

DESCRIPTION

Title of Invention

METHOD FOR MANUFACTURING ADHESIVE SHEET, METHOD
FOR MANUFACTURING DICING/DIE-BONDING TAPE, METHOD
5 FOR MANUFACTURING SEMICONDUCTOR DEVICE, METHOD
FOR TREATING ADHESIVE, METHOD FOR IMMOBILIZING
ADHEREND, AND METHOD FOR PEELING ADHEREND

Technical Field

[0001] The present invention relates to a method for producing a tacky
10 adhesive sheet, a method for producing a dicing/die bonding integrated
tape, a method for producing a semiconductor device, a method for
treating a tacky adhesive, a method for immobilizing an adherend, and a
method for peeling an adherend.

Background Art

15 [0002] A tacky adhesive has been used in various use applications in the
industrial field. Industrially, the tacky adhesive force (bulk property of
the tacky adhesive itself attributed to a cross-linking density or the like)
is generally controlled by adjusting the cross-linking density.

[0003] On the other hand, a method of increasing tacky adhesion
20 between an adherend and a tacky adhesive by executing a surface
treatment to the adherend has been known. For example, Patent
Literature 1 describes that, by executing a plasma treatment to a synthetic
resin product (adherend), tacky adhesion between the synthetic resin
product and a coating film is improved. Furthermore, Patent Literature
25 2 describes that, in a tacky adhesive sheet, by executing a plasma
treatment or the like to a plastic film base material (adherend), the anchor

property of a plastic film base material surface with respect to a tacky adhesive layer may be improved. In both the patent literatures, it is disclosed that the surface treatment is executed to the adherend from the viewpoint of increasing tacky adhesion.

5 **Citation List**

Patent Literature

[0004] Patent Literature 1: JP No. S59-100143

Patent Literature 2: JP No. 2011-068718

Summary of Invention

10 **Technical Problem**

[0005] However, there is still a room for improvement in tacky adhesive force of a conventional tacky adhesive. In this regard, a main object of the present invention is to provide a method for producing a tacky adhesive sheet, the method capable of producing a tacky adhesive sheet
15 having a tacky adhesive layer excellent in tacky adhesive force.

Solution to Problem

[0006] As an influencing factor of tacky adhesion between the adherend and the tacky adhesive, other than the tacky adhesive force of the tacky adhesive (bulk property of the tacky adhesive itself), compatibility
20 (wettability) of the tacky adhesive with respect to the adherend is mentioned. However, according to the studies of the present inventors, it has been clear that, in the method of controlling the tacky adhesive force of the tacky adhesive by adjusting the cross-linking density of the tacky adhesive, tacky adhesive force and wettability have a so-called trade-off
25 relation. For example, when the cross-linking density is adjusted so as to increase tacky adhesive force, the wettability of the tacky adhesive

with respect to the adherend tends to be decreased. Further, as a result of further studies based on such findings, it has been found that, by executing a plasma treatment to a tacky adhesive layer instead of an adherend, a contact angle of a surface to be treated is decreased, and tacky adhesive force can be improved, thereby completing the present invention.

[0007] An aspect of the present invention provides a method for producing a tacky adhesive sheet, the method including a step of preparing a tacky adhesive sheet precursor having a base material and a tacky adhesive layer provided on the base material, and a step of executing a plasma treatment to a surface of the tacky adhesive layer on the side opposite to the base material in the tacky adhesive sheet precursor.

[0008] The plasma treatment may be a plasma treatment using atmospheric pressure plasma. A treatment temperature of the plasma treatment may be lower than a lower temperature of a melting point of the base material and a melting point of the tacky adhesive layer.

[0009] The method for producing a tacky adhesive sheet may further include a step of pasting a protective material onto the surface of the tacky adhesive layer subjected to the plasma treatment on the side opposite to the base material. In the protective material, a surface on the side which is pasted to the tacky adhesive layer subjected to the plasma treatment may be a surface treated by the plasma treatment.

[0010] In another aspect, the present invention provides a tacky adhesive sheet obtained by the aforementioned producing method.

[0011] In still another aspect, the present invention provides a method

for producing a dicing/die bonding integrated tape, the method including a step of forming a bonding adhesive layer on the surface of the tacky adhesive layer subjected to the plasma treatment on the side opposite to the base material in the tacky adhesive sheet obtained by the
5 aforementioned producing method.

[0012] In still another aspect, the present invention provides a dicing/die bonding integrated tape obtained by the aforementioned producing method.

[0013] In still another aspect, the present invention provides a method
10 for producing a semiconductor device, the method including a step of pasting the bonding adhesive layer of the dicing/die bonding integrated tape obtained by the aforementioned producing method to a semiconductor wafer, a step of individuating the semiconductor wafer, the bonding adhesive layer, and the tacky adhesive layer subjected to the
15 plasma treatment, a step of picking up a semiconductor element attached with the bonding adhesive layer from the tacky adhesive layer subjected to the plasma treatment, and a step of bonding the semiconductor element to a support substrate for mounting a semiconductor element via the bonding adhesive layer.

[0014] In still another aspect, the present invention provides a method
20 for treating a tacky adhesive, the method including a step of executing a plasma treatment to a tacky adhesive. The plasma treatment may be a plasma treatment using atmospheric pressure plasma. A treatment temperature of the plasma treatment may be lower than a melting point
25 of the tacky adhesive.

[0015] In still another aspect, the present invention provides a method

for immobilizing an adherend, the method including a step of pasting a second adherend to a first adherend via the tacky adhesive treated by the aforementioned method. Furthermore, in further still another aspect, the present invention provides a method for peeling an adherend, the method including a step of treating with water at least one of an interface between the first adherend of the adherend immobilized by the aforementioned method and the tacky adhesive and an interface between the second adherend and the tacky adhesive to peel the first adherend and the second adherend.

