

DESCRIPTION

Title of Invention

DICING DIE BONDING SHEET

5

Technical Field

[0001]

The present invention relates to a dicing die bonding sheet including an adhesive layer on a base material.

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Priority is claimed on Japanese Patent Application No. 2014-253241, filed on December 15, 2014, the content of which is incorporated herein by reference.

Background Art

[0002]

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A dicing die bonding sheet including an adhesive layer on a base material is used during a process of performing dicing on a semiconductor wafer, picking up a semiconductor chip, and bonding the picked-up semiconductor chip to a substrate, a lead frame, or another semiconductor chip.

[0003]

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In such a sheet, since the adhesive layer is typically colorless and transparent, it is difficult to detect whether the adhesive layer is in a state of being bonded to a bonding target such as a semiconductor wafer or a semiconductor chip when the sheet is precut-processed or the semiconductor chip is subjected to die bonding. Problems occur during the process of manufacturing a semiconductor device when the adhesive layer is

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not bonded to a desired site. Further, since the adhesive layer is colorless and

transparent at the time when the adhesive layer is cleaved by stealth dicing or cool expanding, it is not easy to confirm whether the adhesive layer has been reliably cleaved. Therefore, the production efficiency of the semiconductor device is degraded.

[0004]

5 In the process of manufacturing a semiconductor device, the adhesive layer is detected using an optical sensor which is capable of detecting light in a wavelength range of 290 to 450 nm, but it became difficult to detect the adhesive layer due to reduction in thickness of the adhesive layer.

[0005]

10 Under these circumstances, an adhesive layer containing a pigment which absorbs or reflects light in a wavelength range of 290 to 450 nm is disclosed as an adhesive layer which can be easily detected (see PTL 1).

Such an adhesive layer is colored by containing a pigment and thus the presence of the adhesive layer can be easily visually confirmed.

15 Citation List

Patent Literature

[0006]

[PTL 1] Japanese Unexamined Patent Application, First Publication No.

2009-059917

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Summary of Invention

Technical Problem

[0007]

However, since the adhesive layer described in PTL 1 contains a pigment, a
25 problem of a decrease in reliability may occur due to generation of aggregates or color

irregularity and occurrence of cracks in a finally obtained semiconductor package in a case where the thickness of the adhesive layer is small.

[0008]

The present invention has been made in consideration of the above-described
5 problem, and an object thereof is to provide a dicing die bonding sheet from which a semiconductor package in which the presence or the state of an adhesive layer is easily confirmed and which is highly reliable is obtained.

Solution to Problem

[0009]

10 In order to solve the above-described problem, the present invention provides a dicing die bonding sheet including: an adhesive layer, which contains a dye, on a base material, in which the content of the dye in the adhesive layer is 8.3% by mass or less, and the color difference between the base material and the adhesive layer in the $L^*a^*b^*$ color coordinate system is in a range of 30 to 53.

15 In the dicing die bonding sheet of the present invention, the dye may be a disazo dye.

In the dicing die bonding sheet of the present invention, the dye may not contain metal atoms or metal ions in the structure thereof.

Advantageous Effects of Invention

20 [0010]

According to the present invention, it is possible to provide a dicing die bonding sheet from which a semiconductor package in which the presence or the state of an adhesive layer is easily confirmed and which is highly reliable is obtained.

25 Description of Embodiments

[0011]

<<Dicing die bonding sheet>>

A dicing die bonding sheet of the present embodiment includes an adhesive layer, which contains a dye, on a base material. Further, the content of the dye in the adhesive layer is 8.3% by mass or less, and the color difference (hereinafter, also abbreviated as “ ΔE ”) between the base material and the adhesive layer in the $L^*a^*b^*$ color coordinate system is in a range of 30 to 53.

In the present specification, L^* , a^* , and b^* are calculated in conformity with JIS Z8781-4:2013.

10 [0012]

In the dicing die bonding sheet, the color difference (ΔE) is set to be in a predetermined range by the adhesive layer containing a specific amount of dye. As a result, it is possible to easily visually confirm whether the dicing die bonding sheet includes an adhesive layer.

15 [0013]

When the dicing die bonding sheet is precut-processed or the semiconductor chip is picked-up or subjected to die bonding, it is possible to easily visually confirm whether the adhesive layer is in a state of being bonded to a bonding target such as a semiconductor wafer or a semiconductor chip or to suppress occurrence of a problem in the process of manufacturing a semiconductor device by means of using the above-described dicing die bonding sheet.

[0014]

Further, in the process of manufacturing a semiconductor chip, when the dicing die bonding sheet to which a wafer having a brittle portion formed therein due to irradiation with a laser adheres is expanded and the wafer and the sheet are cleaved, that

is, the wafer and the sheet are subjected to so-called stealth dicing, it is possible to easily visually confirm the state whether the adhesive layer is reliably cleaved and to suppress a decrease in production efficiency of the semiconductor device by means of using the above-described dicing bonding sheet.

5 Moreover, even when the adhesive layer formed with the brittle portion at a low temperature is expanded and cleaved, that is, the adhesive layer is subjected to so-called cool expanding, similar to when the stealth dicing is performed, it is possible to easily visually confirm the state whether the adhesive layer is reliably cleaved and to suppress a decrease in production efficiency of the semiconductor device.

10 Typically, it is confirmed whether the adhesive layer is cleaved through visual observation or observation using a microscope when the adhesive layer is expanded. However, according to the present invention, visual confirmation is easily performed and thus the adhesive layer can be confirmed in a short time. At the time of picking up the target chip, chips in the periphery are also lifted simultaneously when the adhesive layer
15 is not cleaved. Therefore, problems occur.

[0015]

In addition, when the adhesive layer contains a dye and the content thereof is 8.3% by mass or less, cracks and peeling in a bonded portion are suppressed in a semiconductor package obtained using the dicing die bonding sheet and thus the
20 reliability becomes high. In a case where the adhesive layer contains a pigment in place of a dye and the thickness of the adhesive layer is small, particularly, approximately 10 μm or less, aggregates or color irregularity is generated in the adhesive layer and cracks occur in the finally obtained semiconductor package. Therefore, the reliability is decreased.

25 [0016]

<Base material>

The color difference (ΔE) between the base material and the adhesive layer satisfies the above-described relationship.

The color of the base material is not particularly limited as long as the color thereof is not the same as the color of the adhesive layer, but white is typically preferable.

[0017]

The base material may include a pressure sensitive adhesive layer on the surface thereof (hereinafter, also abbreviated as a “pressure sensitive adhesive base material” and the base material in contact with the pressure sensitive adhesive layer in this case is abbreviated as a “support base material”). However, the base material may not include a pressure sensitive adhesive layer (hereinafter, also abbreviated as a “non-pressure sensitive adhesive base material”).

