

DESCRIPTION

Title of Invention

ADHESIVE FILM FOR USE IN SEMICONDUCTOR DEVICE
5 MANUFACTURE, MANUFACTURING METHOD OF SAID
ADHESIVE FILM, SEMICONDUCTOR DEVICE, AND
MANUFACTURING METHOD OF SEMICONDUCTOR DEVICE

Technical Field

[0001] The present disclosure relates to an adhesive film used in a
10 manufacturing process of a semiconductor device, a method of
manufacturing the adhesive film, a semiconductor device, and a method
of manufacturing the semiconductor device.

Background Art

[0002] Hitherto, a semiconductor device is manufactured through the
15 following steps. First, a semiconductor wafer is attached to a
pressure-sensitive adhesive sheet for dicing, and in this state, the
semiconductor wafer is divided into individual semiconductor chips.
Thereafter, a pick-up step, a mounting step, a reflow step, a die bonding
step, and the like are performed. Patent Literature 1 discloses a
20 pressure-sensitive adhesive sheet (dicing die-bonding sheet) having both
a function of fixing a semiconductor wafer in a dicing step and a
function of bonding a semiconductor chip to a substrate in a die bonding
step.

Citation List

25 Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Publication

No. 2007-288170

Summary of Invention

Technical Problem

[0004] However, in recent years, with the evolution of semiconductor devices for small devices typified by smartphones, the manufacturing process of a semiconductor device has changed significantly from the past. For example, a process not performing the dicing step and the die bonding step using the pressure-sensitive adhesive sheet (dicing die-bonding sheet) described in Patent Literature 1 or a process not performing the reflow step are being put into practical use. According to this, a new aspect of the adhesive film used in the manufacturing process of a semiconductor device is also required. In addition to this situation, the present inventors have developed an adhesive film, which is convenient to use for bonding, to a limited specific region of a substrate, a semiconductor chip having a shape corresponding to the region, in order to respond to the enhancement of the function, a decrease in thickness, and the like of a small device on which a semiconductor device is mounted.

[0005] In a conventional semiconductor device, the shape of a semiconductor chip and the shape of an adhesive piece for bonding the semiconductor chip to a substrate are generally the same, and for example, these shapes are rectangular or square. However, for example, in a case where the region of the substrate to which the semiconductor chip is to be bonded is limited or electrical connection between the semiconductor chip and the substrate is required at a position different from conventional positions, there is a growing need

to use an adhesive piece having a more complicated shape than conventional shapes.

[0006] An object of the present disclosure is to provide an adhesive film provided with an adhesive piece having a complicated shape useful for efficiently performing a bonding step in a manufacturing process of a semiconductor device and a method of manufacturing the adhesive film sufficiently and stably. Further, another object of the present disclosure is to provide a semiconductor device using an adhesive piece having a complicated shape and a method of manufacturing the semiconductor device.

Solution to Problem

[0007] The present disclosure provides a method of manufacturing an adhesive film used in a manufacturing process of a semiconductor device. This manufacturing method includes, in this order, (A) a step of preparing a laminate having at least a strip-shaped carrier film having a width of 100 mm or less and an adhesive layer formed to cover a surface of the carrier film, and (B) a step of die cutting the adhesive layer to obtain a plurality of adhesive pieces disposed on the carrier film to be arranged in a longitudinal direction of the carrier film, in which when the die cutting is performed in the step (B), a cut is formed with respect to the adhesive layer and the carrier film to satisfy the condition shown in the following Inequality (1), and the adhesive piece has a shape with at least one of a projection and a recess formed on at least one side of a rectangle or a square:

$$0 < D/T \leq 0.6 \quad (1)$$

in the inequality, D is a depth (unit: μm) of the cut with respect to the

carrier film, and T is a thickness (unit: μm) of the carrier film.

[0008] Through the above steps (A) and (B), an adhesive film, which includes a strip-shaped carrier film having a width of 100 mm or less and a plurality of adhesive pieces disposed on the carrier film to be arranged in a longitudinal direction of the carrier film, is manufactured. In the step (B), by forming a cut to satisfy the condition shown in Inequality (1), the adhesive film having the above configuration can be manufactured sufficiently and stably.

[0009] As described above, the adhesive piece has a more complicated shape than a rectangle or a square. The shape of the adhesive piece may be appropriately set according to the shape of a region of the substrate to which the semiconductor chip is to be bonded or the shape of the semiconductor chip. For example, the adhesive piece may have six or more corners or eight or more corners. Incidentally, as an example of the shape of the adhesive piece having six corners, an L-shape is exemplified.

[0010] The adhesive film manufactured by the above manufacturing method may further include protective members covering the surfaces of the plurality of adhesive pieces. That is, the laminate prepared in the step (A) may further have a protective film disposed to cover the adhesive layer, and in the step (B), a cut may be formed with respect to the protective film, the adhesive layer, and the carrier film to satisfy the condition shown in the above Inequality (1). In the step (B), by die cutting the protective film along with the adhesive layer, the adhesive piece is in a state of being covered with the protective member. This protective member covers a second surface of the adhesive piece and

having the same shape as that of the adhesive piece. The second surface is of the second surface is opposite to a first surface of the adhesive piece at the carrier film side. By covering the adhesive piece with the protective member, dust or the like can be prevented from adhering to the adhesive piece until use.

[0011] The present disclosure provides an adhesive film used in a manufacturing process of a semiconductor device. This adhesive film includes a strip-shaped carrier film having a width of 100 mm or less, a plurality of adhesive pieces disposed on the carrier film to be arranged in a longitudinal direction of the carrier film, and cuts formed in the carrier film along outer edges of the adhesive pieces, in which a depth of the cut and a thickness of the carrier film satisfy the condition shown in the following Inequality (1), and the adhesive piece has a shape with at least one of a projection and a recess formed on at least one side of a rectangle or a square:

$$0 < D/T \leq 0.6 \quad (1)$$

in the inequality, D is a depth (unit: μm) of the cut with respect to the carrier film, and T is a thickness (unit: μm) of the carrier film.

[0012] According to this adhesive film, the plurality of adhesive pieces disposed to be arranged on the carrier film are sequentially picked up; thereafter, each adhesive piece can be disposed in a predetermined region on the substrate and the bonding step of the substrate and the semiconductor chip can be efficiently performed. For example, when the strip-shaped adhesive film is wound on a reel, the bonding step can be further efficiently performed by a roll-to-roll method. The shape of the adhesive piece may be appropriately set according to the shape of a

region of the substrate to which the semiconductor chip is to be bonded or the shape of the semiconductor chip. The thickness of the carrier film is, for example, 10 to 200 μm .

5 [0013] The size, the number, and the like of the adhesive pieces disposed on the carrier film may be appropriately set according to the design of a semiconductor device to be manufactured. For example, the area of one adhesive piece can be in a range of 10 to 200 mm^2 . The ratio of the region that is the surface of the carrier film and is covered with the plurality of adhesive pieces can be set to 10 to 60% on
10 the basis of the area of the carrier film. One or more rows formed of the plurality of adhesive pieces may be formed on the carrier film.

[0014] The adhesive film may further include a protective member covering a first surface of the adhesive piece at the carrier film side and a second surface opposite to the first surface and having the same shape
15 as that of the adhesive piece. By covering the adhesive piece with the protective member, dust or the like can be prevented from adhering to the adhesive piece until use.

[0015] From the viewpoint of workability of the adhesive film (preventing inadvertent peeling of the adhesive piece from the carrier
20 film during and after die cutting), a sticking force between the carrier film and the adhesive piece is preferably 2 N/m or more.

Advantageous Effects of Invention

[0016] According to the present disclosure, there are provided an adhesive film provided with an adhesive piece having a complicated
25 shape useful for efficiently performing a bonding step in a manufacturing process of a semiconductor device and a method of

manufacturing the adhesive film sufficiently and stably. Further, according to the present disclosure, there are provided a semiconductor device using an adhesive piece having a complicated shape and a method of manufacturing the semiconductor device.

5 **Brief Description of Drawings**

[0017] FIG. 1 is a perspective view schematically illustrating an embodiment of an adhesive film according to the present disclosure.

