

DESCRIPTION

ADHESIVE TAPE FOR SEMICONDUCTOR PROCESSING AND SEMICONDUCTOR
DEVICE PRODUCED USING THE SAME

TECHNICAL FIELD

[0001] The present invention relates to an expandable adhesive tape for semiconductor processing, which can be utilized for fixing a semiconductor wafer in a dicing process of splitting a semiconductor wafer into chip-like elements, which can also be utilized in a die bonding process or a mounting process of applying adhesion between one chip and another chip after dicing or between a chip and a substrate, and which can also be utilized in a process of splitting an adhesive layer along the chips by expansion, and to a semiconductor device produced using this adhesive tape for semiconductor processing.

BACKGROUND ART

[0002] Conventionally, in a production process for a semiconductor device such as an integrated circuit (IC), a back grinding process of grinding the back surface of a wafer in order to reduce the thickness of the wafer after the formation of a circuit pattern; a dicing process of adhering an adhesive tape for semiconductor processing having tacky adhesiveness and elasticity to the back surface of the wafer, and then splitting

the wafer into chip units; an expansion process of expanding the adhesive tape for semiconductor processing (expansion); a pick-up process of picking up the split chips; and a die bonding (mounting) process of adhering the picked-up chips to a lead frame, a package substrate or the like (or in a stacked package, chips are laminated one on another and adhered), are carried out.

[0003] In the back grinding process, a surface protective tape is used in order to protect the circuit pattern-formed surface of a wafer (wafer front surface) from contamination. After completion of grinding of the back surface of the wafer, when this surface protective tape is detached from the wafer front surface, the adhesive tape for semiconductor processing (dicing/die bonding tape) that will be described below is attached to the back surface of the wafer, subsequently the adhesive tape for semiconductor processing side is fixed to a suction table, the surface protective tape is subjected to a treatment for lowering the adhesive force directed to the wafer, and then the surface protective tape is detached. The wafer from which the surface protective tape has been detached is taken up from the suction table in a state of having a wafer attached to the back surface, and is subjected to the subsequent dicing process. Meanwhile, the treatment for lowering the adhesive force is a treatment of irradiation with energy rays in a case in which the surface protective tape is formed from

a component which is curable by energy rays such as ultraviolet radiation, and is a heating treatment in a case in which the surface protective tape is formed from a thermosetting component.

[0004] In the dicing process to the mounting process after the back grinding process, an adhesive tape for semiconductor processing in which a tacky adhesive layer and an adhesive layer are laminated in this order on a substrate film, is used. Generally, in a case in which such an adhesive tape for semiconductor processing is used, first, the adhesive layer of the adhesive tape for semiconductor processing is attached to the back surface of a wafer so as to fix the wafer, and the wafer and the adhesive layer are diced into tip units using a dicing blade. Thereafter, an expansion process of widening the distance between the chips by expanding the adhesive tape in the diameter direction of the wafer is carried out. This expansion process is carried out in order to increase the recognizability of chips by a CCD camera or the like in the subsequent pick-up process, and to prevent the damage of chips caused by adjacent chips being brought into contact with each other when the chips are picked up. Thereafter, the chips are picked up together with the adhesive layer by being detached from the tacky adhesive layer during the pick-up process, and are directly adhered to a lead frame, a package substrate or the like during the mounting process. As such, when an adhesive

tape for semiconductor processing is used, adhesive layer-attached chips can be directly adhered to a lead frame, a package substrate or the like. Accordingly, a process for applying an adhesive or a process for separately adhering a die bonding film to various chips can be omitted.

[0005] However, in the dicing process described above, as explained above, since the wafer and the adhesive layer are diced together using a dicing blade, not only the cutting scraps of the wafer but also the cutting scraps of the adhesive layer are generated. Then, in a case in which the cutting scraps of the adhesive layer clog the dicing grooves of the wafer, chips stick to one another, causing the occurrence of pick-up failure or the like, and there is a problem that the production yield of the semiconductor devices is decreased.

[0006] In order to solve such a problem, there has been proposed a method of dicing only the wafer using a blade in the dicing process, expanding the adhesive tape for semiconductor processing in the expansion process, and thereby splitting the adhesive layer for each of individual chips (for example, Patent Document 1). According to such a method for splitting the adhesive layer by utilizing the tension at the time of expanding, cutting scraps of the adhesive are not generated, and there is no adverse influence on the pick-up process.

[0007] Furthermore, in recent years, a so-called stealth dicing method by which a wafer can be cut in a non-contacting

manner using a laser processing apparatus, has been suggested as a wafer cutting method. For example, Patent Document 2 discloses, as a stealth dicing method, a method for cutting a semiconductor substrate, which includes a step of irradiating a semiconductor substrate, on which a sheet has been adhered through an adhesive layer (die bond resin layer) interposed therebetween, with laser light by adjusting focused light to the interior of the semiconductor substrate, thereby forming regions modified by multiphoton absorption in the interior of the semiconductor substrate, and using these modified regions as planned cut parts; and a step of cutting the semiconductor substrate and the adhesive layer along the planned cut parts by expanding the sheet.

[0008] Furthermore, as another method for cutting a wafer using a laser processing apparatus, for example, Patent document 3 suggests a method of dividing a wafer, the method including a step of mounting an adhesive layer (adhesive film) for die bonding on the back surface of a wafer; a step of attaching an expandable protective tacky adhesive sheet on the adhesive layer side of the wafer to which the adhesive layer has been attached; a step of irradiating the protective tacky adhesive sheet-attached wafer with laser light through the surface of the wafer along streets, and thereby dividing the wafer into individual chips; a step of expanding the protective tacky adhesive sheet to apply tensile force to the adhesive

layer, and breaking the adhesive layer for each of the chips; and a step of detaching the chips having the broken adhesive layer attached thereon, from the protective tacky adhesive sheet.

[0009] According to these wafer cutting methods described in Patent Document 2 and Patent Document 3, since a wafer is cut in a non-contacting manner by means of irradiation with laser light and expanding of a tape, the physical burden on the wafer is small, and cutting of the wafer is enabled without generating cutting scraps of the wafer (chipping) such as in the case of performing blade dicing of the current mainstream. Furthermore, since the adhesive layer is divided by expanding the adhesive layer, there is no chance of generating cutting scraps of the adhesive layer. Therefore, attention has been paid to these methods as an excellent technology that can replace blade dicing.

CITATION LIST

PATENT DOCUMENT

[0010] Patent Document 1: JP 2007-5530 A
Patent Document 2: JP 2003-338467 A
Patent Document 3: JP 2004-273895 A

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0011] As described in Patent Documents 1 to 3 mentioned above, a method of splitting the adhesive layer by expanding the adhesive layer by expansion may be carried out such that, in order to enhance the splittability of the adhesive layer, the process of expanding is carried out at a low temperature such as 0°C or -15°C, and the subsequent pick-up process and the mounting process are operated at normal temperature.

However, when it is attempted to enhance splittability of the adhesive layer at a low temperature, splittability at normal temperature also increases, and the adhesive layer becomes brittle. Accordingly, incisions or cracks easily occur due to the impact at the time of transportation or the like, and even if incisions or cracks do not occur, when the adhesive layer is stretched or the like during a precutting process of processing the adhesive layer to a defined size, there is a problem that the adhesive layer readily cracks.

[0012] Thus, it is an object of the present invention to provide an adhesive tape for semiconductor processing having excellent processability, in which there is no occurrence of incisions or cracks caused by the impact at the time of transportation or the like, and even if the adhesive layer is stretched during a precutting process of processing the adhesive layer to a defined size, the adhesive layer does not crack.

