

DESCRIPTION

TAPE FOR SEMICONDUCTOR PROCESSING

TECHNICAL FIELD

[0001] The present invention relates to a tape for semiconductor processing, and more particularly, the invention relates to a tape for semiconductor processing having a metal layer for protecting the back surface of a semiconductor chip that is mounted by a face-down method.

BACKGROUND ART

[0002] In recent years, there has been an increasing demand for thickness reduction and size reduction of semiconductor devices and packages thereof. Production of semiconductor devices is achieved by using a mounting method referred to as a so-called face-down method. In the face-down method, a semiconductor chip on which convex-shaped electrodes called bumps intended for conduction are formed on the circuit surface is used, and is connected to the substrate through the electrodes by having the circuit surface turned over (face down) (so-called flip-chip connection).

[0003] In such a semiconductor device, damage or the like of the semiconductor chip may be prevented by protecting the back surface of the semiconductor chip using a tape for

semiconductor processing (see Patent Document 1). Furthermore, it is also known that a one-sided adhesive film composed of a metal layer and an adhesive layer is attached onto a semiconductor element by means of the adhesive layer (see Patent Document 2).

[0004] According to a representative procedure of flip-chip connection, solder bumps and the like formed on the surface of a semiconductor chip having a tape for semiconductor processing adhered thereon are immersed in a flux, subsequently the bumps are brought into contact with an electrode formed on the substrate (if necessary, solder bumps have also been formed on this electrode), and lastly the solder bumps are melted so as to bring the solder bumps and the electrode into reflow connection. A flux is used for the purpose of cleaning solder bumps at the time of soldering, preventing oxidation, improving the wettability of the solder, and the like. According to the above-described procedure, a satisfactory electrical connection between the semiconductor chip and the substrate can be established.

[0005] Thus, a film for a flip-chip type semiconductor back surface, which includes an adhesive layer and a protective layer laminated on this adhesive layer, with the protective layer being constructed from a heat-resistant resin having a glass transition temperature of 200°C or higher or a metal, has been proposed as a tape for semiconductor processing that can prevent

the occurrence of stains even if the flux adheres and is capable of producing a semiconductor device having excellent external appearance (see Patent Document 3).

CITATION LIST

PATENT DOCUMENT

[0006] Patent Document 1: JP 2007-158026 A

Patent Document 2: JP 2007-235022 A

Patent Document 3: JP 2012-033626 A

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0007] As disclosed in Patent Document 1 described above, in a case in which a protective film is formed by curing a resin including a radiation-curable component or a thermosetting component by means of radiation or heat, since the difference between the thermal expansion coefficient of the protective film after curing and the thermal expansion coefficient of the semiconductor wafer is large, there is a problem that warpage occurs in the semiconductor wafer or the semiconductor chip during processing.

[0008] However, in Patent Document 2 or Patent Document 3, there is a problem that the adhesive force between the metal protective layer and the adhesive layer is not sufficient, package cracks are generated between the protective layer and

the adhesive layer at the time of packaging, and reliability is decreased. Furthermore, Patent Document 3 discloses a film for flip-chip type semiconductor back surface in which a protective layer and an adhesive layer are provided on the pressure-sensitive adhesive layer of a dicing tape having a pressure-sensitive adhesive layer laminated on a base material. In the case of using a film for flip-chip type semiconductor back surface of such a dicing tape-integrated type, there is a problem that the adhesive force between the protective layer and the pressure-sensitive adhesive layer is not sufficient, detachment occurs between the protective layer and the pressure-sensitive adhesive layer at the time of dicing of dividing a semiconductor wafer into individual chips, and the semiconductor wafer cannot be divided satisfactorily.

[0009] Thus, it is an object of the invention to provide a tape for semiconductor processing, which can satisfactorily divide a semiconductor wafer at the time of dicing and can prevent the generation of package cracks at the time of packaging.

MEANS FOR SOLVING PROBLEM

[0010] In order to solve the problems described above, a tape for semiconductor processing according to the invention includes a dicing tape having a base film and a pressure-sensitive adhesive layer; a metal layer provided on

the pressure-sensitive adhesive layer; and an adhesive layer provided on the metal layer, the adhesive layer being intended for adhering the metal layer to the back surface of a semiconductor chip, and the surface roughness RzJIS according to ten-point average roughness of the metal layer is 0.5 μm or more and less than 10.0 μm .

[0011] Regarding the tape for semiconductor processing, it is preferable that the metal layer is a copper foil.

[0012] Furthermore, regarding the tape for semiconductor processing, it is preferable that the adhesive layer contains (A) an epoxy resin, (B) a curing agent, (C) a phenoxy resin, and (D) a surface-treated inorganic filler, and that the content of component (D) is from 40% by weight to 65% by weight with respect to the sum of the contents of components (A) to (D).

[0013] Regarding the tape for semiconductor processing, it is also preferable that the pressure-sensitive adhesive layer contains an acrylic polymer composed of an acrylic acid ester represented by $\text{CH}_2=\text{CHCOOR}$ (wherein R represents an alkyl group having 4 to 8 carbon atoms); a hydroxyl group-containing monomer; and an isocyanate compound having a radical reactive carbon-carbon double bond in the molecule.

EFFECT OF THE INVENTION

[0014] According to the invention, a semiconductor wafer can be satisfactorily divided at the time of dicing, and the

generation of package cracks at the time of packaging can be prevented.

BRIEF DESCRIPTION OF DRAWINGS

[0015] Fig. 1 is a cross-sectional view schematically illustrating the structure of a tape for semiconductor processing according to embodiments of the invention; and

Fig. 2 is a cross-sectional view for describing the method of using a tape for semiconductor processing according to embodiments of the invention.

MODE(S) FOR CARRYING OUT THE INVENTION

[0016] Hereinafter, embodiments of the invention will be described in detail.

[0017] Fig. 1 is a cross-sectional view illustrating a tape for semiconductor processing 10 according to embodiments of the invention. This tape for semiconductor processing 10 has a dicing tape 13 composed of a base film 11 and a pressure-sensitive adhesive layer 12 provided on the base film 11, and provided on the pressure-sensitive adhesive layer 12 are a metal layer 14 for protecting a semiconductor chip C (see Fig. 2), and an adhesive layer 15 provided on the metal layer 14.

[0018] In regard to the adhesive layer 15, it is preferable that the surface on the opposite side of the surface that is

brought into contact with the metal layer 14 is protected by a separator (releasable liner) (not illustrated in the diagram). The separator has a function as a protective material that protects the adhesive layer 15 until the tape for semiconductor processing is subjected to practical use. Furthermore, the separator can be used as a supporting base material when the metal layer 14 is bonded to the pressure-sensitive adhesive layer 12 of the dicing tape 13 during the production process of the tape for semiconductor processing 10.

[0019] The dicing tape 13, the metal layer 14, and the adhesive layer 15 may be cut in advance (precut) into a predetermined shape according to the process or apparatus to be used. Furthermore, the tape for semiconductor processing 10 of the invention may have a shape that has been cut for each sheet of semiconductor wafer W, or may have a shape obtained by winding a long sheet composed of a plurality of tapes that has been cut for each sheet of semiconductor wafer W, into a roll. In the following description, various constituent elements will be described.

[0020] <Base film 11>

Regarding the base film 11, any conventionally known base film can be used without any particular limitations; however, in a case in which a radiation-curable material is used as the pressure-sensitive adhesive layer 12 that will be described below, it is preferable to use a base film having radiation

transmissibility.

[0021] Examples of the material of the base film include homopolymers or copolymers of α -olefins, such as polyethylene, polypropylene, an ethylene-propylene copolymer, polybutene-1, poly-4-methylpentene-1, an ethylene-vinyl acetate copolymer, an ethylene-ethyl acrylate copolymer, an ethylene-methyl acrylate copolymer, an ethylene-acrylic acid copolymer, and an ionomer, or mixtures thereof; thermoplastic elastomers such as polyurethane, a styrene-ethylene-butene or pentene-based copolymer, and a polyamide-polyol copolymer; and mixtures thereof. The base film 11 may be a mixture of two or more kind of materials selected from the group of these materials, or may be a single-layered product or a multilayer product of these materials.