FIG. 2 is a cross-sectional view taken along line II-II illustrated in FIG. 1.

10 FIG. 3(a) to FIG. 3(f) are plan views illustrating variations in the shape of an adhesive piece.

FIG. 4 is a plan view illustrating an example of arrangement of a T-shaped adhesive piece and a semiconductor chip.

15 FIG. 5 is a cross-sectional view schematically illustrating a laminate in which a carrier film, an adhesive layer, and a protective film are laminated in this order.

FIG. 6 is a perspective view illustrating a state in which a plurality of adhesive pieces are formed on a carrier film by die cutting.

20 FIG. 7 is a cross-sectional view schematically illustrating a state in which an adhesive piece and a protective member covering the adhesive piece are picked up from a carrier film.

FIG. 8 is a cross-sectional view schematically illustrating an example of a semiconductor device manufactured using the adhesive piece according to the present disclosure.

25 FIG. 9(a) is a cross-sectional view schematically illustrating a device used for evaluation of pickup property in Examples and

Comparative Examples, in which an adhesive piece peels off from a carrier film at a corner portion of a double clip, and FIG. 9(b) is a cross-sectional view illustrating a state in which the adhesive piece passes through the corner portion while sticking to the carrier film.

5 **Description of Embodiments**

[0018] Hereinafter, embodiments of the present disclosure will be described with reference to the drawings as appropriate. Incidentally, the present invention is not limited to the following embodiments. In the present specification, (meth)acryl means acryl or methacryl.

10 [0019] <Adhesive film for use in semiconductor device manufacture>

FIG. 1 is a perspective view schematically illustrating an adhesive film according to the present embodiment. FIG. 2 is a cross-sectional view taken along line II-II illustrated in FIG. 1. An adhesive film 10 illustrated in these drawings includes a strip-shaped carrier film 1 having a width of 100 mm or less, a plurality of adhesive pieces 3p disposed on the carrier film 1 to be arranged in a longitudinal direction thereof (a direction of arrow X illustrated in FIG. 1), protective members 5p covering surfaces F2 of the adhesive pieces 3p and having the same shape as that of the adhesive piece 3p, and cuts 1c formed in the carrier film 1 along outer edges of the adhesive pieces 3p. As illustrated in FIG. 2, the surface F2 (second surface) of the adhesive piece 3p is a surface opposite to a surface F1 (first surface) of the adhesive piece 3p at the carrier film 1 side.

20 [0020] The adhesive film 10 is applicable to various bonding steps (for example, bonding of a semiconductor chip and a substrate) in a manufacturing process of a semiconductor device. According to the

adhesive film 10, the plurality of adhesive pieces 3p disposed to be arranged on the carrier film 1 are sequentially picked up; thereafter, each adhesive piece 3p can be disposed in a predetermined region on the substrate and the bonding step of the substrate and the semiconductor chip can be efficiently performed. Incidentally, FIGS. 1 and 2 illustrate a case where one row 3A formed of the plurality of adhesive pieces 3p is provided on the carrier film 1, but two or more rows 3A may be provided on the carrier film 1.

[0021] The adhesive piece 3p according to the present embodiment has a shape like a thick T (T-shape) as illustrated in FIG. 1. This shape has eight corners C1 to C8 as illustrated in FIG. 3(a). Incidentally, this shape can be said to be a shape with one projection formed at the center of one side of a rectangle, or can also be said to be a shape with one recess respectively formed at both ends of one side of the rectangle.

[0022] The shape of the adhesive piece 3p is not limited to the shape illustrated in FIG. 3(a), and may have a shape with at least one of a projection and a recess formed on at least one side of a rectangle or a square. For example, as illustrated in FIG. 3(b), the adhesive piece 3p may be L-shaped and have six corners C1 to C6. As illustrated in FIG. 3(c), the adhesive piece 3p may have a shape with one recess formed on the rectangle or the square and have eight corners C1 to C8. As illustrated in FIG. 3(d), the adhesive piece 3p may have a shape with a recess formed at one corner (the lower left in FIG. 3(d)) of the rectangle or the square and a projection formed on one side (the right side in FIG. 3(d)) and have ten corners C1 to C10. As illustrated in FIG. 3(e), the adhesive piece 3p may have a shape with a projection formed on one

side of the rectangle or the square and a recess formed on the other side and have 12 corners C1 to C12. Incidentally, the shape of the recess or the projection may be a triangle or an arc as illustrated in FIG. 3(f).

[0023] The shape of the adhesive piece may be appropriately set according to the shape of a region of the substrate to which the semiconductor chip is to be bonded or the shape of the semiconductor chip. Further, in a case where the shape of the semiconductor chip is, for example, a rectangle or a square, a plurality of terminals are provided at the corners, and these terminals need to be connected to the wiring of the substrate, the shape of the adhesive piece may be determined so that the terminal and the wiring are not covered with the adhesive piece. FIG. 4 is a plan view illustrating an example of arrangement of a T-shaped adhesive piece 3p and a rectangular semiconductor chip S. In regions R1 and R2 illustrated in FIG. 4, no adhesive exists between the substrate and the semiconductor chip, and the substrate and the semiconductor chip can be electrically connected in these regions R1 and R2.

[0024] The adhesive piece 3p in the present embodiment is assumed to have a sufficiently small size, and the area of one adhesive piece 3p is, for example, 10 to 200 mm² and may be 20 to 160 mm² or 25 to 100 mm². The ratio of a region that is the surface of the carrier film 1 and is covered with the plurality of adhesive pieces 3p (the area ratio of the adhesive piece) is, for example, 10 to 60% and may be 10 to 35% or 15 to 33% on the basis of the area of the carrier film 1. This area ratio may be calculated by dividing an area A of one adhesive piece 3p by the product of a pitch (a pitch P in FIG. 1) of the adhesive piece 3p provided

on the carrier film 1 and a width (a width W in FIG. 1) of the carrier film 1. That is, this area ratio R may be a value calculated by the following equation.

$$\text{Area ratio } R (\%) = A / (P \times W) \times 100$$

5 [0025] The adhesive piece 3p and the protective member 5p covering the adhesive piece 3p are formed by die cutting (see FIG. 6). At the time of die cutting, the cut 1c is formed in the carrier film 1 along the outer edge of the adhesive piece 3p. When a depth of the cut 1c with respect to the carrier film 1 is designated as D μm and a thickness of the carrier film is designated as T μm (see FIG. 2), the depth of the cut 1c satisfies the condition shown in the following Inequality (1), preferably satisfies the condition shown in Inequality (2), and more preferable satisfies the condition shown in Inequality (3).

$$0 < D/T \leq 0.6 \quad (1)$$

15 $0.1 \leq D/T \leq 0.6 \quad (2)$

$$0.15 \leq D/T \leq 0.6 \quad (3)$$

[0026] Since the value of D/T is a value larger than the lower limits of the above Inequalities (1) to (3) or equal to or larger than the lower limits thereof, the die cutting as illustrated in FIG. 6 can be suitably performed even in the case of the shape of the adhesive piece 3p being complicated. Specifically, it is possible to sufficiently prevent the adhesive piece 3p and the protective member 5p from remaining on an unnecessary portion 30 side without adhering to the carrier film 1. On the other hand, when the value of D/T is smaller than the upper limits of the above Inequalities (1) to (3) or equal to or smaller than the upper limits thereof, the pickup illustrated in FIG. 7 can be suitably performed.

Specifically, in a state in which a constant tension is applied to the adhesive film 10, while the surface of the adhesive film 10 at the carrier film 1 side is brought into contact with a wedge-shaped member 60, the adhesive film 10 is moved in a direction of the arrow illustrated in FIG. 7, and thus, as illustrated in FIG. 7, the front sides of the adhesive piece 3p and the protective member 5p tend to float from the carrier film 1.

