming a metal member connected to a first end portion of the first metal wiring and protruding to a side opposite to the substrate side from the first wiring layer, a third step of preparing a light receiving element having a first surface on which a light receiving portion and an electrode terminal electrically connected to the light receiving portion are provided, a fourth step of disposing the light receiving element such that a second end portion of the first metal wiring

different from the first end portion and the electrode terminal are electrically connected, the light receiving portion is disposed at a position facing the opening portion, and an internal space is formed between the substrate and the light receiving element, a fifth step of forming a resin portion that covers the light receiving element, the metal member, and the first wiring layer, with which the internal space is filled, and having transparency to light to be detected by the light receiving portion, a sixth step of exposing the second surface and an end portion on a side opposite to a side connected to the first metal wiring of the metal member by polishing or grinding the resin portion from a side facing a second surface on a side opposite to the first surface of the light receiving element, a seventh step of forming a second wiring layer including a second metal wiring electrically connected to the end portion of the metal member on the second surface of the light receiving element and an end surface of the resin portion continuous with the second surface, and an eighth step of separating the substrate from the first wiring layer and the resin portion. [0018] In the manufacturing method, the resin portion covers the light receiving portion by filling the internal space between the light receiving element and the substrate with the resin portion in the fifth step. However, since the resin portion has transparency to light to be detected by the light receiving portion, deterioration in light receiving sensitivity caused by the resin portion covering the light receiving portion is suppressed. Further, in the fifth step, it is possible to collectively form the resin portion that fills the internal space between the light receiving element and the substrate and covers each member (light receiving element, metal member, or first wiring layer) with a single resin material.

Accordingly, it is possible to avoid deterioration in reliability (for example, damage or the like of the metal wiring due to stress caused by a difference in thermal expansion coefficient between two resin portions or the like) due to the mixture of two types of resin portions (for example, two resin portions made of materials different from each other or formed at different timings). As described above, according to the manufacturing method, the optical semiconductor package can be manufactured with high reliability.

[0019] The eighth step may be performed after at least the sixth step. The seventh step may be performed after the sixth step, and the eighth step may be performed after the seventh step. According to the above configuration, the substrate is also attached in the sixth step (or the sixth step and the seventh step), and thus, the sixth step (or the sixth step and the seventh step) can be performed with high reliability in a state where the support stability of each member is improved.

[0020] The light receiving element may have a light receiving surface on the first surface. According to the above configuration, the optical semiconductor package in which a front surface of a front surface incidence type light receiving element is the first surface can be manufactured with high reliability.

Advantageous Effects of Invention

[0021] According to the present disclosure, it is possible to provide the method for manufacturing the optical semiconductor package capable of improving reliability.

Brief Description of Drawings

[0022] FIG. 1 is a sectional view of an optical semiconductor package of

a first embodiment.

FIG. 2 is a diagram illustrating an example of a manufacturing step of the optical semiconductor package of FIG. 1.

5 FIG. 3 is a diagram illustrating an example of the manufacturing step of the optical semiconductor package of FIG. 1.

FIG. 4 is a diagram illustrating an example of the manufacturing step of the optical semiconductor package of FIG. 1.

FIG. 5 is a diagram illustrating an example of the manufacturing step of the optical semiconductor package of FIG. 1.

10 FIG. 6 is a diagram illustrating an example of the manufacturing step of the optical semiconductor package of FIG. 1.

FIG. 7 is a diagram illustrating an example of the manufacturing step of the optical semiconductor package of FIG. 1.

15 FIG. 8 is a sectional view of an optical semiconductor package of a second embodiment.

FIG. 9 is a diagram illustrating an example of a manufacturing step of the optical semiconductor package of FIG. 8.

FIG. 10 is a diagram illustrating an example of the manufacturing step of the optical semiconductor package of FIG. 8.

20 FIG. 11 is a diagram illustrating an example of the manufacturing step of the optical semiconductor package of FIG. 8.

FIG. 12 is a sectional view of an optical semiconductor package of a third embodiment.

25 FIG. 13 is a diagram illustrating an example of a manufacturing step of the optical semiconductor package of FIG. 12.

FIG. 14 is a diagram illustrating an example of the manufacturing

step of the optical semiconductor package of FIG. 12.

FIG. 15 is a diagram illustrating an example of the manufacturing step of the optical semiconductor package of FIG. 12.

FIG. 16 is a diagram illustrating a modification of the manufacturing step of the optical semiconductor package of FIG. 1.

Description of Embodiments

[0023] Hereinafter, embodiments of the present disclosure are described with reference to the drawings. The same or corresponding parts in the drawings are denoted by the same reference signs, and repetitive descriptions will be omitted. Note that, in the drawings, there are some parts exaggerated for easy understanding of characteristic parts according to the embodiments. Thus, dimensional ratios in the drawings may be different from actual dimensional ratios.

[0024] [First Embodiment]

(Structure of Optical Semiconductor Package)

As illustrated in FIG. 1, an optical semiconductor package 1A of a first embodiment includes a light receiving element 2, a molding resin 3 (resin portion), a wiring layer 4 (first wiring layer), a wiring layer 5 (second wiring layer), and metal pillars 6 (metal members). The optical semiconductor package 1A is a type of fan out wafer level package (FOWLP)/fan out panel level package (FOPLP).

[0025] The light receiving element 2 is a semiconductor chip including light receiving portion 21, and is formed in a rectangular plate shape. The light receiving element 2 has a first surface 2a and a second surface 2b. In FIG. 1, a facing direction in which the first surface 2a and the second surface 2b face each other is represented as a Z-axis direction, a

direction along one side of the light receiving element 2 as viewed from the Z-axis direction is represented as an X-axis direction, and a direction along another side (a side perpendicular to the one side) of the light receiving element 2 as viewed from the Z-axis direction is represented as a Y-axis direction.

[0026] The light receiving portion 21 and a plurality of (two in the present embodiment) electrode terminals 22 electrically connected to the light receiving portion 21 are provided on the first surface 2a. In the present embodiment, as an example, one light receiving portion 21 is provided substantially at a central portion of the first surface 2a as viewed from the Z-axis direction, but a plurality of light receiving portions 21 may be provided on the first surface 2a. In this case, the plurality of light receiving portions 21 may be arrayed one-dimensionally or two-dimensionally, for example, as viewed from the Z-axis direction. The light receiving portion 21 is disposed at a position along the first surface. That is, the light receiving element 2 has a light receiving surface on the first surface 2a. More specifically, a portion of the first surface 2a facing the light receiving portion 21 functions as the light receiving surface. In the example of FIG. 1, the light receiving portion 21 is embedded in the light receiving element 2 such that a light incident surface (surface on the first surface 2a side) of the light receiving portion 21 is substantially flush with the first surface 2a. Examples of the light receiving portion 21 include a Si photodiode (SiPD), a Si avalanche photodiode (SiAPD), a multi-pixel photon counter (Si-MPPC), and the like. Two electrode terminals 22 are provided to protrude on the first surface 2a.

[0027] An insulating layer 23 is provided on the first surface 2a. The

insulating layer 23 is provided to surround the plurality of (two in the present embodiment) electrode terminals 22 provided on the first surface 2a. An opening 23a for exposing each electrode terminal 22 is formed in the insulating layer 23. The insulating layer 23 can be made of, for example, an inorganic film such as silicon dioxide (SiO_2) or silicon nitride (Si_3N_4), or an organic film such as polyimide.