[0022] The thickness of the base film 11 is not particularly limited, and may be appropriately set. However, the thickness is preferably 50 to 200 μm .

[0023] In order to enhance the adhesiveness between the base film 11 and the pressure-sensitive adhesive layer 12, the surface of the base film 11 may be subjected to a chemical or physical surface treatment such as a chromic acid treatment, exposure to ozone, exposure to flame, exposure to a high voltage electric shock, or an ionizing radiation treatment.

[0024] According to the present embodiment, the pressure-sensitive adhesive layer 12 is provided directly on

the base film 11; however, the pressure-sensitive adhesive layer 12 may be provided indirectly, with a primer layer for providing adhesiveness, an anchor layer for enhancing cutting properties at the time of dicing, a stress relaxation layer, an antistatic layer or the like interposed therebetween.

[0025] <Pressure-sensitive adhesive layer 12>

The resin used for the pressure-sensitive adhesive layer 12 is not particularly limited, and a chlorinated polypropylene resin, an acrylic resin, a polyester resin, a polyurethane resin, an epoxy resin and the like, which are known to be used for pressure-sensitive adhesives, can be used. However, an acrylic pressure-sensitive adhesive that uses an acrylic polymer as a base polymer is preferred.

[0026] Examples of the acrylic polymer include acrylic polymers that use one kind or two or more kinds of a (meth)acrylic acid alkyl ester (for example, a linear or branched alkyl ester having an alkyl group with 1 to 30 carbon atoms, and particularly 4 to 18 carbon atoms, such as a methyl ester, an ethyl ester, a propyl ester, an isopropyl ester, a butyl ester, an isobutyl ester, a s-butyl ester, a t-butyl ester, a pentyl ester, an isopentyl ester, a hexyl ester, a heptyl ester, an octyl ester, a 2-ethylhexyl ester, an isooctyl ester, a nonyl ester, a decyl ester, an isodecyl ester, an undecyl ester, a dodecyl ester, a tridecyl ester, a tetradecyl ester, a hexadecyl ester, an octadecyl ester, or an eicosyl ester); and a (meth)acrylic acid

cycloalkyl ester (for example, a cyclopentyl ester or a cyclohexyl ester), as monomer components. Here, the term (meth)acrylic acid ester refers to acrylic acid ester and/or methacrylic acid ester, and the term (meth) as used herein has the same meaning in all cases.

[0027] The acrylic polymer may include a unit corresponding to another monomer component that is copolymerizable with the (meth)acrylic acid alkyl ester or cycloalkyl ester as necessary, for the purpose of modifying the cohesive force, heat resistance and the like of the polymer. Examples of such a monomer component include carboxyl group-containing monomers such as acrylic acid, methacrylic acid, carboxyethyl (meth)acrylate, carboxypentyl (meth)acrylate, itaconic acid, maleic acid, fumaric acid, and crotonic acid; acid anhydride monomers such as maleic anhydride and itaconic anhydride; hydroxyl group-containing monomers such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, 8-hydroxyoctyl (meth)acrylate, 10-hydroxydecyl (meth)acrylate, 12-hydroxylauryl (meth)acrylate, and (4-hydroxymethylcyclohexyl)methyl (meth)acrylate; sulfonic acid group-containing monomers such as styrenesulfonic acid, allylsulfonic acid, 2-(meth)acrylamido-2-methylpropanesulfonic acid, (meth)acrylamidopropanesulfonic acid, sulfopropyl

(meth)acrylate, and (meth)acryloyloxynaphthalenesulfonic acid; phosphoric acid group-containing monomers such as 2-hydroxyethylacryloyl phosphate; acrylamide, and acrylonitrile. These copolymerizable monomer components can be used singly or as mixtures of two or more kinds thereof. The amount of use of these copolymerizable monomers is preferably 40% by weight or less of the total amount of the monomer components.

[0028] Furthermore, since the acrylic polymer is crosslinked, the acrylic polymer may also include a polyfunctional monomer or the like as necessary, as a monomer component for copolymerization. Examples of such a polyfunctional monomer include hexanediol di(meth)acrylate, (poly)ethylene glycol di(meth)acrylate, (poly)propylene glycol di(meth)acrylate, neopentyl glycol di(meth)acrylate, pentaerythritol di(meth)acrylate, trimethylolpropane tri(meth)acrylate, pentaerythritol tri(meth)acrylate, dipentaerythritol hexa(meth)acrylate, epoxy (meth)acrylate, polyester (meth)acrylate, and urethane (meth)acrylate. These polyfunctional monomers can also be used singly or as mixtures of two or more kinds thereof. The amount of use of the polyfunctional monomer is preferably 30% by weight or less of the total amount of the monomer components, from the viewpoint of pressure-sensitive adhesion characteristics and the like.

[0029] Production of the acrylic polymer can be carried

out by, for example, applying an appropriate method such as a solution polymerization method, an emulsion polymerization method, a bulk polymerization method or a suspension polymerization method to one kind of component monomer or a mixture of two or more kinds of component monomers. In regard to the pressure-sensitive adhesive layer 12, a composition with suppressed inclusion of low molecular weight substances is preferred from the viewpoint of preventing contamination of wafers, and from this point of view, it is preferable to use an acrylic polymer having a weight average molecular weight of 300,000 or more, and particularly 400,000 to 3,000,000, as a main component. Therefore, the pressure-sensitive adhesive can be of an appropriately crosslinked type based on an internal crosslinking method, an external crosslinking method or the like.

[0030] In order to enhance the pick-up properties by controlling the crosslinking density of the pressure-sensitive adhesive layer 12, for example, an adequate method such as a method of performing a crosslinking treatment using an appropriate external crosslinking agent such as a polyfunctional isocyanate-based compound, a polyfunctional epoxy-based compound, a melamine-based compound, a metal salt-based compound, a metal chelate-based compound, an amino resin-based compound, or a peroxide; or a method of mixing low molecular weight compounds each having two or more

carbon-carbon double bonds, and performing a crosslinking treatment by irradiation with energy rays or the like, can be employed. In the case of using an external crosslinking agent, the amount of use thereof is appropriately determined based on the balance between the crosslinking agent and the base polymer to be crosslinked, and also based on the use applications as a pressure-sensitive adhesive. Generally, it is preferable that the external crosslinking is incorporated in an amount of about 5 parts by weight or less, more preferably 0.1 parts by weight to 5 parts by weight, with respect to 100 parts by weight of the base polymer. For the pressure-sensitive adhesive, if necessary, various additives such as a tackifier and an aging preventing agent may also be used in addition to the components described above, from the viewpoint of preventing deterioration or the like.

[0031] As the pressure-sensitive adhesive that constitutes the pressure-sensitive adhesive layer 12, a radiation-curable pressure-sensitive adhesive is suitable. An example of the radiation-curable pressure-sensitive adhesive may be an addition type radiation-curable pressure-sensitive adhesive obtained by incorporating a radiation-curable monomer component or a radiation-curable oligomer component to the pressure-sensitive adhesive described above.

[0032] Examples of the radiation-curable monomer

component to be incorporated include urethane (meth)acrylate, trimethylolpropane tri(meth)acrylate, tetramethylolmethane tetra(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol monohydroxypenta(meth)acrylate, dipentaerythritol hexa(meth)acrylate, and 1,4-butanediol di(meth)acrylate. These monomer components can be used singly or in combination of two or more kinds thereof.

[0033] Furthermore, examples of the radiation-curable oligomer component include various oligomers such as urethane-based, polyether-based, polyester-based, polycarbonate-based, and polybutadiene-based oligomers, and those having a molecular weight in the range of about 100 to 30,000 are suitable. Regarding the amount of incorporation of the radiation-curable monomer component or oligomer component, an amount that can lower the pressure-sensitive adhesive force of the pressure-sensitive adhesive layer can be appropriately determined depending on the kind of the pressure-sensitive adhesive layer. Generally, the amount of incorporation is, for example, 5 parts by weight to 500 parts by weight, and preferably about 70 parts by weight to 150 parts by weight, with respect to 100 parts by weight of the base polymer such as the acrylic polymer that constitutes the pressure-sensitive adhesive.

