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ELECTRONIC COMPONENT DEVICE

Abstract

An image pickup unit, which is an electronic component device, includes: a stacked device which is an electronic component including an external electrode; and a wiring board. The wiring board has a first principal surface and includes a bonding electrode and an alignment mark on the first principal surface, the external electrode of the electronic component is bonded to the bonding electrode, and on the first principal surface, an area of a region in which a first region where the bonding electrode is virtually moved in a predetermined first direction, and the alignment mark are superimposed on each other is less than 50% of an area of the alignment mark.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation application of U.S. patent application Ser. No. 18/379,238 filed on Oct. 12, 2023, which is a continuation application of PCT/JP2021/024598 filed on Jun. 29, 2021, the entire contents of each of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION
1. Field of the Invention
[0002] The present invention relates to an electronic component device including an electronic component disposed on a wiring board.
2. Description of the Related Art
[0003] It is important to reduce a diameter of an image pickup unit disposed in a distal end portion of an insertion portion of an endoscope for alleviating invasiveness.
[0004] Japanese Patent Application Laid-Open Publication No. 2012-18993 discloses a stacked device manufactured using a wafer-level packaging method for efficiently manufacturing an image pickup unit with a small diameter. In the wafer-level packaging method, the stacked device is produced by dicing a stacked wafer in which a plurality of lens wafers each including a plurality of lenses and a plurality of image pickup devices are adhesively bonded.
[0005] International Publication No. 2015/082328 (Japanese Patent No. 6533787) discloses an image pickup unit in which a stacked device including an image pickup device is housed in a recess of a three-dimensional wiring board. By using an MID (molded interconnect device) as the three-dimensional wiring board, the manufacturing process can be simplified.
SUMMARY OF THE INVENTION
[0006] An electronic component device according to an embodiment includes: an electronic component including an external electrode; and a wiring board. The wiring board has a first principal surface, and includes a bonding electrode and an alignment mark on the first principal surface, the external electrode of the electronic component is bonded to the bonding electrode, and on the first principal surface, an area of a region in which a first region where the bonding electrode is virtually moved in a predetermined first direction, and the alignment mark are superimposed on each other is less than 50% of an area of the alignment mark.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0007] FIG. **1** is a perspective view of an image pickup unit of a first embodiment;
[0008] FIG. **2** is an exploded perspective view of the image pickup unit of the first embodiment;
[0009] FIG. **3** is a top view of a MID of the image pickup unit of the first embodiment;
[0010] FIG. **4** is a top view of a part of the MID of the image pickup unit of the first embodiment;
[0011] FIG. **5** is a flowchart of a method of manufacturing the image pickup unit of the first embodiment;
[0012] FIG. **6** is a plan view for explaining a method of manufacturing the MID of the image pickup unit of the first embodiment;
[0013] FIG. **7** is a plan view for explaining the method of manufacturing the MID of the image

pickup unit of the first embodiment;
[0014] FIG. **8** is a perspective view for explaining the method of manufacturing the image pickup unit of the first embodiment;
[0015] FIG. **9** is a top view of a part of a MID of an image pickup unit of a modification 1 of the first embodiment;
[0016] FIG. **10** is a top view of a part of a MID of an image pickup unit of a modification 2 of the first embodiment; and
[0017] FIG. **11** is a perspective view of an endoscope of a second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] Hereinafter, embodiments of the present invention will be described with reference to the drawings.
[0019] Note that the drawings based on the embodiments are schematic illustrations. The relation between the thickness and the width of each portion, the ratio in thickness of each portion, and the like differ from the actual relation, ratio, and the like. There are also some portions with different dimensional relations and ratios among the drawings. Illustration of and assignment of reference signs to some constituent elements are omitted. The direction toward an object is referred to as "upward."