[0028] The molding resin 3 seals a side surface of the light receiving element 2 to surround the light receiving element 2 as viewed from the Z-axis direction. The molding resin 3 also covers the metal pillars 6. The molding resin 3 may be made of, for example, an epoxy resin or the like. The molding resin 3 has an end surface 3a formed to be flush with a front surface of the insulating layer 23 and an end surface 3b formed to be flush with the second surface 2b of the light receiving element 2.

[0029] The wiring layer 4 is provided on the second surface 2b of the light receiving element 2 and on the end surface 3b of the molding resin 3 continuous with the second surface 2b, on the second surface 2b side of the light receiving element 2. The wiring layer 4 is a rewiring layer including an insulating layer 41 and metal wirings 42 (first metal wirings). The insulating layer 41 can be made of, for example, an inorganic film such as silicon dioxide (SiO_2) or silicon nitride (Si_3N_4), or an organic film such as polyimide. The metal wiring 42 is, for example, a copper (Cu) wiring.

[0030] Openings 41a are provided in portions of the insulating layer 41 overlapping the metal pillars 6 in the Z-axis direction. The metal wiring 42 electrically connected to an end portion 6b (second end portion) of the metal pillar 6 on the wiring layer 4 side is provided within the opening

41a. A width of the opening 41a is larger than a width of the end portion 6b of the metal pillar 6. Accordingly, a wiring width w11 of a portion of the metal wiring 42 connected to the end portion 6b is larger than a width w12 of the end portion 6b of the metal pillar 6.

5 [0031] A plating portion 43 is provided at an outer end portion of the metal wiring 42 (an end portion positioned on a side opposite to the metal pillar 6 in the Z-axis direction). The plating portion 43 is a portion bonded to a printed circuit board or the like by, for example, solder or the like. The plating portion 43 is, for example, two-layer plating (Ni/Au
10 plating) of nickel and gold.

[0032] The wiring layer 5 is provided on a side opposite to a side where the wiring layer 4 is positioned with respect to the light receiving element 2 and the molding resin 3. That is, the wiring layer 5 is provided on the insulating layer 23 and the end surface 3a of the molding resin 3, on the
15 first surface 2a side of the light receiving element 2. The wiring layer 5 is a rewiring layer including an insulating layer 51 and metal wirings 52 (second metal wirings). The insulating layer 51 can be made of, for example, an inorganic film such as silicon dioxide (SiO₂) or silicon nitride (Si₃N₄), or an organic film such as polyimide. The metal wiring 52 is,
20 for example, a copper (Cu) wiring.

[0033] An opening 51a is provided in a portion of the insulating layer 51 overlapping the metal pillar 6 in the Z-axis direction. The metal wiring 52 electrically connected to an end portion 6a (first end portion) on the wiring layer 5 side of the metal pillar 6 is provided within the opening
25 51a. A width of the opening 51a is larger than a width of the end portion 6a of the metal pillar 6. Accordingly, a wiring width w21 of a portion

of the metal wiring 52 connected to the end portion 6a is larger than a width w22 of the end portion 6a of the metal pillar 6.

[0034] An opening portion 51b is provided in a portion of the insulating layer 51 overlapping the light receiving portion 21 in the Z-axis direction. That is, the insulating layer 51 is formed not to cover the light receiving portion 21 in the Z-axis direction.

[0035] The metal wiring 52 electrically connects the end portion 6a of the metal pillar 6 and the electrode terminal 22 of the light receiving element 2. That is, the light receiving element 2 (electrode terminal 22) is electrically connected to the plating portion 43 via the metal wiring 52, the metal pillar 6, and the metal wiring 42.

[0036] The metal pillar 6 is a metal member formed in a columnar shape. The metal pillar 6 is made of, for example, copper. The metal pillar 6 is, for example, a so-called copper pillar or a copper post.

[0037] In the present embodiment, two electrode terminals 22, two metal wirings 52, two metal pillars 6, and two metal wirings 42 are provided. More specifically, a set of the electrode terminal 22, the metal wiring 52, the metal pillar 6, and the metal wiring 42 electrically connected to each other is provided on each of both sides of the light receiving portion 21 as viewed from the Y-axis direction. Note that, in a case where the plurality of light receiving portions 21 are provided as described above, the number (that is, the number of sets described above) of electrode terminals 22 may vary in accordance with the number of the light receiving portions 21.

[0038] (Method for Manufacturing Optical Semiconductor Package)

An example of a manufacturing step of the optical semiconductor

package 1A will be described with reference to FIGS. 2 to 7. In the present embodiment, the optical semiconductor package 1A is manufactured by a chip on wafer (CoW) method or a chip on panel (CoP) method.

5 [0039] First, as illustrated in FIG. 2, the light receiving element 2 and the end portion 6a of the metal pillar 6 are temporarily bonded to a temporary bonding surface 50a (for example, a surface to which an adhesive for temporary bonding is applied) of a substrate 50 that is a temporary bonding member (first step). That is, the light receiving element 2 and
10 the metal pillar 6 are temporarily bonded to the substrate 50 in such a manner that the light receiving element and the metal pillar can be removed later. The light receiving element 2 is temporarily bonded to the substrate 50 such that the first surface 2a faces the substrate 50. In the present embodiment, the insulating layer 23 provided on the first
15 surface 2a of the light receiving element 2 is temporarily bonded to the substrate 50.

[0040] The substrate 50 is, for example, a silicon wafer, a glass wafer, a SUS carrier, or the like. On the substrate, a plurality of unit regions corresponding to one optical semiconductor package 1A are formed side
20 by side in a lattice shape (two-dimensional shape). FIGS. 2 to 7 illustrate a state of one unit region in each manufacturing step.

[0041] An example of a method for temporarily bonding the metal pillar 6 to the substrate 50 will be described with reference to FIG. 3. In this example, a support member 100 which positions each metal pillar 6 in a
25 state where the end portions 6a of the plurality of (the number of unit regions $\times$ the number of metal pillars included in each unit region) metal

pillars 6 are exposed is used. Specifically, a step of temporarily bonding the metal pillar 6 to the substrate 50 in the first step includes a step of positioning and supporting the metal pillar 6 in a state where the end portion 6a of the metal pillar 6 is exposed by the support member 100, and a step of temporarily bonding the end portion 6a of the metal pillar 6 to the substrate 50 by bringing the temporary bonding surface 50a of the substrate 50 into contact with the end portion 6a of the metal pillar 6 supported by the support member 100. According to the above configuration, the metal pillar 6 can be temporarily bonded to the substrate 50 by a relatively simple operation of bringing the temporary bonding surface 50a of the substrate 50 into contact with the metal pillar 6 in a state of being positioned and supported by the support member 100. [0042] First, as illustrated in (A) of FIG. 3, the metal pillar 6 is positioned and supported by the support member 100 in a state where the end portion 6a of the metal pillar 6 is exposed. In this example, the support member 100 includes a plate-shaped member 101 in which a through-hole 101a having a width larger than a width of the metal pillar 6 is formed, and a support substrate 102 on which the end portion 6b of the metal pillar 6 is placed and supported. Note that, a size of the through-hole 101a is adjusted to a size that allows the metal pillar 6 to be inserted and allows positional deviation of the metal pillar 6 in a lateral direction to fall within a range of tolerance. Each metal pillar 6 is positioned by being inserted into the through-hole 101a of the plate-shaped member 101, and is supported by the support substrate 102. In a state where the metal pillar 6 is supported by the support member 100, the end portion 6a protrudes to a side opposite to the support substrate 102 side with respect to the

plate-shaped member 101. Note that, the plate-shaped member 101 and the support substrate 102 may be formed separately as illustrated in FIG. 3, or may be integrally formed. In addition, a space (gap) may be provided between the plate-shaped member 101 and the support substrate 102 as illustrated in FIG. 3, or such a space may not be provided.