[0034] Another example of the radiation-curable pressure-sensitive adhesive may be an intrinsic type

radiation-curable pressure-sensitive adhesive obtained by using a polymer having a carbon-carbon double bond in a side chain or the main chain of the polymer or at the main chain terminals as the base polymer, in addition to the addition type radiation-curable pressure-sensitive adhesive. An intrinsic radiation-curable pressure-sensitive adhesive does not need to contain an oligomer component and the like, which are low molecular weight components, or does not include much. Therefore, a pressure-sensitive adhesive layer having a stable layer structure can be formed, without allowing oligomer components and the like to migrate around within the enclosure of the pressure-sensitive adhesive over time, and this is preferable.

[0035] Regarding the base polymer having a carbon-carbon double bond, any polymer having a carbon-carbon double bond and having pressure-sensitive adhesiveness can be used without any particular limitations. It is preferable that such a base polymer has an acrylic polymer as the basic skeleton. Examples of the acrylic polymer basic skeleton include the acrylic polymers listed above as examples.

[0036] The method for introducing a carbon-carbon double bond into an acrylic polymer is not particularly limited, and various methods can be employed. However, it is advantageous to introduce a carbon-carbon double bond into a polymer side chain, in view of molecular design. For example, a method of

copolymerizing in advance a monomer having a functional group into an acrylic polymer, and then subjecting the copolymerization product to a condensation or addition reaction with a compound having a carbon-carbon double bond and a functional group that is capable of reacting with the aforementioned functional group, while maintaining the radiation-curability of the carbon-carbon double bond, may be employed.

[0037] Examples of combinations of these functional groups include a combination of a carboxylic acid group and an epoxy group, a combination of a carboxylic acid group and an aziridyl group, and a combination of a hydroxyl group and an isocyanate group. Among these combinations of functional groups, a combination of a hydroxyl group and an isocyanate group is suitable, from the viewpoint of the ease of tracing the reaction. As long as a combination which allows production of the acrylic polymer having a carbon-carbon double bond by the combination of these functional groups is employed, the functional group may be on any side of the acrylic polymer and the compound. However, in the preferred combination described above, it is suitable that the acrylic polymer has a hydroxyl group, and the compound has an isocyanate group. In this case, examples of the isocyanate compound having a carbon-carbon double bond include methacryloyl isocyanate, 2-methacryloyloxyethyl isocyanate, and

m-isopropenyl- α,α -dimethylbenzyl isocyanate. Furthermore, as the acrylic polymer, acrylic polymers copolymerized with the hydroxyl group-containing monomers described above or ether-based compounds such as 2-hydroxyethyl vinyl ether, 4-hydroxybutyl vinyl ether, and diethylene glycol monovinyl ether, are used.

[0038] Regarding the intrinsic radiation-curable pressure-sensitive adhesive, the base polymer having a carbon-carbon double bond (particularly, an acrylic polymer) can be used alone; however, a photopolymerizable compound such as the radiation-curable monomer component or oligomer component described above may also be incorporated to the extent that the characteristics are not deteriorated. The amount of incorporation of the photopolymerizable compound is usually within the range of 30 parts by weight or less, and preferably within the range of 0 to 10 parts by weight, with respect to 100 parts by weight of the base polymer.

[0039] It is preferable that a photopolymerization initiator is incorporated into the radiation-curable pressure-sensitive adhesive, in a case in which the pressure-sensitive adhesive is cured by ultraviolet radiation or the like.

[0040] Among the acrylic polymers described above, particularly acrylic polymer A, which is composed of an acrylic acid ester represented by the formula: $\text{CH}_2=\text{CHCOOR}$ (wherein R

represents an alkyl group having 4 to 8 carbon atoms), a hydroxyl group-containing monomer, and an isocyanate compound having a radical reactive carbon-carbon double bond in the molecule, is preferred.

[0041] If the alkyl group of the acrylic acid alkyl ester has fewer than 4 carbon atoms, the acrylic acid ester has high polarity and excessively large peeling force, and the pick-up properties may be deteriorated. On the other hand, if the alkyl group of the acrylic acid alkyl ester has more than 8 carbon atoms, since the tackiness of the pressure-sensitive adhesive layer 12 is decreased, the adhesiveness or stickiness to the metal layer 15 is reduced, and as a result, detachment of the metal layer 15 may occur at the time of dicing.

[0042] The acrylic polymer A may also include a unit corresponding to another monomer component, if necessary.

[0043] For the acrylic polymer A, an isocyanate compound having a radical reactive carbon-carbon double bond is used. That is, it is preferable that the acrylic polymer has a configuration in which a double bond-containing isocyanate compound is added, by an addition reaction, to a polymer obtained from a monomer composition of the acrylic acid ester or the hydroxyl group-containing monomer. Therefore, it is preferable that the acrylic polymer has a radical reactive carbon-carbon double bond in the molecular structure. Thereby, an active energy ray-curable pressure-sensitive adhesive layer

(ultraviolet-curable pressure-sensitive adhesive layer or the like) that is cured when irradiated with active energy radiation (ultraviolet radiation or the like) can be provided, and the peeling force between the metal layer 15 and the pressure-sensitive adhesive layer 12 can be reduced.

[0044] Examples of the double bond-containing isocyanate compound include methacryloyl isocyanate, acryloyl isocyanate, 2-methacryloyloxyethyl isocyanate, 2-acryloyloxyethyl isocyanate, and m-isopropenyl- α,α -dimethylbenzyl isocyanate. The double bond-containing isocyanate compounds can be used singly or in combination of two or more kind thereof.

[0045] Furthermore, in the active energy ray-curable pressure-sensitive adhesive, an external crosslinking agent can be appropriately used in order to adjust the pressure-sensitive adhesive force before the irradiation with active energy radiation, or the pressure-sensitive adhesive force after the irradiation with active energy radiation. Regarding a specific means for an external crosslinking method, a method of adding a so-called crosslinking agent such as a polyisocyanate compound, an epoxy compound, an aziridine compound, or a melamine-based crosslinking agent, and causing the pressure-sensitive adhesive to react, may be used. In the case of using an external crosslinking agent, the amount of use of the agent is appropriately determined on the basis of the balance between the crosslinking agent and the base polymer to

be crosslinked, and on the basis of the use applications as the pressure-sensitive adhesive. The amount of use of the external crosslinking agent is generally 20 parts by weight or less (preferably 0.1 parts by weight to 10 parts by weight) with respect to 100 parts by weight of the base polymer. Furthermore, if necessary, various conventionally known additives such as a tackifier, an aging preventing agent and a foaming agent, may also be incorporated into the active energy ray-curable pressure-sensitive adhesive, in addition to the components described above.

[0046] The thickness of the pressure-sensitive adhesive layer 12 is not particularly limited and can be appropriately determined; however, the thickness is generally about 5 to 200 μm . The pressure-sensitive adhesive layer 12 may be composed of a single layer, or may be composed of multiple layers.

[0047] <Metal layer 14>

The metal that constitutes the metal layer 14 is not particularly limited, and it is preferable that the metal is, for example, at least one metal selected from the group consisting of aluminum, iron, titanium, tin, nickel and copper, and/or an alloy thereof, from the viewpoint of laser marking performance. Among these, copper, aluminum, or an alloy thereof has high thermal conductivity, and an effect of heat dissipation through the metal layer is also obtained. Furthermore, copper, aluminum, iron, nickel, or an alloy

thereof also gives an effect of suppressing warping in an electronic device package.