[0027] It is speculated that when the value of D/T is larger than 0.6, an adhesive composition constituting the adhesive piece 3p (the adhesive layer 3) enters the cut 1c, and thus pickup property tends to be insufficient. For example, in a case where the laminate 20 receives an excessive pressing force from a rotating body 51 and a roll 52 illustrated in FIG. 6 at the time of die cutting, the value of D/T tends to excessively increase (the cut 1c tends to get excessively deeper). It is speculated that this pressing force promotes the adhesive composition to enter the cut 1c or causes the adhesive composition to easily protrude from the protective member 5p. According to the studies by the present inventors, at the time of using the adhesive film 10, from the viewpoint of pickup property, a distance of the adhesive composition protruding from the outer edge of the protective member 5p is preferably less than 40 μm .

[0028] Hereinafter, the configuration of the adhesive film 10 will be described.

[Carrier film]

The carrier film 1 is strip-shaped and has a width of 100 mm or less, as described above. The width of the carrier film 1 may be appropriately set according to the size of the adhesive piece 3p disposed

on the carrier film 1 and the number of the rows 3A. For example, as illustrated in FIG. 1, when the number of the rows 3A is one, the width of the carrier film 1 is preferably 10 to 50 mm and may be 10 to 30 mm or 10 to 20 mm. When the width of the carrier film 1 is set to 10 mm or more, in the case of employing the roll-to-roll method, a decrease in workability caused by the carrier film 1 being twisted is easily prevented.

[0029] The material of the carrier film 1 is not particularly limited as long as it can sufficiently withstand tension applied in the manufacturing process of the adhesive film 10 and the manufacturing process of a semiconductor device. The carrier film 1 is preferably transparent from the viewpoint of visibility of the adhesive piece 3p and/or the protective member 5p disposed on the carrier film 1. As the carrier film 1, plastic films including a polyester-based film such as a polyethylene terephthalate film, a polyolefin-based film such as a polytetrafluoroethylene film, a polyethylene film, a polypropylene film, a polymethylpentene film, a polyvinyl acetate film, a homocopolymer or copolymer such as poly-4-methylpentene-1, an ethylene-vinyl acetate copolymer, an ethylene-ethyl acrylate copolymer, or mixtures thereof, a polyvinyl chloride film, a polyimide film, and the like can be used. The carrier film 1 may have a single-layer structure or a multilayer structure.

[0030] The thickness of the carrier film 1 may be appropriately selected within a range that does not impair workability, is, for example, 10 to 200 μm , and may be 20 to 100 μm or 25 to 80 μm . These thickness ranges are practically acceptable and economically effective.

[0031] In order to increase the sticking force of the adhesive piece 3p with respect to the carrier film 1, the surface of the carrier film 1 may be subjected to a chemical or physical surface treatment such as a corona treatment, a chromic acid treatment, ozone exposure, flame exposure, high-voltage electric shock exposure, or an ionizing radiation treatment. As the carrier film 1, a film made of a fluororesin and having a low surface energy can also be used. Examples of such a film include A-63 (release processing agent: modified silicone type) manufactured by Teijin Film Solutions Limited and A-31 (release processing agent: Pt-based silicone type) manufactured by Teijin Film Solutions Limited.

[0032] In order to prevent an excessive increase in the sticking force of the adhesive piece 3p with respect to the carrier film 1, a release layer configured by a release agent such as a silicone-based release agent, a fluorine-based release agent, or a long-chain alkyl acrylate-based release agent may be formed on the surface of the carrier film 1.

[0033] The sticking force between the carrier film 1 and the adhesive piece 3p is preferably 2 N/m or more and more preferably 2 to 10 N/m, and may be 2 to 6 N/m or 2 to 4 N/m. When this sticking force is 2 N/m or more, inadvertent peeling of the adhesive piece 3p from the carrier film 1 is easily prevented in the process of manufacturing the adhesive film 10; on the other hand, when the sticking force is 10 N/m or less, the adhesive piece 3p and the protective member 5p covering the adhesive piece 3p are easy to pick up stably from the carrier film 1 at the time of using the adhesive film 10. Incidentally, the sticking force of the adhesive piece 3p with respect to the carrier film 1 means a 90° peeling strength, and specifically, means a peeling strength

measured when a sample in which an adhesive layer made of the same composition as that of the adhesive piece 3p and having a width of 20 mm is formed on the carrier film 1 is prepared and this adhesive layer is peeled off from the carrier film at an angle of 90° and at a peeling rate of 50 mm/min.

[0034] [Adhesive piece]

The adhesive piece 3p is formed along with the protective member 5p by simultaneously die cutting the adhesive layer 3 formed to cover the surface of the carrier film 1 and the protective film 5 disposed to cover the adhesive layer 3 (see FIG. 6). The thickness of the adhesive piece 3p may be appropriately selected within a range that does not impair workability, is, for example, 3 to 50 μm, and may be 5 to 40 μm or 7 to 30 μm. When the thickness of the adhesive piece 3p is 3 μm or more, sufficient adhesion property is easily secured; on the other hand, when thickness thereof is 50 μm or less, protruding of the adhesive composition constituting the adhesive piece 3p from the protective member 5p is easily suppressed.

[0035] The adhesive composition constituting the adhesive piece 3p is sufficient to have properties that can be used without any problem in the manufacturing process of a semiconductor device (for example, adhesion property and heat resistance to heat of about 150°C), and properties that have been conventionally used in the manufacturing process of a semiconductor device may be appropriately employed. The adhesive piece 3p preferably contains a thermoplastic resin, a thermosetting resin, a curing accelerator, and a filler, and may contain a photoreactive monomer, a photopolymerization initiator, and the like as

necessary. With a decrease in thickness of the substrate, a substrate having low heat resistance tends to be used, and a decrease in temperature in the manufacturing process of a semiconductor device tends to be required. It is preferable that the adhesive piece 3p can
5 bond a target object under a temperature condition of 160°C or lower.

[0036] (Thermoplastic resin)

As the thermoplastic resin, a resin having thermoplasticity, or a resin having thermoplasticity in at least an uncured state and forming a crosslinked structure after heating can be used. As the thermoplastic
10 resin, from the viewpoint of having excellent contractility, heat resistance, and releasability as a tape for semiconductor processing, a (meth)acrylic copolymer having a reactive group (hereinafter, also referred to as a "reactive group-containing (meth)acrylic copolymer" in some cases) is preferred.

15 In the case of containing a reactive group-containing (meth)acrylic copolymer as the thermoplastic resin, the adhesive piece 3p may employ an aspect not containing a thermosetting resin. That is, an aspect containing a reactive group-containing (meth)acrylic copolymer, a curing accelerator, and a filler may be employed.

20 The thermoplastic resin can be used alone or in combination of two or more kinds thereof.

[0037] Examples of the (meth)acrylic copolymer include (meth)acrylic acid ester copolymers such as an acrylic resin and acrylic rubber, and acrylic rubber is preferred. The acrylic rubber is preferably acrylic
25 rubber containing an acrylic acid ester as a main component and formed by copolymerization of a monomer selected from a (meth)acrylic acid

ester and acrylonitrile.

[0038] Examples of the (meth)acrylic acid ester include methyl acrylate, ethyl acrylate, propyl acrylate, isopropyl acrylate, butyl acrylate, isobutyl acrylate, hexyl acrylate, cyclohexyl acrylate, 2-ethylhexyl acrylate, lauryl acrylate, methyl methacrylate, ethyl methacrylate, propyl methacrylate, isopropyl acrylate, butyl methacrylate, isobutyl methacrylate, hexyl methacrylate, cyclohexyl methacrylate, 2-ethylhexyl methacrylate, and lauryl methacrylate.

As the (meth)acrylic acid ester copolymer, a copolymer containing butyl acrylate and acrylonitrile as copolymerization components and a copolymer containing ethyl acrylate and acrylonitrile as copolymerization components are preferred.

[0039] The reactive group-containing (meth)acrylic copolymer is preferably a reactive group-containing (meth)acrylic copolymer containing a (meth)acrylic monomer having a reactive group as a copolymerization component. Such a reactive group-containing (meth)acrylic copolymer can be obtained by copolymerizing a (meth)acrylic monomer having a reactive group and a monomer composition containing the above-described monomer.