[0043] Subsequently, as illustrated in (B) of FIG. 3, the temporary bonding surface 50a of the substrate 50 is brought into contact with the end portion 6a of the metal pillar 6 supported by the support member 100. Accordingly, as illustrated in (C) of FIG. 3, the end portion 6a of the metal pillar 6 is temporarily bonded to the temporary bonding surface 50a of the substrate 50.

[0044] According to the above configuration, since the metal pillar 6 is supported by the support member 100 in a state where the end portion 6a of the metal pillar 6 protrudes from the plate-shaped member 101, when the temporary bonding surface 50a of the substrate 50 is brought into contact with the end portion 6a, it is possible to prevent the temporary bonding surface 50a of the substrate 50 from coming into contact with the plate-shaped member 101. That is, it is possible to accurately prevent the temporary bonding surface 50a of the substrate 50 from adhering to the plate-shaped member 101.

[0045] Here, as illustrated in FIG. 4, a metal pillar 6A having a flange 62 may be used instead of the metal pillar 6. The metal pillar 6A includes a shaft 61 including the end portion 6b and the flange 62 including the end portion 6a and formed to be wider than the shaft 61. The flange 62 is a portion extending outward in a direction orthogonal to an axial direction of the shaft 61 at the end portion 6a. A shape of the flange 62

viewed from the axial direction is, for example, a circular shape. The through-hole 101a of the plate-shaped member 101 is set to have a width larger than a width of the shaft 61 and smaller than a width of the flange 62. The metal pillar 6A is supported by the plate-shaped member 101 by inserting the shaft 61 into the through-hole 101a and bringing the inner surface 62a on the end portion 6b side of the flange 62 into contact with a peripheral edge portion of the through-hole 101a of the plate-shaped member 101. In this state, the temporary bonding surface 50a of the substrate 50 is brought into contact with the end portion 6a of the metal pillar 6A, and thus, the end portion 6a of the metal pillar 6A can be temporarily bonded to the substrate 50. According to the above configuration, since the flange 62 can be hooked and supported by the peripheral edge portion of the through-hole 101a of the plate-shaped member 101, the support substrate 102 for supporting the end portion 6b becomes unnecessary. As a result, the support member 100 can be simplified. In addition, the flange 62 is provided, and thus, a posture (perpendicularity) of the metal pillar 6A erected on the substrate 50 can be further stabilized.

[0046] However, the method for forming the metal pillar 6 on the substrate 50 is not limited to the above method. For example, the metal pillar 6 may be formed on the substrate 50 by transferring the metal pillar 6 to a designated position on the substrate 50 by a transfer device configured to be able to transfer the metal pillars 6. According to the above method, the metal pillar 6 can be accurately disposed at any position on the substrate 50 by controlling the transfer device. In addition, the metal pillar 6 may be formed on the substrate 50 by

performing a pre-semiconductor step (seed layer formation, photolithography, electrolytic Cu plating, resist removal, seed layer etching, or the like) for forming the metal pattern (metal pillar 6) on the substrate 50. By the above method, a pattern (position and shape) of the metal pillar 6 can also be controlled with high accuracy. Alternatively, the metal pillar 6 (that is, a structure in which a metal pad and a wire are combined) may be formed by forming the metal pad on the substrate 50, performing wire bonding such that the wire extending vertically on the metal pad is formed, and cutting the wire bonded onto the metal pad at an appropriate length. According to the above method, the wire (metal pillar 6) having any diameter and length can be formed by adjusting a bonding condition (parameter).

[0047] Subsequently, as illustrated in (A) of FIG. 5, the molding resin 3 covering the light receiving element 2 and the metal pillars 6 disposed in each unit region is formed on the substrate 50 (second step). Focusing on one unit region, the molding resin 3 is formed to cover the second surface 2b and the side surface of the light receiving element 2 and to cover the entire portion (the end portion 6b and the side surface) of each metal pillar 6 except for the end portion 6a.

[0048] Subsequently, as illustrated in (B) of FIG. 5, the second surface 2b of the light receiving element 2 and the end portion 6b of the metal pillar 6 are exposed by polishing or grinding the molding resin 3 from a side (that is, the end surface 3b side) facing the second surface 2b of the light receiving element 2 (third step). Note that, in the present specification, the “polishing or grinding” includes a case where only one of polishing and grinding is performed and also includes a case where

both polishing and grinding are performed. At this time, in each unit region, both the end surface 3b of the molding resin 3 and the second surface 2b of the light receiving element 2 may be polished or ground. Similarly, the end portion 6b of the metal pillar 6 may also be polished or ground. That is, after the second surface 2b of the light receiving element 2 or the end portion 6b of the metal pillar 6 in each unit region is exposed by polishing or grinding the end surface 3b of the molding resin 3, processing of collectively polishing or grinding the end surface 3b of the molding resin 3 and the second surface 2b or the end portion 6b may be continued. As a result, as illustrated in (B) of FIG. 5, the light receiving element 2 is thinned, and the second surface 2b of the light receiving element 2 and the end portion 6b of the metal pillar 6 are exposed to the outside. Through the above processing, the second surface 2b of the light receiving element 2, the end portion 6b of the metal pillar 6, and the end surface 3b of the molding resin 3 are substantially flush with each other.

[0049] Subsequently, as illustrated in (A) of FIG. 6, the wiring layer 4 is formed on the second surface 2b of the light receiving element 2 and on the end surface 3b of the molding resin 3 continuous with the second surface 2b. In the present embodiment, the insulating layer 41 and the metal wiring 42 are formed on the second surface 2b of the light receiving element 2, the end portion 6b of the metal pillar 6, and the end surface 3b of the molding resin 3.

[0050] For example, from the state illustrated in (B) of FIG. 5, the structure illustrated in (A) of FIG. 6 is obtained by patterning the insulating layer 41 and patterning the metal wiring 42 by using a

semiconductor process (seed layer formation, photolithography, electrolytic plating, or the like). The wiring layer 4 is formed such that a wiring width of a portion of the metal wiring 42 connected to the end portion 6b is larger than a width of the end portion 6b. More specifically, a width of the opening 41a of the insulating layer 41 is formed to be larger than the width of the end portion 6b of the metal pillar 6. Accordingly, the wiring width w11 (see FIG. 1) of the portion of the metal wiring 42 connected to the end portion 6b is formed to be larger than the width w12 (see FIG. 1) of the end portion 6b of the metal pillar 6. According to the above configuration, it is possible to absorb the positional deviation of the metal pillar 6 that may occur in the second step (step of forming the molding resin 3). That is, a wiring width of the metal wiring 42 is increased, and thus, even though the position of the metal pillar 6 is slightly deviated due to the inflow of the molding resin 3 in the second step, the metal wiring 42 and the metal pillar 6 (end portion 6b) can be more reliably brought into contact with each other.

