

DESCRIPTION

TAPE FOR ELECTRONIC DEVICE PACKAGING

TECHNICAL FIELD

[0001] The present invention relates to a tape for electronic device packaging. More particularly, the invention relates to a tape for electronic device packaging having a metal layer.

BACKGROUND ART

[0002] In recent years, the demand for thickness reduction and size reduction of electronic equipment such as mobile telephones and laptop computers is ever increasing. Thus, in order to achieve thickness reduction and size reduction of electronic device packages such as semiconductor packages that are mounted on electronic equipment, the number of electrodes in an electronic device or a circuit board is increased, and the pitch is also made narrower. An example of such an electronic device package is a flip chip (FC) mounting package.

[0003] In regard to the flip chip mounting package, as explained above, since the number of electrodes is increased, or the pitch is narrowed, there is a problem of an increase in the amount of heat generation. Thus, as a

heat dissipating structure of a flip chip mounting package, it has been suggested to provide a metal layer on the back surface of an electronic device, with an adhesive layer interposed therebetween (see, for example, Patent Document 1).

[0004] Furthermore, in the flip chip mounting package, there are occasions in which the coefficient of linear expansion of the electronic device is greatly different from the coefficient of linear expansion of the circuit board. In this case, during the process for producing an electron device package, when an intermediate product is heated and cooled, there occur differences in the amount of expansion and the amount of shrinkage between the electronic device and the circuit board. Due to these differences, warpage occurs in the electronic device package. It has been suggested that even for a structure capable of suppressing such warpage, a metal layer should be provided on the back surface of the electronic device, with an adhesive layer interposed therebetween (see, for example, Patent Document 2).

[0005] Furthermore, in regard to the flip chip mounting package, it has also been suggested that a metal layer is provided on the back surface of an electronic device, with an adhesive layer interposed therebetween, and this metal layer is used as a protective layer for laser

marking (see, for example, Patent Document 3).

[0006] In recent years, there are occasions in which on a semiconductor chip, another semiconductor chip having the same size is laminated, and three-dimensional packaging is achieved. Here, in order to make it possible to laminate another semiconductor chip having the same size on a semiconductor chip, it is necessary to have a spacer laminated between the two. It is because the other semiconductor chip is laminated also on the electrode pad portion in the semiconductor chip. It has been suggested to use an adhesive layer-attached metal layer as the spacer described above (see, for example, Patent Document 4).

Patent Document 4 describes that the spacer is provided by a step of bonding an adhesive sheet for spacer having a metal layer equipped with an adhesive layer on at least one surface, onto a dicing sheet, with the adhesive layer being employed as a bonding surface; a step of dicing the adhesive sheet for spacer and thereby forming chip-like spacers having an adhesive layer; a step of pushing up the spacer by means of a pin, and detaching the pushed-up spacer from the dicing sheet together with the adhesive layer by means of a pickup apparatus that is used when semiconductor chips are detached together with an adhesive layer from a dicing sheet; and a step of fixing the spacer onto an adherend with the adhesive layer.

CITATION LIST

PATENT DOCUMENT

[0007] Patent Document 1: JP 2007-235022 A

Patent Document 2: JP 5487847 B

Patent Document 3: JP 5419226 B

Patent Document 4: JP 4954569 B

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0008] As described above, an adhesive layer-attached metal layer is useful for various electronic device packages; however, from the viewpoint of productivity, it is desirable to perform pickup or fixation to an adherend using existing apparatuses, as disclosed in Patent Document 4.

[0009] In existing pickup apparatuses, pickup is performed by vacuum suctioning semiconductor chips with a collet. At this time, since it is necessary to reliably pick up semiconductor chips, the position of the collet is corrected by recognizing the positions of semiconductor chips and thereby detecting shifts of the semiconductor chips, and picking up of the semiconductor chips is carried out.

[0010] As a method of recognizing semiconductor chips,

pattern recognition is mainly used. A method of using pattern recognition involves registering of a circuit, an alignment mark, a chip contour or the like of semiconductor chips in advance as a template, matching this template with an image of the semiconductor chips captured by an image capture device, and thus recognizing the positions of the semiconductor chips. In a case in which a circuit or an alignment mark is not formed as in the case of a bare chip, a template configured to have a chip surface that is uniform with the chip contour is registered.

[0011] When it is attempted to pick up an adhesive layer-attached metal layer from a pressure-sensitive adhesive tape using such an existing pickup apparatus, since the metal layer does not have a circuit, a template configured to have a metal layer surface that is uniform with the metal layer contour, similarly to a bare chip, is used. However, in a case in which the metal layer has high surface roughness, the image capture device detects unevenness of the surface, and it is considered that the metal layer surface thus imaged is different from the template. As a result, there is a problem that individual pieces of the metal layer cannot be recognized.

[0012] Thus, it is an object of the invention to provide a tape for electronic device packaging, which enables, when an adhesive layer-attached metal layer is

picked up from a pressure-sensitive adhesive tape, satisfactory recognition of individual pieces of an adhesive layer-attached metal layer that are intended to be picked up by a pickup apparatus.

MEANS FOR SOLVING PROBLEM

[0013] In order to solve the problems described above, the tape for electronic device packaging according to the invention includes a pressure-sensitive adhesive tape having a base film and a pressure-sensitive adhesive layer; an adhesive layer provided by lamination on a surface of the pressure-sensitive adhesive layer, the surface being on the opposite side of the base film; and a metal layer provided by lamination on a surface of the adhesive layer, the surface being on the opposite side of the pressure-sensitive adhesive layer, in which the metal layer has a surface roughness RzJIS of less than 5.0 μm , the surface roughness RzJIS being based on the 10-point average roughness of the surface on the opposite side of the adhesive layer.

[0014] Regarding the tape for electronic device packaging, it is preferable that the specular gloss at an incident angle of the metal layer of 60 degrees is less than 100%.

[0015] Regarding the tape for electronic device

packaging, it is preferable that the thickness of the metal layer is 5 μm or more and less than 200 μm .

[0016] Regarding the tape for electronic device packaging, it is preferable that the pressure-sensitive adhesive force between the pressure-sensitive adhesive tape and the adhesive layer in a state in which the adhesive layer and the metal layer are picked up from the pressure-sensitive adhesive tape is 0.03 to 0.5 N/25 mm.

[0017] Regarding the tape for electronic device packaging, it is preferable that the metal layer contains copper or aluminum.

[0018] Regarding the tape for electronic device packaging, it is preferable that the adhesive layer contains (A) an epoxy resin, (B) a curing agent, (C) an acrylic resin or a phenoxy resin, and (D) a surface-treated inorganic filler.

[0019] Furthermore, regarding the tape for electronic device packaging, it is preferable that the pressure-sensitive adhesive layer contains an acrylic polymer configured to include an acrylic acid ester represented by the formula: $\text{CH}_2=\text{CHCOOR}$ (wherein R represents an alkyl group having 4 to 18 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

[0020] According to the invention, when an adhesive layer-attached metal layer is picked up from a pressure-sensitive adhesive tape, individual pieces of the adhesive layer-attached metal layer that need to be picked up can be satisfactorily recognized by a pickup apparatus.

BRIEF DESCRIPTION OF DRAWINGS

[0021] Fig. 1 is a cross-sectional view schematically illustrating the structure of a tape for electronic device packaging according to embodiments of the invention;

Fig. 2(a) is a plan view schematically illustrating the structure of a tape for electronic device packaging according to the embodiments of the invention, and Fig. 2(b) is a cross-sectional view of the same;

Fig. 3 is a perspective view schematically illustrating the structure of a tape for electronic device packaging according to the embodiments of the invention;

Fig. 4 is a set of explanatory diagrams schematically illustrating a method for producing a tape for electronic device packaging according to the embodiments of the invention, while Fig. 4(A) is a cross-sectional view in the longitudinal direction illustrating a sticking step for a metal layer; Fig. 4(B) is a cross-sectional view in the longitudinal direction illustrating a sticking step for an

adhesive layer; Fig. 4(C) is a cross-sectional view in the transverse direction illustrating a precutting step; and Fig. 4(D) is a perspective view illustrating a removal step for unnecessary parts;

Fig. 5 is a set of explanatory diagrams schematically illustrating a method for producing a tape for electronic device packaging according to the embodiments of the invention, while Fig. 5(A) is a cross-sectional view in the transverse direction illustrating a sticking step for a pressure-sensitive adhesive tape; Fig. 5(B) is a cross-sectional view in the transverse direction illustrating a precutting step; and Fig. 5(C) is a cross-sectional view in the transverse direction illustrating a removal step for unnecessary parts;

Fig. 6 is a set of cross-sectional views schematically describing a method of using the tape for electric device packaging according to the embodiments of the invention;

Fig. 7 is a set of cross-sectional views schematically describing a method of using the tape for electronic device packaging according to the embodiments of the invention; and

Fig. 8 is a cross-sectional view schematically illustrating the structure of an electronic device package using the tape for electronic device packaging according to

the embodiments of the invention.