[0040] As the reactive group, from the viewpoint of improving heat resistance, an epoxy group, a carboxyl group, an acryloyl group, a methacryloyl group, a hydroxyl group, and an episulfide group are preferred, and of them, from the viewpoint of crosslinkability, an epoxy group and a carboxyl group are more preferred.

[0041] In the present embodiment, the reactive group-containing (meth)acrylic copolymer is preferably an epoxy group-containing

(meth)acrylic copolymer containing a (meth)acrylic monomer having an epoxy group as a copolymerization component. In this case, examples of the (meth)acrylic monomer having an epoxy group include glycidyl acrylate, 4-hydroxybutyl acrylate glycidylether, 3,4-epoxycyclohexylmethyl acrylate, glycidyl methacrylate, 4-hydroxybutyl methacrylate glycidylether, and 3,4-epoxycyclohexylmethyl methacrylate. The (meth)acrylic monomer having a reactive group is preferably glycidyl acrylate or glycidyl methacrylate from the viewpoint of heat resistance.

[0042] The Tg of the thermoplastic resin is preferably -50°C to 50°C. When the Tg of the thermoplastic resin is 50°C or lower, flexibility of the adhesive piece 3p is easily secured. Further, in a case where irregularities are present when the adhesive piece is attached to an adherend, the adhesive piece easily follows the irregularities and has appropriate adhesion property. On the other hand, when the Tg of the thermoplastic resin is -50°C or higher, an excessive increase in flexibility of the adhesive piece 3p is easily suppressed and excellent handleability, adhesion property, and releasability can be achieved.

[0043] The Tg of the thermoplastic resin is a midpoint glass transition temperature value obtained by differential scanning calorimetry (DSC). The Tg of the thermoplastic resin is specifically a midpoint glass transition temperature calculated by the method according to JIS K 7121:1987 by measuring a change in calorific value under the conditions of a temperature increasing rate of 10°C/min and a measurement temperature of -80 to 80°C.

[0044] The weight average molecular weight of the thermoplastic resin

is preferably 100000 or more and 2000000 or less. When the weight average molecular weight is 100000 or more, in the case of use for temporary fixing, heat resistance is easily secured. On the other hand, when the weight average molecular weight is 2000000 or less, in the case of use for temporary fixing, a decrease in flow and a decrease in adhesiveness are easily suppressed. From the viewpoints mentioned above, the weight average molecular weight of the thermoplastic resin is more preferably 500000 or more and 2000000 or less and further preferably 1000000 or more and 2000000 or less. Incidentally, weight average molecular weight is a value in terms of polystyrene using a calibration curve of standard polystyrene by gel permeation chromatography (GPC).

[0045] In a case where the (meth)acrylic copolymer having a reactive group contains glycidyl acrylate or glycidyl methacrylate as a copolymerization component, the total content thereof is preferably 0.1 to 20% by mass, more preferably 0.5 to 15% by mass, and further preferably 1.0 to 10% by mass on the basis of the total amount of the copolymerization components. When the content is within the above range, all of the flexibility, adhesion property, and releasability of the adhesive piece 3p are easily achieved at a higher level.

[0046] As the (meth)acrylic copolymer having a reactive group as described above, those obtained by a polymerization method such as pearl polymerization or solution polymerization may be used. Alternatively, a commercially available product such as HTR-860P-3CSP (trade name, manufactured by Nagase ChemteX Corporation) may be used.

[0047] (Thermosetting resin)

As the thermosetting resin, any resin that is cured by heat can be used without particular limitation. Examples of the thermosetting resin include an epoxy resin, an acrylic resin, a silicone resin, a phenolic resin, a thermosetting polyimide resin, a polyurethane resin, a melamine resin, and a urea resin. These resins can be used alone or in combination of two or more kinds thereof.

[0048] The epoxy resin is not particularly limited as long as it is cured and has a heat-resistant effect. As the epoxy resin, a bifunctional epoxy resin such as bisphenol A type epoxy, a novolak type epoxy resin such as a phenol novolak type epoxy resin or a cresol novolak type epoxy resin, and the like can be used. As the epoxy resin, a conventionally known resin such as a polyfunctional epoxy resin, a glycidyl amine type epoxy resin, a heterocyclic ring-containing epoxy resin, or an alicyclic epoxy resin can be used as well.

[0049] Examples of the bisphenol A type epoxy resin include Epikote 807, Epikote 815, Epikote 825, Epikote 827, Epikote 828, Epikote 834, Epikote 1001, Epikote 1004, Epikote 1007, and Epikote 1009 (all manufactured by Mitsubishi Chemical Corporation), DER-330, DER-301, and DER-361 (all manufactured by The Dow Chemical Company), and YD8125 and YDF8170 (all manufactured by Nippon Steel & Sumikin Chemical Co., Ltd.).

Examples of the phenol novolak type epoxy resin include Epikote 152 and Epikote 154 (all manufactured by Mitsubishi Chemical Corporation), EPPN-201 (manufactured by Nippon Kayaku Co., Ltd.), and DEN-438 (manufactured by The Dow Chemical Company).

Examples of an o-cresol novolak type epoxy resin include YDCN-700-10 (manufactured by Nippon Steel & Sumikin Chemical Co., Ltd.), EOCN-102S, EOCN-103S, EOCN-104S, EOCN-1012, EOCN-1025, and EOCN-1027 (all manufactured by Nippon Kayaku Co., Ltd.), and YDCN701, YDCN702, YDCN703, and YDCN704 (all manufactured by Nippon Steel & Sumikin Chemical Co., Ltd.).

Examples of the polyfunctional epoxy resin include Epon 1031S (manufactured by Mitsubishi Chemical Corporation), ARALDITE 0163 (manufactured by BASF Japan), and Denacol EX-611, EX-614, EX-614B, EX-622, EX-512, EX-521, EX-421, EX-411, and EX-321 (all manufactured by Nagase ChemteX Corporation).

Examples of the amine type epoxy resin include Epikote 604 (manufactured by Mitsubishi Chemical Corporation), YH-434 (manufactured by Nippon Steel & Sumikin Chemical Co., Ltd.), TETRAD-X and TETRAD-C (all manufactured by MITSUBISHI GAS CHEMICAL COMPANY, INC.), and ELM-120 (manufactured by SUMITOMO CHEMICAL COMPANY, LIMITED).

Examples of the heterocyclic ring-containing epoxy resin include ARALDITE PT810 (manufactured by BASF Japan), and ERL4234, ERL4299, ERL4221, and ERL4206 (all manufactured by Union Carbide Corporation). These epoxy resins can be used alone or in combination of two or more kinds thereof.

[0050] As the epoxy resin curing agent that is a part of the thermosetting resin component, a known resin which is generally used can be used. Specific examples thereof include amines, polyamides, acid anhydrides, polysulfides, boron trifluoride, bisphenols having two

or more phenolic hydroxyl groups in one molecule such as bisphenol A, bisphenol F, and bisphenol S, and phenolic resins such as a phenol novolak resin, a bisphenol A novolak resin, and a cresol novolak resin. As the epoxy resin curing agent, particularly, from the viewpoint of having excellent electric corrosion resistance upon absorption of moisture, phenolic resins such as a phenol novolak resin, a bisphenol A novolak resin, and a cresol novolak resin are preferred.

Incidentally, the epoxy curing agent may be used simultaneously with the epoxy resin or may be used alone.

[0051] Among the phenolic resin curing agents, materials having structures such as PHENOLITE LF4871, PHENOLITE TD-2090, PHENOLITE TD-2149, PHENOLITE VH-4150, and PHENOLITE VH4170 (all manufactured by DIC Corporation, trade name), H-1 (manufactured by Meiwa Plastic Industries, Ltd., trade name), and Epicure MP402FPY, Epicure YL6065, Epicure YLH129B65, Milex XL, Milex XLC, Milex XLC-LL, Milex RN, Milex RS, and Milex VR (all manufactured by Mitsubishi Chemical Corporation, trade name) are preferably used.

[0052] The content of the thermosetting resin in the adhesive piece 3p is preferably 10 to 500 parts by mass, more preferably 30 to 450 parts by mass, and further preferably 50 to 400 parts by mass, with respect to 100 parts by mass of the thermoplastic resin. When the content of the thermosetting resin is within the above range, excellent sticking property after thermosetting of the adhesive piece 3p is easily achieved.