In a case where the base material is the pressure sensitive adhesive base material, the integral laminated structure of the support base material and the pressure sensitive adhesive layer may satisfy the above-described color difference (ΔE) relationship between the base material and the adhesive layer.

[0018]

It is preferable that the materials of the non-pressure sensitive adhesive base material and the support base material are various resins, and specific examples thereof include polyethylene (low density polyethylene (LDPE), linear low density polyethylene (LLDPE), high density polyethylene (HDPE), or the like), polypropylene, polybutene, polybutadiene, polymethylpentene, polyvinyl chloride, a vinyl chloride copolymer, polyethylene terephthalate, polybutylene terephthalate, polyurethane, polyurethane acrylate, polyimide, an ethylene vinyl acetate copolymer, an ionomer resin, an ethylene-(meth)acrylic acid copolymer, an ethylene-(meth)acrylic acid ester copolymer,

polystyrene, polycarbonate, a fluorine resin, and water additives, denatured products, cross-linked products, and copolymers of any of these resins.

[0019]

The non-pressure sensitive adhesive base material and the support base material
5 may be formed of a single layer (monolayer) or two or more plural layers. In a case where the non-pressure sensitive adhesive base material and the support base material are formed of a plurality of layers, all of the materials of respective layers may be the same as or different from each other or materials of only some layers may be the same as each other.

10 [0020]

The thickness of the non-pressure sensitive adhesive base material and the thickness of the support base material can be suitably selected based on the purpose thereof, but are respectively preferably in a range of 50 to 300 μm and more preferably in a range of 60 to 100 μm .

15 [0021]

For the purpose of improving adhesiveness of the non-pressure sensitive adhesive base material and the support base material to a layer provided thereon, that is, an adhesive layer or a pressure sensitive adhesive layer, the surface thereof may be subjected to a roughening treatment using a sand blast treatment or a solvent treatment;
20 or an oxidation treatment such as a corona discharge treatment, an electron beam irradiation treatment, a plasma treatment, an ozone-ultraviolet irradiation treatment, a flame treatment, a chromic acid treatment or a hot air treatment. Further, the surface of the non-pressure sensitive adhesive base material and the support base material may be subjected to a plasma treatment.

25 Among these, from the viewpoint of suppressing generation of fragments of a

base material due to friction of a blade during dicing, it is particularly preferable that the surface of the non-pressure sensitive adhesive base material and the support base material is subjected to an electron beam irradiation treatment.

[0022]

5 [Pressure sensitive adhesive layer]

As the pressure sensitive adhesive layer, a known layer can be suitably used.

In a case where the pressure sensitive adhesive layer is colorless, the pressure sensitive adhesive base material reflects the color of the support base material. In a case where the pressure sensitive adhesive layer is colored, the pressure sensitive adhesive base
10 material reflects the color of the pressure sensitive adhesive layer or both colors of the support base material and the pressure sensitive adhesive layer.

[0023]

The pressure sensitive adhesive layer can be formed using a pressure sensitive adhesive composition containing various components constituting the pressure sensitive
15 adhesive layer. The ratio between the contents of non-volatile components in the pressure sensitive adhesive composition is applied to the pressure sensitive adhesive layer.

In a case where the pressure sensitive adhesive layer contains components polymerized by performing irradiation with energy rays, the semiconductor chip can be
20 picked up by performing irradiation with energy rays and reducing the stickiness thereof. Such a pressure sensitive adhesive layer can be formed using various pressure sensitive adhesive compositions containing an energy ray-polymerizable acrylic polymer polymerized by irradiation with energy rays.

[0024]

25 As preferred examples of the pressure sensitive adhesive compositions, a

composition containing the acrylic polymer and an energy ray polymerizable compound (pressure sensitive adhesive composition (i)) and a composition containing an acrylic polymer which has a hydroxyl group and a polymerizable group in the side chain thereof (for example, an acrylic polymer which has a hydroxyl group and a polymerizable group in the side chain thereof through a urethane bond) and an isocyanate-based crosslinking agent (pressure sensitive adhesive composition (ii)) can be exemplified, and a pressure sensitive adhesive composition further containing a solvent is preferable.

[0025]

The pressure sensitive adhesive compositions may further contain any of various additives such as a photopolymerization initiator, a dye, a pigment, a deterioration inhibitor, an antistatic agent, a flame retardant, a silicone compound, and a chain transfer agent, in addition to the above-described components.

[0026]

The thickness of the pressure sensitive adhesive layer can be suitably selected based on the purpose thereof, but is preferably in a range of 1 to 100 μm , more preferably in a range of 1 to 60 μm , and particularly preferably in a range of 1 to 30 μm .

[0027]

A pressure sensitive adhesive composition is obtained by blending various components such as an acrylic polymer in order to constitute a pressure sensitive adhesive layer.

The order of adding each component at the time of blending is not particularly limited, and two or more components may be added at the same time.

A method of mixing each component at the time of blending is not particularly limited and may be suitably selected from known methods such as a method of mixing components by rotating a stirring bar or a stirring blade; a method of mixing components

using a mixer; and a method of mixing components by applying ultrasonic waves.

The temperature and the time at the time of adding and mixing components are not particularly limited as long as the blended components do not deteriorate and may be suitably adjusted, but the temperature thereof is preferably in a range of 15°C to 30°C.

5 In a case where a solvent is used, the solvent may be used by being mixed with any of blended components other than the solvent and diluting the blended components in advance or may be used by being mixed with these blended components without diluting any of blended components other than the solvent in advance.

[0028]

10 A pressure sensitive adhesive layer can be formed by coating the surface of the support base material with the pressure sensitive adhesive composition and drying the surface. At this time, the applied pressure sensitive adhesive composition may be heated for crosslinking as necessary.

 The pressure sensitive adhesive composition can be heated under heating
15 conditions of 100°C to 130°C for 1 to 5 minutes, but the heating conditions are not limited thereto. Further, a pressure sensitive adhesive layer can be also formed by adhering the pressure sensitive adhesive layer, formed by coating the surface of peeling layer of a peeling material with the pressure sensitive adhesive composition and drying the surface thereof, to the surface of the support base material and removing the peeling
20 material.

[0029]

 The surface of the support base material or the surface of the peeling layer of the peeling material may be coated with the pressure sensitive adhesive composition according to a known method, and examples thereof include methods using various
25 coaters such as an air knife coater, a blade coater, a bar coater, a gravure coater, a roll

coater, a roll knife coater, a curtain coater, a die coater, a knife coater, a screen coater, a Mayer bar coater, and a kiss coater.

[0030]

<Adhesive layer>

- 5 The adhesive layer contains a dye. A dye is different from a pigment and aggregates are unlikely to be generated in the adhesive layer when a dye is contained. Therefore, the dicing die bonding sheet maintains high quality.