MODE(S) FOR CARRYING OUT THE INVENTION

[0022] In the following description, embodiments of the invention will be described in detail.

[0023] Fig. 1 is a cross-sectional view illustrating a tape for electronic device packaging 1 according to the embodiments of the invention. This tape for electronic device packaging 1 comprises a pressure-sensitive adhesive tape 5 composed of a base film 51 and a pressure-sensitive adhesive layer 52 provided on the base film 51, and on the pressure-sensitive adhesive layer 52, an adhesive layer 4 and a metal layer 3 provided by lamination on the adhesive layer 4 are provided. The metal layer 3 may be provided indirectly on the adhesive layer 4, with a primer layer or the like for improving the adhesiveness to the adhesive layer 4 interposed therebetween.

[0024] Regarding the tape for electronic device packaging 1 of the invention, it is preferable that, as illustrated in Fig. 2 and Fig. 3, the pressure-sensitive adhesive tape 5 is cut into a shape corresponding to a ring frame R (see Fig. 7), and the metal layer 3 and the adhesive layer 4 are also cut into a predetermined shape correspondingly to this (precut processing). In the present embodiment, the tape for electronic device

packaging 1 is subjected to precut processing.

[0025] Regarding the tape for electronic device packaging 1 of the invention, it is preferable that, as illustrated in Fig. 2 and Fig. 3, a long base tape 2 having formed thereon a plurality of laminates each obtained by laminating a metal layer 3, an adhesive layer 4, and a pressure-sensitive adhesive tape 5 (label portion 5a) that has been cut into a shape corresponding to a ring frame R, has a shape of being wound up into a roll. According to the present embodiment, the tape for electronic device packaging 1 is wound into a roll form; however, the tape for electronic device packaging 1 may also have a shape in which the laminates provided on the base tape 2 have been cut out one by one.

[0026] In a case in which the tape for electronic device packaging is precut processed and wound into a roll form, as illustrated in Fig. 2 and Fig. 3, the tape for electronic device packaging 1 has a base tape 2, and provided on the base tape 2 are: a metal layer 3 having a predetermined planar shape; an adhesive layer 4 having a predetermined planar shape, which is provided by lamination on the metal layer 3 on the opposite side of the base tape 2 side of the metal layer 3; and a pressure-sensitive adhesive tape 5 having a label portion 5a having a predetermined planar shape, which is provided so as to

cover the adhesive layer 4 and to come into contact with the base tape 2 around the adhesive layer 4, and a peripheral portion 5b that surrounds the outer side of the label portion 5a.

[0027] The label portion 5a has a shape corresponding to a ring frame R for dicing. The shape corresponding to the shape of the ring frame R for dicing is preferably a shape that is approximately the same shape as the inner side of the ring frame R, and is an analogous shape having a larger size than that of the inner side of the ring frame R. Furthermore, the shape is not necessarily a circular shape; however, a shape close to a circular shape is preferred, and a circular shape is more preferred. The peripheral portion 5b includes a form that completely surrounds the outer side of the label portion 5a, and a form that does not completely surrounds as illustrated in the diagram. The peripheral portion 5b needs not be provided; however, if the peripheral portion 5b is provided, the winding tension loaded to the label portion 5a can be dispersed in the shape of being wound into a roll.

The adhesive layer 4 has a predetermined flat surface shape, and this flat surface shape is a shape smaller than the label portion 5a so that the ring frame R can be stuck onto the peripheral edge of the label portion 5a of the

pressure-sensitive adhesive tape 5 and pushed up by a push-up member of a pick-up apparatus (see Fig. 7(C)). It is preferable that the adhesive layer 4 has a shape that is approximately the same as the shape of the label portion 5a, which is an analogous shape having a size smaller than the size of the label portion 5a. The adhesive layer 4 may not be necessarily circular in shape; however, a shape close to a circular shape is preferred, and a circular shape is more preferred.

[0028] The metal layer 3 has a shape similar to that of the adhesive layer 4, and the adhesive layer 4 is laminated on the metal layer 3. Regarding the lamination as used herein, it is acceptable as long as major parts are laminated, and it is not necessarily essential that the metal layer 3 and the adhesive layer 4 have the same shape. However, in view of the convenience of production, it is preferable that the metal layer 3 and the adhesive layer 4 have approximately the same shape. In the following description, the various constituent elements will be described.

[0029] <Base tape 2>

The base tape 2 can be constructed from a known separator; however, a base tape used for the precut processing of a tape for electronic device packaging can also be used directly. In a case in which the base tape

that is used for precut processing of a tape for electronic device packaging is used directly, the base tape 2 needs to maintain the metal layer 3 by pressure-sensitive adhesion during precut processing. Therefore, for example, a tape having a resin film and a pressure-sensitive adhesive layer for a base tape, which is provided on one surface of the resin film, can be suitably used.

[0030] Regarding the material for the resin film that constitutes the base tape 2, known materials can be used, and examples thereof include polyester (PET, PBT, PEN, PBN, and PTT)-based films, polyolefin (PP and PE)-based films, copolymer (EVA, EEA, and EBA)-based films, and films having enhanced adhesiveness and mechanical strength by partially substituting these materials. Laminates of these films may also be employed. From the viewpoints of heat resistance, smoothness, and easy availability, it is preferable that the material for the resin film that constitutes the base tape 2 is selected from polyethylene terephthalate, polypropylene, and polyethylene.

[0031] The thickness of the resin film that constitutes the base tape 2 is not particularly limited, and may be appropriately set; however, the thickness is preferably 10 to 150 μm .

[0032] Regarding the resin that is used for the pressure-sensitive adhesive layer for a base tape, 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 employs an acrylic polymer as a base polymer is preferred.

[0033] 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.

[0034] 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.

[0035] 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.

[0036] Preparation 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 for a base tape, 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.

[0037] Furthermore, in order to enhance the detachability of the pressure-sensitive adhesive tape 5 by controlling the crosslinking density of the pressure-sensitive adhesive layer for a base tape, 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 ray 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 external crosslinking agent and the base polymer to be crosslinked, and based on the use applications as a pressure-sensitive adhesive. Generally, it is preferable that the external crosslinking agent is incorporated in an amount of about 20 parts by weight or less, and more preferably 0.1 parts by weight to 20 parts by weight, relative to 100 parts by weight of the base polymer.

[0038] The thickness of the pressure-sensitive adhesive layer for a base tape is not particularly limited and can be appropriately determined; however, the thickness is generally about 3 to 200 μm . The pressure-sensitive adhesive layer for a base tape may be composed of a single layer, or may also be composed of a plurality of layers.

[0039] <Pressure-sensitive adhesive tape 5>

There are no particular limitations on the pressure-sensitive adhesive tape 5, and any conventional dicing tape can be used. As the pressure-sensitive adhesive tape 5, for example, a product obtained by providing a pressure-sensitive adhesive layer 52 on a base film 51 can be suitably used.

[0040] Regarding the base film 51, any conventionally known base film can be used without any particular limitations; however, in the case of using a radiation-curable material as the pressure-sensitive adhesive layer 52 that will be described below, it is preferable to use a material having radiation transmissibility.

[0041] Examples of the material 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 may be a mixture of two or more materials selected from the group of these materials, or may be a single-layered film or a multilayer film of these materials.

[0042] The thickness of the base film 51 is not particularly limited and may be set as appropriate; however, when the expansion step at the time of picking up is considered, the thickness is preferably 50 to 200 μm .

[0043] In order to enhance the adhesiveness between the base film 51 and the pressure-sensitive adhesive layer

52, the surface of the base film 51 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.