Advantageous Effects of Invention

[0016] According to the present invention, it is possible to provide a producing method capable of producing a tacky adhesive sheet having a tacky adhesive layer excellent in tacky adhesive force. Furthermore, according to the present invention, it is possible to provide a method for producing a dicing/die bonding integrated tape using the tacky adhesive sheet obtained by such a producing method. Furthermore, according to the present invention, it is possible to provide a method for producing a semiconductor device using the dicing/die bonding integrated tape obtained by such a producing method. Further, according to the present invention, it is possible to provide a method for treating a tacky adhesive, a method for immobilizing an adherend, and a method for peeling an adherend.

Brief Description of Drawings

[0017] FIG. 1 is a cross-sectional view schematically illustrating an embodiment of a method for producing a tacky adhesive sheet. FIGS. 1(a), 1(b), 1(c), and 1(d) are cross-sectional views schematically

illustrating respective steps.

FIG. 2 is a cross-sectional view schematically illustrating an embodiment of a method for producing a dicing/die bonding integrated tape. FIGS. 2(a), 2(b), and 2(c) are cross-sectional views schematically illustrating respective steps.

FIG. 3 is a cross-sectional view schematically illustrating an embodiment of a method for producing a semiconductor device. FIGS. 3(a), 3(b), 3(c), 3(d), 3(e), and 3(f) are cross-sectional views schematically illustrating respective steps.

FIG. 4 is a cross-sectional view schematically illustrating an embodiment of a semiconductor device.

Description of Embodiments

[0018] Hereinafter, embodiments of the present invention will be described with reference to the drawings as appropriate. However, the present invention is not limited to the following embodiments. In the following embodiments, the constituent elements (including a step or the like) are not always indispensable unless otherwise specified. The sizes of constituent elements in the respective drawings are conceptual, and the relative size relationships between the constituent elements are not restricted to those illustrated in the respective drawings.

[0019] The same applies to numerical values and ranges thereof in the present specification, and the present invention is not limited thereby. A numerical range expressed by using "to" in the present specification indicates a range including the numerical values before and after "to" as the minimum value and the maximum value, respectively. In a numerical range described in the present specification in a stepwise

manner, an upper or lower limit value described in one numerical range may be replaced with an upper or lower limit value in the other numerical range described in a stepwise manner. Furthermore, in a numerical range described in the present specification, an upper or lower limit value of the numerical range may be replaced with a value shown in Examples. [0020] In the present specification, (meth)acrylate means acrylate or methacrylate corresponding thereto.

[0021] [Method for producing tacky adhesive sheet]

FIG. 1 is a cross-sectional view schematically illustrating an embodiment of a method for producing a tacky adhesive sheet. A method for producing a tacky adhesive sheet according to the present embodiment includes a step of preparing a tacky adhesive sheet precursor having a base material and a tacky adhesive layer provided on the base material (a step of preparing a tacky adhesive sheet precursor), and a step of executing a plasma treatment to a surface of the tacky adhesive layer on the side opposite to the base material in the tacky adhesive sheet precursor (a step of executing a plasma treatment). The method for producing a tacky adhesive sheet according to the present embodiment may further include a step of pasting a protective material onto the surface of the tacky adhesive layer subjected to the plasma treatment on the side opposite to the base material (a step of disposing a protective material).

[0022] <Step of preparing tacky adhesive sheet precursor>

In this step, a tacky adhesive sheet precursor 100 to be subjected to a plasma treatment is prepared (see FIG. 1(a)). The tacky adhesive sheet precursor 100 has a base material 10 and a tacky adhesive layer 20 provided on the base material 10.

[0023] The base material 10 is not particularly limited as long as it has a melting point (or a decomposition point or a softening point) higher than heat generated by the plasma treatment, and a base film that is used in the field of a tacky adhesive can be used. It is preferable that the base film can be expanded in a die bonding step. Examples of such a base film include plastic films including a polyester-based film such as a polyethylene terephthalate film, a polyolefin-based film such as a polytetrafluoroethylene film, a polyethylene film, a polypropylene film, a polymethylpentene film, and a polyvinyl acetate film, a polyvinyl chloride film, and a polyimide film. In the base material 10, a surface on which the tacky adhesive layer 20 is formed may be subjected to a surface treatment such as a corona treatment.

[0024] The tacky adhesive layer 20 is a layer configured by a tacky adhesive component. The tacky adhesive component constituting the tacky adhesive layer 20 is not particularly limited as long as it has a melting point (or a decomposition point or a softening point) higher than heat generated by the plasma treatment, and a component having tacky adhesive force at room temperature (25°C) and having sticking force with respect to a layer (for example, a bonding adhesive layer described below) stacked on the tacky adhesive layer 20. The tacky adhesive component constituting the tacky adhesive layer 20 may contain a base resin. Examples of the base resin include an acrylic resin, synthetic rubber, natural rubber, and a polyimide resin. The base resin preferably has a functional group such as a hydroxyl group or a carboxy group that can react with a cross-linking agent or the like which will be described below, from the viewpoint of reducing the remaining paste of the tacky

adhesive component. The base resin may be a resin that is cured with high energy rays such as ultraviolet rays and radiation or a resin that is cured by heat. The base resin is preferably a resin that is cured with high energy rays and more preferably a resin that is cured with ultraviolet rays (an ultraviolet curable base resin).

[0025] In the case of using a resin, which is cured by high energy rays, as the base resin, a photopolymerization initiator may be used in combination as necessary. The photopolymerization initiator may be, for example, an aromatic ketone compound, a benzoin ether compound, a benzyl compound, an ester compound, an acridine compound, a 2,4,5-triarylimidazole dimer, or the like.