[0053] (Curing accelerator)

Examples of the curing accelerator include imidazoles,

dicyandiamide derivatives, dicarboxylic acid dihydrazides, triphenylphosphine, tetraphenylphosphonium tetraphenylborate, 2-ethyl-4-methylimidazole-tetraphenylborate, and 1,8-diazabicyclo[5,4,0]undecene-7-tetraphenylborate. These resins can be used alone or in combination of two or more kinds thereof.

[0054] In a case where the adhesive piece 3p contains a (meth)acrylic copolymer having an epoxy group, it is preferable to contain a curing accelerator promoting the curing of the epoxy group contained in the acrylic copolymer. Examples of the curing accelerator promoting the curing of the epoxy group include a phenol-based curing agent, an acid anhydride-based curing agent, an amine-based curing agent, an imidazole-based curing agent, an imidazoline-based curing agent, a triazine-based curing agent, and a phosphine-based curing agent. Among these, from the viewpoints of quick curability, heat resistance, and releasability, an imidazole-based curing agent that can be expected to shorten the process time and improve workability is preferred. These compounds can be used alone or in combination of two or more kinds thereof.

[0055] The content of the curing accelerator in the adhesive piece 3p is preferably 0.01 to 50 parts by mass, more preferably 0.02 to 20 parts by mass, and further preferably 0.025 to 10 parts by mass, with respect to 100 parts by mass of the thermoplastic resin. When the content of the curing accelerator is within the above range, there is a tendency that a decrease in storage stability can be sufficiently suppressed while the curability of the adhesive piece 3p is improved.

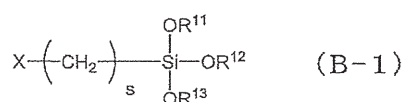
[0056] (Inorganic filler)

The adhesive piece 3p preferably contains an inorganic filler. Examples of the inorganic filler include metal fillers such as silver powder, gold powder, and copper powder, and non-metallic inorganic fillers such as silica, alumina, boron nitride, titania, glass, iron oxide, and ceramics. The inorganic filler can be selected according to desired functions.

[0057] The inorganic filler preferably has an organic group on a surface. When the surface of the inorganic filler is modified with the organic group, both dispersibility into an organic solvent at the time of preparing varnish for forming the adhesive piece 3p and a high elastic modulus and excellent releasability of the adhesive piece 3p are easily attained.

[0058] The inorganic filler having an organic group on a surface can be obtained, for example, by mixing a silane coupling agent represented by the following Formula (B-1) and an inorganic filler and stirring them at a temperature of 30°C or higher. The fact that the surface of the inorganic filler is modified with the organic group can be confirmed by UV measurement, IR measurement, XPS measurement, and the like.

[0059]



[0060] In Formula (B-1), X represents an organic group selected from the group consisting of a phenyl group, a glycidoxy group, an acryloyl group, a methacryloyl group, a mercapto group, an amino group, a vinyl group, an isocyanate group, a methacryloxy group, s represents an integer of 0 or 1 to 10, and R¹¹, R¹², and R¹³ each independently

represent an alkyl group having 1 to 10 carbon atoms.

Examples of the alkyl group having 1 to 10 carbon atoms include a methyl group, an ethyl group, a propyl group, a butyl group, a pentyl group, a hexyl group, a heptyl group, an octyl group, a nonyl group, a decyl group, an isopropyl group, an isobutyl group.

The alkyl group having 1 to 10 carbon atoms is preferably a methyl group, an ethyl group, and a pentyl group from the viewpoint of ease of availability. From the viewpoint of heat resistance, X is preferably an amino group, a glycidoxy group, a mercapto group, and an isocyanate group and more preferably a glycidoxy group and a mercapto group. s in Formula (B-1) is preferably 0 to 5 and more preferably 0 to 4 from the viewpoints of suppressing film fluidity at high temperatures and improving heat resistance.

[0061] Examples of the silane coupling agent include trimethoxyphenylsilane, dimethyldimethoxyphenylsilane, triethoxyphenylsilane, dimethoxymethylphenylsilane, vinyltrimethoxysilane, vinyltriethoxysilane, vinyltris(2-methoxyethoxy)silane, N-(2-aminoethyl)-3-aminopropylmethyldimethoxysilane, N-(2-aminoethyl)-3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, 3-aminopropyltrimethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropylmethyldimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, 3-isocyanatepropyltriethoxysilane, 3-methacryloxypropyltrimethoxysilane,

3-mercaptopropyltrimethoxysilane, 3-ureidopropyltriethoxysilane,
N-(1,3-dimethylbutylidene)-3-(triethoxysilyl)-1-propanamine,
N,N'-bis(3-(trimethoxysilyl)propyl)ethylenediamine,
polyoxyethylenepropyltrialkoxysilane, and
5 polyethoxydimethylsiloxane.

Among these, 3-aminopropyltriethoxysilane,
3-glycidoxypropyltrimethoxysilane, 3-isocyanatepropyltriethoxysilane,
and 3-mercaptopropyltrimethoxysilane are preferred, and
trimethoxyphenylsilane, 3-glycidoxypropyltrimethoxysilane, and
10 3-mercaptopropyltrimethoxysilane are more preferred. The silane
coupling agent can be used alone or in combination of two or more
kinds thereof.

[0062] The content of the coupling agent is preferably 0.01 to 50 parts
by mass and more preferably 0.05 to 20 parts by mass from the
15 viewpoint of attaining a balance between heat resistance and storage
stability and is further preferably 0.5 to 10 parts by mass from the
viewpoint of improving heat resistance, with respect to 100 parts by
mass of the inorganic filler.

[0063] The content of the inorganic filler in the adhesive piece 3p is
20 preferably 600 parts by mass or less, more preferably 500 parts by mass
or less, and further preferably 400 parts by mass or less, with respect to
100 parts by mass of the thermoplastic resin. The lower limit of the
content of the inorganic filler is not particularly limited, but is
preferably 5 parts by mass or more and more preferably 8 parts by mass
25 or more, with respect to 100 parts by mass of the thermoplastic resin.
When the content of the inorganic filler is within the above range,

shrinkage due to thermal curing can be suppressed and both a high elastic modulus and excellent releasability of the adhesive piece 3p are easily attained.

[0064] (Organic filler)

5 The adhesive piece 3p may contain an organic filler. Examples of the organic filler include carbon, a rubber-based filler, silicone-based fine particles, polyamide fine particles, and polyimide fine particles. The content of the organic filler is preferably 300 parts by mass or less, more preferably 200 parts by mass or less, and further preferably 100
10 parts by mass or less, with respect to 100 parts by mass of the thermoplastic resin. The lower limit of the content of the organic filler is not particularly limited, but is preferably 5 parts by mass or more with respect to 100 parts by mass of the thermoplastic resin.

[0065] (Organic solvent)

15 The adhesive piece 3p may be diluted with an organic solvent as necessary. The organic solvent is not particularly limited, but can be determined in consideration of volatility or the like at the time of film formation from boiling points. Specifically, solvents having a relatively low boiling point such as methanol, ethanol,
20 2-methoxyethanol, 2-ethoxyethanol, 2-butoxyethanol, methyl ethyl ketone, acetone, methyl isobutyl ketone, toluene, and xylene are preferred from the viewpoint that curing of a film hardly proceeds at the time of film formation. Further, for improving film forming properties, solvents having a relatively high boiling point such as
25 dimethylacetamide, dimethylformamide, N-methylpyrrolidone, and cyclohexanone are preferably used. These solvents can be used alone

or in combination of two or more kinds thereof.

[0066] [Protective member]

The protective member 5p is formed along with the adhesive piece 3p by simultaneously die cutting the adhesive layer 3 formed to cover the surface of the carrier film 1 and the protective film 5 disposed to cover the adhesive layer 3 (see FIG. 6). Since the protective member 5p according to the present embodiment is formed simultaneously with the adhesive piece 3p by die cutting, the shape of the protective member 5p has substantially the same as that of the adhesive piece 3p. The protective film 5 may be any material that can be subjected to punching processing in the manufacturing process of the adhesive film 10 and can easily peel the protective member 5p from the adhesive piece 3p in the manufacturing process of a semiconductor device.