[0044] According to the present embodiment, the pressure-sensitive adhesive layer 52 is provided directly on the base film 51; however, the pressure-sensitive adhesive layer 52 may be provided indirectly, with a primer layer for providing adhesiveness, an anchor layer for enhancing the cutting properties at the time of dicing, a stress relaxation layer, an antistatic layer or the like, interposed therebetween.

[0045] The resin that is used for the pressure-sensitive adhesive layer 52 of the pressure-sensitive adhesive tape 5 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.

[0046] 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.

[0047] 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, crosslinking properties 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.

[0048] 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.

[0049] Preparation 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 52, a composition with suppressed inclusion of low molecular weight substances is preferred, 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.

[0050] Furthermore, in order to enhance the pick-up properties by controlling the crosslinking density of the pressure-sensitive adhesive layer 52, 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 agent is incorporated in an amount of about 20 parts by weight or less, and more preferably 0.1 parts by weight to 20 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.

[0051] As the pressure-sensitive adhesive that constitutes the pressure-sensitive adhesive layer 52, 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.

[0052] 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.

[0053] 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 an oligomer having a molecular weight in the range of about 100 to 30,000 is 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 52 can be appropriately determined depending on the kind of the pressure-sensitive adhesive layer 52.

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.

[0054] Regarding the radiation-curable pressure-sensitive adhesive, there may also be mentioned 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 type radiation-curable pressure-sensitive adhesive does not need to contain an oligomer component and the like, which are low

molecular weight components, or do not include many oligomer components and the like. Therefore, a pressure-sensitive adhesive layer 52 having a stable layer structure can be formed, without allowing oligomer components and the like to migrate around in the pressure-sensitive adhesive over time, and this is preferable.

[0055] 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.

[0056] 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 easy 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.

[0057] 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.

[0058] Regarding the intrinsic type 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.

[0059] 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.

[0060] Among the acrylic polymers described above, particularly acrylic polymer A, which is configured to include an acrylic acid ester represented by the formula: $\text{CH}_2=\text{CHCOOR}$ (wherein R represents an alkyl group having 4 to 18 carbon atoms), a hydroxyl group-containing monomer, and an isocyanate compound having a radical reactive carbon-carbon double bond in the molecule, is preferred.

[0061] If the alkyl group of the acrylic acid alkyl ester has fewer than 4 carbon atoms, the acrylic acid alkyl 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 18 carbon atoms, the glass transition temperature of the pressure-sensitive adhesive layer 52 becomes too high, thereby the adhesion characteristics at normal temperature are deteriorated, and as a result, detachment of the adhesive layer 4 and the metal layer 3 may occur at the time of dicing.

[0062] The acrylic polymer A may also include a unit corresponding to another monomer component, if necessary.

[0063] 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 ray (ultraviolet radiation or the like) can be provided, and the peeling force between the metal layer 3 and the pressure-sensitive adhesive layer 52 can be reduced.

[0064] 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.

[0065] 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 ray, or the pressure-sensitive adhesive force after the irradiation with active energy ray. 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.

[0066] Examples of the polyisocyanate compound include lower aliphatic polyisocyanates such as 1,2-ethylene

diisocyanate, 1,4-butylene diisocyanate, and 1,6-hexamethylene diisocyanate; alicyclic polyisocyanates such as cyclopentylene diisocyanate, cyclohexylene diisocyanate, isophorone diisocyanate, hydrogenated tolylene diisocyanate, and hydrogenated xylene diisocyanate; and aromatic polyisocyanates such as 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, 4,4'-diphenylmethane diisocyanate, and xylene diisocyanate. In addition to them, a trimethylolpropane/tolylene diisocyanate trimer adduct [manufactured by Tosoh Corp., trade name "CORONATE L"], a trimethylolpropane/hexamethylene diisocyanate trimer adduct [manufactured by Tosoh Corp., trade name "CORONATE HL"], and the like are also used. Examples of the epoxy compound include N,N,N',N'-tetraglycidyl-m-xylenediamine, diglycidylaniline, 1,3-bis(N,N-glycidylaminomethyl)cyclohexane, 1,6-hexanediol diglycidyl ether, neopentyl glycol diglycidyl ether, ethylene glycol diglycidyl ether, propylene glycol diglycidyl ether, polyethylene glycol diglycidyl ether, polypropylene glycol diglycidyl ether, sorbitol polyglycidyl ether, glycerol polyglycidyl ether, pentaerythritol polyglycidyl ether, polyglycerol polyglycidyl ether, sorbitan polyglycidyl ether, trimethylolpropane polyglycidyl ether, adipic acid diglycidyl ester, o-phthalic acid diglycidyl ester, triglycidyl tris(2-hydroxyethyl) isocyanurate, resorcin

diglycidyl ether, bisphenol-S-diglycidyl ether, and any epoxy-based resin having two or more epoxy groups in the molecule.

[0067] In the case of using an external crosslinking agent, the amount of use thereof is determined as appropriate based on the balance between the external crosslinking agent and the base polymer to be crosslinked, and according to the use application as a pressure-sensitive adhesive. The amount of use of the external crosslinking agent is generally 20 parts by weight or less (preferably 0.1 part by weight to 10 parts by weight) with respect to 100 parts by weight of the base polymer. The active energy ray-curable pressure-sensitive adhesive may also have, if necessary, conventionally known additives such as various tackifiers, aging preventing agents, and foaming agents incorporated therein in addition to the components described above.

[0068] 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.

[0069] The thickness of the pressure-sensitive adhesive layer 52 is not particularly limited and can be appropriately determined; however, the thickness is

generally about 5 to 200 μm . The pressure-sensitive adhesive layer 52 may be composed of a single layer, or may be composed of multiple layers.

[0070] <Metal layer 3>

The metal that constitutes the metal layer 3 is not particularly limited, and it is preferable that the metal is, for example, at least one metal selected from the group consisting of stainless steel, aluminum, iron, titanium, tin, nickel and copper, from the viewpoint of heat dissipation properties and from the viewpoint of preventing warpage in the electronic device package 8. Among these, it is particularly preferable that the metal layer 3 includes copper, from the viewpoint of obtaining high thermal conductivity and a heat dissipation effect. Furthermore, from the viewpoint of preventing warpage in the electronic device package 8, it is particularly preferable that the metal layer 3 includes aluminum.

[0071] The thickness of the metal layer 3 is preferably 5 μm or more and less than 200 μm . When the thickness is set to be 5 μm or more, even if expansion is achieved to a large extent, the metal layer warping or detaching from the pressure-sensitive adhesive tape can be suppressed, and therefore, the distance between adjacent metal layers can be increased, which facilitates identification of boundaries. Furthermore, when the

thickness is less than 200 μm , processing is easy, and the phenomenon in which, on the occasion in which it is needed to bend the metal layer along the core or the sticking roll during winding or sticking, the metal layer becomes so firm that wrinkles of folding are generated in the metal layer, and recognition errors occur in the pickup apparatus, can be suppressed.

[0072] The surface roughness RzJIS based on the 10-point average roughness of the surface of the metal layer 3, the surface being on the opposite side of the adhesive layer 4, is less than 5.0 μm . By adjusting the surface roughness RzJIS based on the 10-point average roughness of the metal layer 3 to be less than 5.0 μm , a problem of surface unevenness of the surface which causes the imaged metal layer 3 to be different from the template, can be suppressed. Therefore, the registered template matches the image of individual pieces of the metal layer 3 captured for pickup, and the individual pieces are recognized as objects of pickup. The surface roughness RzJIS according to the present specification is the 10-point average roughness defined in Appendix JA of JIS B 0601:2013.

[0073] As such a metal layer 3, a metal foil can be used, and the metal foil may be an electrolytic foil or a rolled foil, as long as the surface roughness RzJIS of the surface on the opposite side of the adhesive layer 4 is

less than 5.0 μm or less. The surface roughness RzJIS can be regulated by the conditions for electrolysis (liquid composition, liquid temperature, current, additives, and the like) in the case of an electrolytic foil.

[0074] The specular gloss at an incident angle of the metal layer 3 of 60 degrees is preferably less than 100%. If the angle or light intensity in the pickup apparatus results in the specular gloss being too high, glare results from the reflected light coming from individual pieces of the metal layer 3 to be picked or nearby pieces, and the contour of the individual pieces of the metal layer 3 to be picked up cannot be easily recognized. If the degree of gloss of the metal layer 3 is less than 100%, glaring is suppressed, and the contour of the individual pieces of the metal layer 3 can be satisfactorily recognized. The degree of gloss is a value measured according to JIS Z8741.