[0026] The tacky adhesive component may contain a cross-linking agent that can form a cross-linked structure with the functional group of the base resin in order to adjust tacky adhesive force. The cross-linking agent preferably has at least one functional group selected from the group consisting of an epoxy group, an isocyanate group, an aziridine group, and a triazinyl group. The cross-linking agent may be used alone or in combination of two or more kinds thereof.

[0027] Adjustment of the content of the cross-linking agent is effective for maintaining the effect obtained by the plasma treatment. The content of the cross-linking agent is preferably 5 parts by mass or more, more preferably 7 parts by mass or more, and further preferably 10 parts by mass or more, with respect to 100 parts by mass of the base resin. When the content of the cross-linking agent is 5 parts by mass or more with respect to 100 parts by mass of the base resin, there is a tendency that attenuation of the effect obtained by the plasma treatment can be

suppressed. The content of the cross-linking agent may be 30 parts by mass or less with respect to 100 parts by mass of the base resin. When the content of the cross-linking agent is 30 parts by mass or less with respect to 100 parts by mass of the base resin, there are tendencies that the effect obtained by the plasma treatment is likely to be maintained and a decrease in adhesiveness between the tacky adhesive layer and the protective material can be suppressed.

[0028] The tacky adhesive component may contain other components. Examples of the other components include catalysts such as amine and tin to be added for promoting a cross-linking reaction between the base resin and the photopolymerization initiator; tackifiers such as a rosin-based tackifier and a terpene resin-based tackifier to be added for appropriately adjusting tacky adhesive characteristics; and various surfactants.

[0029] In an embodiment, the tacky adhesive layer 20 may be a layer configured by a tacky adhesive component containing an acrylic resin having a hydroxyl group and a cross-linking agent having an isocyanate group.

[0030] The acrylic resin having a hydroxyl group as the base resin is obtained by polymerizing a monomer component containing (meth)acrylate having a hydroxyl group. The polymerization method can be appropriately selected from known polymerization methods such as various radical polymerizations, and examples thereof include a suspension polymerization method, a solution polymerization method, and a bulk polymerization method.

[0031] In the case of polymerizing a monomer component in the above-

described polymerization method, a polymerization initiator may be used as necessary. Examples of such a polymerization initiator include ketone peroxide, peroxyketal, hydroperoxide, dialkyl peroxide, diacyl peroxide, peroxycarbonate, peroxyester, 2,2'-azobisisobutyronitrile, 2,2'-azobis(2,4-dimethylvaleronitrile), and 2,2'-azobis(4-methoxy-2'-dimethylvaleronitrile).

[0032] The tacky adhesive sheet precursor 100 having the tacky adhesive layer 20 can be produced by using a known method. The tacky adhesive sheet precursor 100 can be obtained, for example, by a producing method including a step of diluting a material for a tacky adhesive layer with a dispersion medium to prepare a varnish, a step of coating the obtained varnish onto the aforementioned base material 10, and a step of removing the dispersion medium from the coated varnish.

[0033] The thickness of the tacky adhesive layer 20 in the tacky adhesive sheet precursor 100 may be 0.1 to 30 μm . When the thickness of the tacky adhesive layer 20 is 0.1 μm or more, there is a tendency that sufficient tacky adhesive force can be secured. When the thickness of the tacky adhesive layer 20 is 30 μm or less, there is a tendency of having an economic advantage.

[0034] The whole thickness of the tacky adhesive sheet precursor 100 (the total thickness of the base material 10 and the tacky adhesive layer 20) may be 5 to 150 μm , 50 to 150 μm or 100 to 150 μm .

[0035] In the tacky adhesive sheet precursor 100, before executing the plasma treatment, a protective material may be pasted to a surface of the tacky adhesive layer 20 on the side opposite to the base material 10. The same protective material exemplified in a protective material 30

described below can be used.

[0036] <Step of executing plasma treatment>

In this step, the plasma treatment (A of FIG. 1(b)) is executed to a surface of the tacky adhesive layer 20 on the side opposite to the base material 10 in the tacky adhesive sheet precursor 100 (see FIG. 1(b)).
5 Thereby, a tacky adhesive sheet 110 having a tacky adhesive layer subjected to a plasma treatment A (a tacky adhesive layer 20A obtained after the plasma treatment) can be produced (see FIG. 1(c)).

[0037] Plasma is in a state in which molecules constituting gas are partially or fully ionized and separated into cations and electrons that move freely. By treating the surface of the tacky adhesive layer on the side opposite to the base material using a gas in a plasma state, a chemical reaction proceeds on the surface of the tacky adhesive layer, a hydrophilic group containing oxygen is imparted, a contact angle of a surface to be treated is decreased, and thus wettability can be improved. The tacky adhesive force of the tacky adhesive layer 20 of the tacky adhesive sheet precursor can be improved by utilizing this reaction.

[0038] The plasma treatment is not particularly limited, and may be a plasma treatment using atmospheric pressure plasma from the viewpoints of cost, treatment capacity, and damage reduction. The plasma treatment using atmospheric pressure plasma can be executed, for example, by using an ultra-high-density atmospheric pressure plasma unit (manufactured by Fuji Machine Manufacturing Co., Ltd., trade name: FPB-20 TYPE II).

[0039] The treatment temperature of the plasma treatment is preferably lower than a lower temperature of the melting point of the base material

10 and the melting point of the tacky adhesive layer 20, from the viewpoint of avoiding damage to the base material 10 and the tacky adhesive layer 20 caused by the plasma treatment. The plasma treatment is preferably performed while conditions such as a treatment temperature, a treatment speed, and the like are adjusted so that wrinkles, deflection, and the like do not occur in the tacky adhesive sheet precursor 100 (the base material 10 and the tacky adhesive layer 20) within a time for treating the tacky adhesive sheet precursor, that is, the tacky adhesive sheet is not significantly thermally deformed. When wrinkles, deflection, and the like occur, these may cause a trouble in apparatus operation at the time of the plasma treatment. The temperature condition of the plasma treatment may be, for example, 300°C or lower, 250°C or lower, or 200°C or lower.