[0051] Note that, in contrast to the above configuration, the wiring layer 4 may be formed such that the wiring width of the portion of the metal wiring 42 connected to the end portion 6b is smaller than the width of the end portion 6b of the metal pillar 6 (see a second embodiment to be described later). In this case, the metal wiring 42 can be formed without being affected by a size (width) of the metal pillar 6. For example, in a case where the width of the metal pillar 6 (end portion 6b) is relatively large, when the width of the metal wiring 42 is set to be larger than the width of the metal pillar 6, there may be a problem that the metal wiring 42 easily interferes with the other wiring provided in the wiring layer 4.

According to the above configuration, occurrence of such a problem can be avoided.

[0052] Subsequently, as illustrated in (B) of FIG. 6, the substrate 50 is separated from the light receiving element 2, the metal pillar 6, and the molding resin 3 (fifth step). In addition, a processed surface (surface to be processed) is changed from a surface on the second surface 2b side of the light receiving element 2 to a surface on the first surface 2a side of the light receiving element 2 (that is, a surface exposed after the substrate 50 is separated).

[0053] Subsequently, after the substrate 50 is separated from the light receiving element 2, the metal pillar 6, and the molding resin 3 as described above (that is, after the fifth step), as illustrated in (A) of FIG. 7, the wiring layer 5 is formed on a side opposite to the side where the wiring layer 4 is positioned with respect to the light receiving element 2 and the molding resin 3 (sixth step). In the present embodiment, the insulating layer 51 and the metal wiring 52 are formed on a portion of the insulating layer 23 not overlapping the light receiving portion 21, on the end portion 6a of the metal pillar 6, and on the end surface 3a of the molding resin 3. In addition, electroless plating is performed on the outer end portion of the metal wiring 42, and thus, the plating portion 43 is formed on a front surface of the outer end portion.

[0054] For example, from the state illustrated in (B) of FIG. 6, the structure illustrated in (A) of FIG. 7 is obtained by patterning the insulating layer 51 and patterning the metal wiring 52 by using a semiconductor process (seed layer formation, photolithography, electrolytic plating, or the like). The wiring layer 5 is formed such that

the wiring width of the portion of the metal wiring 52 connected to the end portion 6a is larger than the width of the end portion 6a. More specifically, the width of the opening 51a of the insulating layer 51 is formed to be larger than the width of the end portion 6a of the metal pillar 6. Accordingly, the wiring width w21 (see FIG. 1) of the portion of the metal wiring 52 connected to the end portion 6a is formed to be larger than the width w22 (see FIG. 1) of the end portion 6a of the metal pillar 6. According to the above configuration, it is possible to absorb the positional deviation of the metal pillar 6 that may occur in the second step (step of forming the molding resin 3). That is, the wiring width of the metal wiring 52 is increased, and thus, even though the position of the metal pillar 6 is slightly deviated due to the inflow of the molding resin 3 in the second step, the metal wiring 52 and the metal pillar 6 (end portion 6a) can be more reliably brought into contact with each other.

[0055] Note that, in contrast to the above configuration, the wiring layer 5 may be formed such that the wiring width of the portion of the metal wiring 52 connected to the end portion 6a is smaller than the width of the end portion 6a of the metal pillar 6 (see the second embodiment to be described later). In this case, the metal wiring 52 can be formed without being affected by the size (width) of the metal pillar 6. For example, in a case where the width of the metal pillar 6 (end portion 6a) is relatively large, when the width of the metal wiring 52 is set to be larger than the width of the metal pillar 6, there may be a problem that the metal wiring 52 easily interferes with the other wiring provided in the wiring layer 5. According to the above configuration, occurrence of such a problem can be avoided.

[0056] Subsequently, as illustrated in (B) of FIG. 7, dicing is performed along boundary lines L between the unit regions. Accordingly, a plurality of divided optical semiconductor packages 1A are obtained.

[0057] (Effects)

5 In the method for manufacturing the optical semiconductor package 1A, in the first step, the light receiving element 2 is temporarily bonded to the substrate 50 such that the gap is not formed between the substrate 50 and the light receiving element 2. Accordingly, in the second step, it is possible to prevent the molding resin 3 from flowing
10 between the light receiving element 2 and the substrate 50, that is, it is possible to prevent the molding resin 3 from being formed at the position facing the light receiving portion 21. As a result, it is possible to avoid deterioration in light receiving sensitivity caused by the light receiving portion 21 being covered with the molding resin 3. In addition, the light
15 receiving element 2 and the metal pillar 6 are temporarily bonded to the substrate 50, and thus, the second step can be stably and accurately performed in a state where each member is stably fixed. More specifically, the occurrence of warpage of the package when the molding resin 3 is cured can be suppressed. As described above, according to the
20 manufacturing method, the optical semiconductor package 1A can be manufactured with high reliability. In addition, the light receiving element 2 has the light receiving surface on the first surface 2a. According to the above configuration, the optical semiconductor package 1A in which the surface of the front surface incidence type light receiving element 2 is the first surface 2a can be manufactured with high reliability.

25 [0058] In addition, according to the method for manufacturing the optical

semiconductor package 1A, the following effects are also obtained. That is, as in the method disclosed in Patent Literature 1, in a case where the light receiving element is disposed to be separated from the glass substrate by using bump connection, the light receiving element is inclined with respect to the glass substrate due to variation in the amount of bumps, and optical axis deviation occurs. As a result, uniformity may be reduced. On the other hand, according to the method for manufacturing the optical semiconductor package 1A, since the light receiving element 2 (insulating layer 23) is brought into close contact with the substrate 50, it is possible to prevent the light receiving element 2 from being disposed to be inclined with respect to substrate 50, and it is possible to avoid occurrence of the above problem.

[0059] In addition, in the method disclosed in Patent Literature 1, it is necessary to dispose the light receiving element away from the glass substrate to some extent in order to enclose the underfill between the glass substrate and the light receiving element. In this case, the light receiving element is positioned at the back of the package, and thus, the wiring layer formed on the glass substrate has a structure that blocks a field of view of the light receiving portion, and an active area of the light receiving element becomes narrow. According to the method for manufacturing the optical semiconductor package 1A, such a problem can be avoided.

[0060] In addition, in the method disclosed in Patent Literature 1, there is a case where a void is generated within the underfill enclosed between the glass substrate and the light receiving element, or it is necessary to perform a special treatment for eliminating the void. However,

according to the method for manufacturing the optical semiconductor package 1A, since the underfill is not formed at the position facing the light receiving element 2 (light receiving portion 21), the occurrence of the above problem can be avoided.

5 [0061] (Modification)

Optical components such as glass, a band pass filter, and a lens may be attached to a position on the insulating layer 23 facing the light receiving portion 21. The step of attaching such an optical component may be performed, for example, after the step of forming the wiring layer 10 5 (sixth step). Alternatively, the above-described optical component may be attached to the light receiving element 2 in advance before the manufacturing step of the present embodiment is executed. In addition, the step (fifth step) of separating (peeling) the substrate 50 from the light receiving element 2 and the like may be performed at any timing between 15 the completion of the second step and the start of the sixth step. For example, the substrate 50 may be removed immediately after the completion of the second step. Alternatively, the fifth step may be performed after at least the third step. For example, the fourth step may be performed after the third step, and the fifth step may be performed 20 after the fourth step. According to the above configuration, the substrate 50 is also attached in the third step (or the third step and the fourth step), and thus, it is possible to obtain an advantage that the third step (alternatively, the third step and the fourth step) can be performed with high reliability in a state where the support stability of each member 25 is improved. In particular, in the present embodiment, since the light receiving portion 21 is exposed to the outside via the insulating layer 23,

the light receiving portion 21 can be appropriately protected from an impact or the like from the outside in each step by attaching the substrate 50. In addition, when the sixth step is performed, the substrate (for example, the substrate 50) as the temporary bonding member may be attached onto the wiring layer 4 in order to enhance the support stability of each member.