[0067] The sticking force between the adhesive piece 3p and the protective member 5p is preferably 16 N/m or less and more preferably 10 N/m or less, and may be 5 N/m or less or 4.5 N/m or less. In particular, in a case where the adhesive piece 3p is made of a resin composition having thermosetting property, the sticking force of the protective member 5p to the adhesive piece 3p is preferably within the above range after a heat treatment at 100°C for 10 minutes. When the sticking force is 16 N/m or less, the adhesive piece 3p in the state of being covered with the protective member 5p is temporarily attached to an adherend (for example, a substrate), for example, under the condition of 100°C for 3 seconds, and then the protective member 5p can be easily peeled off from the adhesive piece 3p by an adhesive tape or the

like. Incidentally, the sticking force of the protective member 5p to the adhesive piece 3p means a 90° peeling strength, and specifically, means a peeling strength measured when a sample in which an protective film having the same width as that of the adhesive layer is disposed on the adhesive layer made of the same composition as that of the adhesive piece 3p and having a width of 20 mm is prepared and this protective film is peeled off from the adhesive layer at an angle of 90° and at a peeling rate of 300 mm/min.

[0068] As the protective film 5, plastic films including a polyester-based film such as a polyethylene terephthalate film, a polyolefin-based film such as a polytetrafluoroethylene film, a polyethylene film, a polypropylene film, a polymethylpentene film, a polyvinyl acetate film, a homocopolymer or copolymer such as poly-4-methylpentene-1, an ethylene-vinyl acetate copolymer, an ethylene-ethyl acrylate copolymer, or mixtures thereof, a polyvinyl chloride film, a polyimide film, and the like can be used. The protective film 5 may have a single-layer structure or a multilayer structure. When the adhesive layer 3 is covered with the protective film 5, an excessive tension can be prevented from being applied to the adhesive layer 3, and foreign matter can be prevented from being mixed into the adhesive layer 3 at the time of die cutting.

[0069] The thickness of the protective film 5 may be appropriately selected within a range that does not impair workability, is, for example, 10 to 200 μm, and may be 20 to 100 μm or 25 to 80 μm. These thickness ranges are practically acceptable and economically effective.

[0070] The light transmittance of the protective member 5p is

preferably lower than the light transmittance of the carrier film 1. By employing such a configuration, the position, orientation, and the like of the adhesive piece 3p can be recognized by a device such as a camera, and the bonding step in the manufacturing process of a semiconductor device can be easily automated. For example, as the protective member 5p, a member colored so that the transmittance of light having a wavelength of 500 nm is less than 10% (more preferably less than 7%) is preferably used.

[0071] <Method of manufacturing adhesive film>

Next, the method of manufacturing the adhesive film 10 will be described. The manufacturing method of the present embodiment includes the following steps:

(A) a step of preparing the laminate 20 having the strip-shaped carrier film 1 having a width of 100 mm or less, the adhesive layer 3 formed to cover the surface of the carrier film 1, and the protective film 5 disposed to cover the adhesive layer 3; and

(B) a step of die cutting the adhesive layer 3 and the protective film 5 in the laminate 20 to obtain the plurality of adhesive pieces 3p disposed on the carrier film 1 to be arranged in a longitudinal direction of the carrier film 1.

[0072] FIG. 5 is a cross-sectional view schematically illustrating the laminate 20 prepared in the step (A). The laminate 20 can be produced as follows. First, a raw material resin composition of the adhesive layer 3 is dissolved in a solvent such as an organic solvent to prepare a varnished coating liquid. This coating liquid is coated on the carrier film 1 and then the solvent is removed, thereby forming the adhesive

layer 3. Examples of the coating method include a knife coating method, a roll coating method, a spray coating method, a gravure coating method, a bar coating method, and a curtain coating method. Next, the protective film 5 is pasted to the surface of the adhesive layer 3 under the condition of normal temperature to 60°C. Thereby, the laminate 20 can be obtained. Incidentally, the laminate 20 may be obtained by forming the adhesive layer 3 on the carrier film having a wide width, then pasting the protective film 5 to cover the adhesive layer 3 to thereby produce the laminated film, and cutting (slitting) the laminated film with a width of 100 mm or less.

[0073] FIG. 6 is a perspective view illustrating a state in which the plurality of adhesive pieces 3p and the protective members 5p covering the plurality of adhesive pieces 3p are formed on the carrier film 1 by die cutting in the step (B). As illustrated in FIG. 6, when the laminate 20 passes between the rotating body 51 having a plurality of blades 51c for performing the die cutting on the outer peripheral surface and the roll 52 paired with the rotating body 51, the adhesive piece 3p and the protective member 5p corresponding to the shape of the blade 51c are continuously formed on the carrier film 1. At this time, the surface of the laminate 20 at the protective film 5 side faces the rotating body 51 and the surface thereof at the carrier film 1 side faces the roll 52. The depth of the cut formed in the laminate 20 by the blade 51c can be adjusted by adjusting a distance between a rotating shaft 51a of the rotating body 51 and a rotating shaft 52a of the roll 52 or changing the height of the blade 51c.

[0074] As described above, at the time of die cutting, the cut 1c is

formed in the carrier film 1 along the outer edge of the adhesive piece 3p. When a depth of the cut 1c with respect to the carrier film 1 is designated as D μ m and a thickness of the carrier film is designated as T μ m (see FIG. 2), the depth of the cut 1c satisfies the condition shown in the following Inequality (1), preferably satisfies the condition shown in Inequality (2), and more preferable satisfies the condition shown in Inequality (3).

$$0 < D/T \leq 0.6 \quad (1)$$

$$0.1 \leq D/T \leq 0.6 \quad (2)$$

$$0.15 \leq D/T \leq 0.6 \quad (3)$$

[0075] Since the value of D/T is a value larger than the lower limits of the above Inequalities (1) to (3) or equal to or larger than the lower limits thereof, the die cutting as illustrated in FIG. 6 can be suitably performed. On the other hand, when the value of D/T is smaller than the upper limits of the above Inequalities (1) to (3) or equal to or smaller than the upper limits thereof, the pickup illustrated in FIG. 7 can be suitably performed.

[0076] The laminate 20 that has passed between the rotating body 51 and the roll 52 is separated into the adhesive film 10 and the unnecessary portion 30 as illustrated in FIG. 6, and then the adhesive film 10 and the unnecessary portion 30 are wound on a reel (not illustrated), respectively. The unnecessary portion 30 includes the adhesive layer 3 and the protective film 5 from which the adhesive piece 3p and the protective member 5p are cut out.

[0077] <Method of using adhesive film>

Next, the method of using the adhesive film 10 will be

described. FIG. 7 is a cross-sectional view schematically illustrating a state in which the adhesive piece 3p and the protective member 5p covering the adhesive piece 3p are picked up from the carrier film 1. In a state in which a constant tension is applied to the adhesive film 10, while the surface of the adhesive film 10 at the carrier film 1 side is brought into contact with the wedge-shaped member 60, the adhesive film 10 is moved in a direction of the arrow illustrated in FIG. 7. According to this, as illustrated in FIG. 7, the front sides of the adhesive piece 3p and the protective member 5p are in a state of floating from the carrier film 1. In this state, for example, the adhesive piece 3p and the protective member 5p are picked up by a pickup device 65 having a suction force. For example, when a camera or the like visually recognizing the protective member 5p is used as the pickup device 65, information on the existence, the orientation, and the like of the adhesive piece 3p and the protective member 5p can be figured out. The subsequent bonding step can be appropriately performed on the basis of these items of information.