MEANS FOR SOLVING PROBLEM

[0013] In order to solve the problem described above, the adhesive tape for semiconductor processing related to the present invention has an adhesive layer and a tacky adhesive sheet laminated therein, in which the adhesive layer has a tear strength (A) according to the right angled tear method defined in JIS K7128-3, of 0.8 MPa or more.

[0014] It is preferable for the adhesive tape for semiconductor processing that in the adhesive layer, a tear strength (B) obtainable when a cutting portion having a length of 1 mm from the tip of the right angled part is incised, on the center line passing through the tip of a right angled part of a test specimen in the right angled tear method, is 0.5 MPa or more.

[0015] Furthermore, it is preferable for the adhesive tape for semiconductor processing that the elongation percentage of the tacky adhesive sheet is 200% or more.

[0016] Furthermore, it is preferable for the adhesive tape for semiconductor processing that when the tacky adhesive sheet is stretched to an elongation percentage of 200% and then is heated to 120°C, the elongation percentage becomes 120% or less.

[0017] Furthermore, it is preferable for the adhesive tape for semiconductor processing that the adhesive layer has a tear strength (C) according to the right angled tear method defined in JIS K7128-3 at -15°C is 0.8 MPa or less.

[0018] Furthermore, it is preferable that the adhesive tape for semiconductor processing is used in order to split the wafer attached on the adhesive layer and the adhesive layer, or only the adhesive layer, correspondingly to individual chips, by expanding the tacky adhesive sheet.

[0019] Furthermore, in order to solve the problems described above, the semiconductor device related to the present invention is produced using the adhesive tape for semiconductor processing described above.

EFFECT OF THE INVENTION

[0020] According to the present invention, since the adhesive layer has a tear strength (A) without slits according to the test method for a right angled test specimen disclosed in JIS K7128-3 of 0.8 MPa or more, it is possible to provide a tape for semiconductor having excellent processability, in which incisions or cracks caused by the impact at the time of transportation or the like are not generated, and even if the adhesive layer is stretched during a precutting step of processing the adhesive layer to a defined size, the adhesive layer does not crack or the like.

BRIEF DESCRIPTION OF DRAWINGS

[0021] Fig. 1 is a cross-sectional view diagram schematically illustrating the structure of an adhesive tape

for semiconductor processing related to an embodiment of the present invention.

Fig. 2 is a cross-sectional view diagram illustrating the state in which a surface protective tape is attached to a wafer.

Fig. 3 is a cross-sectional view diagram for explaining the process of attaching a wafer and a ring frame to the adhesive tape for semiconductor processing related to the embodiment of the present invention.

Fig. 4 is a cross-sectional view diagram for explaining the process of detaching a surface protective tape from the surface of a wafer.

Fig. 5 is a cross-sectional view diagram illustrating the condition in which a modified region has been formed on a wafer by laser processing.

Fig. 6(a) is a cross-sectional view diagram illustrating the state in which the adhesive tape for semiconductor processing related to the embodiment of the present invention is mounted on an expansion apparatus; Fig. 6(b) is a cross-sectional view diagram illustrating the course of splitting a wafer into chips by expanding the adhesive tape for semiconductor processing; and Fig. 6(c) is a cross-sectional view diagram illustrating the adhesive tape for semiconductor processing, the adhesive layer and the chips after the expanding.

Fig. 7 is a cross-sectional view diagram for explaining

a heat shrinking step.

Fig. 8(a) is a plan view diagram of the test specimen used for the right angled tear method; and Fig. 8(b) is a plan view diagram of the test specimen having a cutting portion incised therein.

MODE(S) FOR CARRYING OUT THE INVENTION

[0022] Hereinafter, embodiments of the present invention will be described in detail.

[0023] Fig. 1 is a cross-sectional view diagram illustrating an adhesive tape for semiconductor processing 10 related to an embodiment of the present invention. An adhesive tape for semiconductor processing 10 of the present invention is intended such that when a wafer is split into chips by expanding, an adhesive layer 13 is split along with the chips. This adhesive tape for semiconductor processing 10 includes a tacky adhesive sheet 15 composed of a substrate film 11 and a tacky adhesive layer 12 provided on the substrate film 11; and an adhesive layer 13 provided on the tacky adhesive layer 12, and the back surface of a wafer is attached onto the adhesive layer 13. The respective layers may be cut in advance into a predetermined shape (precutting) in accordance with the process or apparatus used. Furthermore, the adhesive tape for semiconductor processing 10 of the present invention may be in the form in which the adhesive tape has been cut out for each

sheet of wafer, or may be in the form in which a long sheet formed by plural pieces of the adhesive tape that has been cut out for each sheet of wafer, is wound into a roll shape. In the following description, the configurations of the various layers will be explained.

[0024] <Substrate film>

If the substrate film 11 has uniform and isotropic expansibility, it is preferable from the viewpoint that the wafer can be cut without tilting in any direction during the expansion step, and the material for the substrate film 11 is not particularly limited. Generally, crosslinked resins have high restoring force against pulling compared to non-crosslinked resins, and have high contraction stress when heat is applied to the resins in a stretched state after the expansion step. Therefore, excellent results are obtained in view of a heat shrinking step of eliminating the slack produced in the adhesive tape after the expansion step, through thermal shrinkage, and applying tension to the adhesive tape to thereby stably maintaining the distances between individual chips. Among the crosslinked resins, thermoplastic crosslinked resins are more preferably used. On the other hand, non-crosslinked resins have low restoring force against pulling compared to crosslinked resins. Therefore, after the expansion step in a low temperature range such as -15°C to 0°C , when the adhesive tape is once relaxed and returned to normal temperature, and

then is directed to a pick-up step and a mounting step, the adhesive tape does not easily shrink. Therefore, excellent results are obtained from the viewpoint that the adhesive layers adhered to the chips can be prevented from being brought into contact with each other. Among the non-crosslinked resins, olefin-based non-crosslinked resins are more preferably used.

[0025] An example of such a thermoplastic crosslinked resin is an ionomer resin obtained by crosslinking, for example, an ethylene-(meth)acrylic acid binary copolymer or a ternary copolymer containing ethylene-(meth)acrylic acid-(meth)acrylic acid alkyl ester as main polymer constituent components, with metal ions. These ionomer resins are appropriate for the expansion step in terms of uniform expansibility, and are particularly suitable from the viewpoint that the restoring force strongly works at the time of heating due to the crosslinking. The metal ions that are included in the ionomer resins are not particularly limited; however, examples thereof include zinc and sodium. Zinc ions are less susceptible to elution, and are preferable from the viewpoint of low contaminability. In the (meth)acrylic acid alkyl ester of the ternary copolymer, an alkyl group having 1 to 4 carbon atoms is preferable from the viewpoint of having a high elastic modulus and being capable of propagating strong force to the wafer. Examples of such a (meth)acrylic acid alkyl ester include methyl methacrylate, ethyl methacrylate, propyl

methacrylate, butyl methacrylate, methyl acrylate, ethyl acrylate, propyl acrylate, and butyl acrylate.