First Embodiment

[0020] An image pickup unit **1**, which is an electronic component device, of the present embodiment shown in FIG. **1** and FIG. **2** includes a wiring board **10**, a stacked device **20** which is an electronic component, and a resin **30**. Note that in FIG. **2**, the resin **30** is not shown.
[0021] The stacked device **20** includes a light receiving surface **20**SA and a back surface **20**SB on a side opposite to the light receiving surface **20**SA, and includes, on the back surface **20**SB, external electrodes **25** that output an image pickup signal. The stacked device **20** in a substantially rectangular parallelepiped shape includes an optical system **22** in which a plurality of optical devices are stacked and an image pickup device (image sensor) **21**. The optical device is, for example, a hybrid lens device (composite device) including a glass plate and a resin lens or an IR cut filter device.
[0022] The configuration of the optical system **22**, that is, the configuration (thickness, shape), the type, the number, and the stacking order of the optical devices may be modified in various ways in accordance with the specification. A patterned light-shielding film may be disposed, as an aperture, on a principal surface of any one of the optical devices.
[0023] The stacked device **20** is produced using the wafer-level packaging method that dices a bonded wafer in which a stacked wafer composed of a plurality of optical device wafers each including a plurality of optical devices and a plurality of image pickup device wafers including a plurality of image pickup devices are bonded. Therefore, the stacked device **20** is in a rectangular parallelepiped shape. The stacked device **20** may be produced using the wafer-level packaging method that dices a bonded wafer in which a plurality of image pickup devices are adhesively bonded to a stacked wafer.
[0024] The image pickup device **21** with a silicon base material includes a light receiving portion composed of a CCD or the like. The stacked device **20** (image pickup device **21**) includes solder bumps **29** on the external electrodes **25** on the back surface **20**SB. At least one semiconductor device that processes an image pickup signal may be stacked on a lower surface of the image pickup device **21**. In the stacked device with the semiconductor device stacked, the electrodes on a lower surface of the semiconductor device are the external electrodes **25**. A cover glass may be disposed on an upper surface of the image pickup device **21**.
[0025] The three-dimensional wiring board **10** (hereinafter, referred to as a "wiring board **10**") includes a first principal surface **10**SA, a side surface **10**SS orthogonal to the first principal surface **10**SA, and a second principal surface **10**SB on a side opposite to the first principal surface **10**SA. The first principal surface **10**SA includes a recess H**10**. The recess H**10** includes four wall surfaces

H**10**SS and a bottom surface H**10**SB. Of the four wall surfaces H**10**SS, two side surfaces H**10**SS are parallel to the direction of the side surface **10**SS relative to the recess H**10** (first direction: Y-direction in the drawing). An opening of the recess H**10** is in a substantially rectangular shape with curved corners, but may be in a rectangular shape.

[0026] The wiring board **10** includes a main portion **11** including the recess H**10**, and an extending portion **12** including a third principal surface **10**SA**2** that is parallel to the first principal surface **10**SA and that has a distance from the second principal surface **10**SB that is shorter as compared to the first principal surface **10**SA. A side surface of the extending portion **12** is the side surface **10**SS. The wiring board **10** also includes an extending portion **13** on a side opposite to the extending portion **12** across the main portion **11**. As long as the extending portion **12** includes the side surface **10**SS having a gate cut (projection) **10**P described later, the third principal surface **10**SA**2** may not be parallel to the first principal surface **10**SA, for example. The extending portion **12** may include a through hole or an electronic component may be mounted on the extending portion **12**.

[0027] The wiring board **10** may not include the extending portions **12**, **13**. In the wiring board with no extending portions **12**, **13**, a side surface of the main portion **11** is the side surface **10**SS.

[0028] As shown in FIG. **3** and FIG. **4**, a plurality of bonding electrodes **15** and a plurality of alignment marks **16** (**16**A, **16**B) are disposed on the bottom surface H**10**SB of the recess H**10**. Though not shown, the bonding electrodes **15** are electrically connected to electrodes on the second principal surface **10**SB via surface wiring and through wiring. The bonding electrodes **15** may be connected to the electrodes on the second principal surface **10**SB via wiring on the wall surface of the recess H**10**, wiring on the first principal surface **10**SA, and wiring on the side surface of the main portion **11**.

[0029] The stacked device **20** is disposed in the recess H**10** of the wiring board **10**. The external electrodes **25** of the stacked device **20** are bonded to the bonding electrodes **15** on the bottom surface H**10**SB of the recess H**10** by means of the solder bumps **29**. In other words, the light receiving portion of the image pickup device **21** is electrically connected to the electrodes on the second principal surface **10**SB via the external electrodes **25**, the solder bumps **29**, the bonding electrodes **15**, and the through wiring.