[0031]

- The thickness of the adhesive layer can be suitably selected based on the
10 purpose thereof, but is preferably in a range of 1 to 100 μm , more preferably in a range of 5 to 75 μm , and particularly preferably in a range of 5 to 50 μm .

- According to the present embodiment, even in a case where the thickness of the adhesive layer is small, for example, approximately 10 μm or less, since generation of aggregates in the adhesive layer is suppressed unlike the case where a pigment is used as
15 a coloring component, occurrence of cracks in the finally obtained semiconductor package is suppressed.

[0032]

- The color of the adhesive layer is not particularly limited as long as the color thereof is not the same as the color of the base material (the pressure sensitive adhesive
20 base material and the non-pressure sensitive adhesive base material). However, from the viewpoint that the color of ring frame tape is typically black, it is preferable that the color of the adhesive layer is a color other than black in order to distinguish the adhesive layer from the ring frame tape. In a case where the color of the base material is white, from the viewpoints that ΔE is in a preferable range and the presence and the state of the

adhesive layer are easily visually confirmed as described above, it is preferable that the color of the adhesive layer from a short wavelength side to a long wavelength side is any color from among blue to red. As such an adhesive layer, an adhesive layer in which L* (brightness) in the L*a*b* color coordinate system is in a range of 15 to 97, a*

- 5 (chromaticity) is in a range of -11 to +15, and b* (chromaticity) is in a range of -30 to +5 may be exemplified. In addition, it is preferable that the color of the adhesive layer is blue.

[0033]

- The content of the dye in the adhesive layer is 8.3% by mass or less and
- 10 preferably 8.1% by mass or less. When the content thereof is in such a range, adverse effects caused by the adhesive layer containing a dye are suppressed. More specifically, in a case where a semiconductor package is manufactured using a dicing die bonding sheet including such an adhesive layer, generation of peeling or cracks (package cracks) in a bonded portion of a substrate and a semiconductor chip is suppressed in the obtained
- 15 semiconductor package, and thus a decrease in reliability is suppressed. Further, in a case where the pressure sensitive adhesive base material is used in the dicing die bonding sheet, transition of the dye from the adhesive layer to the pressure sensitive adhesive layer is also suppressed.

[0034]

- 20 The lower limit of the content of the dye in the adhesive layer is not particularly limited as long as ΔE described below is set to a target value. From the viewpoint that ΔE is easily adjusted to be in a preferable range, the content of the dye in the adhesive layer is preferably 0.05% by mass or greater, more preferably 0.07% by mass or greater, and particularly preferably 0.10% by mass or greater.

- 25 [0035]

The dye is not particularly limited as long as the adhesive layer can be colored as described above within the range not impairing the effects of the present invention, and known dyes can be suitably used.

Specific examples of the dye include an azo dye, a nitroso dye, a quinoline dye, a sulfur dye, a nitro dye, a methane dye, a polymethine dye, an aminoketone dye, a thiazole dye, an oxyketone dye, a stilbene dye, an indamine dye, an indophenol dye, a diphenylmethane dye, an anthraquinone dye, a triarylmethane dye, an azine dye, an indigoid dye, a xanthene dye, an oxazine dye, a thiazine dye, a phthalocyanine dye, and an acridine dye.

10 [0036]

The dye may be any of a water-soluble dye and a water-insoluble dye and a water-insoluble dye is preferable and an oil-soluble dye is more preferable as the dye.

[0037]

From the viewpoints that the availability is high and the adhesive layer is easily adjusted to have target characteristics, it is preferable that the dye is an azo dye having an azo group ($-N=N-$).

The azo dye may be any of a monoazo dye, a disazo dye, a trisazo dye, a tetrakisazo dye, and a polyazo dye (the number of azo groups in a molecule is 5 or greater) depending on the number of azo groups in a molecule, but a disazo dye is preferable from the viewpoints that the structure thereof is relatively rigid, the heat resistance is higher, and an adhesive layer having excellent characteristics is easily formed.

[0038]

From the viewpoints of further improving the reliability of the semiconductor package as described above and maintaining the conductivity of the adhesive layer to be

low, it is preferable that the dye does not contain metal atoms or metal ions in the structure thereof.

[0039]

The color difference (ΔE) between the base material and the adhesive layer in the $L^*a^*b^*$ color coordinate system is in a range of 30 to 53, preferably in a range of 31 to 52, and more preferably in a range of 32 to 52.

When ΔE is in the above-described range, the presence and the state of the adhesive layer are easily visually confirmed as described above.

[0040]

More specifically, ΔE can be obtained by calculating L^* , a^* , and b^* in each of the base material and the adhesive layer and then calculating the following Equation (I).

$$\Delta E = [(L1^* - L2^*)^2 + (a1^* - a2^*)^2 + (b1^* - b2^*)^2]^{1/2} \dots (I)$$

(In the equation, $L1^*$ represents the value of L^* of the base material, $L2^*$ represents the value of L^* of the adhesive layer, $a1^*$ is the value of a^* of the base material, $a2^*$ represents the value of a^* of the adhesive layer, $b1^*$ represents the value of b^* of the base material, and $b2^*$ represents the value of b^* of the adhesive layer.)

[0041]

It is preferable that the adhesive layer has pressure sensitive adhesiveness or thermosetting properties and more preferable that the adhesive layer has both of pressure sensitive adhesiveness and thermosetting properties. The adhesive layer having both of pressure sensitive adhesiveness and thermosetting properties can be attached by being lightly pressed to various adherends in an uncured state. Further, the adhesive layer may be attached to various adherends by being heated and softened. The adhesive layer is finally made into a cured product having excellent impact resistance after being

thermally cured. Such a cured product also has excellent shear strength, and adhesion properties can be sufficiently held under severe conditions of a high temperature and a high humidity.

[0042]

5 [Adhesive composition]

The adhesive layer can be formed using an adhesive composition containing components such as the dye used for constituting the adhesive layer and the ratio between the contents of non-volatile components in the adhesive composition is applied to the adhesive layer.

10 It is preferable that the adhesive layer is formed using an adhesive composition containing a binder resin (a), an epoxy-based thermosetting resin (b), and the dye (hereinafter also referred to as a “dye (s)”).

[0043]

(Binder resin (a))

15 The binder resin (a) is a polymer compound used for imparting film forming properties and flexibility to the adhesive layer.

The binder resin (a) may be used alone or in combination of two or more kinds thereof.

[0044]

20 As the binder resin (a), an acrylic resin, a polyester resin, a urethane resin, an acrylic urethane resin, a silicone resin, a rubber-based polymer, or a phenoxy resin can be used. Among these, an acrylic resin is preferable.

[0045]

As the acrylic resin, a known acrylic polymer can be used.

25 The weight average molecular weight (Mw) of the acrylic resin is preferably in a

range of 10000 to 2000000 and more preferably in a range of 100000 to 1500000.