[0048] The surface roughness RzJIS based on the 10-point average roughness of the metal layer 14 is 0.5 μm or more and less than 10.0 μm . When the surface roughness RzJIS is adjusted to be 0.5 μm or more, the contact area between the metal layer 14 and the adhesive layer 15 increases, and the metal layer 14 and the adhesive layer 15 are physically firmly adhered to each other due to the anchor effect provided by the surface unevenness of the metal layer 14. Therefore, the metal layer 14 can be prevented from being detached by the load of the dicing blade or the water stream of cutting water. Also, since the adhesive layer adheres strongly after being cured, the occurrence of package cracks at the time of packaging or a reliability test can be prevented. Furthermore, the surface roughness RzJIS is preferably 1.0 μm or more, and if the surface roughness is 2.0 μm or more, it is preferable from the viewpoint that the anchor effect is manifested more effectively. If the surface roughness RzJIS is less than 10.0 μm , the adhesive or the pressure-sensitive adhesive can infiltrate into the surface unevenness of the metal layer 14. If the adhesive does not infiltrate into the surface unevenness of the metal layer 14, those parts become voids (pores), and these voids serve as starting points for the popcorn phenomenon (water vapor explosion) at the time of reflow or at the time of a reliability

test, causing the occurrence of package cracks. The surface roughness RzJIS according to the present specification is the 10-point average roughness defined in the annex JA of JIS B 0601:2013.

[0049] The thickness of the metal layer 14 can be appropriately determined in consideration of the handleability, processability and the like of the semiconductor wafer W or the semiconductor chip C, and the thickness is usually in the range of 2 to 200 μm . When the metal layer is 200 μm or less, winding processing is facilitated, and if the metal layer is 50 μm or less, it is preferable from the viewpoint that this thickness can contribute to thickness reduction of the semiconductor package. Meanwhile, from the viewpoint of handleability, the thickness needs to be 2 μm or more at the minimum.

[0050] <Adhesive layer 15>

The adhesive layer 15 is a layer obtained by processing an adhesive into a film in advance.

[0051] The adhesive layer 15 is formed from at least a thermosetting resin, and it is preferable that the adhesive layer is formed from at least a thermosetting resin and a thermoplastic resin.

[0052] Examples of the thermoplastic resin include natural rubber, butyl rubber, isoprene rubber, chloroprene rubber, an ethylene-vinyl acetate copolymer, an ethylene-acrylic acid copolymer, an ethylene-acrylic acid

ester copolymer, a polybutadiene resin, a polycarbonate resin, a thermoplastic polyimide resin, a polyamide resin such as 6-nylon or 6,6-nylon, a phenoxy resin, an acrylic resin, a saturated polyester resin such as PET (polyethylene terephthalate) or PBT (polybutylene terephthalate), a polyamideimide resin, and a fluororesin. The thermoplastic resins can be used singly, or two or more kinds thereof can be used in combination. Among these thermoplastic resins, an acrylic resin is particularly preferred from the viewpoint of having less ionic impurities and having excellent stress relaxation performance; and a phenoxy resin is particularly preferred from the viewpoint of achieving a balance between flexibility and strength and having high toughness, because the resins make it easier to secure reliability of semiconductor elements from the respective viewpoints.

[0053] The acrylic resin is not particularly limited, and a polymer containing as components one kind or two or more kinds of acrylic acid or methacrylic acid esters each having a linear or branched alkyl group having 30 or fewer carbon atoms (preferably 4 to 18 carbon atoms, more preferably 6 to 10 carbon atoms, and particularly preferably 8 or 9 carbon atoms) may be used. That is, according to the invention, the acrylic resin is meant to also include a methacrylic resin in a broad sense. Examples of the alkyl group include a methyl group, an ethyl group, a propyl group, an isopropyl group, a n-butyl group, a

t-butyl group, an isobutyl group, a pentyl group, an isopentyl group, a hexyl group, a heptyl group, a 2-ethylhexyl group, an octyl group, an isooctyl group, a nonyl group, an isononyl group, a decyl group, an isodecyl group, an undecyl group, a dodecyl group (lauryl group), a tridecyl group, a tetradecyl group, a stearyl group, and an octadecyl group.

[0054] Furthermore, the other monomer (monomer other than an alkyl ester of acrylic acid or methacrylic acid with an alkyl group having 30 or fewer carbon atoms) for forming the acrylic resin is not particularly limited, and examples include carboxyl group-containing monomers such as acrylic acid, methacrylic acid, carboxyethyl acrylate, carboxypentyl acrylate, itaconic acid, maleic acid, fumaric acid, and crotonic acid; acid anhydride monomers such as maleic anhydride and itaconic anhydride; hydroxyl group-containing monomers such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, 8-hydroxyoctyl (meth)acrylate, 10-hydroxydecyl (meth)acrylate, 12-hydroxylauryl (meth)acrylate, and (4-hydroxymethylcyclohexyl)-methyl acrylate; sulfonic acid group-containing monomers such as styrenesulfonic acid, allylsulfonic acid, 2-(meth)acrylamido-2-methylpropanesulfonic acid, (meth)acrylamidopropanesulfonic acid, sulfopropyl (meth)acrylate, and (meth)acryloyloxynaphthalenesulfonic

acid; and phosphoric acid group-containing monomers such as 2-hydroxyethylacryloyl phosphate. Meanwhile, the term (meth)acrylic acid refers to acrylic acid and/or methacrylic acid, and the term (meth) of the invention means the same in all cases.

[0055] Examples of the thermosetting resin include, in addition to an epoxy resin and a phenolic resin, an amino resin, an unsaturated polyester resin, a polyurethane resin, a silicone resin, and a thermosetting polyimide resin. The thermosetting resins can be used singly or in combination of two or more kinds thereof. Regarding the thermosetting resin, an epoxy resin having a smaller content of ionic impurities that corrode semiconductor elements is particularly suitable. Furthermore, a phenolic resin can be suitably used as a curing agent for an epoxy resin.

[0056] The epoxy resin is not particularly limited, and for example, bifunctional epoxy resins or polyfunctional epoxy resins, such as a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, a bisphenol S type epoxy resin, a brominated bisphenol A type epoxy resin, a hydrogenated bisphenol A type epoxy resin, a bisphenol AF type epoxy resin, a biphenyl type epoxy resin, a naphthalene type epoxy resin, a fluorene type epoxy resin, a phenol-novolac type epoxy resin, an orthocresol-novolac type epoxy resin, a trishydroxyphenylmethane type epoxy resin, and a

tetraphenylolthane type epoxy resin; or epoxy resins such as a hydantoin type epoxy resin, a trisglycidyl isocyanurate type epoxy resin, or a glycidylamine type epoxy resin, can be used.

[0057] As the epoxy resin, among the examples, a novolac type epoxy resin, a biphenyl type epoxy resin, a trishydroxyphenylmethane type epoxy resin, and a tetraphenylolthane type epoxy resin are particularly preferred. It is because these epoxy resins are highly reactive with phenolic resins as curing agents, and have excellent heat resistance or the like.

[0058] The phenolic resin acts as a curing agent for an epoxy resin, and examples thereof include novolac type phenolic resins such as a phenol novolac resin, a phenol aralkyl resin, a cresol novolac resin, a tert-butylphenol novolac resin, and a nonylphenol novolac resin; resol type phenolic resins, and polyoxystyrene such as polyparaoxystyrene. The phenolic resins can be used singly or in combination of two or more kinds thereof. Among these phenolic resins, a phenol novolac resin and a phenol aralkyl resin are particularly preferred. It is because the connection reliability of semiconductor devices can be enhanced.

[0059] In regard to the mixing ratio between the epoxy resin and the phenolic resin, it is suitable to mix the epoxy resin with the phenolic resin such that the amount of hydroxyl groups in the phenolic resin per equivalent of epoxy groups in

the epoxy resin component would be, for example, 0.5 equivalents to 2.0 equivalents, and more suitably 0.8 equivalents to 1.2 equivalents. That is, if the mixing ratio of the two components is not in the range described above, the curing reaction does not proceed sufficiently, and the characteristics of the epoxy resin cured product are easily deteriorated.

[0060] A thermosetting accelerating catalyst for the epoxy resin and the phenolic resin may also be used. The thermosetting accelerating catalyst is not particularly limited, and can be appropriately selected for use from among known thermosetting accelerating catalysts. The thermosetting accelerating catalysts can be used singly or in combination of two or more kinds thereof. As the thermosetting accelerating catalyst, for example, an amine-based curing accelerating agent, a phosphorus-based curing accelerating agent, an imidazole-based curing accelerating agent, a boron-based curing accelerating agent, and a phosphorus-boron-based curing agent can be used.