[0078] Next, the adhesive piece 3p in a state of being covered with the protective member 5p is disposed at a predetermined position and orientation of a substrate (not illustrated). In this state, the temporary bonding of the adhesive piece 3p to the substrate is performed. The temporary bonding may be performed, for example, for 0.1 to 10 seconds under the conditions of a temperature of 60 to 150°C and a pressing force of 0.03 to 1 MPa. By the temporary bonding, the adhesive piece 3p weakly sticks to the substrate but close enough not to peel off from the substrate. In the state, the protective member 5p is

peeled off from the adhesive piece 3p using an adhesive tape or the like.
A semiconductor chip (not illustrated) having a shape different from that
of the adhesive piece 3p is disposed on the surface of the adhesive piece
3p exposed by peeling of the protective member 5p, and then the
5 semiconductor chip is pressure-bonded against the substrate. The
pressure bonding may be performed, for example, for 0.1 to 10 seconds
under the conditions of a temperature of 60 to 150°C and a pressing
force of 0.05 to 1 MPa. Incidentally, with a decrease in thickness of
the substrate, the heating temperature is desirably low, the pressure
10 bonding temperature is preferably 160°C or lower, and the subsequent
thermosetting temperature is also preferably 160°C or lower.

[0079] <Semiconductor device>

FIG. 8 is a cross-sectional view schematically illustrating an
example of a semiconductor device manufactured using the adhesive
15 piece 3p. A semiconductor device 100 illustrated in FIG. 8 includes
the semiconductor chip S, a substrate 50 to which the semiconductor
chip S is electrically connected, and the adhesive piece 3p disposed
between the semiconductor chip S and the substrate 50 and bonding the
semiconductor chip S and the substrate 50. The shape of the
20 semiconductor chip S is, for example, rectangular or square, whereas
the shape of the adhesive piece 3p is T-shaped, and the shape of the
semiconductor chip S is different from the shape of the adhesive piece
3p. By employing such a configuration, as illustrated in FIG. 4, the
substrate 50 and the semiconductor chip S can be electrically connected
25 by conductive materials A1 and A2 in the regions R1 and R2.

[0080] A method of manufacturing the semiconductor device 100

includes a step of preparing a laminate (not illustrated) in which the substrate 50, the adhesive piece 3p, and the semiconductor chip S are laminated in this order, and a step of heating the laminate to bond the substrate 50 and the semiconductor chip S through the adhesive piece.

5 The temperature when the substrate 50 and the semiconductor chip S are bonded is preferably low, for example, 160°C or lower.

[0081] Hereinbefore, embodiments of the present disclosure have been described in detail, but the present disclosure is not limited to the above embodiments. For example, in the above embodiment, a case where
10 the colored protective film 5 is used so that the existence, the orientation, and the like of the protective member 5p can be figured out by a camera or the like has been exemplified, but instead of this case, a predetermined position of the protective member 5p may be marked. Further, if the adhesive piece 3p is colored, the protective member 5p
15 may not be provided. Incidentally, in a case where the orientation of the adhesive piece 3p does not matter (for example, in a case where the shape of the adhesive piece 3p is circular), there is no need to identify the orientation.

Examples

20 [0082] Hereinafter, the present disclosure will be described on the basis of Examples. The present disclosure is not limited to the following Examples.

[0083] <Example 1>

(Preparation of adhesive varnish)

25 The following materials were mixed and degassed under vacuum to obtain an adhesive varnish.

- Thermoplastic resin: HTR-860P-3 (trade name, manufactured by Nagase ChemteX Corporation, glycidyl group-containing acrylic rubber, molecular weight: 1000000, Tg: -7°C) 100 parts by mass
 - Thermosetting resin: YDCN-700-10 (trade name, manufactured by Nippon Steel & Sumikin Chemical Co., Ltd., o-cresol novolak type epoxy resin, epoxy equivalent: 210) 30 parts by mass
 - Thermosetting resin: LF-4871 (trade name, manufactured by DIC Corporation, bisphenol A type epoxy resin, epoxy equivalent: 118) 95 parts by mass
 - Thermosetting resin: YDF-8170C (trade name, manufactured by Nippon Steel & Sumikin Chemical Co., Ltd., bisphenol F type epoxy resin, epoxy equivalent: 157) 100 parts by mass
 - Curing accelerator: 2PZ-CN (trade name, manufactured by SHIKOKU CHEMICALS CORPORATION, imidazole compound) 0.3 part by mass
 - Surface treatment filler: SC-2050-HLG (trade name, manufactured by Admatechs Company Limited) 330 parts by mass
 - Silane coupling agent: A-189 (trade name, manufactured by NUC Corporation, γ -mercaptopropyl trimethoxysilane) 0.9 part by mass
 - Silane coupling agent: A-1160 (trade name, manufactured by NUC Corporation, γ -ureidopropyl triethoxysilane) 2 parts by mass
- [0084] (Production of adhesive film)

The adhesive varnish was coated on surface release-treated polyethylene terephthalate (manufactured by Teijin Film Solutions Limited, trade name: Teijin Tetron Film A-53, thickness T: 38 μ m). Through a drying step, a film having a 25 μ m-thick adhesive layer

formed on one surface of the polyethylene terephthalate film (carrier film) was obtained. This film and a colored polyethylene film having a thickness of 50 μm (manufactured by TAMAPOLY CO., LTD., TDM-1) were pasted to obtain a laminated film. This laminated film was slit with a width of 15 mm to obtain a strip-shaped laminate.

[0085] The laminate obtained in the above manner was subjected to die cutting by using a device having a configuration illustrated in FIG. 6 to obtain an adhesive film according to this Example. The shape of the adhesive piece was set to a shape (area: 29 mm^2) of a rectangle having a size of about 7 mm in length $\times$ about 6 mm in width with some corners missing. The pitch P was set to about 9 mm. The depth D of the cut with respect to the carrier film was 13 μm and the value of D/T (= 13/38) was about 0.3. Regarding the depth D of the cut, the respective depths of arbitrary 10 cuts formed in the carrier film were measured on the basis of an electron microscopic image and then an average value thereof was obtained. The same applies to the following Examples and Comparative Examples.

[0086] <Example 2>

An adhesive film was produced in the same manner as in Example 1, except that a carrier film subjected to a surface treatment different from the carrier film used in Example 1 was used and the depth D of the cut with respect to the carrier film was changed. As the carrier film, a surface release-treated polyethylene terephthalate film (manufactured by Teijin Film Solutions Limited, trade name: Teijin Tetron Film A-63, thickness T: 38 μm) was used. The depth D of the cut with respect to the carrier film was 18 μm and the value of D/T (=

18/38) was about 0.5.

[0087] <Example 3>

An adhesive film was produced in the same manner as in Example 2, except that the depth D of the cut with respect to the carrier film was changed. The depth D of the cut with respect to the carrier film was 21 μm and the value of D/T ($= 21/38$) was about 0.6.

[0088] <Comparative Example 1>

An adhesive film was produced in the same manner as in Example 1, except that the depth D of the cut with respect to the carrier film was changed. The depth D of the cut with respect to the carrier film was 26 μm and the value of D/T ($= 26/38$) was about 0.7.

[0089] <Comparative Example 2>

An adhesive film was produced in the same manner as in Example 1, except that the depth D of the cut with respect to the carrier film was changed. The depth D of the cut with respect to the carrier film was 33 μm and the value of D/T ($= 33/38$) was about 0.9.

[0090] <Comparative Example 3>

An adhesive film was produced in the same manner as in Example 1, except that a carrier film subjected to a surface treatment different from the carrier film used in Example 1 was used and the depth D of the cut with respect to the carrier film was changed. As the carrier film, a surface release-treated polyethylene terephthalate film (manufactured by Teijin Film Solutions Limited, trade name: Teijin Tetron Film A-31, thickness T: 38 μm) was used. The depth D of the cut with respect to the carrier film was 29 μm and the value of D/T ($= 29/38$) was about 0.8.

[0091] The following items were evaluated for the adhesive films according to Examples and Comparative Examples. Tables 1 and 2 show the results.