When the weight average molecular weight of the acrylic resin is extremely small, the adhesive force between the adhesive layer and the pressure sensitive adhesive layer

becomes strong and thus pickup failure occurs in the semiconductor chip. Further,

5 when the weight average molecular weight of the acrylic resin is extremely large, the adhesive layer is not occasionally able to follow the uneven surface of an adherend and this may cause voids.

Moreover, in the present specification, the weight average molecular weight is a value in terms of polystyrene which is measured by gel permeation chromatography

10 (GPC) unless otherwise noted.

[0046]

The glass transition temperature (T_g) of the acrylic resin is preferably in a range of -60°C to 70°C and more preferably in a range of -30°C to 50°C . When T_g of the acrylic resin is extremely low, the peeling force between the adhesive layer and the

15 pressure sensitive adhesive layer becomes strong and thus pickup failure occurs in the semiconductor chip. Further, when T_g of the acrylic resin is extremely high, the adhesive force for fixing the semiconductor wafer may become insufficient.

[0047]

Examples of a monomer constituting the acrylic resin include (meth)acrylic acid

20 esters, for example, alkyl (meth)acrylate, in which the number of carbon atoms in an alkyl group is in a range of 1 to 18, such as methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, butyl (meth)acrylate, or 2-ethylhexyl (meth)acrylate;

(meth)acrylate having a cyclic skeleton such as cycloalkyl (meth)acrylate, benzyl (meth)acrylate, isobornyl (meth)acrylate, dicyclopentanyl (meth)acrylate,

25 dicyclopentenyl (meth)acrylate, dicyclopentenylloxyethyl (meth)acrylate, or imide

(meth)acrylate; hydroxyl group-containing (meth)acrylate such as hydroxymethyl (meth)acrylate, 2-hydroxyethyl (meth)acrylate, or 2-hydroxypropyl (meth)acrylate; and glycidyl group-containing (meth)acrylate such as glycidyl (meth)acrylate.

Further, an acrylic resin obtained by copolymerizing a monomer such as acrylic acid, methacrylic acid, itaconic acid, vinyl acetate, acrylonitrile, styrene, or N-methylol acrylamide may be used as the acrylic resin.

The monomer constituting the acrylic resin may be used alone or in combination of two or more kinds thereof.

Further, in the present specification, the concept of “(meth)acrylic acid” includes both of “acrylic acid” and “methacrylic acid” and the concept of “(meth)acrylate” includes both of “acrylate” and “methacrylate”.

[0048]

The acrylic resin may have functional groups which can be bonded with other compounds such as a vinyl group, a (meth)acryloyl group, an amino group, a hydroxyl group, a carboxyl group, and an isocyanate group. The functional groups may be bonded to other compounds through a crosslinking agent (f) described below or may be directly bonded to other compounds without the crosslinking agent (f). When the functional groups of the acrylic resin are bonded to other compounds, the reliability of the semiconductor package using the dicing die bonding sheet tends to be increased.

[0049]

The content of the acrylic resin in the solid content of the adhesive composition is preferably 50% by mass or greater. In this manner, in a case where the adhesive layer is used for a process of collective curing at the time of resin sealing of the semiconductor chip, the properties of the adhesive layer become preferable. This is because wire bonding is performed on the semiconductor chip before the resin sealing of the

semiconductor chip is carried out during such a process, but the wire bonding can be performed in a state in which a certain degree of hardness is maintained even when the adhesive layer before curing is exposed to a high temperature. That is, when the content of the acrylic resin in the adhesive composition is relatively high, the storage modulus of the adhesive layer even before thermal curing can be set to be high. Therefore, even when the adhesive layer is in a state of being uncured or semi-cured, vibration or displacement of the chip at the time of wire bonding is suppressed and the wire bonding can be stably performed.

Further, the content of the acrylic resin in the solid content of the adhesive composition is more preferably in a range of 50% to 85% by mass. When the content of the acrylic resin is in such a range, easy-pickup properties of the semiconductor chip are improved.

[0050]

In the present invention, in order to improve the easy-pickup properties by improving the peeling properties of the adhesive layer and to suppress generation of voids by the adhesive layer following the uneven surface of an adherend, a thermoplastic resin other than an acrylic resin (hereinafter, also simply referred to as a “thermoplastic resin”) may be used alone or a thermoplastic resin and an acrylic resin may be used in combination as the binder resin (a).

The weight average molecular weight of the thermoplastic resin is preferably in a range of 1000 to 100000 and more preferably in a range of 3000 to 80000.

The glass transition temperature (T_g) of the thermoplastic resin is preferably in a range of -30°C to 150°C and more preferably in a range of -20°C to 120°C .

Examples of the thermoplastic resin include a polyester resin, a urethane resin, a phenoxy resin, polybutene, polybutadiene, and polystyrene.

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

[0051]

There is a concern that the hardness at the time when the adhesive layer before curing is exposed to a high temperature is decreased and the wire bonding aptitude of the adhesive layer in a state of being uncured or semi-cured is degraded while the above-described effects are obtained using the thermoplastic resin. Consequently, it is preferable that the content of the acrylic resin of the adhesive composition is set in consideration of such influence.

10 [0052]

(Epoxy-based thermosetting resin (b))

The epoxy-based thermosetting resin (b) is formed of an epoxy resin and a thermosetting agent.

The epoxy-based thermosetting resin (b) may be used alone or in combination of two or more kinds thereof.

[0053]

Specific known examples of the epoxy resin include bi- or higher functional epoxy compounds such as a polyfunctional epoxy resin, a biphenyl compound, bisphenol A diglycidyl ether, and a hydrogenated product thereof, an ortho-cresol novolak epoxy resin, a dicyclopentadiene type epoxy resin, a biphenyl type epoxy resin, a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, and a phenylene skeleton type epoxy resin.

[0054]

Further an epoxy resin having an unsaturated hydrocarbon group may be used as the epoxy resin. As the epoxy resin having an unsaturated hydrocarbon group, a

compound formed by converting a part of an epoxy resin of a polyfunctional epoxy resin to a group containing an unsaturated hydrocarbon group may be exemplified. Such a compound can be produced by adding acrylic acid to an epoxy group for a reaction.

Further, as the epoxy resin having an unsaturated hydrocarbon group, a compound in

5 which a group having an unsaturated hydrocarbon group is directly bonded to an aromatic ring or the like constituting an epoxy resin may be exemplified. The unsaturated hydrocarbon group is a polymerizable unsaturated group, and specific examples thereof include an ethenyl group (vinyl group), a 2-propenyl group (allyl group), an acryloyl group, a methacryloyl group, an acrylamide group, and a
10 methacrylamide group. Among these, an acryloyl group is preferable.

The epoxy resin having an unsaturated hydrocarbon group has higher compatibility with an acrylic resin than with an epoxy resin which does not have an unsaturated hydrocarbon group. Therefore, the package reliability of the semiconductor device is improved by using the adhesive composition which includes the epoxy resin

15 having an unsaturated hydrocarbon group.