[0030] For example, the resin **30**, which is, a thermosetting epoxy resin, seals a gap between the recess H**10** and the stacked device **20**. The resin **30** seals the stacked device **20** and simultaneously mitigates the stress applied to the stacked device **20**. To prevent external light from entering through a side surface of the stacked device **20**, it is preferable that the resin **30** should have a light shielding property by, for example, including light shielding particles.

[0031] The external electrodes **25** of the stacked device **20** and the bonding electrodes **15** on the bottom surface H**10**SB of the recess H**10** of the wiring board **10** are aligned using an alignment apparatus such that first, at least two alignment marks **16** of the wiring board **10** fixed to a jig **50** (see FIG. **8**) are detected, and then, the stacked device **20** or the wiring board **10** is moved so that the stacked device **20** and the wiring board **10** are in a predetermined relative position based on the positions of the alignment marks **16**.

[0032] For example, the alignment apparatus calculates a correlation coefficient (similarity) with a template (size/shape of the alignment mark **16**) based on an image of a search region SA (FIG. **4**) of the bottom surface H**10**SB of the recess H**10** that is photographed, and performs geometric pattern matching using the similarity as a scale to detect the alignment mark **16**.

[0033] The wiring board **10** includes, on the side surface **10**SS, the projection **10**P projecting in the first direction (Y-direction in the drawing) parallel to the two side surfaces H**10**SS of the four wall surfaces H**10**SS of the recess H**10**. As will be described later, since the projection **10**P shown in FIG. **3** is a gate cut, a projecting length (d) of the projection **10**P differs among a plurality of wiring boards **10**. Therefore, the initial positions of the plurality of wiring boards **10** fixed to the jig **50** vary.

[0034] The bonding electrode **15** and the alignment mark **16** are identical in shape and size due to

restrictions on the specification of the stacked device **20** and the detecting capacity of the alignment apparatus. For example, the bonding electrode **15** is in a round shape with a diameter of 100 μm and the alignment mark **16** is also in a round shape with a diameter of 100 μm. Therefore, when the alignment mark **16** is detected, the bonding electrode **15** could be misrecognized as the alignment mark **16**. Even when the bonding electrode **15** and the alignment mark **16** are substantially identical in shape (substantially round shape) and size, the bonding electrode **15** could be misrecognized as the alignment mark **16**.

[0035] Note that substantially identical in shape and size means that the area of a superposed region where the bonding electrode **15** and the alignment mark **16** smaller than the bonding electrode **15** are virtually superposed on each other is, for example, 60% or greater of the area of the alignment mark **16**. The bonding electrode **15** and the alignment mark **16** are in a substantially round shape including a circle or in a substantially rectangular shape including a rectangle.

[0036] As shown in FIG. **4**, in the wiring board **10** of the image pickup unit **1**, a first region A**15** where the bonding electrode **15** is virtually moved in the first direction (Y-direction) and the alignment mark **16** are not superposed on each other on the bottom surface H**10**SB of the recess H**10**.

[0037] In a micro-image pickup unit, it is not easy to accurately perform positioning between the bonding electrodes on the bottom surface of the recess and the external electrodes on the back surface of the stacked device. Particularly in the MID, variations in the outer dimension inevitably occur. Therefore, the bonding electrode was occasionally misrecognized as the alignment mark for positioning.

[0038] However, in the image pickup unit **1**, the search region SA of the alignment apparatus is set larger in the Y-direction considering the variations in the projecting amount of the projection **10**P. Meanwhile, by setting the search region SA so as not to include the first region A**15**, the bonding electrode **15** is not misrecognized as the alignment mark **16**. Since the stacked device **20** and the wiring board **10** can be easily aligned, the image pickup unit **1** can be easily manufactured.

<Method of Manufacturing Image Pickup Unit>

[0039] Following a flowchart of FIG. **5**, a method of manufacturing the image pickup unit **1** will be described.

<Step S**10**> Injection Molding

[0040] As shown in FIG. **6**, the plurality of wiring boards **10** are produced using the injection molding method. A MID resin is injected from gates **42** into a mold (not shown) including the shape of a plurality of three-dimensional wiring boards, via a sprue **40** through runners **41**. A plurality of molded bodies removed from the mold, which become the plurality of wiring boards **10**, are connected by means of the sprue **40** and the runners **41**.