Measurement of the degree of gloss can be carried out using a commercially available gloss meter, and for example, a gloss meter manufactured by Nippon Denshoku Industries Co., Ltd., HANDY GLOSS METER PG-1, and the like can be used.

[0075] In the case of regulating the specular gloss, known surface treatments may be carried out singly or in combination. For example, after a roughening treatment such as Cu plating is carried out, size reduction of roughening particles, increase of the number of roughening

particles, and smoothening of the surface of the roughening particles may be carried by periodic reverse (PR) pulse electrolysis, or the like. Furthermore, if necessary, an alkali immersion treatment may also be carried out for the purpose of removing the residue of surface contaminants such as additives for foil production, or smoothing the surface of roughening particles.

[0076] <Adhesive layer 4>

The adhesive layer 4 is a layer obtained by processing an adhesive into a film in advance.

[0077] The adhesive layer 4 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.

[0078] 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 fluoro resin. 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.

[0079] 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 1 to 18 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.

[0080] The other monomer (a monomer other than an alkyl ester of acrylic acid or methacrylic acid having an alkyl group with 30 or fewer carbon atoms) for forming an acrylic resin is not particularly limited, and examples thereof include a carboxyl group-containing monomer such as acrylic acid, methacrylic acid, carboxyethyl acrylate, carboxypentyl acrylate, itaconic acid, maleic acid, fumaric acid, or crotonic acid; an acid anhydride monomer such as maleic anhydride or itaconic anhydride; a hydroxyl group-containing monomer 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, or (4-hydroxymethylcyclohexyl) methacrylate; a sulfonic acid group-containing monomer such as styrenesulfonic acid, allylsulfonic acid, 2-(meth)acrylamido-2-methylpropanesulfonic acid, (meth)acrylamidopropanesulfonic acid, sulfopropyl (meth)acrylate, or (meth)acryloyloxynaphthalenesulfonic acid; a phosphoric acid group-containing monomer such as 2-hydroxyethylacryloyl phosphate; or acrylonitrile. The term (meth)acrylic acid means acrylic acid and/or methacrylic acid, and the term (meth) of the invention has the same meaning in all cases.

[0081] 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.

[0082] 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.

[0083] 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.

[0084] 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.

[0085] 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.

[0086] 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 accelerating agent can be used.

[0087] Regarding the curing agent for an epoxy resin, it is preferable to use a phenolic resin as explained above; however, known curing agents such as imidazoles, amines, and acid anhydrides can also be used.

[0088] It is important that the adhesive layer 4 has adhesiveness (stickiness) to an adherend 9 such as an electronic device. Thus, in order to crosslink the

adhesive layer 4 in advance to some extent, a polyfunctional compound that reacts with a functional group at the molecular chain terminal of a polymer or the like may be added to the adhesive layer as a crosslinking agent. Thereby, the adhesion characteristics at high temperature can be enhanced, and an improvement of heat resistance can be attempted.

[0089] 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.

[0090] 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.

[0091] If necessary, other additives can be incorporated as appropriate into the adhesive layer 4. 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.

[0092] The filler may be any of an inorganic filler and an organic filler; however, an inorganic filler is suitable. An enhancement of thermal conductivity of the adhesive layer 4, regulation of the elastic modulus, and the like can be promoted by incorporating a filler such as an inorganic filler. Examples of the inorganic filler include ceramics such as silica, clay, gypsum, calcium carbonate, barium sulfate, alumina, beryllium oxide, silicon carbide, aluminum nitride, 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 or 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 regarding silica, fused silica is particularly suitable. The average particle size of the inorganic filler is preferably within

the range of 0.001 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, and according to the invention, the particle size obtainable when the cumulative volume is 50% in the particle size distribution, is designated as the average particle size.

[0093] The amount of incorporation of the filler (particularly, inorganic filler) is preferably 98% by weight or less (0% by weight to 98% by weight) with respect to the organic resin components. Particularly, in the case of silica, the amount of incorporation is suitably 0% by weight to 70% by weight, and in the case of a functional inorganic filler for thermal conduction or electrical conduction, the amount of incorporation is suitably 10% by weight to 98% by weight.

[0094] 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.

[0095] It is particularly preferable, from the viewpoints of adhesiveness and reliability, that the adhesive layer 4 contains (A) an epoxy resin, (B) a curing agent, (C) an acrylic resin or a phenoxy resin, and (D) a surface-treated inorganic filler.

[0096] 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, the above-mentioned known curing agent can be used.

[0097] The (C) acrylic resin has high toughness while achieving a good balance between flexibility and strength. A preferable acrylic resin is a crosslinkable functional group-containing (meth)acrylic copolymer obtained by polymerizing a monomer having an epoxy group, a glycidyl group, an alcoholic hydroxyl group, a phenolic hydroxyl group, or a carboxyl group as a crosslinkable functional group, the acrylic copolymer having a T_g (glass transition temperature) of -50°C to 50°C. Furthermore, if the acrylic resin contains acrylonitrile or the like and exhibits rubber characteristics, superior toughness is obtained.

The (C) phenoxy resin has a long molecular chain and has a structure similar to the structure 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.

[0098] Regarding the (D) surface-treated inorganic filler , an inorganic filler that has been surface-treated with a coupling agent may be mentioned. As the inorganic filler, those known inorganic fillers described above can be used, and examples thereof include silica and alumina. When the inorganic filler is surface-treated with a coupling agent, the inorganic filler acquires satisfactory dispersibility. Accordingly, an adhesive layer having excellent fluidity can be obtained, and therefore the adhesive force to the metal layer 3 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.

[0099] For example, 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.

[0100] The thickness of the adhesive layer 4 is not particularly limited; however, from the viewpoint of sufficiently achieving adhesion between the metal layer and an adherend, the thickness is preferably 3 μm or more, more preferably 5 μm or more. In order to contribute to thickness reduction of the semiconductor package, the thickness is preferably 150 μm or less, and more preferably 100 μm or less. The adhesive layer 4 may be composed of a single layer, or may be composed of a plurality of layers.

[0101] In regard to the adhesive layer 4, it is preferable that the loss tangent, $\tan \delta$, at 25°C and 50% RH is 0.4 or greater. Furthermore, the loss tangent, $\tan \delta$, of the adhesive layer 4 at 25°C and 50% RH is preferably 3 or less.

[0102] The loss tangent, $\tan \delta$, is a value obtainable when the measurement is carried out at 25°C at a

measurement frequency of 1 Hz by increasing the temperature from 0°C at a rate of temperature increase of 5°C/min, using a dynamic viscoelasticity measuring apparatus.

[0103] When the loss tangent, $\tan \delta$ of the adhesive layer 4 at 25°C and 50% RH is 0.4 or higher, the adhesive layer 4 can be relieved from the stress caused by the push-up of a pin of the pickup apparatus. Therefore, even if the push-up amount of the pin becomes large, pin marks occurring in the metal layer 3 can be suppressed. When the loss tangent, $\tan \delta$, is 3 or less, pickup can be carried out satisfactorily without impairing the responsiveness to the push-up of the pin.

[0104] In order to increase the loss tangent, $\tan \delta$, it is desirable that the amount of low molecular weight components such as an epoxy resin and a phenolic resin is increased, while the amount of high molecular weight components such as an acrylic resin is decreased. In the case of incorporating a filler, the amount of incorporation of the filler may be reduced.

[0105] Regarding the adhesive layer 4, it is preferable that the pressure-sensitive adhesive force (23°C, peeling angle: 180°, and linear velocity: 300 mm/min) between the adhesive layer and the metal layer 3 in B-stage (uncured state or semicured state) is 0.3 N/25 mm or higher, more preferably 0.5 N/25 mm or higher, and even

more preferably 1.0 N/25 mm or higher. If the pressure-sensitive adhesive force is less than 0.3 N/25 mm, when the individualized samples are expanded, there is a risk that detachment may occur between the adhesive layer 4 and the metal layer 3.

[0106] It is preferable that the water absorption ratio of the adhesive layer 4 is 1.5 vol% or less. The method for measuring the water absorption ratio is as follows. That is, an adhesive layer 4 (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).

$$\text{Water absorption ratio (vol\%)} = [(M2 - M1)/(M1/d)] \times 100 \quad (1)$$

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.