[0061] Regarding the curing agent for an epoxy resin, it is preferable to use a phenolic resin as described above; however, known curing agents such as imidazoles, amines, and acid anhydrides can also be used.

[0062] It is important that the adhesive layer 15 has adhesiveness (stickiness) to the back surface (surface where circuits are not formed) of a semiconductor wafer. Thus, in

order to crosslink the adhesive layer 15 in advance to a certain extent, a polyfunctional compound that reacts with the functional group at the molecular chain terminal of the polymer or the like may also be added as a crosslinking agent. Thereby, the adhesion characteristics at high temperature can be enhanced, and an improvement of heat resistance can be promoted.

[0063] Regarding the crosslinking agent, any known crosslinking agent can be used without any particular limitations. Specific examples thereof include an isocyanate-based crosslinking agent, an epoxy-based crosslinking agent, a melamine-based crosslinking agent, a peroxide-base crosslinking agent, a urea-based crosslinking agent, a metal alkoxide-based crosslinking agent, a metal chelate-based crosslinking agent, a metal salt-based crosslinking agent, a carbodiimide-based crosslinking agent, an oxazoline-based crosslinking agent, an aziridine-based crosslinking agent, and an amine-based crosslinking agent. As the crosslinking agent, an isocyanate-based crosslinking agent or an epoxy-based crosslinking agent is suitable. The crosslinking agents can be used singly or in combination of two or more kinds thereof.

[0064] According to the invention, it is also possible to apply a crosslinking treatment by irradiation with an electron beam, ultraviolet radiation or the like, instead of using a crosslinking agent or simultaneously with the use of a

crosslinking agent.

[0065] If necessary, other additives can be incorporated as appropriate into the adhesive layer 15. Examples of the other additives include a filler, a flame retardant, a silane coupling agent, an ion trapping agent, an extending agent, an aging preventing agent, an oxidation preventing agent, and a surfactant.

[0066] The filler may be any one of an inorganic filler and an organic filler; however, an inorganic filler is suitable. By incorporating a filler such as an inorganic filler, enhancement of thermal conductivity of the adhesive layer 15, regulation of the elastic modulus, and the like can be promoted. Examples of the inorganic filler include ceramics such as silica, clay, gypsum, calcium carbonate, barium sulfate, alumina, beryllium oxide, silicon carbide, and silicon nitride; metals such as aluminum, copper, silver, gold, nickel, chromium, lead, tin, zinc, palladium, and solder, or alloys; and various inorganic powders formed from carbon and the like. The fillers can be used singly or in combination of two or more kinds thereof. Regarding the filler, among them, silica or alumina is suitable, and as the silica, fused silica is particularly suitable. The average particle size of the inorganic filler is preferably in the range of 0.1 μm to 80 μm . The average particle size of the inorganic filler can be measured using, for example, a laser diffraction type particle size distribution analyzer.

[0067] The amount of incorporation of the filler (particularly, inorganic filler) is preferably 80% by weight or less (0% by weight to 80% by weight), and particularly suitably 0% by weight to 70% by weight, with respect to the organic resin components.

[0068] Examples of the flame retardant include antimony trioxide, antimony pentoxide, and a brominated epoxy resin. The flame retardants can be used singly or in combination of two or more kinds thereof. Examples of the silane coupling agent include β -(3,4-epoxycyclohexyl)ethyltrimethoxysilane, γ -glycidoxypropyltrimethoxysilane, and γ -glycidoxypropylmethyldiethoxysilane. The silane coupling agents can be used singly or in combination of two or more kinds thereof. Examples of the ion trapping agent include hydrotalcites and bismuth hydroxide. The ion trapping agents can be used singly or in combination of two or more kinds thereof.

[0069] It is particularly preferable, from the viewpoints of adhesiveness and reliability, that the adhesive layer 15 contains (A) an epoxy resin, (B) a curing agent, (C) a phenoxy resin, and (D) a surface-treated inorganic filler, and the content of component (D) is from 40% by weight to 65% by weight with respect to the total amount of components (A) to (D).

[0070] By using the (A) epoxy resin, high adhesiveness, water resistance and heat resistance are obtained. As the epoxy resin, the above-mentioned known epoxy resins can be used.

Regarding the (B) curing agent, any known curing agent can be used.

[0071] Regarding the (C) phenoxy resin, a phenoxy resin has a long molecular chain and has a structure similar to that of an epoxy resin. Since a phenoxy resin acts as a flexible material in a composition having a high crosslinking density and imparts high toughness, a composition having high strength and high toughness is obtained. A preferred phenoxy resin is a phenoxy resin having a main skeleton of bisphenol A type; however, in addition to that, commercially available phenoxy resins such as a bisphenol F type phenoxy resin, a bisphenol A/F mixed type phenoxy resin, and a brominated phenoxy resin are also preferable.

[0072] Regarding the (D) surface-treated inorganic filler, an inorganic filler that has been surface-treated with a silane coupling agent may be used. As the inorganic filler, the above-mentioned known inorganic fillers can be used; however, preferred examples include silica and alumina. When the inorganic filler is surface-treated with a silane coupling agent, the inorganic filler may have satisfactory dispersibility. Accordingly, excellent fluidity is obtained, and therefore, the adhesive force to the metal layer can be increased. Also, since the inorganic filler can be filled at a high density, the water absorption ratio can be lowered, and the moisture resistance can be increased.

[0073] The surface treatment of an inorganic filler with a silane coupling agent is carried out according to a known method, by dispersing the inorganic filler in a silane coupling agent solution, thereby causing the hydroxyl groups present at the surface of the inorganic filler to react with silanol groups produced as a result of hydrolysis of hydrolyzable groups such as alkoxy groups of the silane coupling agent, and producing Si-O-Si bonds on the surface of the inorganic filler.

[0074] When the content of the (D) surface-treated inorganic filler is adjusted to be 40% by weight or more with respect to the total amount of the (A) epoxy resin, (B) curing agent, (C) phenoxy resin, and (D) surface-treated inorganic filler, the water absorption ratio and the saturation moisture absorption ratio can be lowered. Also, the thermal conductivity of the adhesive layer is increased, and thus it is preferable from the viewpoint of obtaining an effect of heat dissipation through the metal layer. When the content of the (D) surface-treated inorganic filler is adjusted to be 65% by weight or less with respect to the total amount of the (A) epoxy resin, (B) curing agent, (C) phenoxy resin, and (D) surface-treated inorganic filler, fluidity provided by the resin components can also be secured, and therefore, it is preferable from the viewpoint of obtaining excellent adhesive force to the metal layer or the wafer.

[0075] The thickness of the adhesive layer 15 is not

particularly limited; however, usually, from the viewpoint of handleability, the thickness is preferably 3 μm or more, more preferably 5 μm or more, and from the viewpoint of contributing to thickness reduction of the semiconductor package, the thickness is preferably 100 μm or less, and more preferably 50 μm or less. It is also preferable that the adhesive layer 15 has a thickness equal to or larger than the surface roughness Rz_{JIS} of the metal layer 14 based on the 10-point average roughness. When the thickness of the adhesive layer 15 is equal to or more than the surface roughness Rz_{JIS} , it is easy for the adhesive to infiltrate into the surface unevenness of the metal layer 14, and an anchor effect is likely to be obtained. Furthermore, the adhesive layer 15 may be composed of a single layer, or may be composed of multiple layers.

[0076] The adhesive layer 15 is preferably such that the peeling force (23°C, peeling angle 180°, linear velocity 300 mm/min) between the adhesive layer 15 and the metal layer 14 in the B-stage (uncured state or semicured state) is 0.3 N or greater. If the peeling force is less than 0.3 N, detachment occurs between the semiconductor wafer W or the semiconductor chip C and the adhesive layer 15, or between the adhesive layer 15 and the metal layer 14, at the time of dicing of the semiconductor wafer W, and there is a risk that chipping (defects) may occur in the semiconductor chip C.