[0062] [Second Embodiment]

(Structure of Optical Semiconductor Package)

As illustrated in FIG. 8, an optical semiconductor package 1B of the second embodiment is different from the optical semiconductor package 1A in that a transparent molding resin 3B is provided instead of the molding resin 3. In addition, the optical semiconductor package 1B is also different from the optical semiconductor package 1A in that the end portion 6a of the metal pillar 6 (metal member) is at a position higher than an upper surface (a surface on a side opposite to the first surface 2a) of the insulating layer 23 and the optical semiconductor package 1B further includes a metal pillar 7 that connects the end portion 52b of the metal wiring 52 on a side opposite to a side connected to the end portion 6a and the electrode terminal 22. Hereinafter, portions of a configuration of the optical semiconductor package 1B different from the optical semiconductor package 1A will be described, and portions of the configuration of the optical semiconductor package 1B similar to the optical semiconductor package 1A will not be described.

[0063] The molding resin 3B is made of a material having transparency to light (wavelength) to be detected by the light receiving portion 21. The molding resin 3B can be made of, for example, a transparent epoxy

resin or the like. The molding resin 3B is provided not only on the side surface of the light receiving element 2 but also on a portion (that is, a region on the insulating layer 23) facing the first surface 2a of the light receiving element 2, and covers the entire side surfaces of the metal pillar 6 and the metal pillar 7. The molding resin 3B is also provided inside the opening portion 51b of the wiring layer 5. That is, the end surface 3a on a side opposite to the end surface 3b (the end surface formed to be flush with the second surface 2b) of the molding resin 3B is formed to be flush with an outer surface of the wiring layer 5 (insulating layer 51).

[0064] In the optical semiconductor package 1B, the wiring layer 5 (first wiring layer) is separated from the insulating layer 23 in the Z-axis direction. Thus, the metal pillar 7 for electrically connecting the metal wiring 52 (first metal wiring) and the electrode terminal 22 is provided. In the optical semiconductor package 1B, the metal wiring 52 has an end portion 52a (first end) disposed on an outer side (a portion not overlapping the light receiving element 2) in the X-axis direction, and an end portion 52b (second end) disposed on an inner side (a portion overlapping the light receiving element 2) in the X-axis direction. The end portion 52a is connected to the end portion 6a of the metal pillar 6. The end portion 52b is connected to an end portion 7a of the metal pillar 7 (an end portion on a side opposite to the electrode terminal 22 side). Note that, the optical semiconductor package 1B does not necessarily need to include the metal pillar 7 having a columnar shape. For example, the end portion 52b and the electrode terminal 22 may be connected via a conductive bump. That is, the end portion 52b and the electrode terminal 22 may be electrically connected by any conductive member.

In addition, the conductive member is disposed between the end portion 52b and the electrode terminal 22, and thus, a gap for introducing the molding resin 3B into an internal space S (see (B) of FIG. 9) in a fifth step to be described later may be formed between the insulating layer 23 and the insulating layer 51.

[0065] (Method for Manufacturing Optical Semiconductor Package)

An example of a manufacturing step of the optical semiconductor package 1B will be described with reference to FIGS. 9 to 11. In the present embodiment, the optical semiconductor package 1B is manufactured by a CoW method or a CoP method. FIGS. 9 to 11 illustrate a state of one unit region in each manufacturing step. Hereinafter, description will be made focusing on only one unit region.

[0066] First, as illustrated in (A) of FIG. 9, the wiring layer 5 in which the opening portion 51b for exposing the substrate 50 is provided is formed on the substrate 50 that is the temporary bonding member (first step). The wiring layer 5 includes the insulating layer 51 and the metal wiring 52. The opening portion 51b is provided in the insulating layer 51. For example, the wiring layer 5 illustrated in (A) of FIG. 9 is obtained by patterning the insulating layer 51 and patterning the metal wiring 52 by using a semiconductor process (seed layer formation, photolithography, electrolytic plating, or the like). Note that, in the present embodiment, the width of the opening 51a of the insulating layer 51 is formed to be smaller than the width of the end portion 6a of the metal pillar 6, and as a result, the wiring width of the portion of the metal wiring 52 connected to the end portion 6a is formed to be smaller than the width of the end portion 6a of the metal pillar 6. However, as in the

first embodiment, the wiring width of the portion of the metal wiring 52 connected to the end portion 6a may be formed to be larger than the width of the end portion 6a of the metal pillar 6.

[0067] Subsequently, as illustrated in (A) of FIG. 9, the metal pillar 6 connected to the end portion 52a of the metal wiring 52 and protruding from the wiring layer 5 to the side opposite to the substrate 50 side is formed (second step). The metal pillar 6 is formed by, for example, plating, solder bump forming, or the like. The metal pillar 6 has the end portion 6a connected to the end portion 52a and the end portion 6b on the side opposite to the end portion 6a.

[0068] Subsequently, as illustrated in (B) of FIG. 9, the light receiving element 2 is prepared (third step). Subsequently, the light receiving element 2 is disposed such that the end portion 52b of the metal wiring 52 different from the end portion 52a is electrically connected to the electrode terminal 22 via the metal pillar 7, the light receiving portion 21 is disposed at the position facing the opening portion 51b, and the internal space S is formed between the substrate 50 and the light receiving element 2 (fourth step). The metal pillar 7 has the end portion 7a connected to the end portion 52b and an end portion 7b on a side opposite to the end portion 7a. Note that, as described above, the metal pillar 7 may be any conductive member, and may be, for example, a conductive bump formed by bump-bonding the end portion 7b and the electrode terminal 22. Here, an upper surface of the insulating layer 51 (surface on a side opposite to the substrate 50 side) and a lower surface of the insulating layer 23 (surface facing the substrate 50) are separated from each other, and the gap is present between the insulating layer 51 and the

insulating layer 23. That is, the internal space S communicates with the outside via the gap. In other words, the internal space S is not a closed space blocked from the outside.

[0069] Subsequently, as illustrated in (A) of FIG. 10, the molding resin 3B is formed (fifth step). As described above, the molding resin 3B is made of a material having transparency to light to be detected by the light receiving portion 21, covers the light receiving element 2, the metal pillars 6 and 7, and the wiring layer 5, and fills the internal space S (see (B) of FIG. 9).