[0026] Furthermore, regarding the thermoplastic crosslinked resin, in addition to the ionomer resins, a product obtained by crosslinking a resin selected from a low density polyethylene having a specific gravity of 0.910 or more but less than 0.930, an ultralow density polyethylene having a specific gravity of less than 0.910, or ethylene-vinyl acetate copolymers, by irradiating the resin with energy rays such as an electron beam, is also suitable. Since such a thermoplastic crosslinked resin has crosslinked sites and non-crosslinked sites co-existing in the resin, thermoplastic crosslinked resins have certain uniform expansibility. Furthermore, since restoring force strongly works at the time of heating, thermoplastic crosslinked resins are also suitable for eliminating the slack of the adhesive tape caused by the expansion step. Also, because thermoplastic crosslinked resins mostly do not contain chlorine in the composition of the molecular chain, even if waste tapes are disposed by incineration after use, the thermoplastic crosslinked resins do not generate chlorinated aromatic hydrocarbons such as dioxin and analogues thereof, and therefore, the resins have reduced burden on the environment. When the amount of the energy rays irradiated to the polyethylene or the ethylene-vinyl acetate copolymer is appropriately regulated,

a resin having sufficient uniform expansibility can be obtained.

[0027] Furthermore, an example of the non-crosslinked resin include a mixed resin composition of, for example, polypropylene and a styrene-butadiene copolymer.

[0028] Regarding polypropylene, for example, a homopolymer of propylene, or a block type or random type propylene-ethylene copolymer can be used. A random type propylene-ethylene copolymer has low rigidity and is preferable. When the percentage content of an ethylene constituent unit in the propylene-ethylene copolymer is 0.1% by weight or more, the propylene-ethylene copolymer is excellent from the viewpoint of the rigidity of a resulting tape, and from the viewpoint that the compatibility between the resins in the mixed resin composition is high. When it is said that a tape has adequate rigidity, the cuttability of the wafer is enhanced, and in a case in which the resins have high compatibility, the amount of the mixed resin composition extruded is easily stabilized. The percentage content is more preferably 1% by weight or more. Furthermore, when the percentage content of an ethylene constituent unit in the propylene-ethylene copolymer is 7% by weight or less, excellent results are obtained from the viewpoint that polypropylene is stabilized and is easily polymerized. The percentage content is more preferably 5% by weight or less.

[0029] Regarding the styrene-butadiene copolymer, a hydrogenated styrene-butadiene copolymer may be used. When a styrene-butadiene copolymer is hydrogenated, the styrene-butadiene copolymer has satisfactory compatibility with propylene, and the embrittlement and discoloration caused by oxidative deterioration attributed to the double bonds in butadiene can be prevented. Furthermore, when the percentage content of a styrene constituent unit in the styrene-butadiene copolymer is 5% by weight or more, it is preferable from the viewpoint that the styrene-butadiene copolymer is stabilized and is easily polymerized. Furthermore, when the percentage content is 40% by weight or less, the styrene-butadiene copolymer is flexible and is excellent in view of expansibility. The percentage content is more preferably 25% by weight or less, and even more preferably 15% by weight or less. Regarding the styrene-butadiene copolymer, a block type copolymer and a random type copolymer can all be used. A random type copolymer is preferable because the styrene phase is uniformly dispersed, excessive increase in rigidity can be suppressed, and expansibility is enhanced.

[0030] When the percentage content of polypropylene in the mixed resin composition is 30% by weight or more, excellent results are obtained from the viewpoint that the thickness unevenness of the substrate film can be suppressed. When the thickness is uniform, expansibility is likely to become

isotropic, and it can be easily prevented that the stress relaxing properties of the substrate film become excessively strong, that the distance between chips become smaller over time, and that the adhesive layers are brought into contact with one another and are fused again. The percentage content is more preferably 50% by weight or more. Furthermore, when the percentage content of polypropylene is 90% by weight or less, rigidity of the substrate film can be easily adjusted appropriately. If the rigidity of the substrate film becomes too high, since the force required to expand the substrate film becomes larger, there are occasions in which the load of the apparatus is increased, and expansion that is sufficient for the splitting of the wafer or the adhesive layer, may not be achieved. Therefore, it is important to appropriately adjust the rigidity. The lower limit of the percentage content of the styrene-butadiene copolymer in the mixed resin composition is preferably 10% by weight or more, and it is easy to adjust the rigidity of the substrate film to a level appropriate for the apparatus. When the upper limit is 70% by weight or less, excellent results are obtained from the viewpoint that the thickness unevenness can be suppressed, and the upper limit is more preferably 50% by weight or less.

[0031] Meanwhile, in the example illustrated in Fig. 1, the substrate film 11 is a single layer; however, the present invention is not limited to this, and the substrate film may

have a multilayer structure obtained by laminating two or more kinds of resins, or two or more layers of a single kind of resin may be laminated. Regarding the two or more kinds of resins, it is preferable that the resins are coherently crosslinkable or non-crosslinkable, from the viewpoint that the characteristics of the respective resins are manifested in an enhanced manner. When the resins are laminated in combination of crosslinkable resins and non-crosslinkable resins, it is preferable from the viewpoint that the defects of the respective resins complementary to one another. The thickness of the substrate film 11 is not particularly defined; however, it is desirable that the substrate film has a strength barely sufficient to be easily stretchable and remain unbroken during the expansion step for the adhesive tape for semiconductor processing 10. For example, it is desirable that the thickness is about 50 μm to 300 μm , and the thickness is more preferably 80 μm to 200 μm .

[0032] Regarding the method for producing a multilayer substrate film 11, an extrusion method, a lamination method and the like, which are conventionally known, can be used. In the case of using a lamination method, an adhesive may be interposed between the layers. Regarding the adhesive, a conventionally known adhesive can be used.

[0033] <Tacky adhesive layer>

The tacky adhesive layer 12 can be formed by applying a

tacky adhesive composition on the substrate film 11. It is desirable that the tacky adhesive layer 12 that constitutes the adhesive tape for semiconductor processing 10 of the present invention does not cause detachment from the adhesive layer 13 at the time of dicing, and has retentivity to the extent defects such as chip flying do not occur, or has characteristics by which detachment from the adhesive layer 13 is made easy at the time of pick-up.

[0034] In regard to the adhesive tape for semiconductor processing 10 of the present invention, the configuration of the tacky adhesive composition that constitutes the tacky adhesive layer 12 is not particularly limited; however, in order to enhance the pick-up performance after dicing, an energy ray-curable tacky adhesive composition is preferable, and a material which can be easily detached from the adhesive layer 13 after curing is preferable. According to one embodiment, a tacky adhesive composition containing 60 mol% or more of a (meth)acrylate having an alkyl chain having 6 to 12 carbon atoms as a base resin, and containing a polymer (A) having an energy ray-curable carbon-carbon double bond having an iodine value of 5 to 30, may be mentioned as an example. Here, the energy rays mean light rays such as ultraviolet radiation, or ionizing radiation such as an electron beam.

[0035] In regard to such a polymer (A), the amount of introduction of the energy ray-curable carbon-carbon double

bonds is 5 or more as an iodine value, excellent results are obtained from the viewpoint that the effect of reducing the tacky adhesive force after irradiation with energy rays is increased. The amount of introduction is more preferably 10 or more. Furthermore, when the amount of introduction is 30 or less as the iodine value, excellent results are obtained from the viewpoint that superior chip retentivity is exhibited until the pick-up of the chips after irradiation with energy rays, and it is easy to widen the gaps between the chips at the time of expansion immediately before the pick-up step. If the gaps between the chips can be sufficiently widened before the pick-up step, it is preferable because image recognition of each chip at the time of pick-up is facilitated, or it is easy to pick up the chips. Furthermore, when the amount of introduction of the carbon-carbon double bonds is from 5 to 30 as the iodine value, it is preferable because the polymer (A) is stable, and production thereof is facilitated.