[0040] The plasma treatment can adjust a treatment area. Therefore, the plasma treatment can be executed to a part or the whole of the surface of the tacky adhesive layer 20 on the side opposite to the base material 10 in the tacky adhesive sheet precursor 100. When the plasma treatment is executed to a part of the surface of the tacky adhesive layer 20, a contact angle of a surface to be treated can be adjusted, and thus it is possible to easily separately form a part with a low contact angle (that is, a part in which the tacky adhesive force of the tacky adhesive layer is high) and a part with a high contact angle (that is, a part in which the tacky adhesive force of the tacky adhesive layer is low) in the same surface.

[0041] <Step of disposing protective material>

In this step, the protective material 30 is pasted on the surface of the tacky adhesive layer subjected to the plasma treatment (the tacky

adhesive layer 20A obtained after the plasma treatment) on the side opposite to the base material 10 (see FIG. 1(d)). Thereby, a protective material-attached tacky adhesive sheet 120 can be obtained. As a method of pasting the protective material 30, a known method can be used for pasting.

[0042] The protective material 30 is not particularly limited, and a protective film that is used in the field of a tacky adhesive can be used. Examples of the protective film include plastic films including a polyester-based film such as a polyethylene terephthalate film, a polyolefin-based film such as a polytetrafluoroethylene film, a polyethylene film, a polypropylene film, a polymethylpentene film, and a polyvinyl acetate film, a polyvinyl chloride film, and a polyimide film. Furthermore, as the protective film, paper, non-woven fabric, a metal foil, and the like can be used. The surface of the protective material 30 on the side of the tacky adhesive layer 20A obtained after the plasma treatment may be treated by a release agent such as a silicone-based peeling agent, fluorine-based peeling agent, or a long-chain alkyl acrylate-based peeling agent.

[0043] In the protective material 30, a surface of the protective material 30 on the side which is pasted to the tacky adhesive layer 20A obtained after the plasma treatment may a surface treated by the plasma treatment. A material having a surface treated by the plasma treatment is used as the protective material 30, and thereby there is a tendency that a state where the wettability of the tacky adhesive layer 20A obtained after the plasma treatment can be maintained for a long period of time.

[0044] The thickness of the protective material 30 is not particularly

limited, and may be 5 to 500 μm , 10 to 200 μm , or 15 to 100 μm .

[0045] [Method for producing dicing/die bonding integrated tape]

FIG. 2 is a cross-sectional view schematically illustrating an embodiment of a method for producing a dicing/die bonding integrated tape. A method for producing a dicing/die bonding integrated tape according to the present embodiment includes a step of forming a bonding adhesive layer 40 on the surface (the surface subjected to the plasma treatment) of the tacky adhesive layer 20A obtained after the plasma treatment on the side opposite to the base material 10 in the tacky adhesive sheet 110 obtained by the aforementioned producing method (see FIGS. 2(a) and 2(b)).

[0046] The bonding adhesive layer 40 is a layer configured by a bonding adhesive component. Examples of the bonding adhesive component constituting the bonding adhesive layer 40 include a thermosetting bonding adhesive component, a photocrosslinkable bonding adhesive component, a thermoplastic bonding adhesive component, and an oxygen reactive bonding adhesive component. From the viewpoint of adhesiveness, the bonding adhesive layer preferably contains a thermosetting bonding adhesive component.

[0047] The thermosetting bonding adhesive component preferably contains an epoxy resin and a phenolic resin that may be a curing agent of the epoxy resin, from the viewpoint of adhesiveness.

[0048] The epoxy resin can be used without particular limitation as long as it has an epoxy group in the molecule. Examples of the epoxy resin include a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, a bisphenol S type epoxy resin, a phenol novolak type epoxy resin, a cresol

novolak type epoxy resin, a bisphenol A novolak type epoxy resin, a bisphenol F novolak type epoxy resin, a dicyclopentadiene skeleton-containing epoxy resin, a stilbene type epoxy resin, a triazine skeleton-containing epoxy resin, a fluorene skeleton-containing epoxy resin, a triphenolmethane type epoxy resin, a biphenyl type epoxy resin, a xylylene type epoxy resin, a biphenyl aralkyl type epoxy resin, a naphthalene type epoxy resin, and a diglycidyl ether compound of a polyfunctional phenol or a polycyclic aromatic compound such as anthracene. These may be used alone or in combination of two or more kinds thereof. The content of the epoxy resin may be 2 to 50% by mass based on the total amount of the bonding adhesive layer.

[0049] The phenolic resin can be used without particular limitation as long as it has a phenolic hydroxyl group in the molecule. Examples of the phenolic resin include novolak type phenolic resins obtained by condensation or co-condensation of phenols such as phenol, cresol, resorcin, catechol, bisphenol A, bisphenol F, phenylphenol, and aminophenol and/or naphthols such as α -naphthol, β -naphthol, and dihydroxynaphthalene with a compound having an aldehyde group such as formaldehyde in the presence of an acidic catalyst; and phenol aralkyl resins and naphthol aralkyl resins synthesized from phenols such as allylated bisphenol A, allylated bisphenol F, allylated naphthalene diol, phenol novolak, and phenol and/or naphthols with dimethoxyparaxylene or bis(methoxymethyl)biphenyl. These may be used alone or in combination of two or more kinds thereof. The content of the phenolic resin may be 2 to 50% by mass based on the total amount of the bonding adhesive layer.