[0070] Subsequently, as illustrated in (B) of FIG. 10, the second surface 2b of the light receiving element 2 and the end portion 6b of the metal pillar 6 are exposed by polishing or grinding the molding resin 3B from the side (that is, the end surface 3b side) facing the second surface 2b of the light receiving element 2 (sixth step). At this time, in each unit region, the second surface 2b of the light receiving element 2 may be polished or ground together with the end surface 3b of the molding resin 3B. Similarly, the end portion 6b of the metal pillar 6 may also be polished or ground. That is, after the second surface 2b of the light receiving element 2 or the end portion 6b of the metal pillar 6 in each unit region is exposed by polishing or grinding the end surface 3b of the molding resin 3B, processing of collectively polishing or grinding the end surface 3b of the molding resin 3B and the second surface 2b or the end portion 6b may be continued. As a result, as illustrated in (B) of FIG. 10, the second surface 2b of the light receiving element 2 and the end portion 6b of the metal pillar 6 are exposed to the outside. Through the above processing, the second surface 2b of the light receiving element 2,

the end portion 6b of the metal pillar 6, and the end surface 3b of the molding resin 3B are substantially flush with each other.

[0071] Subsequently, as illustrated in (A) of FIG. 11, the wiring layer 4 is formed on the second surface 2b of the light receiving element 2 and on the end surface 3b of the molding resin 3B continuous with the second surface 2b (seventh step). In the present embodiment, the insulating layer 41 and the metal wiring 42 (second metal wiring) are formed on the second surface 2b of the light receiving element 2, the end portion 6b of the metal pillar 6, and the end surface 3b of the molding resin 3B. In addition, electroless plating is performed on the outer end portion of the metal wiring 42, and thus, the plating portion 43 is formed on a front surface of the outer end portion.

[0072] For example, from the state illustrated in (B) of FIG. 10, the structure illustrated in (A) of FIG. 11 is obtained by patterning the insulating layer 41 and patterning the metal wiring 42 by using a semiconductor process (seed layer formation, photolithography, electrolytic plating, or the like). Note that, in the present embodiment, the width of the opening 41a of the insulating layer 41 is formed to be smaller than the width of the end portion 6b of the metal pillar 6, and as a result, the wiring width of the portion of the metal wiring 42 connected to the end portion 6b is formed to be smaller than the width of the end portion 6b of the metal pillar 6. However, as in the first embodiment, the wiring width of the portion of the metal wiring 42 connected to the end portion 6b may be formed to be larger than the width of the end portion 6b of the metal pillar 6.

[0073] Subsequently, as illustrated in (B) of FIG. 11, the substrate 50 is

separated from the wiring layer 5 and the molding resin 3B (eighth step). Subsequently, dicing is performed along the boundary line L between the unit regions. Accordingly, a plurality of divided optical semiconductor packages 1B are obtained.

5 [0074] (Effects)

10 In the optical semiconductor package 1B, the internal space S between the light receiving element 2 and the substrate 50 is filled with the molding resin 3B in the fifth step, and thus, the molding resin 3B covers the light receiving portion 21. However, since the molding resin 3B has transparency to light to be detected by the light receiving portion 21, deterioration in light receiving sensitivity caused by the molding resin 3B covering the light receiving portion 21 is suppressed. Further, in the fifth step, the molding resin 3B which fills the internal space S between the light receiving element 2 and the substrate 50 and covers the members (light receiving element 2, metal pillars 6 and 7, and wiring layer 5) can be collectively made of a single resin material. Accordingly, it is possible to avoid deterioration in reliability (for example, damage or the like of the metal wiring due to stress caused by a difference in thermal expansion coefficient between two resin portions or the like) due to the mixture of two types of resin portions (for example, two resin portions made of materials different from each other or formed at different timings). As described above, according to the manufacturing method, the optical semiconductor package 1B can be manufactured with high reliability. In addition, the light receiving element 2 has the light receiving surface on the first surface 2a. According to the above configuration, the optical semiconductor package 1B in which the front

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surface of the front surface incidence type light receiving element 2 is the first surface 2a can be manufactured with high reliability.

[0075] In the method for manufacturing the optical semiconductor package 1B, the fifth step is performed under a reduced pressure, the molding resin 3B having no void can collectively be formed without using a special device.

[0076] (Modification)

The step (eighth step) of separating (peeling) the substrate 50 from the wiring layer 5 and the like may be performed at any timing after the fifth step is completed. For example, the substrate 50 may be removed immediately after the completion of the fifth step. Alternatively, the eighth step may be performed after at least the sixth step. For example, the seventh step may be performed after the sixth step, and the eighth step may be performed after the seventh step. According to the above configuration, by attaching the substrate 50 also in the sixth step (or the sixth step and the seventh step), it is possible to obtain an advantage that the sixth step and the seventh step can be performed with high reliability in a state where the support stability of each member is improved.

[0077] [Third Embodiment]

(Structure of Optical Semiconductor Package)

As illustrated in FIG. 12, an optical semiconductor package 1C of a third embodiment is different from the optical semiconductor package 1A in that a wiring layer 5C is provided instead of the wiring layer 5. Hereinafter, portions of a configuration of the optical semiconductor package 1C different from the optical semiconductor package 1A will be

described, and portions of the configuration of the optical semiconductor package 1C similar to the optical semiconductor package 1A will not be described.

[0078] The wiring layer 5C is different from the wiring layer 5 of the optical semiconductor package 1A in that the wiring layer 5C includes an insulating layer 51C instead of the insulating layer 51. The insulating layer 51C is different from the insulating layer 51 in that the insulating layer is made of a transparent resin insulating film and the opening portion 51b is not provided. The insulating layer 51C is made of a material having transparency to light to be detected by the light receiving portion 21. The insulating layer 51C can be made of, for example, a transparent epoxy resin, a transparent polyimide resin, or the like.

[0079] (Method for Manufacturing Optical Semiconductor Package)

An example of a manufacturing step of the optical semiconductor package 1C will be described with reference to FIGS. 13 to 15. In the present embodiment, the optical semiconductor package 1C is manufactured by a CoW method or a CoP method. FIGS. 13 to 15 illustrate a state of one unit region in each manufacturing step. Hereinafter, description will be made focusing on only one unit region.

[0080] A method for manufacturing the optical semiconductor package 1C according to the present exemplary embodiment includes a first step of preparing the light receiving element 2 having the first surface 2a on which the light receiving portion 21 and the electrode terminal 22 electrically connected to the light receiving portion 21 are provided, a second step of forming the wiring layer 5C including the insulating layer 51C having transparency to light to be detected by the light receiving

portion 21 and the metal wiring 52 on the substrate 50, a third step of forming the metal member (metal pillar 6) connected to the end portion 52a of the metal wiring 52 and protruding from the wiring layer 5C to the side opposite to the substrate 50 side, a fourth step of disposing the light receiving element 2 on the wiring layer 5C such that the end portion 52b of the metal wiring 52 is electrically connected to the electrode terminal 22, a fifth step of forming the resin portion (molding resin 3) covering the light receiving element 2, the metal pillar 6, and the wiring layer 5C, a sixth step of exposing the second surface 2b of the light receiving element 2 and the end portion 6b of the metal pillar 6 by polishing or grinding the molding resin 3 from the side facing the second surface 2b of the light receiving element 2, a seventh step of forming the wiring layer 4 including the metal wiring 42 electrically connected to the end portion 6b of the metal pillar 6 on the second surface 2b of the light receiving element 2 and on the end surface 3b of the molding resin 3 continuous with the second surface 2b, and an eighth step of separating the substrate 50 from the wiring layer 5C and the molding resin 3.