[0077] It is preferable that the water absorption ratio

of the adhesive layer 15 is 1.5 vol% or less. The method for measuring the water absorption ratio is as follows. That is, an adhesive layer 15 (film-like adhesive) having a size of 50 × 50 mm is used as a sample, and the sample is dried for 3 hours at 120°C in a vacuum dryer and is left to cool naturally in a desiccator. Subsequently, the dry mass is measured and is designated as M1. The sample is immersed in distilled water for 24 hours at room temperature, and after the sample is taken out, the sample surface is wiped with a filter paper. The sample is immediately weighed, and the weight is designated as M2. The water absorption ratio is calculated by the following Formula (1).

$$\text{Water absorption ratio (vol\%)} = [(M2 - M1)/(M1/d)] \times 100$$

(1)

wherein d represents the density of the film.

If the water absorption ratio is higher than 1.5 vol%, there is a risk that package cracks may occur at the time of solder reflow due to the absorbed moisture.

[0078] It is preferable that the saturation moisture absorption ratio of the adhesive layer 15 is 1.0 vol% or less. The method for measuring the saturation moisture absorption ratio is as follows. That is, a circular-shaped adhesive layer 15 (film-like adhesive) having a diameter of 100 mm is used as a sample, and the sample is dried for 3 hours at 120°C in a vacuum dryer and is left to cool naturally in a desiccator.

Subsequently, the dry mass is measured and is designated as M1. The sample is humidified for 168 hours in a constant temperature constant humidity chamber at 85°C and 85%RH, and after the sample is taken out, the sample is immediately weighed, and the weight is designated as M2. The saturation moisture absorption ratio is calculated by the following Formula (2).

$$\text{Saturation moisture absorption ratio (vol\%)} = [(M2 - M1)/(M1/d)] \times 100 \quad (2)$$

wherein d represents the density of the film.

If the saturation moisture absorption ratio is higher than 1.0 vol%, the value of vapor pressure increases as a result of moisture absorption at the time of reflow, and there is a risk that satisfactory reflow characteristics may not be obtained.

[0079] It is preferable that the residual volatile matter content of the adhesive layer 15 is 3.0 wt% or less. The method for measuring the residual volatile components is as follows. That is, an adhesive layer 15 (film-like adhesive) having a size of 50 × 50 mm is used as a sample, and the initial mass of the sample is measured and designated as M1. The sample is heated for 2 hours at 200°C in a hot air circulation constant temperature chamber, subsequently the sample is weighed, and the weight is designated as M2. The residual volatile matter content is calculated by the following formula (3).

$$\text{Residual volatile matter content (wt\%)} = [(M2 - M1)/M1]$$

× 100 (3)

If the residual volatile matter content is higher than 3.0 wt%, the solvent is volatilized by the heating during packaging, and there is a risk that voids may occur in the interior of the adhesive layer 15, and package cracks may occur.

[0080] It is preferable that the ratio of the linear expansion coefficient of the metal layer 14 with respect to the linear expansion coefficient of the adhesive layer 15 (linear expansion coefficient of metal layer 14/linear expansion coefficient of adhesive layer 15) is 0.2 or higher. If this ratio is less than 0.2, detachment between the metal layer 14 and the adhesive layer 15 is likely to occur, and there is a risk that package cracks may occur at the time of packaging, and reliability may be lowered.

[0081] (Separator)

A separator is intended to improve handleability of the adhesive layer 15 as well as to protect the adhesive layer 15. As the separator, polyester (PET, PBT, PEN, PBN, PTT)-based films, polyolefin (PP, PE)-based films, copolymer (EVA, EEA, EBA)-based films, and films having their adhesiveness or mechanical strength further enhanced by substituting portions of these materials, can be used. Laminates of these films may also be used.

[0082] The thickness of the separator is not particularly limited, and may be appropriately set; however, the thickness

is preferably 25 to 50 μm .

[0083] (Tape for semiconductor processing 10)

The method for producing the tape for semiconductor processing 10 according to the present embodiment will be described. First, the adhesive layer 15 can be formed by utilizing a conventional method of preparing a resin composition and forming a film-like layer. Specifically, for example, a method of forming the adhesive layer 15 by applying the resin composition on an appropriate separator (release paper or the like), and drying the resin composition (in a case in which thermal curing is needed, the resin composition is subjected to a heating treatment as necessary and dried), may be used. The resin composition may be a solution or a dispersion liquid. Subsequently, the adhesive layer 15 thus obtained is bonded with a metal layer 14 that has been prepared separately. Regarding the metal layer 14, a commercially available metal foil may be used. Thereafter, the adhesive layer 15 and the metal layer 14 are precut into a circular label shape having a predetermined size using a press-cutting blade, and unnecessary parts of the periphery are removed.

[0084] Next, a dicing tape 13 is produced. The base film 11 can be formed by a conventionally known film-forming method. Examples of the film-forming method include a calender film-forming method, a method of casting in an organic solvent, an inflation extrusion method in a sealed system, a T-die

extrusion method, a co-extrusion method, and a dry lamination method. Next, a pressure-sensitive adhesive composition is applied on the base film 11 and dried (by heating and crosslinking as necessary), and thus a pressure-sensitive adhesive layer 12 is formed. Examples of the application method include roll coating, screen coating, and gravure coating. The pressure-sensitive adhesive layer 12 may be formed on the base film 11 by applying the pressure-sensitive adhesive composition directly on the base film 11, or after the pressure-sensitive adhesive layer 12 is formed by applying the pressure-sensitive adhesive composition on release paper that has been release-treated on the surface or the like, the pressure-sensitive adhesive layer 12 may be transferred onto the base film 11. Thereby, a dicing tape 13 having the pressure-sensitive adhesive layer 12 formed on the base film 11 is produced.

[0085] Subsequently, the dicing tape 13 is laminated on the separator provided with the circular-shaped metal layer 14 and the adhesive layer 15 such that the metal layer 14 and the pressure-sensitive adhesive layer 12 are brought into contact. If necessary, the dicing tape 13 is also precut into a circular label shape having a predetermined size, and thereby the tape for semiconductor processing 10 is produced.

[0086] <Method for use>

Next, the method for producing a semiconductor device

using the tape for semiconductor processing 10 of the present embodiment will be described with reference to Fig. 2.

[0087] The method for producing a semiconductor device includes at least a step of sticking a semiconductor wafer W on a dicing tape-integrated type tape for semiconductor processing 10 (mounting step); a step of dicing the semiconductor wafer W and forming semiconductor chips C (dicing step); a step of detaching the semiconductor chips C together with the tape for semiconductor processing 10 from the pressure-sensitive adhesive layer 12 of the dicing tape 13 (pick-up step); and a step of flip-chip connecting the semiconductor chips C onto an adherend 16 (flip-chip connection step).

[0088] [Mounting step]

First, a separator that is optionally provided on a dicing tape-integrated type tape for semiconductor processing 10 is appropriately detached, and as illustrated in Fig. 2(A), a semiconductor wafer W is stuck on an adhesive layer 15, and this is fixed by adhering and holding the wafer (mounting step). At this time, the adhesive layer 15 is in an uncured state (including a semicured state). Also, the dicing tape-integrated type tape for semiconductor processing 10 is stuck on the back surface of the semiconductor wafer W. The back surface of the semiconductor wafer W means the surface on the opposite side of the circuit surface (also called a

non-circuit surface, a non-electrode-formed surface, or the like). The method for sticking is not particularly limited; however, a method based on pressure bonding is preferred. Pressure bonding is usually carried out by pressing with a pressing means such as a pressing roll.

[0089] [Dicing step]

Next, as illustrated in Fig. 2(B), dicing of the semiconductor wafer W is performed. Thereby, the semiconductor wafer W is individually divided (subdivided) by cutting the wafer into a predetermined size, and thus semiconductor chips C are produced. Dicing is carried out according to a conventional method, for example, from the circuit surface side of the semiconductor wafer W. In the present step, for example, a cutting method called full-cut, by which incisions are inserted to reach the tape for semiconductor processing 10, can be employed. The dicing apparatus that is used for the present step is not particularly limited, and any conventionally known apparatus can be used. Furthermore, since the semiconductor wafer W is adhered and fixed to the tape for semiconductor processing 10 with excellent adhesiveness, chip cracking or chip flying can be suppressed, and damage of the semiconductor wafer W can also be suppressed. In the case of implementing expansion of the dicing tape-integrated type tape for semiconductor processing 10, the expansion can be carried out using a conventionally known

expanding apparatus.