[0050] The bonding adhesive layer 40 may contain, as other components, a curing accelerator such as tertiary amine, imidazoles, and a quaternary ammonium salt; and an inorganic filler such as aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate, magnesium silicate, calcium oxide, magnesium oxide, aluminum oxide, aluminum nitride, aluminum borate whisker, boron nitride, crystalline silica, and amorphous silica. The content of the other components may be 0 to 20% by mass based on the total amount of the bonding adhesive layer.

[0051] In the tacky adhesive sheet 110, the plasma treatment is executed to a part or the whole of the surface of the tacky adhesive layer 20 on the side opposite to the base material 10. In a case where the plasma treatment is executed to a part of the surface of the tacky adhesive layer 20 on the side opposite to the base material 10, the bonding adhesive layer 40 may be formed to partially or entirely cover the surface subjected to the plasma treatment of the tacky adhesive layer 20 and may be formed to partially or entirely cover the surface not subjected to the plasma treatment of the tacky adhesive layer 20. Furthermore, the bonding adhesive layer 40 may be formed to partially or entirely cover both surfaces of the surface subjected to the plasma treatment of the tacky adhesive layer 20 and the surface not subjected to the plasma treatment of the tacky adhesive layer 20. In a case where the plasma treatment is executed to the entire part of the tacky adhesive layer 20, the bonding adhesive layer 40 may be formed to partially or entirely cover the surface subjected to the plasma treatment of the tacky adhesive layer 20.

[0052] As the method of forming the bonding adhesive layer 40 on a

surface of the tacky adhesive layer 20A obtained after the plasma treatment on the side opposite to the base material 10, for example, a method in which a bonding adhesive component is molded into a film shape by using a known method and the obtained film-shaped bonding adhesive is laminated to the surface of the tacky adhesive layer 20A obtained after the plasma treatment on the side opposite to the base material 10 is exemplified. In this way, the dicing/die bonding integrated tape 130 can be obtained (see FIG. 2(b)).

[0053] The dicing/die bonding integrated tape 130 may include a protective material 50 on the surface of the bonding adhesive layer 40 on the side opposite to the tacky adhesive layer 20A. The protective material 50 is not particularly limited, and a protective film that is used in the dicing/die bonding integrated tape can be used. Examples of the protective film include plastic films including a polyester-based film such as a polyethylene terephthalate film, a polyolefin-based film such as a polytetrafluoroethylene film, a polyethylene film, a polypropylene film, a polymethylpentene film, and a polyvinyl acetate film, a polyvinyl chloride film, and a polyimide film. In this way, a protective material-attached dicing/die bonding integrated tape 140 can be obtained (see FIG. 2(c)).

[0054] [Method for producing semiconductor device (semiconductor package)]

FIG. 3 is a cross-sectional view schematically illustrating an embodiment of a method for producing a semiconductor device. The method for producing a semiconductor device according to the present embodiment includes a step of pasting the bonding adhesive layer 40 of

the dicing/die bonding integrated tape 130 obtained by the
aforementioned producing method to a semiconductor wafer W (a wafer
lamination step, see FIGS. 3(a) and 3(b)), a step of individuating the
semiconductor wafer W, the bonding adhesive layer 40, and the tacky
5 adhesive layer subjected to the plasma treatment (the tacky adhesive layer
20A obtained after the plasma treatment) (a dicing step, see FIG. 3(c)), a
step of irradiating the tacky adhesive layer subjected to the plasma
treatment (the tacky adhesive layer 20A obtained after the plasma
treatment) with ultraviolet rays (via the base material 10) as necessary (an
10 ultraviolet irradiation step, see FIG. 3(d)), a step of picking up a
semiconductor element Wa (a bonding adhesive layer-attached
semiconductor element 60) attached with a bonding adhesive layer 40a
from the tacky adhesive layer subjected to the plasma treatment (a tacky
adhesive layer 20Aa) (a pickup step, see FIG. 3(e)), and a step of bonding
15 the bonding adhesive layer-attached semiconductor element 60 to a
support substrate 80 for mounting a semiconductor element via the
bonding adhesive layer 40a (a semiconductor element bonding step, see
FIG. 3(f)).

[0055] <Wafer lamination step>

20 First, the dicing/die bonding integrated tape 130 is disposed in a
predetermined apparatus. Subsequently, the dicing/die bonding
integrated tape 130 is pasted to a main surface Ws of the semiconductor
wafer W via the bonding adhesive layer 40 (see FIGS. 3(a) and 3(b)). A
circuit surface of the semiconductor wafer W is preferably provided on a
25 surface opposite to the main surface Ws.

[0056] <Dicing step>

Next, the semiconductor wafer W, the bonding adhesive layer 40, and the tacky adhesive layer 20A obtained after the plasma treatment are diced (see FIG. 3(c)). At this time, a part of the base material 10 may be diced. As described above, the dicing/die bonding integrated tape 130 also functions a dicing sheet.

[0057] <Ultraviolet irradiation step>

The tacky adhesive layer 20A obtained after the plasma treatment may be irradiated with ultraviolet rays (via the base material 10), as necessary (see FIG. 3(d)). In a case where the base resin in the tacky adhesive component is a material that is cured with ultraviolet rays (an ultraviolet curable base resin), the tacky adhesive layer 20A is cured, and thereby the adhesive force between the tacky adhesive layer 20A and the bonding adhesive layer 40 can be reduced. In ultraviolet irradiation, ultraviolet rays having a wavelength of 200 to 400 nm is preferably used. The ultraviolet irradiation conditions are preferably adjusted so that the illumination and the irradiance level are adjusted in a range of 30 to 240 mW/cm² and a range of 200 to 500 mJ/cm², respectively.