(1) Sticking force of carrier film (90° peeling strength)

5 A laminated film (carrier film/adhesive layer/protective film) not subjected to die cutting was cut out with a width of 20 mm. The surface at the carrier film side was attached to an aluminum plate by using a double-sided tape, and then the protective film was removed. Thereafter, while the angle of the adhesive layer to the carrier film was
10 maintained at 90°, the adhesive layer was pulled up to peel the adhesive layer off from the carrier film. A pulling-up speed was set to 50 mm/min, and a measurement environment temperature was set to $23 \pm 2^\circ\text{C}$. The force required for pulling-up was measured. The sticking force between the carrier film and the adhesive layer was calculated by
15 substituting this measured value (mN) and the width (20 mm) of the sample into the following equation.

$$\text{Sticking force (N/m)} = \text{Measured value (mN)} / 20 \text{ (mm)}$$

The evaluation was performed on the basis of the following criteria.

20 A: The sticking force was 2 N/m or more.

B: The sticking force was less than 2 N/m.

[0092] (2) Protruding distance of adhesive composition constituting adhesive piece

25 A distance from the outer edge of the protective member to a place where the adhesive composition most protrudes was measured on the basis of the microscopic image of the upper surface of the adhesive

film (the surface at the protective member side).

The evaluation was performed on the basis of the following criteria.

A: The protruding distance was 20 μm or less.

5 B: The protruding distance was more than 20 μm .

[0093] (3) Pickup property

A double clip (width: 32 mm) was fixed to an end of a plate to produce a device having a configuration illustrated in FIG. 9(a). In a state in which a constant tension was applied to the adhesive films (width: 15 mm) according to Examples and Comparative Examples, while the surface of the adhesive film 10 at the carrier film side was brought into contact with a corner portion C of a double clip B, the adhesive film 10 was moved in a direction of the arrow illustrated in FIG. 9(a) at a speed of 50 mm/min. The bending angle of the adhesive film 10 in the corner portion C was set to about 150°. It was visually observed whether or not an adhesive piece of 25 adhesive pieces 3p (and the protective members 5p) that are continuously arranged is peeled off from the carrier film and floated at the corner portion C (see FIG. 9(a)). As illustrated in FIG. 9(b), the adhesive pieces 3p that passed through the corner portion C while adhering to the carrier film 1 were counted as "adhesive pieces that were not peeled off."

The evaluation was performed on the basis of the following criteria.

A: The number of adhesive pieces that were not peeled off of 25 adhesive pieces was 2 or less.

B: The number of adhesive pieces that were not peeled off of 25

adhesive pieces was 3 or more.

[0094] [Table 1]

		Example 1	Example 2	Example 3
Carrier film	Type	A-53	A-63	A-63
	Thickness T (μm)	38	38	38
	Depth D (μm) of cut	13	18	21
	D/T	0.3	0.5	0.6
Evaluation	Sticking force of carrier film	A	A	A
	Protruding distance	A	A	A
	Pickup property	A	A	A

[0095] [Table 2]

		Comparative Example 1	Comparative Example 2	Comparative Example 3
Carrier film	Type	A-53	A-53	A-31
	Thickness T (μm)	38	38	38
	Depth D (μm) of cut	25	33	29
	D/T	0.7	0.9	0.8
Evaluation	Sticking force of carrier film	A	A	B
	Protruding distance	A	B	A
	Pickup property	B	B	B

Industrial Applicability

- 5 [0096] According to the present disclosure, there are provided an adhesive film useful for efficiently performing a bonding step in a manufacturing process of a semiconductor device and a method of manufacturing the adhesive film sufficiently and stably, even when a

region of a substrate to which a semiconductor chip is to be bonded is limited or the shape of the semiconductor chip is special.

Reference Signs List

5 [0097] 1: carrier film, 1c: cut, 3: adhesive layer, 3p: adhesive piece, 5: protective film, 5p: protective member, 10: adhesive film, 50: substrate, 100: semiconductor device, C1 to C12: corner of adhesive piece, F1: surface of adhesive piece (first surface), F2: surface of adhesive piece (second surface), S: semiconductor chip.

CLAIMS

1. A method of manufacturing an adhesive film for use in semiconductor device manufacture, the method comprising, in this order:

5 (A) a step of preparing a laminate having at least a strip-shaped carrier film having a width of 100 mm or less and an adhesive layer formed to cover a surface of the carrier film; and

(B) a step of die cutting the adhesive layer to obtain a plurality of adhesive pieces disposed on the carrier film to be arranged in a longitudinal direction of the carrier film, wherein

10 when the die cutting is performed in the step (B), a cut is formed with respect to the adhesive layer and the carrier film to satisfy the condition shown in the following Inequality (1), and

the adhesive piece has a shape with at least one of a projection and a recess formed on at least one side of a rectangle or a square:

15
$$0 < D/T \leq 0.6 \quad (1)$$

in the inequality, D is a depth (unit: μm) of the cut with respect to the carrier film, and T is a thickness (unit: μm) of the carrier film.

2. The method of manufacturing an adhesive film according to claim 1, wherein the adhesive piece has six or more corners.

3. The method of manufacturing an adhesive film according to claim 2, wherein a shape of the adhesive piece is L-shaped.

4. The method of manufacturing an adhesive film according to claim 1, wherein the adhesive piece has eight or more corners.

25 5. The method of manufacturing an adhesive film according to any one of claims 1 to 4, wherein the laminate further has a protective film

disposed to cover the adhesive layer, and

a cut is formed with respect to the protective film, the adhesive layer, and the carrier film to satisfy the condition shown in the above Inequality (1).

- 5 6. An adhesive film for use in semiconductor device manufacture, the adhesive film comprising:

a strip-shaped carrier film having a width of 100 mm or less;

a plurality of adhesive pieces disposed on the carrier film to be arranged in a longitudinal direction of the carrier film; and

- 10 cuts formed in the carrier film along outer edges of the adhesive pieces, wherein

a depth of the cut and a thickness of the carrier film satisfy the condition shown in the following Inequality (1), and

- 15 the adhesive piece has a shape with at least one of a projection and a recess formed on at least one side of a rectangle or a square:

$$0 < D/T \leq 0.6 \quad (1)$$

in the inequality, D is a depth (unit: μm) of the cut with respect to the carrier film, and T is a thickness (unit: μm) of the carrier film.

- 20 7. The adhesive film according to claim 6, wherein the adhesive piece has six or more corners.

8. The adhesive film according to claim 7, wherein a shape of the adhesive piece is L-shaped.

9. The adhesive film according to claim 6, wherein the adhesive piece has eight or more corners.

- 25 10. The adhesive film according to any one of claims 6 to 9, further comprising a protective member covering a second surface of the

adhesive piece, and having the same shape as that of the adhesive piece, wherein the second surface is opposite to a first surface of the adhesive piece at the carrier film side.

5 11. The adhesive film according to any one of claims 6 to 10, wherein an area of the adhesive piece is 10 to 200 mm².

12. The adhesive film according to any one of claims 6 to 11, wherein a ratio of a region that is a surface of the carrier film and is covered with the plurality of adhesive pieces is 10 to 60% on the basis of an area of the carrier film.

10 13. The adhesive film according to any one of claims 6 to 12, wherein a sticking force between the carrier film and the adhesive piece is 2 N/m or more.

14. The adhesive film according to any one of claims 6 to 13, wherein the thickness of the carrier film is 10 to 200 μm.

15 15. A semiconductor device comprising:
a substrate;
a semiconductor chip; and
the adhesive piece of the adhesive film according to any one of claims 6 to 14, wherein

20 the adhesive piece is disposed between the substrate and the semiconductor chip to bond the substrate and the semiconductor chip, and

a shape of the semiconductor chip is different from a shape of the adhesive piece.

25 16. A method of manufacturing a semiconductor device, the method using the adhesive piece of the adhesive film according to any one of

claims 6 to 14.

17. The method of manufacturing a semiconductor device according to claim 16, wherein the method comprises:

5 a step of preparing a laminate in which a substrate, the adhesive piece, and a semiconductor chip are laminated in this order, and

a step of heating the laminate to bond the substrate and the semiconductor chip through the adhesive piece,

wherein a shape of the semiconductor chip is different from a shape of the adhesive piece.

10 18. The method of manufacturing a semiconductor device according to claim 17, wherein the laminate is heated at a temperature equal to or lower than 160°C to bond the semiconductor chip to the substrate by the adhesive piece.