[0055]

From the viewpoint of improving easy-pickup properties, an epoxy resin having a high softening point or glass transition temperature is preferable as the epoxy resin.

[0056]

20 The number average molecular weight of the epoxy resin is not particularly limited, but is preferably in a range of 300 to 30000, more preferably in a range of 400 to 10000, and particularly preferably in a range of 500 to 3000, from the viewpoint of curing properties of the adhesive layer and the strength and the heat resistance thereof after curing.

25 The epoxy equivalent of the epoxy resin is preferably in a range of 100 to 1000

g/eq and more preferably in a range of 300 to 800 g/eq.

[0057]

The epoxy resin may be used alone or in combination of two or more kinds thereof.

5 [0058]

The thermosetting agent functions as a curing agent with respect to the epoxy resin.

As the thermosetting agent, a compound having two or more functional groups, which reacts with an epoxy group, in one molecule may be exemplified. Examples of
10 the functional group include a phenolic hydroxyl group, an alcoholic hydroxyl group, an amino group, a carboxyl group, and a group in which an acid group is made into an anhydride. Among these, a phenolic hydroxyl group, an amino group, and a group in which an acid group is made into an anhydride are preferable, a phenolic hydroxyl group and an amino group are more preferable, and a phenolic hydroxyl group is particularly
15 preferable.

[0059]

Examples of a phenolic curing agent (curing agent having a phenolic hydroxyl group) among examples of thermosetting agents include a polyfunctional phenol resin, biphenol, a novolak type phenol resin, a dicyclopentadiene-based phenol resin, and an
20 aralkyl phenol resin.

Among the examples of the thermosetting agent, dicyandiamide (DICY) may be exemplified as an amine-based curing agent (curing agent having an amino group).

[0060]

The thermosetting agent may include an unsaturated hydrocarbon group.

25 Examples of the thermosetting agent including an unsaturated hydrocarbon

group include a compound formed by substituting some of hydroxyl groups of a phenol resin with a group having an unsaturated hydrocarbon group and a compound formed by directly bonding a group having an unsaturated hydrocarbon group to an aromatic ring of a phenolic resin. The unsaturated hydrocarbon group in the thermosetting agent is the
5 same as the unsaturated hydrocarbon group in the epoxy resin having an unsaturated hydrocarbon group described above.

[0061]

From the viewpoint of improving easy-pickup properties, a thermosetting agent having a high softening point or glass transition temperature is preferable as the
10 thermosetting agent.

[0062]

The number average molecular weight of the thermosetting agent is preferably in a range of 300 to 30000, more preferably in a range of 400 to 10000, and particularly preferably in a range of 500 to 3000.

15 [0063]

The thermosetting agent may be used alone or in combination of two or more kinds thereof.

[0064]

The content of the thermosetting agent of the adhesive composition is preferably
20 in a range of 0.1 to 500 parts by mass and more preferably in a range of 1 to 200 parts by mass with respect to 100 parts by mass of the epoxy resin. When the content of the thermosetting agent is extremely small, adhesiveness may not be obtained due to insufficient curing. When the content of the thermosetting agent is excessive, the moisture absorption rate of the adhesive layer is increased and thus the package
25 reliability may be decreased.

[0065]

The content (total content of the epoxy resin and the thermosetting agent) of the epoxy-based thermosetting resin (b) of the adhesive composition is preferably in a range of 1 to 100 parts by mass, more preferably in a range of 1.5 to 75 parts by mass, and particularly preferably in a range of 2 to 60 parts by mass with respect to 100 parts by mass of the binder resin (a). When the content of the epoxy-based thermosetting resin (b) is in such a range, the hardness of the adhesive layer before curing tends to be maintained and the wire bonding aptitude of the adhesive layer in a state of being uncured or semi-cured is improved. Further, easy-pickup properties of the semiconductor chip are improved.

[0066]

(Dye (s))

The dye (s) is a dye described above.

It is preferable that the content of the dye (s) in the solid content of the adhesive composition is the same as the content of the dye in the adhesive layer described above.

[0067]

In order to improve various physical properties, the adhesive layer may be formed using the adhesive composition that contains the binder resin (a), the epoxy-based thermosetting resin (b), and the dye (s) and further contains other components which do not correspond to the binder resin (a), the epoxy-based thermosetting resin (b), and the dye (s), as necessary.

Preferred examples of other components contained in the adhesive composition include an inorganic filler (c), a curing accelerator (d), a coupling agent (e), a crosslinking agent (f), other thermosetting resins (g) which do not correspond to the epoxy-based thermosetting resin (b), and a general-purpose additive (h).

[0068]

(Inorganic filler (c))

When the adhesive composition further contains the inorganic filler (c), the coefficient of thermal expansion is easily adjusted. Further, the package reliability can
5 be improved by optimizing the coefficient of thermal expansion of the adhesive layer after curing with respect to the semiconductor chip, the metal, or the organic substrate.

In addition, the moisture absorption rate of the adhesive layer after curing can be decreased when the adhesive composition further contains the inorganic filler (c).

[0069]

10 Preferred examples of the inorganic filler (c) include powder such as silica, alumina, talc, calcium carbonate, titanium white, red oxide, silicon carbide, or boron nitride; beads formed by spherodizing silica and the like; surface modified products of silica and the like; single-crystal fibers of silica and the like; and glass fibers.

Among these, it is preferable that the inorganic filler (c) is a silica filler, an
15 alumina filler, or a surface modifier of these.

The inorganic filler (c) may be used alone or in combination of two or more kinds thereof.

[0070]

In a case where the inorganic filler (c) is used, the content of the inorganic filler
20 (c) in the solid content of the adhesive composition is preferably in a range of 1% to 80% by mass.

[0071]

(Curing accelerator (d))

The curing accelerator (d) is used to adjust the curing rate of the adhesive
25 composition.

Preferred examples of the curing accelerator (d) include tertiary amine such as triethylenediamine, benzyl dimethylamine, triethanolamine, dimethylaminoethanol, or tris(dimethylaminomethyl)phenol; imidazoles (imidazole in which one or more hydrogen atoms are substituted with a group other than hydrogen atoms) such as

- 5 2-methylimidazole, 2-phenylimidazole, 2-phenyl-4-methylimidazole, 2-phenyl-4,5-dihydroxymethylimidazole, and 2-phenyl-4-methyl-5-hydroxymethylimidazole; organic phosphines (phosphine in which one or more hydrogen atoms are substituted with an organic group) such as tributylphosphine, diphenylphosphine, and triphenylphosphine; tetraphenyl boron salts
10 such as tetraphenylphosphonium tetraphenylborate and triphenylphosphine tetraphenylborate.

The curing accelerator (d) may be used alone or in combination of two or more kinds thereof.