[0107] It is preferable that the saturation moisture absorption ratio of the adhesive layer 4 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 4 (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.

[0108] It is preferable that the residual volatile matter content of the adhesive layer 4 is 3.0 wt% or less. The method for measuring the residual volatile components

is as follows. That is, an adhesive layer 4 (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).

$$\text{Residual volatile matter content (wt\%)} = [(M2 - M1)/M1] \times 100 \quad (3)$$

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 4, and package cracks may occur.

[0109] The pressure-sensitive adhesive force between the pressure-sensitive adhesive tape 5 and the adhesive layer 4 in a state in which the adhesive layer 4 and the metal layer 3 are to be picked up from the pressure-sensitive adhesive tape 5, is 0.03 to 0.5 N/25 mm. This is the pressure-sensitive adhesive force between the pressure-sensitive adhesive tape 5 and the adhesive layer 4 in a state in which the adhesive layer 4 and the metal layer 3 are to be picked up from the pressure-sensitive adhesive tape 5. Therefore, in the case where the pressure-sensitive

adhesive layer 52 of the pressure-sensitive adhesive tape 5 is constructed from a radiation-curable pressure-sensitive adhesive and the adhesive layer 4 and the metal layer 3 are picked up after irradiating the pressure-sensitive adhesive tape 5 with radiation to lower the pressure-sensitive adhesive force, the pressure-sensitive adhesive force is the pressure-sensitive adhesive force after irradiation with radiation.

[0110] Regarding the pressure-sensitive adhesive force, a pressure-sensitive adhesive tape 5 and an adhesive layer 4, both of which have been cut into a size of 25 mm in width, are bonded together in an environment at 23°C and 50% RH according to JIS Z0237, and the pressure-sensitive adhesive force is measured using a universal tensile testing machine at a peeling angle of 180° and a peeling rate of 300 mm/min.

[0111] In order to adjust the pressure-sensitive adhesive force to the range described above, the viscoelasticity or surface energy of each of the pressure-sensitive adhesive layer 52 of the pressure-sensitive adhesive tape 5 and the adhesive layer 4 may be adjusted, or a combination thereof may be adjusted.

[0112] When the pressure-sensitive adhesive force between the pressure-sensitive adhesive tape 5 and the adhesive layer 4 is 0.5 N/25 mm or less, on the occasion of

picking up the adhesive layer and the metal layer 3 from the pressure-sensitive adhesive tape 5, pickup can be achieved, even if the push-up speed or the push-up amount of the pin is decreased, and thereby the force applied to the metal layer is reduced. Therefore, generation of a pin mark in the metal layer 3 can be suppressed. When the pressure-sensitive adhesive force between the pressure-sensitive adhesive tape 5 and the adhesive layer 4 is 0.03 N/25 mm or larger, on the occasion of expanding the metal layer 3 and the adhesive layer 4, the metal layer 3 and the adhesive layer 4 are satisfactorily retained without being detached from the pressure-sensitive adhesive tape 5.

[0113] Next, an example of the method for producing the tape for electronic device packaging 1 according to the present embodiment will be described. First, a long metal layer 3 is prepared. As the metal layer 3, a commercially available metal foil may be used. Next, as illustrated in Fig. 4(A), the metal layer 3 is stuck onto the pressure-sensitive adhesive surface of the long base tape 2 using a sticking roller r or the like.

[0114] Separately, a long film-like adhesive layer 4 is formed. The adhesive layer 4 can be formed by utilizing a conventionally used method of preparing a resin composition and forming a film-like layer. Specifically, for example, a method of forming the adhesive layer 4 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 or the like 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.

[0115] Next, as illustrated in Fig. 4(B), the adhesive layer 4 that has been detached from the separator is stuck onto the metal layer 3 that is stuck onto the base tape 2, using a sticking roller r or the like.

[0116] In the description given above, it is described that the metal layer 3 is stuck onto the base tape 2, and then the adhesive layer 4 is stuck onto the metal layer 3. However, it is still acceptable that the adhesive layer 4 is stuck onto the metal layer 3, and then the surface on the metal layer 3 side is stuck onto the base tape 2.

[0117] Next, as illustrated in Fig. 4(C), the adhesive layer 4 and the metal layer 3 are precut into a predetermined shape (a circular shape in this embodiment) using a press-cutting blade or the like, and as illustrated in Fig. 4(D), unnecessary parts 6 at the periphery are detached and removed from the base tape 2. Precutting is not limited to the operation described above, and the adhesive layer 4 and the metal layer 3 may be individually divided in advance into a predetermined size such as a size

corresponding to that of the semiconductor chip C, using a lattice-shaped press-cutting blade having a circular-shaped outer frame.

[0118] The method of forming a metal layer 3 and an adhesive layer 4 having a predetermined shape on the base tape 2 is not limited to the method described above. A long metal layer 3 is stuck onto a long base tape 2, the assembly is punched into a predetermined shape, unnecessary parts 6 are removed, and then the adhesive layer 4 that has been formed into a predetermined shape may be stuck onto the metal layer 3 having a predetermined shape.

Alternatively, a metal layer 3 and an adhesive layer 4 that have been respectively formed into a predetermined shape in advance may be stuck onto the base tape 2. However, from the viewpoint of convenience of the production process, it is preferable that the assembly is produced by a process illustrated in Figs. 4(A) to 4(D) as described above.

[0119] Also, separately, a pressure-sensitive adhesive tape 5 is produced. The base film 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 layer composition is

applied on a base film 51 and dried (by heating and crosslinking as necessary), and thus a pressure-sensitive adhesive layer 52 is formed. Examples of the application method include roll coating, screen coating, and gravure coating. The pressure-sensitive adhesive layer 52 may be formed on the base film 51 by applying the pressure-sensitive adhesive layer composition directly on the base film. Alternately, after the pressure-sensitive adhesive layer 52 is formed by applying the pressure-sensitive adhesive layer composition on a release paper that has been release-treated on the surface or the like, the pressure-sensitive adhesive layer may be transferred onto a base film 51. Thereby, a pressure-sensitive adhesive tape 5 having a pressure-sensitive adhesive layer 52 formed on a base film 51 is produced.

[0120] Subsequently, as illustrated in Fig. 5(A), the pressure-sensitive adhesive tape 5 is laminated on the surface on the adhesive layer 4 side of the assembly of the metal layer 3 and the adhesive layer 4 having a predetermined shape, which is provided on the base tape 2, such that the surface on the adhesive layer 4 side is brought into contact with the surface on the pressure-sensitive adhesive layer 52 side of the pressure-sensitive adhesive tape 5.

[0121] Next, as illustrated in Fig. 5(B), the

pressure-sensitive adhesive tape 5 is precut into a predetermined shape using a press-cutting blade or the like, and as illustrated in Fig. 5(C), unnecessary parts 7 of the periphery are removed by detaching from the base tape 2. Thus, the tape for electronic device packaging 1 is produced. Thereafter, the base tape 2 used for the precut processing may be peeled off, and a known separator may be bonded to the pressure-sensitive adhesive layer 52 of the pressure-sensitive adhesive tape 5.

[0122] <Method of use>

Next, the method for producing an electronic device package 8 using the tape for electronic device packaging 1 of the present embodiment will be described with reference to Fig. 6 to Fig. 8. The present embodiment will be described by taking a semiconductor chip C that is flip-chip connected on an adherend 9, as an example of the electronic device package 8.

[0123] [Semiconductor wafer W mounting step]

First, a separate dicing tape D that is similar to the pressure-sensitive adhesive tape 5 of the tape for electronic device packaging 1 of the invention is prepared, and a semiconductor wafer W is stuck onto the center on the dicing tape D as illustrated in Fig. 6(A). This is adhered and retained to be fixed (semiconductor wafer W mounting step), and a ring frame R is stuck to the peripheral edge

of the dicing tape D. At this time, the dicing tape D is stuck to 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 referred to as non-circuit surface, non-electrode-formed surface, or the like). The sticking method is not particularly limited; however, a method by heating and pressure-bonding is preferred. Pressure bonding is usually carried out by pressing with a pressing means such as a pressure-bonding roll.