[0036] Furthermore, when the polymer (A) has a glass transition temperature of -70°C or higher, excellent results are obtained from the viewpoint of heat resistance against the heat associated with irradiation with energy rays, and the glass transition temperature is more preferably -66°C or higher. Furthermore, when the glass transition temperature is 15°C or lower, excellent results are obtained from the viewpoint of the effect of preventing chip flying after dicing in a wafer having

a rough surface state. The glass transition temperature is more preferably 0°C or lower, and even more preferably -28°C or lower.

[0037] The polymer (A) may be a polymer produced by any method; however, for example, a polymer obtained by mixing an acrylic copolymer and a compound having an energy ray-curable carbon-carbon double bond, or a polymer obtained by reacting an acrylic copolymer having a functional group or a methacrylic copolymer (A1) having a functional group, with a compound (A2) having a functional group that can react with the aforementioned functional group and having an energy ray-curable carbon-carbon double bond, is used.

[0038] Among these, an example of the methacrylic copolymer (A1) having a functional group is a polymer obtainable by copolymerizing a monomer (A1-1) having a carbon-carbon double bond, such as an acrylic acid alkyl ester or a methacrylic acid alkyl ester, and a monomer (A1-2) having a carbon-carbon double bond and having a functional group. Examples of the monomer (A1-1) include hexyl acrylate, n-octyl acrylate, isooctyl acrylate, 2-ethylhexyl acrylate, dodecyl acrylate, decyl acrylate, and lauryl acrylate, all of which have an alkyl chain having 6 to 12 carbon atoms; pentyl acrylate, n-butyl acrylate, isobutyl acrylate, ethyl acrylate, and methyl acrylate, all of which are monomers having an alkyl chain having 5 or fewer carbon atoms; and methacrylates similar to those.

[0039] Meanwhile, in regard to the monomer (A1-1), a

component having an alkyl chain having 6 or more carbon atoms is excellent in view of the pick-up properties since the peeling force between the tacky adhesive layer and the adhesive layer can be made small. Furthermore, a component having an alkyl chain having 12 or fewer carbon atoms has a low elastic modulus at room temperature, and is excellent in view of the adhesive force of the interface between the tacky adhesive layer and the adhesive layer. When the adhesive force of the interface between the tacky adhesive layer and the adhesive layer is high, it is preferable, on the occasion of cutting a wafer by expanding the adhesive tape, because the interfacial slippage between the tacky adhesive layer and the adhesive layer can be suppressed, and cuttability is enhanced.

[0040] Furthermore, as a monomer having an alkyl chain with a larger number of carbon atoms is used as the monomer (A1-1), the glass transition temperature is lowered; therefore, a tacky adhesive composition having a desired glass transition temperature can be prepared by appropriately selecting the monomer (A1-1). Furthermore, for the purpose of enhancing the various performances such as compatibility in addition to the glass transition temperature, a low molecular weight compound having a carbon-carbon double bond, such as vinyl acetate, styrene or acrylonitrile, can also be incorporated. In that case, such a low molecular weight compound is incorporated in an amount in the range of 5% by mass or less relative to the

total mass of the monomer (A1-1).

[0041] On the other hand, examples of the functional group carried by the monomer (A1-2) include a carboxyl group, a hydroxyl group, an amino group, a cyclic acid anhydride group, an epoxy group, and an isocyanate group. Specific examples of the monomer (A1-2) include acrylic acid, methacrylic acid, cinnamic acid, itaconic acid, fumaric acid, phthalic acid, a 2-hydroxyalkyl acrylates, a 2-hydroxyalkyl methacrylate, a glycol monoacrylate, a glycol monomethacrylate, N-methylol acrylamide, N-methylol methacrylamide, allyl alcohol, an N-alkylaminoethyl acrylate, an N-alkylaminoethyl methacrylate, an acrylamide, a methacrylamide, maleic anhydride, itaconic anhydride, fumaric anhydride, phthalic anhydride, glycidyl acrylate, glycidyl methacrylate, and allyl glycidyl ether.

[0042] Furthermore, regarding the functional group used for the compound (A2), in a case in which the functional group carried by the compound (A1) is a carboxyl group or a cyclic acid anhydride group, the functional group of the compound (A2) may be a hydroxyl group, an epoxy group, an isocyanate group or the like; in the case of a hydroxyl group, the functional group may be a cyclic acid anhydride group, an isocyanate group or the like; in the case of an amino group, the functional group may be an epoxy group, an isocyanate group or the like; and in the case of an epoxy group, the functional group may be a carboxyl group, a cyclic acid anhydride group, an amino group or the like.

Specific examples thereof include the same groups as those mentioned as the specific examples for the monomer (A1-2). Furthermore, as the compound (A2), a compound in which a portion of the isocyanate groups of a polyisocyanate compound has been urethanized using hydroxyl groups or carboxyl groups and a monomer having an energy ray-curable carbon-carbon double bond, can also be used.

[0043] Meanwhile, in regard to the reaction between the compound (A1) and the compound (A2), a product having desired characteristics such as the acid value or the hydroxyl group value can be produced by leaving unreacted functional groups. When OH groups are left unreacted such that the hydroxyl group value of the polymer (A) is adjusted to 5 to 100, the tacky adhesive force after irradiation with energy rays is reduced, and thereby the risk of pick-up failure can be further reduced. Furthermore, when COOH groups are left unreacted such that the acid value of the polymer (A) is adjusted to 0.5 to 30, an effect of improving the state after restoration of the tacky adhesive layer after the adhesive tape for semiconductor processing of the present invention has been expanded, is obtained, which is preferable. When the hydroxyl group value of the polymer (A) is 5 or larger, excellent results are obtained in view of the effect of reducing the tacky adhesive force after irradiation with energy rays, and when the hydroxyl group value is 100 or less, excellent results are obtained in view of the fluidity

of the tacky adhesive after irradiation with energy rays. Furthermore, when the acid value is 0.5 or more, excellent results are obtained in view of the adhesive tape restorability, and when the acid value is 30 or less, excellent results are obtained in view of the fluidity of the tacky adhesive.

[0044] In regard to the synthesis of the polymer (A) described above, as the organic solvent in the case of performing the reaction by solution polymerization, a ketone-based solvent, an ester-based solvent, an alcohol-based solvent, or an aromatic solvent can be used; however, among these, a solvent which is generally a good solvent for acrylic polymers and has a boiling point of 60°C to 120°C, such as toluene, ethyl acetate, isopropyl alcohol, benzene methyl cellosolve, ethyl cellosolve, acetone, or methyl ethyl ketone, is preferred. As the polymerization initiator, an azobis-based radical generator such as α, α' -azobisisobutyronitrile, or an organic peroxide-based radical generator such as benzoyl peroxide is usually used. At this time, if necessary, a catalyst and a polymerization inhibitor can be used in combination, and by regulating the polymerization temperature and the polymerization time, a polymer (A) having a desired molecular weight can be obtained. Furthermore, in connection with the regulation of the molecular weight, it is preferable to use mercaptan or a carbon tetrachloride-based solvent. Meanwhile, this reaction is not intended to be limited to solution

polymerization, and other methods such as bulk polymerization and suspension polymerization may also be used.