[0058] <Pickup step>

Next, by expanding the base material 10, while the diced bonding adhesive layer-attached semiconductor elements 60 are separated from each other, the bonding adhesive layer-attached semiconductor element 60, which is thrust up by a needle 72 from the side of the base material 10, is sucked by a suction collet 74 so as to be picked up from the tacky adhesive layer 20Aa (see FIG. 3(e)). In a case where the plasma treatment is executed to a part of the surface of the tacky adhesive layer 20 on the side opposite to the base material 10, the surface of the tacky

adhesive layer 20Aa on the side of the bonding adhesive layer 40a may be a surface subjected to the plasma treatment or a surface not subjected to the plasma treatment and may be a surface including both of a surface subjected to the plasma treatment and a surface not subjected to the plasma treatment. Incidentally, the bonding adhesive layer-attached semiconductor element 60 has the semiconductor element Wa and the bonding adhesive layer 40a. The semiconductor element Wa is obtained by dividing the semiconductor wafer W by dicing, and the bonding adhesive layer 40a is obtained by dividing the bonding adhesive layer 40 by dicing. The tacky adhesive layer 20Aa is obtained by dividing the tacky adhesive layer 20A obtained after the plasma treatment by dicing. The tacky adhesive layer 20Aa may remain on the base material 10 when the bonding adhesive layer-attached semiconductor element 60 is picked up. In the pickup step, it is not necessary to expand the base material 10, but by expanding the base material 10, pickup property can be further improved.

[0059] The thrust-up amount by the needle 72 can be appropriately set. Further, from the viewpoint of securing sufficient pickup property even with respect to an extremely thin wafer, for example, two-stage or three-stage thrust-up may be performed. Furthermore, the bonding adhesive layer-attached semiconductor element 60 may be picked up by a method other than the method using the suction collet 74.

[0060] <Semiconductor element bonding step>

After picking up the bonding adhesive layer-attached semiconductor element 60, the bonding adhesive layer-attached semiconductor element 60 is bonded to the support substrate 80 for

mounting a semiconductor element via the bonding adhesive layer 40a (see FIG. 3(f)) by thermo-compression bonding. A plurality of the bonding adhesive layer-attached semiconductor elements 60 may be bonded to the support substrate 80 for mounting a semiconductor element.

[0061] The method for producing a semiconductor device according to the present embodiment may further include a step of electrically connecting the semiconductor element Wa and the support substrate 80 for mounting a semiconductor element by a wire bond 70 and a step of resin-sealing the semiconductor element Wa on a surface 80a of the support substrate 80 for mounting a semiconductor element by using a resin sealing material 92, as necessary.

[0062] FIG. 4 is a cross-sectional view schematically illustrating an embodiment of a semiconductor device. A semiconductor device 200 illustrated in FIG. 4 can be produced through the aforementioned steps. In the semiconductor device 200, a solder ball 94 for electrical connection with an external substrate (mother board) may be formed on the surface of the support substrate 80 for mounting a semiconductor element on the side opposite to the surface 80a.

[0063] [Method for treating tacky adhesive]

A method for treating a tacky adhesive according to an embodiment includes a step of executing a plasma treatment to a tacky adhesive. The tacky adhesive may be the same as the tacky adhesive exemplified in the aforementioned method for producing a tacky adhesive sheet. The plasma treatment may be the same as the plasma treatment exemplified in the aforementioned method for producing a

tacky adhesive sheet. The plasma treatment may be a plasma treatment using atmospheric pressure plasma. A treatment temperature of the plasma treatment may be lower than a melting point of the tacky adhesive.
[0064] [Method for immobilizing adherend]

5 A method for immobilizing an adherend according to an embodiment includes a step of pasting a second adherend to a first adherend via the tacky adhesive treated by the aforementioned method. The first adherend and the second adherend are not particularly limited, and a metal adherend (such as SUS or aluminum), a non-metal adherend
10 (such as polycarbonate or glass), and the like are exemplified. The immobilizing conditions of the adherend can be appropriately set according to the type of the tacky adhesive and the types of the first adherend and the second adherend.

[0065] [Method for peeling adherend]

15 A method for peeling an adherend according to an embodiment includes a step of treating with water (bringing into contact with water) at least one of an interface between the first adherend of the adherend immobilized by the aforementioned method and the tacky adhesive and an interface between the second adherend and the tacky adhesive to peel
20 the first adherend and the second adherend. The tacky adhesive subjected to the plasma treatment has more hydrophilic groups than a tacky adhesive not subjected to the plasma treatment and has a tendency of easily being peeled by treatment with water (contact with water). Incidentally, when the first adherend and the second adherend are peeled,
25 the tacky adhesive may be attached to any one of the first adherend and the second adherend, and may be removed from the first adherend and

the second adherend.

Examples

[0066] Hereinafter, the present invention will be described in detail based on Examples; however, the present invention is not limited thereto.

5 [0067] (Example 1)

[Production of tacky adhesive sheet]

<Preparation of tacky adhesive sheet precursor>

2-ethylhexyl acrylate and methyl methacrylate as monomers and hydroxyethyl acrylate and acrylic acid as monomers containing a functional group were polymerized according to a solution polymerization method, and thereby an acrylic resin having a hydroxyl group was obtained. The weight average molecular weight of the acrylic resin having a hydroxyl group was 400000, and the glass transition temperature was -38°C.

15 [0068] Regarding the weight average molecular weight, the weight average molecular weight (Mw) in terms of polystyrene was measured by using SD-8022/DP-8020/RI-8020 manufactured by Tosoh Corporation as a GPC apparatus, Gelpack GL-A150-S/GL-A160-S manufactured by Hitachi Chemical Company, Ltd. as a column, and tetrahydrofuran as an eluent.

[0069] The glass transition temperature was calculated by the following relation equation (FOX equation).

$$1/T_g = \sum(X_i/T_{g_i})$$

25 [In the above equation, T_g represents a glass transition temperature (K) of a copolymer; X_i represents a mass fraction of each monomer and X₁ + X₂ + ... + X_i + ... + X_n = 1 is established; and T_{g_i}

represents a glass transition temperature (K) of a homopolymer of each monomer.]