[0124] [Semiconductor wafer W dicing step]

Next, dicing of the semiconductor wafer W is performed as illustrated in Fig. 6(B). 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 dicing tape D, 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. In the case of implementing expansion of the dicing tape D, the expansion can be carried out using a conventionally known expanding

apparatus.

[0125] [Semiconductor chip C pick-up step]

As illustrated in Fig. 6(C), picking up of the semiconductor chips C is performed, and thus the semiconductor chips C are detached from the dicing tape D. The method for picking up is not particularly limited, and various conventionally known methods can be employed. For example, a method of placing the dicing tape D bonded together with a semiconductor chip C and a ring frame R on a stage S of a pick-up apparatus, with the base film side facing downward; lifting a hollow cylinder-shaped push-up member T while the ring frame R is fixed, so as to expand the dicing tape D; pushing up the individual semiconductor chips C in this state by means of pins N from the base film side of the dicing tape D; and picking up the pushed-up semiconductor chips C using a pick-up apparatus, may be employed.

[0126] [Flip-chip connection step]

The semiconductor chips C thus picked up are fixed to an adherend 9 such as a substrate by a flip-chip bonding method (flip-chip mounting method) as illustrated in Fig. 6(D). Specifically, the semiconductor chips C are fixed to the adherend 9 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 9. For example, first, a flux is attached to bumps 10, which are connection parts that are formed on the circuit surface side of the semiconductor chips C. Next, the bumps 10 of the semiconductor chips C are contacted with a conductor material 11 (solder or the like) for bonding, which is adhered to a connection pad of the adherend 9, and then the bumps 10 and the conductor material 11 are melted while being pressed. Thereby, electrical conduction between the semiconductor chips C and the adherend 9 is secured, and the semiconductor chips C can be fixed to the adherend 9 (flip-chip bonding process). At this time, voids are formed between the semiconductor chips C and the adherend 9, and the distance of voids is generally about 30 μm to 300 μm . The flux remaining on the facing surfaces of the semiconductor chips C and the adherend 9 or in the gaps therebetween is washed and removed.

[0127] As the adherend 9, 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 9, and flip-chip connecting the semiconductor chip C thereon.

[0128] Next, as illustrated in Fig. 7(A), the base tape 2 of the tape for electronic device packaging 1 according to the present embodiment is detached so as to expose the metal layer 3 and the pressure-sensitive adhesive layer 52 of the pressure-sensitive adhesive tape 5, and the peripheral edges of the pressure-sensitive adhesive layer 52 are fixed to the ring frame R.

[0129] Next, as illustrated in Fig. 7(B), the metal layer 3 and the adhesive layer 4 are cut into a size corresponding to the size of the semiconductor chip C and are divided. Cutting can be carried out by a process similar to the semiconductor wafer W dicing step described above. In a case in which the precut processing of dividing the metal layer 3 and the adhesive layer 4 in advance has been carried out, the present step is not implemented.

[0130] Next, as will be illustrated in Fig. 7(C) the individually divided metal layer 3 and the adhesive layer 4 are picked up and then detached from the pressure-sensitive adhesive tape 5. Picking up can be carried out by a process similar to the semiconductor chip C pick-up step described above.

[0131] Next, the adhesive layer 4 side of the metal

layer 3 and the adhesive layer 4 thus picked up is stuck to the back surface of a semiconductor chip C that has been flip-chip connected, as illustrated in Fig. 8.

Subsequently, the periphery of the metal layer 3-attached semiconductor chip C and the gap between the semiconductor chip C and the adherend 9 are filled with a sealant material (sealant resin or the like), and thus assembly is encapsulated. Encapsulation is carried out by a conventional method. At this time, since the metal layer 3 is provided on the back surface of the semiconductor chip C, the warpage occurring due to the difference between the coefficient of thermal expansion of the semiconductor chip C and the coefficient of thermal expansion of the adherend 9 in the flip-chip bonding process is canceled by the difference between the coefficient of thermal expansion of the semiconductor chip C and the coefficient of thermal expansion of the metal layer 3. Furthermore, since the metal layer 3 is provided on the back surface of the semiconductor chip C, the heat generated at the time of being used as an electronic device is dissipated through the metal layer 3.

[0132] Meanwhile, in the description given above, a package structure in which the metal layer 3 is provided directly on the back surface of a semiconductor chip C, with the adhesive layer 4 interposed therebetween, and the

metal layer 3 is encapsulated together with the semiconductor chip C, has been described. However, it is still acceptable that after the semiconductor chip C is encapsulated, the metal layer 3 is provided on the top surface of the encapsulated body by means of the adhesive layer 4. Since the electronic device package 8 undergoes warpage even at the time of encapsulation, the warpage at the time of encapsulation can be canceled by providing the metal layer 3 on the top surface of the encapsulated body.

[0133] In the description given above, a semiconductor chip C that is flip-chip connected onto an adherend 9 has been described as an example of the electronic device package 8. However, the invention is not intended to be limited to this, and for example, in regard to an electronic device package structure in which different semiconductor chips having the same size are laminated on a semiconductor chip, the metal layer 3 may be provided on the semiconductor chip on the lower side, with the adhesive layer 4 interposed therebetween, in order to use the metal layer 3 of the tape for electronic device packaging 1 of the invention as a spacer between two chips.

[0134] <Examples>

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

be limited to these Examples.

[0135] (1) Production of pressure-sensitive adhesive tape

<Pressure-sensitive adhesive layer composition (1)>

As an acrylic copolymer (A1) having functional groups, a copolymer that was composed of 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate and acrylic acid and had a mass average molecular weight of 700,000, with a proportion of 2-ethylhexyl acrylate of 80 mol%, was produced. Next, 2-isocyanatoethyl methacrylate was added thereto so as to obtain an iodine value of 15, and thus an acrylic copolymer (a-1) having a glass transition temperature of -70°C, a hydroxyl group value of 20 mg KOH/g, and an acid value of 5 mg KOH/g was prepared.

[0136] A pressure-sensitive adhesive layer composition (1) was obtained by dissolving a mixture obtained by adding 10 parts by mass of CORONATE L (manufactured by Tosoh Corp.) as a polyisocyanate to 100 parts by mass of the acrylic copolymer (a-1) and adding 3 parts by mass of IRGACURE 184 (manufactured by BASF SE) as a photopolymerization initiator, in ethyl acetate, and stirring the solution.

[0137] <Pressure-sensitive adhesive layer composition (2)>

As an acrylic copolymer (A1) having a functional

group, an acrylic copolymer (a-2) comprising butyl acrylate, 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate and acrylic acid, and having a proportion of 2-ethylhexyl acrylate of 50 mol%, a mass average molecular weight of 650,000, a glass transition temperature of -60°C , a hydroxyl group value of 25 mg KOH/g, and an acid value of 6 mg KOH/g, was prepared.

[0138] A mixture obtained by adding 10 parts by mass of CORONATE L (manufactured by Tosoh Corp.) as a polyisocyanate to 100 parts by mass of the acrylic copolymer (a-2) was dissolved in ethyl acetate and stirred, and thus a pressure-sensitive adhesive layer composition (2) was obtained.

[0139] <Pressure-sensitive adhesive layer composition (3)>

A mixture obtained by adding 8 parts by mass of CORONATE L (manufactured by Tosoh Corp.) as a polyisocyanate to 100 parts by mass of the acrylic copolymer (a-2) was dissolved in ethyl acetate and stirred, and thus a pressure-sensitive adhesive layer composition (3) was obtained.

[0140] The following was produced as a base film.

<Base film (1)>

Resin beads of a mixture of polypropylene PP and a thermoplastic elastomer HSBR (PP : HSBR = 80 : 20) were

melted at 200°C, and the molten resin was molded into a long film form having a thickness of 80 μm using an extruder. Thus, a base film (1) was produced. As the polypropylene PP, F-300SP (trade name) manufactured by Idemitsu Petrochemical Co., Ltd. was used, and as the thermoplastic elastomer HSB, DYNALON 1320P (trade name) manufactured by JSR Corp. was used.

[0141] <Pressure-sensitive adhesive tape (1)>

The pressure-sensitive adhesive layer composition (1) was applied on a release liner formed from a release-treated polyethylene terephthalate film so as to obtain a thickness after drying of 10 μm , and the composition was dried for 3 minutes at 110°C to obtain a pressure-sensitive adhesive layer. Subsequently, the pressure-sensitive adhesive layer was bonded with the base film (1), and thus a pressure-sensitive adhesive tape (1) was produced.