[0041] The surface of the molded bodies formed of the MID resin is irradiated with a laser so that a region having a catalytic activity for electroless plating is formed. Further, a through hole is formed on the bottom surface of the recess H**10**. Thereafter, the molded bodies are subjected to an electroless plating treatment, so as to become the wiring boards **10** on which the bonding electrodes **15**, the alignment marks **16**, and the like are disposed.

[0042] As already described, the wiring board **10** includes the first principal surface **10**SA and the side surface **10**SS orthogonal to the first principal surface **10**SA, and includes the bonding electrodes **15** and the alignment marks **16** on the bottom surface H**10**SB of the recess H**10** on the first principal surface **10**SA.

<Step S**20**> Gate Cutting

[0043] As shown in FIG. **7**, the plurality of wiring boards **10** that are connected by means of the runners **41** are cut at the respective gates **42** to be made into individual pieces of the wiring boards **10**. Therefore, the wiring board **10** includes, on the side surface **10**SS, the gate cut **10**P that is a projection projecting in the first direction parallel to the wall surface H**10**SS of the recess H**10**.

<Step S**30**> Disposing on Jig

[0044] Though not shown, the stacked device **20** in a rectangular parallelepiped shape is produced using the wafer-level packaging method that dices the bonded wafer in which the plurality of image pickup devices are bonded to the stacked wafer composed of the plurality of optical device wafers each including the plurality of optical devices. The stacked device **20** includes the solder bumps **29** on the external electrodes **25** on the back surface **20**SB.

[0045] As shown in FIG. **8**, the wiring board **10** is fixed to the jig **50**. The jig **50** may be a part of the alignment apparatus. At this time, the gate cut **10**P of the wiring board **10** abuts on one surface of the jig **50**.

[0046] As already described, the projecting amount d of the gate cut **10**P from the side surface **10**SS is not constant among the plurality of wiring boards **10**.

<Step S**40**> Positioning

[0047] While moving at least one of the wiring board **10** or the stacked device **20**, the positioning between the bonding electrodes **15** of the wiring board **10** and the external electrodes **25** of the stacked device **20** is performed.

[0048] First, the alignment mark **16** is detected. Depending on the shape of the alignment mark **16**, only one alignment mark **16** may be detected, but to improve the accuracy, it is preferable that at least two alignment marks **16** should be detected.

[0049] When the alignment mark **16** is detected, the positions of the bonding electrodes **15** in predetermined relative positions with respect to the position of the alignment mark **16** are presumed. With a state in which the positions of the external electrodes **25** of the stacked device **20** are aligned so as to be superposed on the presumed positions of the bonding electrodes **15** of the wiring board **10**, the stacked device **20** is inserted into the recess H**10** of the wiring board **10**.

[0050] For example, from the positions of the two alignment marks **16** (X-coordinate value, Y-coordinate value) of the wiring board **10** fixed to the jig on a stage of the alignment apparatus, XY coordinates **15**P of two of the plurality of bonding electrodes **15** are presumed. A retaining member retaining the stacked device **20** moves the positions of the external electrodes **25** to the XY coordinates **15**P and then moves the stacked device **20** in a Z-direction, so that with the aligned state, the stacked device **20** is inserted into the recess H**10** of the wiring board **10**. Note that for temporarily fixing the stacked device **20** to the recess H**10**, an adhesive may be used.

[0051] The search region SA of the alignment apparatus is set so as not to include the first region A**15**. Therefore, the bonding electrode **15** is not misrecognized as the alignment mark **16**.

<Step S**50**> Bonding

[0052] With the state in which the wiring board **10** and the stacked device **20** are positioned, e.g., the state of temporary fixing, a reflow heating treatment is performed and the external electrodes **25** and the bonding electrodes **15** are bonded by means of the solder bumps **29**. Thereafter, the resin **30** is injected into a gap between the recess H**10** and the stacked device **20** and then, curing treatment is performed. In bonding by means of the solder bumps **29**, a solder paste may be applied to the external electrodes **25** in advance.

[0053] In the method of manufacturing the image pickup unit **1** of the present embodiment, positioning between the wiring board **10** and the stacked device **20** is easy.