[0070] 12 parts by mass of a polyfunctional isocyanate cross-linking agent (manufactured by Mitsubishi Chemical Corporation, trade name "MITEC NY730A-T") was mixed with respect to 100 parts by mass of the acrylic resin having a hydroxyl group and stirred by using a three-one motor and a stirring blade, and thereby a varnish for forming a tacky adhesive layer was obtained.

[0071] The obtained varnish for forming a tacky adhesive layer was coated on a base film A (a polyethylene terephthalate film having a thickness of 38 μm) by using an applicator while adjusting a gap so that the thickness of the tacky adhesive layer became 10 μm . After the coated varnish for forming a tacky adhesive layer was dried at 80°C for 5 minutes, a base film B (a polyolefin-based film having a thickness of 80 μm) in which the surface was subjected to a corona treatment was laminated on the tacky adhesive layer, left to stand at room temperature (25°C) for 2 weeks, and sufficiently aged, and thereby a tacky adhesive sheet precursor having a configuration of the base film A/the tacky adhesive layer/the base film B was obtained.

[0072] <Execution of plasma treatment>

The base film A of the tacky adhesive sheet precursor was peeled, a plasma treatment was executed to a surface of the tacky adhesive layer on the side opposite to the base film B in the tacky adhesive sheet precursor by using an ultra-high-density atmospheric pressure plasma unit (manufactured by Fuji Machine Manufacturing Co., Ltd., trade name: FPB-20 TYPE II), and thereby a tacky adhesive sheet was

produced. Thereafter, a protective material (a polyethylene terephthalate (PET) film) was disposed on the surface of the tacky adhesive layer subjected to the plasma treatment, and thereby a protective material-attached tacky adhesive sheet of Example 1 was obtained.

5 [0073] (Conditions of plasma treatment)

Use of heater: Not used

Irradiation rate: 500 mm/sec

Irradiation distance: 5 mm

Slit nozzle: 20 mm width

10 Used gas: Nitrogen and air

Gas flow rate: Nitrogen 60 L/min, air 21 L/min

Number of times of repetition: One time (irradiation method: 20 mm width × 8 lines)

Sample size: 150 mm × 150 mm

15 Incidentally, the irradiation distance, the irradiation rate, the heater setting, and the like were adjusted to set a treatment temperature of 100°C or lower so that wrinkles, deflection, and the like did not occur in the tacky adhesive sheet precursor 100 (the base material 10 and the tacky adhesive layer 20) within a time for treating the tacky adhesive sheet precursor.

20 [0074] (Example 2)

A protective material-attached tacky adhesive sheet of Example 2 was obtained in the same manner as in Example 1, except that the same plasma treatment (the number of times of repetition: one time) as the plasma treatment executed to the tacky adhesive layer was executed to the surface of the protective material on the side of the tacky adhesive

layer.

[0075] (Example 3)

A protective material-attached tacky adhesive sheet of Example 3 was obtained in the same manner as in Example 2, except that the number of times of repetition of the plasma treatment of the protective material was changed from one time to four times.

[0076] (Example 4)

A protective material-attached tacky adhesive sheet of Example 4 was obtained in the same manner as in Example 1, except that the number of times of repetition of the plasma treatment of the tacky adhesive layer was changed from one time to four times.

[0077] (Example 5)

A protective material-attached tacky adhesive sheet of Example 5 was obtained in the same manner as in Example 4, except that the same plasma treatment (the number of times of repetition: one time) as the plasma treatment executed to the tacky adhesive layer was executed to the surface of the protective material on the side of the tacky adhesive layer.

[0078] (Example 6)

A protective material-attached tacky adhesive sheet of Example 6 was obtained in the same manner as in Example 5, except that the number of times of repetition of the plasma treatment of the protective material was changed from one time to four times.

[0079] (Comparative Example 1)

A protective material-attached tacky adhesive sheet of Comparative Example 1 was obtained in the same manner as in Example

1, except that the plasma treatment was not executed to the tacky adhesive layer.

[0080] [Evaluation]

<Measurement of contact angle of water with respect to surface subjected to plasma treatment of tacky adhesive layer>

As for the protective material-attached tacky adhesive sheets of Examples 1 to 6 and Comparative Example 1, the contact angle of water with respect to the surface subjected to the plasma treatment was measured. A contact angle meter (manufactured by Kyowa Interface Science Co., Ltd., trade name: Drop Master 300) was used in the measurement. The measurement was performed by peeling the protective material of the protective material-attached tacky adhesive sheet and adding water dropwise as a probe liquid to the surface subjected to the plasma treatment of the tacky adhesive layer. The measurement conditions were set to a temperature of 23°C to 28°C, a droplet amount of the probe liquid of 1.5 μ L, and a measurement timing of 5 seconds after dropwise addition of the probe liquid. The number of trials of measurement was set to 10 times, and a median value of numerical values thus obtained was obtained as a contact angle θ . The results are shown in Table 1.