[0142] <Pressure-sensitive adhesive tape (2)>

A pressure-sensitive adhesive tape (2) was produced in the same manner as in the case of the pressure-sensitive adhesive tape (1), except that the pressure-sensitive adhesive layer composition (2) was used.

[0143] <Pressure-sensitive adhesive tape (3)>

A pressure-sensitive adhesive tape (3) was produced in the same manner as in the case of the pressure-sensitive adhesive tape (1), except that the pressure-sensitive

adhesive layer composition (3) was used.

[0144] (2) Production of adhesive layer

[0145] <Adhesive layer (1)>

80 parts by mass of an acrylic resin (manufactured by Nagase Chemtex Corp., trade name "TEISANRESIN SG-P3", Mw 850,000, Tg 12°C), 10 parts by mass of a naphthalene type epoxy resin (manufactured by DIC Corp., trade name "HP-4700"), and 10 parts by mass of a phenolic resin (manufactured by Meiwa Plastic Industries, Ltd., trade name "MEH7851") as a curing agent were dissolved in methyl ethyl ketone, and thus an adhesive layer composition solution was prepared. This adhesive layer composition solution was applied on a release-treated film (release liner) formed from a silicone release-treated polyethylene terephthalate film having a thickness of 50 μm , and then was dried for 5 minutes at 130°C. Thereby, an adhesive layer (1) having a thickness of 20 μm was produced.

[0146] <Adhesive layer (2)>

100 parts by mass of a bisphenol A type phenoxy resin (manufactured by Nippon Steel & Sumikin Chemical Co., Ltd., trade name "YP-50S", Mw 60,000, Tg 84°C), 40 parts by mass of a cresol novolac type epoxy resin (manufactured by Nippon Kayaku Co., Ltd., trade name "EOCN-1020", epoxy equivalent 198, softening point 64°C), 100 parts by mass of a liquid bisphenol A type epoxy resin (Nippon Steel &

Sumikin Chemical Co., Ltd., trade name "YD-128", Mw 400, epoxy equivalent 190), 1.5 parts by mass of imidazole (manufactured by Shikoku Chemicals Corp., trade name "2PHZ-PW") as a curing agent, and 20 parts by mass of a silica filler (manufactured by Admatechs Co., Ltd., trade name "SO-C2", average particle size 0.5 μm) were dissolved or dispersed in methyl ethyl ketone, and thus an adhesive layer composition solution was prepared. An adhesive layer (2) having a thickness of 20 μm was produced in the same manner as in the case of the adhesive layer (1) using the aforementioned adhesive layer composition solution.

[0147] The following was prepared as the metal layer.

<Metal layer (1)>

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

<Metal layer (2)>

GTS (Furukawa Electric Co., Ltd., copper foil, thickness 9 μm , surface roughness RzJIS 6.0 μm)

<Metal layer (3)>

1085 (UACJ, aluminum foil, thickness 20 μm , surface roughness RzJIS 1.9 μm)

<Metal layer (4)>

1085 (UACJ, aluminum foil, thickness 20 μm , surface roughness RzJIS 4.9 μm)

<Metal layer (5)>

SUS304 (Nippon Steel & Sumikin Materials Co., Ltd., stainless steel foil, thickness 20 μm , surface roughness RzJIS 2.1 μm)

<Metal layers (6) to (11)>

An electrolytic copper foil having a thickness of 35 μm , a degree of gloss at M surface of 230%, a degree of gloss at S surface of 100% was degreased and washed with acid, and then the electrolytic copper foil was subjected to a roughening treatment, a PR pulse electrolysis, and alkali immersion treatment under the conditions indicated in the following Tables 1 and 2. Thus, metal layer (6) to (11) were prepared.

The surface roughness RzJIS in the metal layers (1) to (11) is the surface roughness RzJIS based on the 10-point average roughness of a surface of the metal layer, the surface not being stuck to the adhesive layer. The degree of gloss in the metal layers (6) to (11) is a specular gloss at an incident angle of 60 degrees of a surface of the metal layer, the surface not being stuck to the adhesive layer, and is a specular gloss measured using a gloss meter manufactured by Nippon Denshoku Industries, Ltd., HANDY GLOSS METER PG-1 according to JIS Z 8741.

[0148] [Table 1]

Roughening treatment in common			PP pulse electrolysis in common					
Copper	Sulfuric acid	Temperature	Copper	Sulfuric acid	Temperature	ton	trev	toff
[g/L]	[g/L]	[°C]	[g/L]	[g/L]	[°C]	[ms]	[ms]	[ms]
30	180	25	50	100	30	200	50	200

[0149]

[Table 2]

		Metal layer (6)	Metal layer (7)	Metal layer (8)	Metal layer (9)	Metal layer (10)	Metal layer (11)
Treated surface		M	M	M	S	S	M
Roughening treatment	PPS [mg/L]	1.5	0.5	1	0.5	0.5	2
	Current density [A/dm ²]	80	30	40	40	40	60
	Time [s]	4	4	4	4	4	6
PP pulse electrolysis	Ion [A/dm ²]	4	1	2	2	1	-
	I _{rev} [A/dm ²]	-6	-2	-4	-4	-2	-
	Time [s]	60	5	30	30	20	-
Alkali immersion treatment	Time [s]	8	-	16	6	16	-
	Temperature [°C]	40	-	45	40	45	-
Surface roughness RzJIS [μm]		0.62	1.2	1.53	2.23	2.81	3.56
Degree of gloss [%]		86	117	24	28	9	1

[0150] (5) Production of tape for electronic device packaging

<Example 1>

A single-sided adhesive film was produced by laminating an adhesive layer (1) and a metal layer (1) on the release liner described above, under the conditions of a lamination angle of 120°, a pressure of 0.2 MPa, and a rate of 10 mm/s. The pressure-sensitive adhesive tape (1) was precut into a circular shape so that the pressure-sensitive adhesive tape could be stuck onto a ring frame, and the single-sided adhesive film was precut into a circular shape that was smaller than the pressure-sensitive adhesive tape (1). The adhesive layer (1) side exposed by peeling off the release-treated film of the single-sided adhesive film, and the pressure-sensitive adhesive layer of the pressure-sensitive adhesive tape (1) were bonded together such that the pressure-sensitive adhesive layer would be exposed at the periphery of the single-sided

adhesive film. Thus, a tape for electronic device packaging according to Example 1 illustrated in Fig. 1 was produced.

[0151] <Examples 2 to 12 and Comparative Example 1>

Tapes for electronic device packaging of Examples 2 to 12 and Comparative Example 1 were produced by the same technique as in Example 1, except that the combination of the pressure-sensitive adhesive tape, the adhesive layer composition, and the metal layer was set to the combinations described in Tables 3 and 4.

[0152] The following measurement and evaluations were carried out on the tapes for electronic device packaging according to Examples 1 to 12 and Comparative Example 1. The results are presented in Tables 3 and 4.

[0153] (Pressure-sensitive adhesive force between pressure-sensitive adhesive tape and adhesive layer)

The adhesive layer according to each of the Examples and Comparative Examples was peeled off from the release liner, a shape retaining tape (manufactured by Sekisui Chemical Co., Ltd., trade name "FORTE") was bonded to the surface of the adhesive layer using a 2-kg roller, and the resultant was cut into a strip form having a width of 25 mm. Thus, a specimen having a base film, a pressure-sensitive adhesive layer, an adhesive layer, and a shape retaining tape laminated in this order was produced. Among

the specimens thus produced, Examples 1, 3, 4, and 7 to 12 were irradiated with 200 mJ/cm² of ultraviolet radiation using an air cooled type high pressure mercury lamp (80 W/cm, distance of irradiation 100 mm). Subsequently, each specimen was dividedly gripped into a laminate of "base film and pressure-sensitive adhesive layer" and a laminate of "adhesive layer and shape retaining tape" by means of a Stograph (trade name "VE10") manufactured by Toyo Seiki Seisakusho, Ltd., and the pressure-sensitive adhesive force between the pressure-sensitive adhesive layer and the adhesive layer was measured at a linear velocity of 300 mm/min. The unit of the pressure-sensitive adhesive force is [N/25 mm]. Measurement was carried out according to a 180° peeling method, and the measurement temperature was 23°C, while the measurement humidity was 50%. The specimen was divided into a laminate of "base film and pressure-sensitive adhesive layer" and a laminate of "adhesive layer and shape retaining tape", and the "adhesive layer and shape retaining tape" was detached from the "base film and pressure-sensitive adhesive layer", because if only the adhesive layer is gripped and detached, there is a risk that the adhesive layer may be stretched.