[0081] First, the light receiving element 2 (see (B) of FIG. 13) is prepared (first step). Subsequently, as illustrated in (A) of FIG. 13, the wiring layer 5C is formed on the substrate 50 which is the temporary bonding member (second step). As described above, the wiring layer 5C includes the insulating layer 51C and the metal wiring 52. For example, the wiring layer 5C illustrated in (A) of FIG. 13 is obtained by patterning the insulating layer 51C and patterning the metal wiring 52 by using a semiconductor process (seed layer formation, photolithography, electrolytic plating, or the like). Note that, in the present embodiment,

the width of the opening 51a of the insulating layer 51C is formed to be larger than the width of the end portion 6a of the metal pillar 6, and as a result, the wiring width of the portion of the metal wiring 52 connected to the end portion 6a is formed to be larger than the width of the end portion 6a of the metal pillar 6. However, as in the second embodiment, the wiring width of the portion of the metal wiring 52 connected to the end portion 6a may be formed to be smaller than the width of the end portion 6a of the metal pillar 6.

[0082] Subsequently, as illustrated in (A) of FIG. 13, the metal pillar 6 connected to the end portion 52a of the metal wiring 52 and protruding from the wiring layer 5C to the side opposite to the substrate 50 side is formed (third step). The metal pillar 6 is formed by, for example, plating, solder bump forming, or the like.

[0083] Subsequently, as illustrated in (B) of FIG. 13, the light receiving element 2 is disposed on the wiring layer 5C such that the end portion 52b of the metal wiring 52 is electrically connected to the electrode terminal 22 (fourth step). The end portion 52b and the electrode terminal 22 are connected by, for example, bump-bonding. Accordingly, the insulating layer 51C and the insulating layer 23 are brought into contact with each other, and the gap is not formed between the insulating layer 51C and the insulating layer 23. Note that, the end portion 52b and the electrode terminal 22 may be connected by hybrid bonding using copper and an insulating film.

[0084] Subsequently, as illustrated in (A) of FIG. 14, the molding resin 3 is formed (fifth step). The molding resin 3 is formed to cover the light receiving element 2, the metal pillar 6, and the wiring layer 5C.

[0085] Subsequently, as illustrated in (B) of FIG. 14, the second surface 2b of the light receiving element 2 and the end portion 6b of the metal pillar 6 are exposed by polishing or grinding the molding resin 3 from the side (that is, the end surface 3b side) facing the second surface 2b of the light receiving element 2 (sixth step). At this time, in each unit region, both the end surface 3b of the molding resin 3 and the second surface 2b of the light receiving element 2 may be polished or ground. Similarly, the end portion 6b of the metal pillar 6 may also be polished or ground. That is, after the second surface 2b of the light receiving element 2 or the end portion 6b of the metal pillar 6 in each unit region is exposed by polishing or grinding the end surface 3b of the molding resin 3, processing of collectively polishing or grinding the end surface 3b of the molding resin 3 and the second surface 2b or the end portion 6b may be continued. As a result, as illustrated in (B) of FIG. 14, the second surface 2b of the light receiving element 2 and the end portion 6b of the metal pillar 6 are exposed to the outside. Through the above processing, the second surface 2b of the light receiving element 2, the end portion 6b of the metal pillar 6, and the end surface 3b of the molding resin 3 are substantially flush with each other.

[0086] Subsequently, as illustrated in (A) of FIG. 15, the wiring layer 4 is formed on the second surface 2b of the light receiving element 2 and on the end surface 3b of the molding resin 3 continuous with the second surface 2b (seventh step). In the present embodiment, the insulating layer 41 and the metal wiring 42 are formed on the second surface 2b of the light receiving element 2, the end portion 6b of the metal pillar 6, and the end surface 3b of the molding resin 3. In addition, electroless plating

is performed on the outer end portion of the metal wiring 42, and thus, the plating portion 43 is formed on a front surface of the outer end portion. [0087] For example, from the state illustrated in (B) of FIG. 14, the structure illustrated in (A) of FIG. 15 is obtained by patterning the insulating layer 41 and patterning the metal wiring 42 by using a semiconductor process (seed layer formation, photolithography, electrolytic plating, or the like). Note that, in the present embodiment, the width of the opening 41a of the insulating layer 41 is formed to be larger than the width of the end portion 6b of the metal pillar 6, and as a result, the wiring width of the portion of the metal wiring 42 connected to the end portion 6b is formed to be larger than the width of the end portion 6b of the metal pillar 6. However, as in the second embodiment, the wiring width of the portion of the metal wiring 42 connected to the end portion 6b may be formed to be smaller than the width of the end portion 6b of the metal pillar 6.

[0088] Subsequently, as illustrated in (B) OF FIG. 15, the substrate 50 is separated from the wiring layer 5 and the molding resin 3 (eighth step). Subsequently, dicing is performed along the boundary line L between the unit regions. Accordingly, a plurality of divided optical semiconductor packages 1C are obtained.

[0089] According to the manufacturing method described above, the optical semiconductor package 1C can be manufactured by a procedure of manufacturing the wiring layer 5 on the front surface side (first surface 2a side) of the light receiving element 2 first, then mounting the light receiving element 2 (chip mount), forming the resin mold (molding resin 3), and manufacturing the wiring layer 4 on the back surface side (second

surface 2b side) of the light receiving element 2. Note that, in the manufacturing method, the step (eighth step) of separating (peeling) the substrate 50 from the wiring layer 5 and the like may be performed at any timing after the fifth step is completed. For example, the substrate 50 may be removed immediately after the completion of the fifth step. However, the substrate 50 is also attached in the sixth step and the seventh step, and thus, it is possible to obtain an advantage that the sixth step and the seventh step can be performed with high reliability in a state where the support stability of each member is improved.

[0090] In the method for manufacturing the optical semiconductor package 1C, the “wiring layer 5C” and the “insulating layer 51C” are replaced with the “wiring layer 5” and the “insulating layer 51”, and the step illustrated in FIG. 13 is replaced with the step illustrated in FIG. 16. Thus, the optical semiconductor package having a structure similar to the optical semiconductor package 1A can be manufactured.

[0091] More specifically, the second step of the method for manufacturing the optical semiconductor package 1C is replaced with the “second step of forming, on the substrate 50, the wiring layer 5 which includes the insulating layer 51 and the metal wiring 52 and on which the opening portion 51b for exposing the substrate 50 is provided”. Accordingly, at a point in time when the third step is completed, the structure illustrated in (A) of FIG. 16 is obtained instead of the structure illustrated in (A) of FIG. 13.

[0092] In addition, the fourth step of the method for manufacturing the optical semiconductor package 1C is replaced with the “fourth step of disposing the light receiving element 2 on the wiring layer 5 such that the

end portion 52b of the metal wiring 52 and the electrode terminal 22 are electrically connected, and the light receiving portion 21 is disposed at the position facing the opening portion 51b, and a closed space S1 is formed between the substrate 50 and the light receiving element 2”.

5 Accordingly, at a point in time when the fourth step is completed, the structure illustrated in (B) of FIG. 16 is obtained instead of the structure illustrated in (B) of FIG. 13. Here, the closed space S1 is a sealed space surrounded by the substrate 50, the insulating layer 23, and the insulating layer 51. Thus, in the fifth step, the molding resin 3 is formed to cover
10 the light receiving element 2, the metal pillar 6, and the wiring layer 5, and the closed space S1 is not filled with the molding resin 3. As a result, at a point in time when the subsequent sixth to eighth steps and dicing are completed, the optical semiconductor package having a structure similar to the optical semiconductor package 1A illustrated in FIG. 1 is obtained.