[0072]

- 15 In a case where the curing accelerator (d) is used, the content of the curing accelerator (d) in the adhesive composition is preferably in a range of 0.01 to 10 parts by mass and more preferably in a range of 0.1 to 1 part by mass with respect to 100 parts by mass of the epoxy-based thermosetting resin (b). When the content of the curing accelerator (d) is in such a range, the adhesive layer has excellent adhesion properties
20 under conditions of a high temperature and a high humidity and high package reliability can be achieved even in a case of being exposed to severe reflow conditions. When the content of the curing accelerator (d) is extremely small, effects obtained by using the curing accelerator (d) cannot be sufficiently obtained. When the content of the curing accelerator (d) is excessive, the curing accelerator (d) with high polarity moves to an
25 adhesive interface side with an adherend and is segregated in the adhesive layer under the

conditions of a high temperature and a high humidity. Therefore, the reliability of the package is decreased.

[0073]

(Coupling agent (e))

- 5 The adhesiveness and adhesion properties of the adhesive layer to the adherend can be improved by means of using, as the coupling agent (e), a coupling agent that has a functional group reacting with an inorganic compound and a functional group reacting with an organic functional group. The water resistance can be improved without impairing the heat resistance of a cured product obtained by curing the adhesive layer by
- 10 means of using the coupling agent (e).

[0074]

A compound having functional groups reacting with functional groups included in the binder resin (a) and the epoxy-based thermosetting resin (b) is preferable as the coupling agent (e). Further, a silane coupling agent is desired as the coupling agent (e).

- 15 Preferred examples of the silane coupling agent include
- γ -glycidoxypentyltrimethoxysilane, γ -glycidoxypentylmethyldiethoxysilane, β -(3,4-epoxycyclohexyl)ethyltrimethoxysilane, γ -(methacryloxypropyl)trimethoxysilane, γ -aminopropyltrimethoxysilane, N-6-(aminoethyl)- γ -aminopropyltrimethoxysilane, N-6-(aminoethyl)- γ -aminopropylmethyldiethoxysilane,
- 20 N-phenyl- γ -aminopropyltrimethoxysilane, γ -ureidopropyltriethoxysilane, γ -mercaptopropyltrimethoxysilane, γ -mercaptopropylmethyldimethoxysilane, bis(3-triethoxysilylpropyl)tetrasulfane, methyltrimethoxysilane, methyltriethoxysilane, vinyltrimethoxysilane, vinyltriacetoxysilane, and imidazolesilane.

The coupling agent (e) may be used alone or in combination of two or more

kinds thereof.

[0075]

In a case where the coupling agent (e) is used, the content of the coupling agent (e) of the adhesive composition is preferably in a range of 0.03 to 20 parts by mass, more preferably in a range of 0.05 to 10 parts by mass, and particularly preferably in a range of 0.1 to 5 parts by mass with respect to 100 parts by mass of the total content of the binder resin (a) and the epoxy-based thermosetting resin (b). When the content of the coupling agent (e) is extremely small, the above-described effects obtained by using the coupling agent (e) may not be obtained. When the content of the coupling agent (e) is extremely large, there is a possibility that outgas is generated.

[0076]

(Crosslinking agent (f))

In a case where the above-described acrylic resin having a functional group that can be bonded to other compounds such as an isocyanate group is used as the binder resin (a), the crosslinking agent (f) used to bond the functional group to other compounds for crosslinking can be used. The initial adhesive force and the cohesive force of the adhesive layer can be adjusted by causing crosslinking using the crosslinking agent (f).

Examples of the crosslinking agent (f) include an organic polyvalent isocyanate compound and an organic polyvalent imine compound.

[0077]

Examples of the organic polyvalent isocyanate compound include an aromatic polyvalent isocyanate compound, an aliphatic polyvalent isocyanate compound, an alicyclic polyvalent isocyanate compound, trimers of these compounds, an isocyanurate product and an adduct product (reactant with a low-molecular active hydrogen-containing compound such as ethylene glycol, propylene glycol, neopentyl

glycol, trimethylolpropane, or castor oil, for example, trimethylolpropane adduct xylylene diisocyanate), and a terminal isocyanate urethane prepolymer obtained by reacting an organic polyvalent isocyanate compound with a polyol compound.

[0078]

- 5 Specific examples of the organic polyvalent isocyanate compound include 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, 1,3-xylylene diisocyanate, 1,4-xylene diisocyanate, diphenylmethane-4,4'-diisocyanate, diphenylmethane-2,4'-diisocyanate, 3-methyldiphenylmethane diisocyanate, hexamethylene diisocyanate, isophorone diisocyanate,
- 10 dicyclohexylmethane-4,4'-diisocyanate, dicyclohexylmethane-2,4'-diisocyanate, a compound obtained by adding tolylene diisocyanate or hexamethylene diisocyanate to all or some of hydroxyl groups of polyols such as trimethylolpropane, and lysine diisocyanate.

[0079]

- 15 Examples of the organic polyvalent imine compound include N,N'-diphenylmethane-4,4'-bis(1-aziridinecarboxamide), trimethylolpropane-tri- β -aziridinyl propionate, tetramethylolmethane-tri- β -aziridinyl propionate, and N,N'-toluene-2,4-bis(1-aziridinecarboxamide)trimethylene melamine.

[0080]

- 20 In a case where an isocyanate-based crosslinking agent is used as the crosslinking agent (f), it is preferable to use a hydroxyl group-containing polymer as the acrylic resin serving as the binder resin (a). In a case where the crosslinking agent (f) contains an isocyanate group and the acrylic resin contains a hydroxyl group, the adhesive layer can be easily introduced to a cross-linked structure through a reaction
- 25 between the crosslinking agent (f) and the acrylic resin.

[0081]

In a case where the crosslinking agent (f) is used, the content of the crosslinking agent (f) in the adhesive composition is preferably in a range of 0.01 to 20 parts by mass, more preferably in a range of 0.1 to 10 parts by mass, and particularly preferably in a range of 0.5 to 5 parts by mass with respect to 100 parts by mass of the binder resin (a).

[0082]

(Other thermosetting resins (g))

As other thermosetting resins (g), thermosetting resins which do not correspond to the epoxy resin in the epoxy-based thermosetting resin (b) may be used and examples thereof include a thermosetting polyimide resin, a polyurethane resin, an unsaturated polyester resin, and a silicone resin.

[0083]

(General-purpose additive (h))

Examples of the general-purpose additive (h) include a plasticizer, an antistatic agent, an antioxidant, a pigment, a dye, and a gettering agent which are known.

[0084]

(Solvent)

When the adhesive composition further contains a solvent, handleability becomes excellent due to the dilution.