[0154] (Loss tangent, $\tan \delta$, of adhesive layer)

The adhesive layer according to each of the Examples and Comparative Examples was cut out into a size of 5.0 cm

× 5.0 cm, the adhesive layers were laminated and bonded together on a hot plate having a stage at 70°C using a hand roller, and thus a specimen having a thickness of about 1.0 mm was obtained. The temperature of this specimen was raised in a temperature range of 10°C to 150°C at a rate of temperature increase of 5°C/min using a rheometer (trade name "RS6000") manufactured by Haake GmbH, and the loss tangent, $\tan \delta$, at 25°C was determined. Measurement was carried out at 50% RH and a measurement frequency of 1 Hz.

[0155] (Recognizability)

The metal layer and the adhesive layer of the tape for electronic device packaging of each sample of the Examples and Comparative Examples were individually divided into samples having a size of 5 mm × 5 mm. Subsequently, the pressure-sensitive adhesive layer was irradiated with 200 mJ/cm² of ultraviolet radiation through the base film side using an air cooled type high pressure mercury lamp (80 W/cm, distance of irradiation 10 cm). For 100 individually divided samples at the central part of the tape for electronic device packaging, it was checked whether the individually divided samples could be recognized in the same manner as in the case of silicon wafer chips, using a dice picker apparatus (trade name "CAP-300II") manufactured by Canon Machinery, Inc. Samples that could be recognized similarly to chips were rated as

O as good products; samples that could be recognized similarly to chips by changing the angle of light irradiation or the dose of irradiation were rated as Δ as acceptable products; and samples that could not be recognized were rated as X as poor products. The results are presented in Tables 3 and 4.

[0156] (Pickup performance)

After the test for recognizability, 250 units of the individually divided samples described above were subjected to a pickup test under the pickup conditions described below, and the height of pin at which 200 or more samples could be picked up (pin height) was calculated. The upper limit of the pin height was set to 400 μm . The results are presented in Tables 3 and 4. The tape for electronic device packaging according to Example 6 had an excessively high pressure-sensitive adhesive force between the pressure-sensitive adhesive tape and the adhesive layer, and the individually divided samples could not be picked up under the present test conditions. Therefore, the pin height could not be calculated. However, recognition of the individually divided samples was enabled, and if the pin height is set to be higher than 400 μm , the samples can be picked up. Therefore, there is no problem with this. If the pin height increases, there is a risk that pin marks may be produced in the metal layer. However, in a case in

which pin marks are produced, when the metal layer and the adhesive layer are stuck onto the back surface of a semiconductor chip, the metal layer may be pressed, and the pin marks may be flattened. Furthermore, in the case of the tape for electronic device packaging according to Comparative Example 1, individually divided samples could not be recognized and could not be picked up. Therefore, the pin height could not be calculated.

<Pickup conditions>

Pickup apparatus: CAP-300II manufactured by Canon Machinery, Inc.

Shape of push-up pin: radius 0.7 mm, radius of curvature R of tip = 0.25 mm, tip $\theta = 15$

Pin push-up speed: 50 mm/sec

[0157] [Table 3]

	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Comparative Example 1
Pressure-sensitive adhesive tape	(1)	(2)	(1)	(1)	(2)	(3)	(2)
Adhesive layer	(2)	(2)	(2)	(1)	(1)	(2)	(2)
Metal layer	(1)	(4)	(3)	(5)	(4)	(4)	(2)
Type	Cu	Al	Al	SUS	Al	Al	Cu
Surface roughness RzJIS [μm]	2.8	4.9	1.9	2.1	4.9	4.9	6.0
Pressure-sensitive adhesive force [N/25 mm]	0.08	0.46	0.08	0.04	0.42	0.58	0.46
Adhesive layer $\tan \delta$	2.33	2.33	2.33	0.43	0.43	2.33	2.33
Recognizability	○	○	○	○	○	○	×
Pin height [μm]	170	370	180	160	350	N.D.	N.D.

[0158] [Table 4]

	Example 7	Example 8	Example 9	Example 10	Example 11	Example 12
Pressure-sensitive adhesive tape	(1)	(1)	(1)	(1)	(1)	(1)
Adhesive layer	(2)	(2)	(2)	(2)	(2)	(2)
Metal layer	(6)	(7)	(8)	(9)	(10)	(11)
Surface roughness RzJIS [μm]	0.62	1.2	1.53	2.23	2.81	3.56
Degree of gloss [%]	86	117	24	28	9	1
Pressure-sensitive adhesive force [N/25 mm]	0.08	0.08	0.08	0.08	0.08	0.08
Adhesive layer $\tan \delta$	2.33	2.33	2.33	2.33	2.33	2.33
Recognizability	○	△	○	○	○	○
Pin height [μm]	170	170	170	160	170	170

[0159] As shown in Tables 3 and 4, the tapes for electronic device packaging according to Examples 1 to 12 gave satisfactory results in connection with the evaluation of recognizability because the surface roughness RzJIS based on the 10-point average roughness of the surface of the metal layer on the opposite side of the adhesive layer was less than 5.0 μm . As shown in Table 4, the tape for electronic device packaging according to Example 8 had a specular gloss of 117% at an incident angle of the metal layer of 60 degrees, and therefore, it was necessary to change the angle of light irradiation and the amount of irradiation. However, since the individually divided samples could be recognized after the angle of irradiation and the amount were regulated, Example 8 was at a tolerable level.

[0160] In contrast, the tape for electronic device packaging according to Comparative Example 1 was such that the surface roughness RzJIS based on the 10-point average roughness of the surface of the metal layer on the opposite side of the adhesive layer was 6.0 μm , inferior results

were obtained in the evaluation of recognizability.

EXPLANATIONS OF LETTERS OR NUMERALS

[0161] 1: Tape for electronic device packaging

 2: Base tape

 3: Metal layer

 4: Adhesive layer

 5: Pressure-sensitive adhesive tape

 5a: Label portion

 5b: Peripheral portion

CLAIMS

1. A tape for electronic device packaging, comprising:
 - a pressure-sensitive adhesive tape having a base film and a pressure-sensitive adhesive layer;
 - an adhesive layer provided by lamination on a surface of the pressure-sensitive adhesive layer, the surface being on the opposite side of the base film; and
 - a metal layer provided by lamination on a surface of the adhesive layer, the surface being on the opposite side of the pressure-sensitive adhesive layer,wherein the metal layer has a surface roughness RzJIS of less than 5.0 μm , the surface roughness RzJIS being based on the 10-point average roughness of the surface on the opposite side of the adhesive layer.
2. The tape for electronic device packaging according to claim 1, wherein the metal layer has a specular gloss at an incident angle of 60 degrees of less than 100%.
3. The tape for electronic device packaging according to claim 1 or 2, wherein the metal layer has a thickness of 5 μm or more and less than 200 μm .
4. The tape for electronic device packaging according to any one of claims 1 to 3, wherein the pressure-sensitive

adhesive force between the pressure-sensitive adhesive tape and the adhesive layer in a state in which the adhesive layer and the metal layer are picked up from the pressure-sensitive adhesive tape is 0.03 to 0.5 N/25 mm.

5. The tape for electronic device packaging according to any one of claims 1 to 4, wherein the metal layer contains copper or aluminum.

6. The tape for electronic device packaging according to any one of claims 1 to 5, wherein the adhesive layer contains: (A) an epoxy resin, (B) a curing agent, (C) an acrylic resin or a phenoxy resin, and (D) a surface-treated inorganic filler.

7. The tape for electronic device packaging according to any one of claims 1 to 6, wherein the pressure-sensitive adhesive layer contains an acrylic polymer configured to include an acrylic acid ester represented by the formula: $\text{CH}_2=\text{CHCOOR}$ (wherein R represents an alkyl group having 4 to 18 carbon atoms), a hydroxyl group-containing monomer, and an isocyanate compound having a radical reactive carbon-carbon double bond in the molecule.