[0045] The polymer (A) can be obtained in this manner as described above; however, according to the present invention, when the molecular weight of the polymer (A) is adjusted to 300,000 or more, excellent results are obtained from the viewpoint of increasing the cohesive force. High cohesive force leads to an effect of suppressing slippage at the interface between the tacky adhesive layer and the adhesive layer at the time of expansion, and since the propagation of tensile force to the adhesive layer is easily achieved, it is preferable from the viewpoint that the divisibility of the adhesive layer is enhanced. When the molecular weight of the polymer (A) is adjusted to 2,000,000 or less, excellent results are obtained from the viewpoint of suppressing gelation at the time of synthesis and application. Meanwhile, the molecular weight according to the present invention means the mass average molecular weight calculated relative to polystyrene standards.

[0046] Furthermore, in regard to the adhesive tape for semiconductor processing 10 of the present invention, the resin composition that constitutes the tacky adhesive layer 12 may further include a compound (B) that acts as a crosslinking agent, in addition to the polymer (A). Examples thereof include a polyisocyanate, a melamine-formaldehyde resin, and an epoxy resin, and these can be used singly or in combination of two

or more kinds thereof. This compound (B) reacts with the polymer (A) or the substrate film, and the compound (B) can enhance, through the resulting crosslinked structure, the cohesive force of the tacky adhesive containing the polymers (A) and (B) as main components, after the application of the tacky adhesive composition.

[0047] There are no particular limitations on the polyisocyanate, and examples thereof include aromatic isocyanates such as 4,4'-diphenylmethane diisocyanate, tolylene diisocyanate, xylene diisocyanate, 4,4'-diphenyl ether diisocyanate, and 4,4'-[2,2-bis(4-phenoxyphenyl)propane] diisocyanate; hexamethylene diisocyanate, 2,2,4-trimethylhexamethylene diisocyanate, isophorone diisocyanate, 4,4'-dicyclohexylmethane diisocyanate, 2,4'-dicyclohexylmethane diisocyanate, lysine diisocyanate, and lysine triisocyanate. Specifically, CORONATE L (manufactured by Nippon Polyurethane Industry Co., Ltd., trade name) and the like can be used. Regarding the melamine-formaldehyde resin, specifically, NIKALAC MX-45 (manufactured by Sanwa Chemical Co., Ltd., trade name), MELAN (manufactured by Hitachi Chemical Co., Ltd., trade name), and the like can be used. Regarding the epoxy resin, TETRAD-X (manufactured by Mitsubishi Chemical Corp., trade name) and the like can be used. According to the present invention, it is

particularly preferable to use a polyisocyanate.

[0048] A tacky adhesive layer in which the amount of addition of the compound (B) has been adjusted to 0.1 parts by mass or more relative to 100 parts by mass of the polymer (A), is excellent in view of the cohesive force. The amount of addition of the compound (B) is more preferably 0.5 parts by mass or more. Furthermore, a tacky adhesive layer in which the amount of addition has been adjusted to 10 parts by mass or less, is excellent in view of suppressing rapid gelation at the time of application, and thus satisfactory workability for the incorporation, application or the like of the tacky adhesive is obtained. The amount of addition is more preferably 5 parts by mass or less.

[0049] Furthermore, according to the present invention, the tacky adhesive layer 12 may also include a photopolymerization initiator (C). The photopolymerization initiator (C) included in the tacky adhesive layer 12 is not particularly limited, and any conventionally known photopolymerization initiator can be used. Examples thereof include benzophenones such as benzophenone, 4,4'-dimethylaminobenzophenone, 4,4'-diethylaminobenzophenone, and 4,4'-dichlorobenzophenone; acetophenones such as acetophenone and diethoxyacetophenone; anthraquinones such as 2-ethylanthraquinone and t-butylanthraquinone; 2-chlorothioxanthone, benzoin ethyl

ether, benzoin isopropyl ether, benzil, a 2,4,5-triaryl imidazole dimer (lophine dimer), and an acridine-based compound, and these can be used singly or in combination of two or more kinds thereof. Regarding the amount of addition of the photopolymerization initiator (C), it is preferable to incorporate the polymerization initiator (C) in an amount of 0.1 parts by mass or more, and more preferably 0.5 parts by mass or more, relative to 100 parts by mass of the polymer (A). Furthermore, the amount of addition is preferably 10 parts by mass or less, and more preferably 5 parts by mass or less.

[0050] In addition, in the energy ray-curable tacky adhesive used for the present invention, a tackifier, a tacky adhesiveness modifier, a surfactant and the like, or other modifiers can be incorporated as necessary. Furthermore, an inorganic compound filler may also be appropriately added thereto.

[0051] The tacky adhesive layer 12 can be formed by utilizing a conventional method for forming a tacky adhesive layer. The tacky adhesive layer 12 can be formed on a substrate film 11 by, for example, a method of forming a tacky adhesive layer by applying the tacky adhesive composition described above on a predetermined surface of a substrate film 11, or a method of applying the tacky adhesive composition on a separator (for example, a plastic film or sheet having a release agent applied thereon) to form the tacky adhesive layer 12, and then

transferring the tacky adhesive layer 12 to a predetermined surface of the substrate. Meanwhile, the tacky adhesive layer 12 may be in the form of a single layer, or may have a laminated form.

[0052] The thickness of the tacky adhesive layer 12 is not particularly limited; however, when the thickness is 2 μm or more, excellent results are obtained in view of the tack force, and the thickness is more preferably 5 μm or more. When the thickness is 15 μm or less, excellent pick-up performance is obtained, and the thickness is more preferably 10 μm or less.

[0053] It is preferable that the tacky adhesive sheet 15 has an elongation percentage of 200% or more. Furthermore, it is preferable that the tacky adhesive sheet 15 is stretched to an elongation percentage of 200% and then is heated to 120°C, and thereby the elongation percentage is adjusted to 120% or less. When the elongation percentage is adjusted to 120% or less by heating the tacky adhesive sheet to 120°C, in a process of splitting the adhesive layer 12 by expansion along the chips, and then causing the chip peripheral part of the adhesive tape for semiconductor processing that has been stretched by expansion to shrink by heating, the adhesive tape for semiconductor processing can be made to properly shrink. As a result, the distance between chips can be maintained, and cracks and the like caused by bumping between chips or the like can be prevented. In order to obtain an elongation percentage

of 200% or more, and to have the elongation percentage adjusted to 120% or less by heating to 120°C after stretching the tacky adhesive sheet up to an elongation percentage of 200%, it is preferable to use a substrate film 11 having such characteristics.

[0054] <Adhesive layer>

In regard to the adhesive tape for semiconductor processing 10 of the present invention, the adhesive layer 13 is intended such that after a wafer is attached to the adhesive tape for semiconductor processing 10 and diced, when chips are picked up, the adhesive layer 13 is detached from the tacky adhesive layer 12 and adheres to the chips. Then, the adhesive layer is used as an adhesive for fixing the chips onto a substrate or a lead frame.

[0055] The adhesive layer 13 is not particularly limited; however, the adhesive layer 13 may be any film-like adhesive that is generally used in wafers, and an example thereof is an adhesive layer containing a thermoplastic resin and a thermally polymerizable component. The thermoplastic resin used for the adhesive layer 13 of the present invention is preferably a resin having thermoplasticity, or a resin which has thermoplasticity in an uncured state and forms a crosslinked structure after being heated. There are no particular limitations, but according to an embodiment, a thermoplastic resin having a weight average molecular weight of 5000 to 200,000 and a glass

transition temperature of 0°C to 150°C may be used. Furthermore, according to another embodiment, a thermoplastic resin having a weight average molecular weight of 100,000 to 1,000,000 and a glass transition temperature of -50°C to 20°C may be used.