[0090] [Pick-up step]

As illustrated in Fig. 2(C), picking up of the semiconductor chips C is performed, and thereby the semiconductor chips C are detached from the dicing tape 13 together with the adhesive layer 15 and the metal layer 14. The method for picking up is not particularly limited, and various conventionally known methods can be employed. For example, a method of pushing up the individual semiconductor chips C using needles from the base film 11 side of the tape for semiconductor processing 10, and picking up the pushed semiconductor chips C using a pick-up apparatus, may be used. Regarding the semiconductor chips C thus picked up, the back surface of the chips are protected by the metal layer 14.

[0091] [Flip-chip connection step]

The semiconductor chips C thus picked up are fixed, as illustrated in Fig. 2(D), to an adherend 16 such as a substrate by a flip-chip bonding method (flip-chip packaging method). Specifically, the semiconductor chips C are fixed to the adherend 16 by a conventional method, in a state in which the circuit surface (also called a surface, a circuit pattern-formed surface, an electrode-formed surface, or the like) of a semiconductor chip C faces the adherend 16. For example, first, a flux is attached to the bumps 17 as connection parts that are formed on the circuit surface side of the

semiconductor chips C. Next, the bumps 17 of the semiconductor chips C are contacted with a conductor material 18 (solder or the like) for bonding, which is adhered to a connection pad of the adherend 16, and then the bumps 17 and the conductor material 18 are melted while being pressed. Thereby, electrical conduction between the semiconductor chips C and the adherend 16 is secured, and the semiconductor chips C can be fixed to the adherend 16 (flip-chip bonding process). At this time, voids are formed between the semiconductor chips C and the adherend 16, and the distance between voids is generally about 30 μm to 300 μm . Furthermore, after the semiconductor chips C are flip-chip bonded (flip-chip connection) onto the adherend 16, the flux remaining on the facing surfaces of the semiconductor chips C and the adherend 16 or in the gaps therebetween is washed and removed, a sealant material (sealant resin or the like) is filled in the gap to encapsulate the system.

[0092] As the adherend 16, various substrates such as a lead frame and a circuit board (wiring circuit board or the like) can be used. The material for such a substrate is not particularly limited; however, a ceramic substrate or a plastic substrate may be used. Examples of the plastic substrate include an epoxy substrate, a bismaleimide triazine substrate and a polyimide substrate. Also, a chip-on-chip structure can be obtained by using another semiconductor chip as the adherend 16, and flip-chip connecting the semiconductor chip C thereon.

[0093] <Examples>

Next, Examples and Comparative Examples will be described in detail in order to further clarify the effects of the invention; however, the invention is not intended to be limited to these Examples.

[0094] (1) Production of dicing tape

 <Dicing tape (1)>

As an acrylic copolymer having functional groups, a copolymer composed of 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate and methacrylic acid, and having a mass average molecular weight of 700,000, with a proportion of 2-ethylhexyl acrylate of 60 mol%, was prepared. Next, 2-isocyanatoethyl methacrylate was added thereto so as to obtain an iodine value of 20, and thus an acrylic copolymer (a-1) having a glass transition temperature of -50°C, a hydroxyl group value of 10 mg KOH/g, and an acid value of 5 mg KOH/g was prepared.

[0095] Resin beads of a zinc ionomer of an ethylene-methacrylic acid copolymer (methacrylic acid content: 13%, softening point: 72°C, and melting point: 90°C) that had been synthesized by a radical polymerization method were melted at 140°C and molded into a long film form having a thickness of 100 μ m using an extruder. Thus, a base film was produced.

[0096] A mixture obtained by adding 5 parts by mass of CORONATE L (trade name, manufactured by Tosoh Corporation) as polyisocyanate to 100 parts by mass of the acrylic copolymer

(a-1), and adding thereto 3 parts by mass of ESACURE KIP 150 (trade name, manufactured by Lamberti S.p.A.) as a photopolymerization initiator, was dissolved in ethyl acetate and stirred. Thus, a pressure-sensitive adhesive composition was prepared.

[0097] The pressure-sensitive adhesive layer composition thus prepared was applied on a releasable liner formed from a release-treated polyethylene terephthalate film, so as to obtain a thickness after drying of 10 μ m, and the composition was dried for 3 minutes at 110°C. Subsequently, the release liner was bonded to the base film described above. Thus, a dicing tape (1) having a pressure-sensitive adhesive layer formed on the base film was produced.

[0098] (2) Production of adhesive layer

[0099] (Adhesive composition b-1)

Methyl ethyl ketone was added to a composition including 20 parts by mass of "1002" (trade name, manufactured by Mitsubishi Chemical Holdings Corporation, solid bisphenol A type epoxy resin, epoxy equivalent 600) as an epoxy resin, 55 parts by mass of "806 " (trade name, manufactured by Mitsubishi Chemical Holdings Corporation, solid bisphenol F type epoxy resin, epoxy equivalent 160, specific gravity 1.20) as an epoxy resin, 70 parts by mass of "MEH7851-4H" (trade name, manufactured by Meiwa Plastic Industries, Ltd., biphenylaralkyl type phenolic resin) as a curing agent, 200

parts by mass of "SO-C2" (trade name, manufactured by Admatechs Co., Ltd., average particle size 0.5 μm) as a silica filler, and 3 parts by mass of "AEROSIL R972" (trade name, manufactured by Nippon Aerosil Co., Ltd., average particle size of primary particle size 0.016 μm) as a silica filler, and the mixture was stirred and mixed. Thus, a uniform composition was obtained.

To this, 100 parts by mass of "YX6954" (trade name, manufactured by Mitsubishi Chemical Holdings Corporation, mass average molecular weight 38,000) as a phenoxy resin, 0.6 parts by mass of "KBM-802" (trade name, manufactured by Shin-Etsu Silicones Co., Ltd., mercaptopropyltrimethoxysilane) as a coupling agent, and 0.5 parts by mass of "CUREZOL 2PHZ-PW" (trade name, manufactured by Shikoku Chemicals Corp., 2-phenyl-4,5-dihydroxymethylimidazole, decomposition temperature 230°C) as a curing accelerator were added, and the mixture was stirred and mixed until the mixture became uniform. This was filtered through a 100-mesh filter, and the filtrate was degassed in a vacuum. Thus, a varnish of an adhesive composition b-1 was obtained.

[0100] (Adhesive composition b-2)

Methyl ethyl ketone was added to a composition including 40 parts by mass of "1002" (trade name, manufactured by Mitsubishi Chemical Holdings Corporation, solid bisphenol A type epoxy resin, epoxy equivalent 600) as an epoxy resin, 100 parts by mass of "806" (trade name, manufactured by Mitsubishi

Chemical Holdings Corporation, bisphenol F type epoxy resin, epoxy equivalent 160, specific gravity 1.20) as an epoxy resin, 5 parts by mass of "DYHARD 100SF" (trade name, Degussa AG, dicyandiamide) as a curing agent, 350 parts by mass of "SO-C2" (trade name, manufactured by Admatechs Co., Ltd., average particle size 0.5 μm) as a silica filler, and 3 parts by mass of "AEROSIL R972" (trade name, manufactured by Nippon Aerosil Co., Ltd., average particle size of primary particle size 0.016 μm) as a silica filler, and the mixture was stirred and mixed. Thus, a uniform composition was obtained.

To this, 100 parts by mass of "PKHH" (trade name, manufactured by Inchem Corporation, mass average molecular weight 52,000, glass transition temperature 92°C) as a phenoxy resin, 0.6 parts by mass of "KBM-802" (trade name, manufactured by Shin-Etsu Silicones Co., Ltd., mercaptopropyltrimethoxysilane) as a coupling agent, and 0.5 parts by mass of "CUREZOL 2PHZ-PW" (trade name, manufactured by Shikoku Chemicals Corp., 2-phenyl-4,5-dihydroxymethylimidazole, decomposition temperature 230°C) as a curing accelerator were added, and the mixture was stirred and mixed until the mixture became uniform. This was filtered through a 100-mesh filter, and the filtrate was degassed in a vacuum. Thus, a varnish of an adhesive composition b-2 was obtained.