The solvent containing the adhesive composition is not particularly limited, and preferred examples thereof include a hydrocarbon such as toluene or xylene; an alcohol such as methanol, ethanol, 2-propanol, isobutyl alcohol (2-methylpropan-1-ol), or 1-butanol; an ester such as ethyl acetate; a ketone such as acetone or methyl ethyl ketone; an ether such as tetrahydrofuran; and an amide (compound having an amide bond) such as dimethylformamide or N-methylpyrrolidone.

The solvent contained in the adhesive composition may be used alone or in combination of two or more kinds thereof.

From the viewpoint of uniformly mixing respective components used for the adhesive composition, it is preferable that the solvent contained in the adhesive composition is methyl ethyl ketone.

[0085]

The adhesive composition is obtained by blending the dye (s) with other components used for constituting the adhesive layer.

The order of adding each component at the time of blending is not particularly limited, and two or more components may be added at the same time.

A method of mixing each component at the time of blending is not particularly limited and may be suitably selected from known methods such as a method of mixing components by rotating a stirring bar or a stirring blade; a method of mixing components using a mixer; and a method of mixing components by applying ultrasonic waves.

The temperature and the time at the time of adding and mixing components are not particularly limited as long as the blended components do not deteriorate and may be suitably adjusted, but the temperature thereof is preferably in a range of 15°C to 30°C.

In a case where a solvent is used, the solvent may be used by being mixed with any of blended components other than the solvent and diluting the blended components in advance or may be used by being mixed with these blended components without diluting any of blended components other than the solvent in advance.

[0086]

The adhesive layer can be formed using the adhesive composition according to the same method as the method used in the case where the pressure sensitive adhesive layer is formed on the support base material described above. In the case where the

pressure sensitive adhesive base material is used, typically, it is difficult to directly coat the pressure sensitive adhesive layer with the adhesive composition. For example, a method of separately forming the adhesive layer and then adhering the adhesive layer to the surface of the pressure sensitive adhesive layer, such as a method of adhering the adhesive layer, formed by coating the surface of the peeling layer of the peeling material with the adhesive composition and drying the surface, to the surface of the pressure sensitive adhesive layer and removing the peeling material is preferable.

[Examples]

[0087]

Hereinafter, the present invention will be described in detail with reference to specific examples, but the present invention is not limited to the examples described below.

[0088]

<Production of dicing die bonding sheet>

[Examples 1 to 6 and Comparative Examples 1 and 2]

(Production of adhesive composition)

Respective components with amounts listed in Table 1 were blended with each other and diluted with methyl ethyl ketone, thereby obtaining an adhesive composition.

Abbreviations of respective components in Table 1 respectively have the following meanings.

[0089]

· Binder resin (a)

(a)-1: acrylic resin (manufactured by TOYO CHEM CO., LTD., weight average molecular weight of 500000, glass transition temperature of 9°C, formed by copolymerization of methyl acrylate (95 parts by mass) and 2-hydroxy ethyl acrylate (5

parts by mass))

- Epoxy-based thermosetting resin (b)

(b)-11: cresol novolak type epoxy resin having acryloyl group (“CNA-147”, manufactured by Nippon Kayaku Co., Ltd.)

5 (b)-21: aralkyl phenol resin (“MIREX XLC-4L”, manufactured by Mitsui Chemicals, Inc.)

- Filler (c)

(c)-1: methacrylic group-modified filler (“SO-C2”, manufactured by Admatechs Co., Ltd., average particle diameter of 0.5 μm , product obtained by treating silica with

10 3-methacryloxypropyltrimethoxysilane)

- Coupling agent (e)

(e)-1: silane coupling agent (“MKC Silicate MSEP2”, manufactured by Mitsubishi Chemical Corporation))

- Crosslinking agent (f)

15 (f)-1: aromatic polyvalent isocyanate (“CORONATE L”, manufactured by Nippon Polyurethane Industry Co., Ltd., tolylene diisocyanate trimer adduct of trimethylolpropane)

- Dye (s)

(s)-1: solvent black 3 (“OIL Black 860”, manufactured by ORIENT

20 CHEMICAL INDUSTRIES CO., LTD., oil-soluble disazo dye)

(s)-2: solvent red 18 (“Red TR-71”, manufactured by Chuo synthetic Chemical Co., Ltd., oil-soluble disazo dye)

[0090]

(Production of dicing die bonding sheet)

A peeling-treated surface of a peeling sheet in which one surface of a film made of polyethylene terephthalate was subjected to a peeling treatment was coated with the adhesive composition obtained in the above-described manner and then dried at 120°C for 3 minutes, thereby forming an adhesive layer having a thickness of 5 μm or 20 μm .

- 5 Further, the same peeling sheet as described above was adhered to the adhesive layer, so as to produce two kinds of non-carrier films respectively having an adhesive layer with a thickness of 5 μm and an adhesive layer with a thickness of 20 μm .

Next, the film having an adhesive layer with a thickness of 20 μm among these non-carrier films was used, one peeling sheet was peeled, and the adhesive layer was
10 transferred onto a pressure sensitive adhesive layer of a dicing tape (“G-562”, manufactured by Lintec Corporation), thereby obtaining a dicing die bonding sheet. In the dicing tape, the color of the base material was white and the pressure sensitive adhesive layer was colorless.

[0091]

- 15 <Evaluation of dicing die bonding sheet>

In regard to the dicing die bonding sheet obtained in the above-described manner, the visibility of the adhesive layer and the reliability of the semiconductor package were evaluated according to the following method.

[0092]

- 20 (Color difference (ΔE) between base material and adhesive layer)

The light transmittance of the dicing tape (“G-562”, manufactured by Lintec Corporation) and the adhesive layer having a thickness of 5 μm obtained in the above-described manner was measured using a spectrometer (“UV-VIS-NIR SPECTROPHOTOMETER UV-3600”, manufactured by Shimadzu Corporation).

Further, the light transmittance of the dicing tape was measured from the pressure sensitive adhesive layer side. At this time, the light transmittance was measured using a large sample chamber MPC-3100 attached to the spectrophotometer, without using a built-in integrating sphere.

5 Further, L^* , a^* , and b^* were respectively calculated with respect to the dicing tape serving as a base material and the adhesive layer from the measurement results of the obtained light transmittance in conformity with JIS Z8781-4:2013, and then the color difference (ΔE) was calculated based on Equation (I) above. The results are listed in Table 1. The calculated results of L^* , a^* , and b^* of the adhesive layer are also listed in
10 Table 1. Further, L^* of the dicing tape was 46, a^* thereof was 1.6, and b^* thereof was -2.9.