[0056] Examples of the former thermoplastic resin include a polyimide resin, a polyamide resin, a polyetherimide resin, a polyamideimide resin, a polyester resin, a polyesterimide resin, a phenoxy resin, a polysulfone resin, a polyether sulfone resin, a polyphenylene sulfide resin, and a polyether ketone resin. Among them, it is preferable to use a polyimide resin or a phenoxy resin. Regarding the latter thermoplastic resin, it is preferable to use a polymer containing a functional group.

[0057] A polyimide resin can be obtained by subjecting a tetracarboxylic acid dianhydride and a diamine to a condensation reaction by a known method. That is, an addition reaction is carried out in an organic solvent using a tetracarboxylic acid dianhydride and a diamine in equimolar amounts or in almost equimolar amounts (the order of addition of the various components is arbitrary) at a reaction temperature of 80°C or lower, and preferably 0°C to 60°C. As the reaction progresses, the viscosity of the reaction liquid slowly increases, and polyamide acid, which is a precursor of polyimide, is produced. This polyamide acid can have its molecular weight regulated by subjecting the polyamide acid to depolymerization by heating the compound at a temperature of

50°C to 80°C. The polyimide resin can be obtained by subjecting the reaction product (polyamide acid) to dehydration cyclization. The dehydration cyclization can be carried out by a thermal cyclization method of performing a heat treatment and a chemical cyclization method of using a dehydrating agent.

[0058] The tetracarboxylic acid dianhydride used as a raw material of the polyimide resin is not particularly limited, and for example, 1,2-(ethylene)bis(trimellitate anhydride), 1,3-(trimethylene)bis(trimellitate anhydride), 1,4-(tetramethylene)bis(trimellitate anhydride), 1,5-(pentamethylene)bis(trimellitate anhydride), 1,6-(hexamethylene)bis(trimellitate anhydride), 1,7-(heptamethylene)bis(trimellitate anhydride), 1,8-(octamethylene)bis(trimellitate anhydride), 1,9-(nonamethylene)bis(trimellitate anhydride), 1,10-(decamethylene)bis(trimellitate anhydride), 1,12-(dodecamethylene)bis(trimellitate anhydride), 1,16-(hexadecamethylene)bis(trimellitate anhydride), 1,18-(octadecamethylene)bis(trimellitate anhydride), pyromellitic dianhydride, 3,3',4,4'-biphenyltetracarboxylic acid dianhydride, 2,2',3,3'-biphenyltetracarboxylic acid dianhydride, 2,2-bis(3,4-dicarboxyphenyl)propane dianhydride, 2,2-bis(2,3-dicarboxyphenyl)propane dianhydride, 1,1-bis(2,3-dicarboxyphenyl)ethane dianhydride, 1,1-bis(3,4-dicarboxyphenyl)ethane dianhydride,

bis(2,3-dicarboxyphenyl)methane dianhydride,
 bis(3,4-dicarboxyphenyl)methane dianhydride,
 bis(3,4-dicarboxyphenyl)sulfone dianhydride,
 3,4,9,10-perylenetetracarboxylic acid dianhydride,
 bis(3,4-dicarboxyphenyl) ether dianhydride,
 benzene-1,2,3,4-tetracarboxylic acid dianhydride,
 3,4,3',4'-benzophenonetetracarboxylic acid dianhydride,
 2,3,2',3'-benzophenonetetracarboxylic acid dianhydride,
 3,3,3',4'-benzophenonetetracarboxylic acid dianhydride,
 1,2,5,6-naphthalenetetracarboxylic acid dianhydride,
 1,4,5,8-naphthalenetetracarboxylic acid dianhydride,
 2,3,6,7-naphthalenetetracarboxylic acid dianhydride,
 1,2,4,5-naphthalenetetracarboxylic acid dianhydride,
 2,6-dichloronaphthalene-1,4,5,8-tetracarboxylic acid
 dianhydride,
 2,7-dichloronaphthalene-1,4,5,8-tetracarboxylic acid
 dianhydride,
 2,3,6,7-tetrachloronaphthalene-1,4,5,8-tetracarboxylic acid
 dianhydride, phenanthrene-1,8,9,10-tetracarboxylic acid
 dianhydride, pyrazine-2,3,5,6-tetracarboxylic acid
 dianhydride, thiophene-2,3,5,6-tetracarboxylic acid
 dianhydride, 2,3,3',4'-biphenyltetracarboxylic acid
 dianhydride, 3,4,3',4'-biphenyltetracarboxylic acid
 dianhydride, 2,3,2',3'-biphenyltetracarboxylic acid
 dianhydride, bis(3,4-dicarboxyphenyl)dimethylsilane

dianhydride, bis(3,4-dicarboxyphenyl)methylphenylsilane
 dianhydride, bis(3,4-dicarboxyphenyl)diphenylsilane
 dianhydride,
 1,4-bis(3,4-dicarboxyphenyldimethylsilyl)benzene
 dianhydride,
 1,3-bis(3,4-dicarboxyphenyl)-1,1,3,3-tetramethyldicyclohexane dianhydride, p-phenylenebis(trimellitate anhydride),
 ethylenetetracarboxylic acid dianhydride,
 1,2,3,4-butanetetracarboxylic acid dianhydride,
 decahydronaphthalene-1,4,5,8-tetracarboxylic acid dianhydride,
 4,8-dimethyl-1,2,3,5,6,7-hexahydronaphthalene-1,2,5,6-tetracarboxylic acid dianhydride,
 cyclopentane-1,2,3,4-tetracarboxylic acid dianhydride,
 pyrrolidine-2,3,4,5-tetracarboxylic acid dianhydride,
 1,2,3,4-cyclobutanetetracarboxylic acid dianhydride,
 bis(exo-bicyclo[2,2,1]heptane-2,3-dicarboxylic acid dianhydride,
 bicyclo[2,2,2]-oct-7-ene-2,3,5,6-tetracarboxylic acid dianhydride, 2,2-bis(3,4-dicarboxyphenyl)hexafluoropropane dianhydride,
 2,2-bis[4-(3,4-dicarboxyphenyl)phenyl]hexafluoropropane dianhydride, 4,4'-bis(3,4-dicarboxyphenoxy)diphenyl sulfide dianhydride,
 1,4-bis(2-hydroxyhexafluoroisopropyl)benzenebis(trimellitic

anhydride),

1,3-bis(2-hydroxyhexafluoroisopropyl)benzenebis(trimellitic anhydride),

5-(2,5-dioxotetrahydrofuryl)-3-methyl-3-cyclohexene-1,2-dicarboxylic acid dianhydride,

tetrahydrofuran-2,3,4,5-tetracarboxylic acid dianhydride,

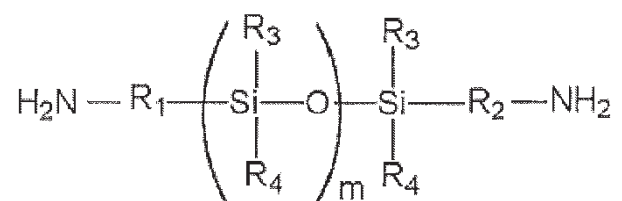
and the like can be used. These compounds can be used singly or in combination of two or more kinds thereof.