15 [0093] Although some embodiments of the present disclosure have been described above, the present disclosure is not limited to the above embodiments. The material and shape of each configuration are not limited to the material and shape described above, and various materials and shapes can be employed. In addition, a part of configurations in one
20 embodiment or modification example described above can be arbitrarily applied to configurations in other embodiments or modification examples. For example, as described in the above embodiments, the substrate 50 can be suitably used as the temporary bonding member, but the temporary bonding member may be a member other than the substrate. For
25 example, a sheet member (for example, a very thin sheet-shaped member) may be used as the temporary bonding member. In addition, in the

above embodiments, the manufacturing method by the CoW method or the CoP method has been illustrated, but a method other than the above method may be adopted. For example, in a case where the optical semiconductor package is manufactured in units of chips, the dicing step in the above embodiments can be omitted.

Reference Signs List

[0094] 1A, 1B, 1C Optical semiconductor package

2 Light receiving element

2a First surface

2b Second surface

3, 3B Molding resin (resin portion)

4 Wiring layer (first wiring layer and second wiring layer)

5 Wiring layer (first wiring layer and second wiring layer)

6, 6A Metal pillar (metal member)

6a End portion (first end portion)

6b End portion (second end portion)

21 Light receiving portion

22 Electrode terminal

42 Metal wiring (first metal wiring and second metal wiring)

50 Substrate

51b Opening portion

52 Metal wiring (first metal wiring and second metal wiring)

61 Shaft

62 Flange

62a Inner surface

100 Support member

- 101 Plate-shaped member
- 101a Through-hole
- 102 Support substrate

CLAIMS

[Claim 1] A method for manufacturing an optical semiconductor package, comprising:

5 a first step of temporarily bonding, to a substrate, a light receiving element having a first surface on which a light receiving portion and an electrode terminal electrically connected to the light receiving portion are provided and a first end portion of a metal member having a columnar shape, the light receiving element being temporarily bonded to the substrate such that the first surface faces the substrate in the first step;

10 a second step of forming a resin portion covering the light receiving element and the metal member on the substrate;

15 a third step of exposing a second surface of the light receiving element on a side opposite to the first surface of the light receiving element and a second end portion on a side opposite to the first end portion of the metal member by polishing or grinding the resin portion from a side facing the second surface;

20 a fourth step of forming a first wiring layer including a first metal wiring electrically connected to the second end portion on the second surface of the light receiving element and on an end surface of the resin portion continuous with the second surface;

a fifth step of separating the substrate from the light receiving element, the metal member, and the resin portion; and

25 a sixth step of forming a second wiring layer including a second metal wiring that electrically connects the first end portion and the electrode terminal on a side opposite to a side on which the first wiring layer is positioned with respect to the light receiving element and the resin

portion after the fifth step.

[Claim 2] The method for manufacturing an optical semiconductor package according to claim 1, wherein

the first step includes

5 a step of positioning and supporting, by a support member, the metal member in a state of exposing the first end portion, and

a step of temporarily bonding the first end portion to the substrate by bringing a temporary bonding surface of the substrate into contact with the first end portion of the metal member supported by the support member.

10 [Claim 3] The method for manufacturing an optical semiconductor package according to claim 2, wherein

the support member has

15 a plate-shaped member in which a through-hole having a width larger than a width of the metal member is formed, and

a support substrate that the second end portion is placed on and is supported by,

20 the metal member is positioned by being inserted into the through-hole of the plate-shaped member and is supported by the support substrate, and

the first end portion protrudes to a side opposite to the support substrate side with respect to the plate-shaped member in a state where the metal member is supported by the support member.

25 [Claim 4] The method for manufacturing an optical semiconductor package according to claim 2, wherein

the metal member has a shaft including the second end portion

and a flange including the first end portion and formed to be wider than the shaft,

the support member is a plate-shaped member in which a through-hole having a width larger than a width of the shaft and smaller than a width of the flange, and

the metal member is supported by the support member by inserting the shaft into the through-hole and bringing an inner surface on the second end portion side of the flange into contact with a peripheral edge portion of the through-hole of the support member.

[Claim 5] The method for manufacturing an optical semiconductor package according to any one of claims 1 to 4, wherein

in the fourth step, the first wiring layer is formed such that a wiring width of a portion of the first metal wiring connected to the second end portion is larger than a width of the second end portion of the metal member.

[Claim 6] The method for manufacturing an optical semiconductor package according to any one of claims 1 to 4, wherein

in the fourth step, the first wiring layer is formed such that a wiring width of a portion of the first metal wiring connected to the second end portion is smaller than a width of the second end portion of the metal member.

[Claim 7] The method for manufacturing an optical semiconductor package according to any one of claims 1 to 6, wherein

in the sixth step, the second wiring layer is formed such that a wiring width of a portion of the second metal wiring connected to the first end portion is larger than a width of the first end portion of the metal

member.

[Claim 8] The method for manufacturing an optical semiconductor package according to any one of claims 1 to 6, wherein

in the sixth step, the second wiring layer is formed such that a wiring width of a portion of the second metal wiring connected to the first end portion is smaller than a width of the first end portion of the metal member.

[Claim 9] The method for manufacturing an optical semiconductor package according to any one of claims 1 to 8, wherein

the fifth step is performed after at least the third step.

[Claim 10] The method for manufacturing an optical semiconductor package according to claim 9, wherein

the fourth step is performed after the third step, and

the fifth step is performed after the fourth step.

[Claim 11] The method for manufacturing an optical semiconductor package according to any one of claims 1 to 10, wherein

the light receiving element has a light receiving surface on the first surface.

[Claim 12] A method for manufacturing an optical semiconductor package, comprising:

a first step of forming, on a substrate, a first wiring layer which includes a first metal wiring and in which an opening portion for exposing the substrate is provided;

a second step of forming a metal member connected to a first end portion of the first metal wiring and protruding to a side opposite to the substrate side from the first wiring layer;

a third step of preparing a light receiving element having a first surface on which a light receiving portion and an electrode terminal electrically connected to the light receiving portion are provided;

a fourth step of disposing the light receiving element such that a second end portion of the first metal wiring different from the first end portion and the electrode terminal are electrically connected, the light receiving portion is disposed at a position facing the opening portion, and an internal space is formed between the substrate and the light receiving element;

a fifth step of forming a resin portion that covers the light receiving element, the metal member, and the first wiring layer, with which the internal space is filled, and having transparency to light to be detected by the light receiving portion;

a sixth step of exposing the second surface and an end portion on a side opposite to a side connected to the first metal wiring of the metal member by polishing or grinding the resin portion from a side facing a second surface on a side opposite to the first surface of the light receiving element;

a seventh step of forming a second wiring layer including a second metal wiring electrically connected to the end portion of the metal member on the second surface of the light receiving element and an end surface of the resin portion continuous with the second surface; and

an eighth step of separating the substrate from the first wiring layer and the resin portion.

[Claim 13] The method for manufacturing an optical semiconductor package according to claim 12, wherein

the eighth step is performed after at least the sixth step.

[Claim 14] The method for manufacturing an optical semiconductor package according to claim 12, wherein

the seventh step is performed after the sixth step, and

5 the eighth step is performed after the seventh step.

[Claim 15] The method for manufacturing an optical semiconductor package according to any one of claims 12 to 14, wherein

the light receiving element has a light receiving surface on the first surface.

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