[0081] [Table 1]

	Number of times of plasma treatment to tacky adhesive layer (times)	Number of times of plasma treatment to protective material (times)	Contact angle θ (°)
Example 1	1	0	94
Example 2	1	1	96
Example 3	1	4	94
Example 4	4	0	85
Example 5	4	1	86
Example 6	4	4	85
Comparative Example 1	0	0	98

[0082] <Measurement of peeling strength of adhesive layer with respect to SUS substrate>

The protective material-attached tacky adhesive sheets of Examples 1 and 2 and Comparative Example 1 were cut into a width of 10 mm and a length of 70 mm or more, the protective material was peeled from the protective material-attached tacky adhesive sheet, the tacky adhesive sheet was then pasted to an SUS plate (SUS430BA), and the resultant product was used as an initial measurement sample. At the time of pasting the tacky adhesive sheet to the SUS plate, a roller with a weight of 3 kg was reciprocated three times on the sample. A peeling guidance tape (manufactured by Oji Tac Co., Ltd., EC Tape) was cut into a width of 10 mm, about 10 mm of the tape was pasted to the tip ends of the sample, and thereby the sample was fixed to the tip ends of a load cell. The position of the load cell was finely adjusted so that the progression of peeling became parallel to the tape width. Furthermore, the initial measurement sample was subjected to refrigeration (5°C) storage for 3 months, and this measurement sample was used as a 3-month later measurement sample. Peeling of the SUS substrate and the tacky

adhesive layer was performed with respect to these measurement samples at a peeling angle of 30 degrees and a peeling rate of 50 mm/min, and the peeling strength was obtained. Incidentally, the SUS substrate was used after being washed with acetone before being used. The results are shown in Table 2. Incidentally, numerical values in Table 2 are relative values based on the numerical value of the peeling strength of Comparative Example 1.

[0083] [Table 2]

	Peeling strength at initial stage (relative value based on Comparative Example 1)	Peeling strength after elapse of three months (relative value based on Comparative Example 1)
Example 1	2.4	1.0
Example 2	3.1	1.4
Comparative Example 1	1.0	1.0

[0084] It is speculated that, even in the case of using, for example, another acrylic resin, synthetic rubber, natural rubber, a polyimide resin, or the like as the base resin instead of the tacky adhesive layer in the protective material-attached tacky adhesive sheets of Examples 1 to 6, the same effect is obtainable.

[0085] In the protective material-attached tacky adhesive sheets of Examples 1 to 6, as compared with the protective material-attached tacky adhesive sheet of Comparative Example 1, the contact angle of the surface subjected to the plasma treatment of the tacky adhesive layer was decreased, and the wettability of the tacky adhesive layer was improved. Furthermore, in the protective material-attached tacky adhesive sheets of Examples 1 and 2, as compared with the protective material-attached

tacky adhesive sheet of Comparative Example 1, the peeling strength was improved and the tacky adhesive force was improved. Furthermore, from comparison between Example 1 and Example 2, it has been clear that, by executing the plasma treatment also to the protective material, the effect obtained by executing the plasma treatment was maintained over a long period of time. From these results, it was confirmed that the producing method of the present invention can produce a tacky adhesive sheet excellent in tacky adhesive force.

Reference Signs List

[0086] 10: base material, 20: tacky adhesive layer, 20A: tacky adhesive layer obtained after plasma treatment, 30: protective material, 40: bonding adhesive layer, 50: protective material, 60: bonding adhesive layer-attached semiconductor element, 70: wire bond, 72: needle, 74: suction collet, 80: support substrate for mounting semiconductor element, 92: resin sealing material, 94: solder ball, W: semiconductor wafer, 100: tacky adhesive sheet precursor, 110: tacky adhesive sheet, 120: protective material-attached tacky adhesive sheet, 130: dicing/die bonding integrated tape, 140: protective material-attached dicing/die bonding integrated tape.

CLAIMS

1. A method for producing a tacky adhesive sheet, the method comprising:

preparing a tacky adhesive sheet precursor having a base material
5 and a tacky adhesive layer provided on the base material; and

executing a plasma treatment to a surface of the tacky adhesive
layer on the side opposite to the base material in the tacky adhesive sheet
precursor.

2. The method for producing a tacky adhesive sheet according to
10 claim 1, wherein the plasma treatment is a plasma treatment using
atmospheric pressure plasma.

3. The method for producing a tacky adhesive sheet according to
claim 1 or 2, wherein a treatment temperature of the plasma treatment is
lower than a lower temperature of a melting point of the base material
15 and a melting point of the tacky adhesive layer.

4. The method for producing a tacky adhesive sheet according to
any one of claims 1 to 3, further comprising pasting a protective material
onto the surface of the tacky adhesive layer subjected to the plasma
treatment on the side opposite to the base material.

20 5. The method for producing a tacky adhesive sheet according to
claim 4, wherein in the protective material, a surface on the side which is
pasted to the tacky adhesive layer subjected to the plasma treatment is a
surface treated by the plasma treatment.

6. A method for producing a dicing/die bonding integrated tape, the
25 method comprising forming a bonding adhesive layer on the surface of
the tacky adhesive layer subjected to the plasma treatment on the side

opposite to the base material in the tacky adhesive sheet obtained by the method according to any one of claims 1 to 3.

7. A method for producing a semiconductor device, the method comprising:

5 pasting the bonding adhesive layer of the dicing/die bonding integrated tape obtained by the method according to claim 6 to a semiconductor wafer;

individuating the semiconductor wafer, the bonding adhesive layer, and the tacky adhesive layer subjected to the plasma treatment;

10 picking up a semiconductor element attached with the bonding adhesive layer from the tacky adhesive layer subjected to the plasma treatment; and

bonding the semiconductor element to a support substrate for mounting a semiconductor element via the bonding adhesive layer.

15 8. A method for treating a tacky adhesive, the method comprising executing a plasma treatment to a tacky adhesive.

9. The method for treating a tacky adhesive according to claim 8, wherein the plasma treatment is a plasma treatment using atmospheric pressure plasma.

20 10. The method for treating a tacky adhesive according to claim 8 or 9, wherein a treatment temperature of the plasma treatment is lower than a melting point of the tacky adhesive.

11. A method for immobilizing an adherend, the method comprising pasting a second adherend to a first adherend via the tacky adhesive treated by the method according to any one of claims 8 to 10.

25 12. A method for peeling an adherend, the method comprising

treating with water at least one of an interface between the first adherend of the adherend immobilized by the method according to claim 11 and the tacky adhesive and an interface between the second adherend and the tacky adhesive to peel the first adherend and the second adherend.