[0059] The diamine used as a raw material of polyimide is not particularly limited, and for example, aromatic diamines such as o-phenylenediamine, m-phenylenediamine, p-phenylenediamine, 3,3'-diaminodiphenyl ether, 3,4'-diaminodiphenyl ether, 4,4'-diaminodiphenyl ether, 3,3'-diaminodiphenylmethane, 3,4'-diaminodiphenylmethane, 4,4'-diaminodiphenyl ether methane, bis(4-amino-3,5-dimethylphenyl)methane, bis(4-amino-3,5-diisopropylphenyl)methane, 3,3'-diaminodiphenyldifluoromethane, 3,4'-diaminodiphenyldifluoromethane, 4,4'-diaminodiphenyldifluoromethane, 3,3'-diaminodiphenylsulfone, 3,4'-diaminodiphenylsulfone, 4,4'-diaminodiphenylsulfone, 3,3'-diaminodiphenyl sulfide, 3,4'-diaminodiphenyl sulfide, 4,4'-diaminodiphenyl sulfide, 3,3'-diaminodiphenyl ketone, 3,4'-diaminodiphenyl ketone, 4,4'-diaminodiphenyl ketone, 2,2-bis(3-aminophenyl)propane,

2,2'-(3,4'-diaminodiphenyl)propane,
 2,2-bis(4-aminophenyl)propane,
 2,2-bis(3-aminophenyl)hexafluoropropane,
 2,2-(3,4'-diaminodiphenyl)hexafluoropropane,
 2,2-bis(4-aminophenyl)hexafluoropropane,
 1,3-bis(3-aminophenoxy)benzene,
 1,4-bis(3-aminophenoxy)benzene,
 1,4-bis(4-aminophenoxy)benzene,
 3,3'-(1,4-phenylenebis(1-methylethylidene))bisaniiline,
 3,4'-(1,4-phenylenebis(1-methylethylidene))bisaniiline,
 4,4'-(1,4-phenylenebis(1-methylethylidene))bisaniiline,
 2,2-bis(4-(3-aminophenoxy)phenyl)propane,
 2,2-bis(4-(4-aminophenoxy)phenyl)propane,
 2,2-bis(4-(3-aminophenoxy)phenyl)hexafluoropropane,
 2,2-bis(4-(4-aminophenoxy)phenyl)hexafluoropropane,
 bis(4-(3-aminophenoxy)phenyl) sulfide,
 bis(4-(4-aminophenoxy)phenyl) sulfide,
 bis(4-(3-aminophenoxy)phenyl)sulfone,
 bis(4-(4-aminophenoxy)phenyl)sulfone, and 3,5-diaminobenzoic
 acid; and aliphatic diamines such as 1,2-diaminoethane,
 1,3-diaminopropane, 1,4-diaminobutane, 1,5-diaminopentane,
 1,6-diaminohexane, 1,7-diaminoheptane, 1,8-diaminooctane,
 1,9-diaminononane, 1,10-diaminodecane, 1,11-diaminoundecane,
 1,12-diaminododecane, 1,2-diaminocyclohexane, a
 diaminopolysiloxane represented by the following formula (1),

1,3-bis(aminomethyl)cyclohexane, and polyoxyalkylenediamines such as JEFFAMINE D-230, D-400, D-2000, D-4000, ED-600, ED-900, ED-2001 and EDR-148 manufactured by Sun Techno Chemical Co., Ltd.; and the like can be used. These compounds can be used singly or in combination of two or more kinds thereof. The glass transition temperature of the polyimide resin is preferably 0°C to 200°C, and the weight average molecular weight is preferably 10,000 to 200,000.

[Chemical Formula 1]



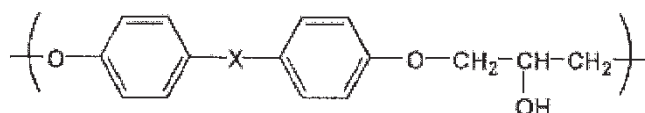
wherein R1 and R2 each represent a divalent hydrocarbon group having 1 to 30 carbon atoms, while R1 and R2 may be respectively identical or different; R3 and R4 each represent a monovalent hydrocarbon group, while R3's and R4's may be respectively identical or different; and m represents an integer of 1 or more.

[0060] Regarding the phenoxy resin, which is one of the preferred thermoplastic resins in addition to those described above, a resin obtainable by a method of reacting various bisphenols and epichlorohydrin, or a method of reacting a liquid epoxy resin and a bisphenol is preferred. Examples of the bisphenol include bisphenol A, bisphenol-bisphenol AF, bisphenol AD, bisphenol F, and bisphenol S. Since a phenoxy

resin has a structure similar to that of an epoxy resin, the phenoxy resin has high compatibility with epoxy resins, and is suitable for imparting satisfactory adhesiveness to an adhesive film.

[0061] An example of the phenoxy resin used for the present invention is a resin having a repeating unit represented by the following formula (2):

[Chemical Formula 2]



[0062] In the formula (2) described above, X represents a single bond or a divalent linking group. Examples of the divalent linking group include an alkylene group, a phenylene group, -O-, -S-, -SO- and -SO₂-. Here, the alkylene group is preferably an alkylene group having 1 to 10 carbon atoms, and more preferably -C(R1)(R2)-. R1 and R2 each represent a hydrogen atom or an alkyl group. The alkyl group is preferably a linear or branched alkyl group having 1 to 8 carbon atoms, and examples thereof include methyl, ethyl, n-propyl, isopropyl, isooctyl, 2-ethylhexyl, and 1,3,3-trimethylbutyl.

Furthermore, the alkyl group may be substituted with a halogen atom, and examples thereof include a trifluoromethyl group. X is preferably an alkylene group, -O-, -S-, a fluorene group, or -SO₂-, and more preferably an alkylene group or -SO₂-. Among them, -C(CH₃)₂-, -CH(CH₃)-, -CH₂-, and -SO₂- are preferred;

$-\text{C}(\text{CH}_3)_2-$, $-\text{CH}(\text{CH}_3)-$ and $-\text{CH}_2-$ are more preferred; and $-\text{C}(\text{CH}_3)_2-$ is particularly preferred.

[0063] If the phenoxy resin represented by formula (2) has repeating units, the phenoxy resin may be a resin having plural repeating units with different X's of the formula (2) described above, or may be composed only of repeating units with identical X's. According to the present invention, a resin composed only of repeating units with identical X's is preferred.

[0064] Furthermore, when a polar substituent such as a hydroxyl group or a carboxyl group is incorporated into the phenoxy resin represented by the formula (2) described above, compatibility with thermally polymerizable components is enhanced, and a uniform external appearance or characteristics can be imparted.

[0065] When the mass average molecular weight of the phenoxy resin is 5000 or more, excellent results are obtained in view of the film forming properties. The mass average molecular weight is more preferably 10,000 or more, and even more preferably 30,000 or more. Furthermore, when the mass average molecular weight is 150,000 or less, it is preferable from the viewpoints of fluidity at the time of heat pressing, or compatibility with other resins. The mass average molecular weight is more preferably 100,000 or less. Furthermore, when the glass transition temperature is -50°C or higher, excellent results are obtained in view of the film forming properties,

and the glass transition temperature is more preferably 0°C or higher, and even more preferably 50°C or higher. When the glass transition temperature is 150°C, excellent adhesive force of the adhesive layer 13 is obtained at the time of die bonding. The glass transition temperature is more preferably 120°C or lower, and even more preferably 110°C or lower.

[0066] On the other hand, examples of the functional group for the polymer containing functional groups as described above include a glycidyl group, an acryloyl group, a methacryloyl group, a hydroxyl group, a carboxyl group, an isocyanurate group, an amino group, and an amide group, and among them, a glycidyl group is preferred.

[0067] Examples of the high molecular weight component containing a functional group include (meth)acrylic copolymers containing functional groups such as a glycidyl group, a hydroxyl group, and a carboxyl group.