[0093]

(Visibility of adhesive layer)

Using a tape mounter ("Adwill RAD2500", manufactured by Lintec
15 Corporation), a dicing die bonding sheet having an adhesive layer with a thickness of 20 μm from among the dicing die bonding sheets of the examples and comparative examples was attached to a polished surface of a dry-polished silicon wafer (a diameter of 150 mm and a thickness of 75 μm) via the adhesive layer, and the silicon wafer was fixed to a wafer dicing ring frame. Next, a chip was obtained by dicing the silicon
20 wafer to have a size of 8 mm $\times$ 8 mm using a dicing device ("DFD651", manufactured by DISCO Corporation). During the dicing, the base material was cut from the surface by a depth of 20 μm .

[0094]

The above-described chip to which the dicing die bonding sheet was attached

was picked up from the base material together with the adhesive layer of the dicing die bonding sheet. Further, a circuit pattern was formed on copper foil (thickness of 18 μm) of a copper foil clad laminate (“CCL-HL830”, manufactured by MITSUBISHI GAS CHEMICAL COMPANY, INC.), and the chip provided with the adhesive layer was

5 crimped onto a substrate through the adhesive layer under conditions of 120°C at 2.45 N (250 gf) for 0.5 seconds using a substrate (“LN001E-001 PCB (Au) AUS303”, manufactured by CHINO GIKEN CORPORATION) formed by laminating a solder resist on the circuit pattern (“PSR-4000 AUS303”, manufactured by TAIYO INK MFG CO., LTD.). Hereinafter, after a chip was obtained by following the same procedures as

10 described above, the chip was picked up from the base material together with the adhesive layer of the dicing die bonding sheet and then the chip was further crimped onto the chip which was crimped onto the above-described substrate through the adhesive layer using a dicing die bonding sheet having an adhesive layer with a thickness of 5 μm from among the dicing die bonding sheets obtained in the above-described manner.

15 During this process, the color of the adhesive layer appearing in the space between the ring frame and the wafer and the color of the picked-up site of the chip provided with the adhesive layer were visually observed, and then it was confirmed whether or not these colors were different from each other, in other words, it was confirmed whether the transfer of the adhesive layer to the chip was able to be visually and clearly confirmed.

20 The results are listed in Table 1. In Table 1, “Yes” indicates that the transfer was visually and clearly confirmed and “No” indicates that the transfer was not visually and clearly confirmed.

[0095]

(Reliability of semiconductor package)

25 The laminate of the substrate and the chip provided with the adhesive layer

which was prepared at the time of evaluation of visibility of the adhesive layer described above was heated at 175°C for 1 hour using an oven. Next, the laminate was taken out of the oven, cooled to room temperature, sealed such that the sealing thickness thereof became 400 μm using a mold resin (“KE-1100AS3”, manufactured by KYOCERA Corporation) and a sealing device (“MPC-06M TriAl Press” manufactured by APIC YAMADA CORPORATION), and then heated at 175°C for 5 hours so that the mold resin was cured. Next, the sealed laminate was attached to dicing tape (“Adwill D-510T”, manufactured by Lintec Corporation), and the resultant was diced to have a size of 8 mm $\times$ 8 mm using a dicing device (“DFD651”, manufactured by DISCO Corporation), thereby obtaining a semiconductor package for evaluating reliability.

[0096]

The obtained semiconductor package was allowed to stand under conditions of 85°C at a relative humidity of 60% for 168 hours so that the moisture was absorbed and IR reflow was carried out three times under conditions of a maximum heating temperature of 260°C for a heating time of 1 minute using a reflow oven (“WL-15-20DNX type”, manufactured by Sagami-hara Industrial Promotion Foundation).

Subsequently, the cross section of the semiconductor package on which the IR flow was performed was observed to find out whether or not floating or peeling was present in a bonded portion of the substrate and the semiconductor chip, it was determined that the peeling was present in a case where peeling was observed in the bonded portion by 0.5 mm or more. Next, the number of semiconductor packages, in which peeling was not observed, was counted with respect to 25 semiconductor packages. Further, the presence of occurrence of package cracks was confirmed with respect to the semiconductor packages on which the IR reflow was performed using a scanning

ultrasonic flaw detector (“Hye-Focus”, manufactured by Hitachi Construction Machinery Co., Ltd.). The results are listed in Table 1. In Table 1, “No” indicates that package cracks did not occur and “Yes” indicates that package cracks occurred.

[0097]

[Table 1]

	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Comparative Example 1	Comparative Example 2
Components contained in adhesive layer (part by mass)	(a)-1	100	100	100	100	100	100	100
	(b)-11	30	30	30	30	30	30	30
	(b)-21	6	6	6	6	6	6	6
	(c)-1	35	35	35	35	35	35	35
	(e)-1	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	(f)-1	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	(s)-1	0.2	0.9	2	9	-	-	20
	(s)-2	-	-	-	-	0.9	-	-
	Adhesive Layer	L*	95	83	72	20	16	74
		a*	-0.9	-5	-9	-3	-2	0.08
		b*	-5	-12	-19	-30	-27	-0.23
Evaluation result	Color difference (ΔE)	49	39	32	38	51	28	54
	Visibility	Yes	Yes	Yes	Yes	Yes	No	No
	Peeling of bonded portion	25/25	25/25	25/25	25/25	25/25	25/25	4/25
	Package cracks	No	No	No	No	No	No	Yes

[0098]

As evident from the results described above, when the adhesive layers contained a dye at a content of 0.1% to 8.3% by mass in the dicing die bonding sheets of Examples 1 to 6, ΔE was in a predetermined range, the adhesive layers had excellent visibility, and the reliability of the obtained semiconductor packages was high.

Meanwhile, since the adhesive layer did not contain a dye in a case of the dicing die bonding sheet of Comparative Example 1, ΔE was out of the predetermined range and the visibility of the adhesive layer was degraded.

Further, in a case of the dicing die bonding sheet of Comparative Example 2, ΔE was out of the predetermined range and the visibility of the adhesive layer was degraded even though the adhesive layer contained a dye. Moreover, since the content of the dye in the adhesive layer was extremely large, peeling was frequently observed in the bonded portion of the substrate and the semiconductor chip in the obtained semiconductor package and package cracks also occurred. Therefore, the reliability was low.

Industrial Applicability

[0099]

The present invention can be applied to production of semiconductor chips or the like.

CLAIMS

1. A dicing die bonding sheet comprising:

an adhesive layer, which contains a binder resin (a), an epoxy-based thermosetting
5 resin (b), and a dye (s), on a base material,

wherein the content of the dye in the adhesive layer is 0.05% by mass or greater
and 8.3% by mass or less,

the content of the epoxy-based thermosetting resin (b) is in a range of 1 to 100 parts by
mass with respect to 100 parts by mass of the binder resin (a), and

10 the color difference between the base material and the adhesive layer in the
L*a*b* color coordinate system is in a range of 30 to 53.

2. The dicing die bonding sheet according to claim 1,

wherein the dye (s) is a disazo dye.

15

3. The dicing die bonding sheet according to claim 1 or 2,

wherein the dye (s) does not contain metal atoms or metal ions in the structure
thereof.

20