[0101] <Adhesive layer (1)>

The adhesive composition b-1 was applied on a separator formed from a release-treated polyethylene terephthalate film, so as to obtain a thickness after drying of 5 μm , and the composition was dried for 5 minutes at 110°C. Thus, an adhesive film having an adhesive layer formed on a separator was produced.

[0102] <Adhesive layer (2)>

An adhesive layer (2) was obtained by a method similar to that used for the adhesive layer (1), except that the adhesive composition b-2 was used instead of the adhesive composition b-1.

[0103] <Adhesive layer (3)>

An adhesive layer (3) was obtained by a method similar to that used for the adhesive layer (1), except that the adhesive composition was applied so as to obtain a thickness after drying of 20 μm .

[0104] (3) Metal layer

The following layers were prepared as metal layers.

<Metal layer (1)>

TQ-M4-VSP (trade name, manufactured by Mitsui Mining & Smelting Co., Ltd., thickness 12 μm , surface roughness RzJIS 0.6 μm)

<Metal layer (2)>

F0-WS (trade name, manufactured by Furukawa Electric Co., Ltd., copper foil, thickness 12 μm , surface roughness RzJIS 1.3

μm)

<Metal layer (3)>

F3-WS (trade name, manufactured by Furukawa Electric Co., Ltd., copper foil, thickness 12 μm, surface roughness RzJIS 2.8 μm)

<Metal layer (4)>

DT-GLD-STD (trade name, manufactured by Furukawa Electric Co., Ltd., copper foil, thickness 18 μm, surface roughness RzJIS 9.0 μm)

<Metal layer (5)>

GHY5-HA (trade name, manufactured by JX Nippon Mining & Metals Corporation, thickness 18 μm, surface roughness RzJIS 0.3 μm)

<Metal layer (6)>

GTS-MP (trade name, manufactured by Furukawa Electric Co., Ltd., copper foil, thickness 35 μm, surface roughness RzJIS 11.0 μm)

[0105] (4) Production of tape for semiconductor processing

<Example 1>

The adhesive layer (1) and the metal layer (1) obtained as described above were bonded together under the conditions of a bonding angle of 120°, a pressure of 0.2 MPa, and a velocity of 10 mm/s, and thus a single-sided adhesive film was produced. The dicing tape (1) was precut into a shape that could be stuck

to a ring frame, and the single-sided adhesive film was precut into a shape that could cover a wafer. The pressure-sensitive adhesive layer of the dicing tape (1) and the metal layer side of the single-sided adhesive film were bonded together such that the pressure-sensitive adhesive layer at the periphery of the single-sided adhesive film would be exposed. Thus, a tape for semiconductor processing of Example 1 was produced.

[0106] <Examples 2 to 5 and Comparative Examples 1 and 2>

Tapes for semiconductor processing of Examples 2 to 5 and Comparative Examples 1 and 2 were produced by a technique similar to that of Example 1, except that the combinations of the dicing tape, the adhesive composition, and the metal layer as described in Table 1 were employed.

[0107] The tapes for semiconductor processing related to Examples 1 to 5 and Comparative Examples 1 and 2 were subjected to the following evaluations. The results are presented in Table 1.

[0108] (Dicing properties)

The adhesive layer of each of the tapes for semiconductor processing related to Examples and Comparative Examples was attached to the back surface of a silicon wafer having a thickness of 200 μm , and dicing was performed to divide the silicon wafer into chips for evaluation having a size of 7.5 mm $\times$ 7.5 mm. For the chip-attached tape for semiconductor processing obtained after dicing, the presence or absence of

the elimination of the adhesive layer-attached chip for evaluation from the metal layer, and of the elimination of the adhesive layer- and metal layer-attached chip for evaluation from the pressure-sensitive adhesive layer, was observed. A chip in which none of the eliminations had occurred was rated as O as a good product, and a chip in which even one of the eliminations had occurred was rated as X as a defective product.

[0109] A silicon wafer having a thickness of 650 μm was diced into a size of 7.5 mm $\times$ 7.5 mm using a common conventional dicing/die-bonding film (FH-900-20 manufactured by Hitachi Chemical Co., Ltd.), and thus elements for evaluation were obtained. These elements for evaluation were die-bonded onto a lead frame that had been subjected to silver plating, and this was used as a substrate for evaluation. The chips for evaluation according to each of various Examples and various Comparative Examples obtained by the technique described for the evaluation of dicing properties were mounted on the elements for evaluation of the substrates for evaluation under the conditions of a temperature of 160°C, a pressure of 0.1 MPa, and a time of 1 second, and twenty reliability samples having a chip-on-chip structure were produced for each of the various Examples and the various Comparative Examples.

[0110] The various reliability samples was treated for 168 hours in a constant temperature constant humidity chamber at 85°C/85%RH, and then a treatment of passing the samples through

an IR (infrared) reflow furnace that was set to obtain a maximum temperature at the sample surface of 260°C for 20 seconds, and cooling the samples by leaving at room temperature, was repeated three times. In regard to the various Examples and various Comparative Examples, the occurrence of detachment between the adhesive layer and the metal layer was observed in the twenty samples that had been treated as described above. A case in which no detachment occurred was rated as O as a good product, and a case in which detachment occurred even in one sample was rated as X as a defective product. When the presence or absence of detachment was observed for the various samples, the observation was made by a reflection method using an ultrasonic probe device (Scanning Acoustic Tomograph: SAT).

[0111] [Table 1]

	Example 1	Example 2	Example 3	Example 4	Example 5	Comparative Example 1	Comparative Example 2
Dicing tape	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Adhesive layer	(1)	(1)	(1)	(3)	(2)	(1)	(3)
Metal layer	(1)	(2)	(3)	(4)	(3)	(5)	(6)
Dicing properties	O	O	O	O	O	X	O
Reliability	O	O	O	O	O	X	X

[0112] As shown in Table 1, in the tapes for semiconductor processing according to Examples 1 to 5, the surface roughness RzJIS of the metal layer was from 0.6 μm to 9.0 μm , which was 0.5 μm or more and less than 10.0 μm as defined in the claims. Thus, results with satisfactory dicing properties and satisfactory reliability were obtained.

[0113] In contrast, the tape for semiconductor processing according to Comparative Example 1 had a surface roughness RzJIS of the metal layer of less than 0.5 μm , and therefore, results with poor dicing properties and poor reliability were obtained. Also, the tape for semiconductor processing according to Comparative Example 2 had a surface roughness RzJIS of the metal layer of 10.0 μm or more, and therefore, results with poor reliability were obtained.

EXPLANATIONS OF LETTERS OR NUMERALS

[0114] 10: Tape for semiconductor processing

11: Base film

12: Pressure-sensitive adhesive layer

13: Dicing tape

14: Metal layer

15: Adhesive layer

CLAIMS

1. A tape for semiconductor processing comprising:
a dicing tape having a base film and a pressure-sensitive adhesive layer;
a metal layer provided on the pressure-sensitive adhesive layer; and
an adhesive layer provided on the metal layer for adhering the metal layer to the back surface of a semiconductor chip, wherein the surface roughness RzJIS of the metal layer based on the 10-point average roughness is 0.5 μm or more and less than 10.0 μm .
2. The tape for semiconductor processing according to claim 1, wherein the metal layer is a copper foil.
3. The tape for semiconductor processing according to claim 1 or claim 2, wherein the adhesive layer contains (A) an epoxy resin, (B) a curing agent, (C) a phenoxy resin, and (D) a surface-treated inorganic filler, and the content of component (D) is from 40% by weight to 65% by weight with respect to the total amount of components (A) to (D).
4. The tape for semiconductor processing according to any one of claims 1 to 3, wherein the pressure-sensitive adhesive layer contains an acrylic polymer composed of an acrylic acid ester represented by the formula: $\text{CH}_2=\text{CHCOOR}$ (wherein R represents an alkyl group having 4 to 8 carbon atoms), a hydroxyl group-containing monomer, and an isocyanate compound having a

radical reactive carbon-carbon double bond in the molecule.