Modifications of First Embodiment

[0054] Since image pickup units **1**A, **1**B of modifications 1, 2 are similar to and have the same effects as the effects of the image pickup unit **1**, the components having the same functions are assigned the same reference signs and the description will be omitted.

Modification 1

[0055] As shown in FIG. **9**, in a wiring board **10**A of the image pickup unit **1**A of the present modification, a superposed region AX in which the first region A**15** where the bonding electrode **15** is virtually moved in the first direction (Y-direction) and the alignment mark **16** are superposed on each other is on the bottom surface H**10**SB of the recess H**10**.

[0056] However, the area of the superposed region AX is 20% of the area of the alignment mark

16.
[0057] Since the search region SA of the alignment apparatus includes the first region A**15**, but does not entirely include the bonding electrode **15**, the bonding electrode **15** is not misrecognized as the alignment mark **16**.
[0058] Note that to prevent the misrecognition, the area of the superposed region AX is preferably less than 50%, particularly less than 30%, of the area of the alignment mark **16**.
Modification 2
[0059] As shown in FIG. **10**, in a wiring board **10**B of the image pickup unit **1**B of the present modification, the first region A**15** where the bonding electrode **15** is virtually moved in the first direction (Y-direction) and a second region B**15** where the bonding electrode **15** is virtually moved in a second direction (X-direction) orthogonal to the first direction (Y-direction), and the alignment mark **16** are not superposed on each other.
[0060] The search region (not shown) of the alignment apparatus does not include the first region A**15** or the second region B**15**. Therefore, in the image pickup unit **1**B, the bonding electrode **15** is far less likely to be misrecognized as the alignment mark **16** than in the image pickup unit **1**.
[0061] Note that even when a part of the alignment mark **16** is superposed on the first region A**15** and the second region B**15**, as long as the total of the area of the first region A**15** and the alignment mark **16** superposed on each other and the area of the second region B**15** and the alignment mark **16** superposed on each other is less than 50% of the area of the alignment mark **16**, the bonding electrode **15** is not misrecognized as the alignment mark **16**.
Second Embodiment
[0062] An endoscope **9** of the present embodiment shown in FIG. **11** includes an insertion portion **91**, an operation portion **92**, a universal cord **93**, and an endoscope connector **94**. The insertion portion **91** in an elongated tubular shape is inserted into a body cavity of a living body.
[0063] The endoscope **9** includes the image pickup unit **1**, **1**A, or **1**B that is disposed in a distal end portion **91**A of the insertion portion **91**. As already described, since the image pickup units **1**, **1**A, and **1**B are easily manufactured, the endoscope **9** is easily manufactured.
[0064] Note that the three-dimensional wiring board including the recess H**10** where the stacked device **20** is disposed may be formed by, for example, processing using a 3D printer or cutting processing, without being limited to the MID. The material of the three-dimensional wiring board is not limited to resin, but may be ceramics or glass epoxy.
[0065] The endoscope **9** is a flexible endoscope for medical use, but the endoscope of another embodiment may be an endoscope for industrial use, or a rigid endoscope including a rigid straight tube as the insertion portion.
[0066] The present invention is not limited to the aforementioned embodiments and the like, and various changes, modifications, and the like can be made within the scope without changing the gist of the present invention.

Claims

1. An electronic component device comprising: an electronic component including an external electrode; and a wiring board, wherein the wiring board has a first principal surface, the wiring board includes a bonding electrode and an alignment mark on the first principal surface, the external electrode of the electronic component is bonded to the bonding electrode, and on the first principal surface, an area of a region in which a first region where the bonding electrode is virtually moved in a predetermined first direction and the alignment mark are superimposed on each other is less than 50% of an area of the alignment mark.
2. The electronic component device according to claim 1, wherein the alignment mark is not superimposed on the first region.
3. The electronic component device according to claim 1, wherein the alignment mark is

substantially identical in shape and size to the bonding electrode.

4. The electronic component device according to claim 1, wherein the alignment mark and the bonding electrode are in a substantially round shape.

5. The electronic component device according to claim 1, wherein a total of the area of the region in which the first region and the alignment mark are superposed on each other and an area of a region in which a second region where the bonding electrode is virtually moved in a second direction orthogonal to the first direction and the alignment mark are superposed on each other is less than 50% of the area of the alignment mark.