[0068] Regarding the (meth)acrylic copolymers, for example, a (meth)acrylic ester copolymer and an acrylic rubber can be used, and an acrylic rubber is preferred. An acrylic rubber is a rubber which contains an acrylic acid ester as a main component and is mainly formed from a copolymer of butyl acrylate and acrylonitrile or the like, or a copolymer of ethyl acrylate and acrylonitrile or the like.

[0069] In a case in which the compound contains a glycidyl group as a functional group, the amount of a glycidyl

group-containing repeating unit is preferably 0.5% to 6.0% by weight, more preferably 0.5% to 5.0% by weight, and particularly preferably 0.8% to 5.0% by weight. A glycidyl group-containing repeating unit is a constituent monomer for a (meth)acrylic copolymer containing glycidyl groups, and specific examples thereof include glycidyl acrylate and glycidyl methacrylate. When the amount of the glycidyl group-containing repeating unit is in this range, adhesive force can be secured, and also, gelation can be prevented.

[0070] Examples of the constituent monomer for the (meth)acrylic copolymer other than glycidyl acrylate and glycidyl methacrylate, include ethyl (meth)acrylate and butyl (meth)acrylate, and these can be used singly or in combination of two or more kinds thereof. Meanwhile, according to the present invention, ethyl (meth)acrylate represents ethyl acrylate and/or ethyl methacrylate. The mixing ratio in the case of using functional monomers in combination may be determined in consideration of the glass transition temperature of the (meth)acrylic copolymer. When the glass transition temperature is adjusted to -50°C or higher, it is preferable from the viewpoint that excellent film forming properties are obtained, and excessive tack at normal temperature can be suppressed. When the tack force at normal temperature is excessive, handling of the adhesive layer becomes difficult. The glass transition temperature is more preferably -20°C or

higher, and even more preferably 0°C or higher. Also, when the glass transition temperature is adjusted to 30°C or lower, excellent results are obtained in view of the adhesive force of the adhesive layer at the time of die bonding, and the glass transition temperature is more preferably 20°C or lower.

[0071] In a case in which a high molecular weight component containing a functional monomer is produced by polymerizing the above-mentioned monomers, the polymerization method therefor is not particularly limited, and for example, methods such as pearl polymerization and solution polymerization can be used. Among them, pearl polymerization is preferred.

[0072] According to the present invention, when the weight average molecular weight of the high molecular weight component containing a functional monomer is 100,000 or more, excellent results are obtained in view of the film forming properties, and the weight average molecular weight is more preferably 200,000 or more, and even more preferably 500,000 or more. Furthermore, when the weight average molecular weight is adjusted to 2,000,000 or less, excellent results are obtained from the viewpoint that the hot fluidity of the adhesive layer at the time of die bonding is increased. When the hot fluidity of the adhesive layer at the time of die bonding is increased, satisfactory adhesion between the adhesive layer and the adherend is obtained, and the adhesive force can be increased. Also, the surface unevenness of the adherend is embedded, and

thus voids can be easily suppressed. The weight average molecular weight is more preferably 1,000,000 or less, and still more preferably 800,000 or less, and when the weight average molecular weight is adjusted to 500,000 or less, superior effects can be obtained.

[0073] Furthermore, the thermally polymerizable component is not particularly limited as long as the thermally polymerizable component can be polymerized by heat, and examples thereof include compounds having functional groups such as a glycidyl group, an acryloyl group, a methacryloyl group, a hydroxyl group, a carboxyl group, an isocyanurate group, an amino group, and an amide group; and trigger materials. These compounds can be used singly or in combination of two or more kinds thereof; however, when the heat resistance of the adhesive layer is considered, it is preferable that the adhesive layer contains a thermosetting resin that is cured by heat and exerts an adhesive action, together with a curing agent and a promoting agent. Examples of the thermosetting resin include an epoxy resin, an acrylic resin, a silicone resin, a phenolic resin, a thermosetting polyimide resin, a polyurethane resin, a melamine resin, and a urea resin. Particularly, from the viewpoint of obtaining an adhesive layer having excellent heat resistance, workability and reliability, it is most preferable to use an epoxy resin.

[0074] The epoxy resin is not particularly limited as long

as the epoxy resin is cured and has an adhesive action, and a bifunctional epoxy resin such as bisphenol A epoxy, or a novolac type epoxy resin such as a phenol-novolac type epoxy resin or a cresol-novolac type epoxy resin can be used. Also, generally known epoxy resins such as a polyfunctional epoxy resin, a glycidylamine type epoxy resin, a heterocyclic-containing epoxy resin, and an alicyclic epoxy resin can be applied.

[0075] Examples of the bisphenol A type epoxy resin include EPIKOTE series (EPIKOTE 807, EPIKOTE 815, EPIKOTE 825, EPIKOTE 827, EPIKOTE 828, EPIKOTE 834, EPIKOTE 1001, EPIKOTE 1004, EPIKOTE 1007, and EPIKOTE 1009) manufactured by Mitsubishi Chemical Corp.; DER-330, DER-301 and DER-361 manufactured by Dow Chemical Company; and YD8125 and YDF8170 manufactured by Nippon Steel & Sumikin Chemical Co., Ltd. Examples of the phenol novolac type epoxy resin include EPIKOTE 152 and EPIKOTE 154 manufactured by Mitsubishi Chemical Corp.; EPPN-201 manufactured by Nippon Kayaku Co., Ltd.; and DEN-438 manufactured by Dow Chemical Company. Examples of the o-cresol novolac type epoxy resin include EOCN-102S, EOCN-103S, EOCN-104S, EOCN-1012, EOCN-1025 and EOCN-1027 manufactured by Nippon Kayaku Co., Ltd.; and YDCN701, YDCN702, YDCN703 and YDCN704 manufactured by Nippon Steel & Sumikin Chemical Co., Ltd. Examples of the polyfunctional epoxy resin include EPON1031S manufactured by Mitsubishi Chemical Corp.; ARALDITE 0163 manufactured by Ciba Specialty Chemicals corporation; and

DENACOL EX-611, EX-614, EX-614 B, EX-622, EX-512, EX-521, EX-421, EX-411 and EX-321 manufactured by Nagase Chemtex Corp. Examples of the amine type epoxy resin include EPIKOTE 604 manufactured by Mitsubishi Chemical Corp.; YH-434 manufactured by Tohto Chemical Industry Co., Ltd.; TETRAD-X and TETRAD-C manufactured by Mitsubishi Gas Chemical Co., Inc.; and ELM-120 manufactured by Sumitomo Chemical Co., Ltd. Examples of the heterocyclic-containing epoxy resin include ARALDITE PT810 manufactured by Ciba Specialty Chemicals corporation; ERL4234, ERL4299, ERL4221 and ERL4206 manufactured by Union Carbide Corp. These epoxy resins can be used singly or in combination of two or more kinds thereof.

[0076] In order to cure the thermosetting resin, additives can be appropriately added thereto. Examples of such additives include a curing agent, a curing accelerator, and a catalyst. In the case of adding a catalyst, a co-catalyst can be used as necessary.

[0077] In a case in which an epoxy resin is used as the thermosetting resin, it is preferable to use an epoxy resin curing agent or a curing accelerator, and it is more preferable to use these in combination. Examples of the curing agent include a phenolic resin, dicyandiamide, a boron trifluoride complex compound, an organic hydrazide compound, an amine, a polyamide resin, an imidazole compound, a urea or thiourea compound, a polymercaptan compound, a polysulfide resin having

mercapto groups at the ends, an acid anhydride, and a light/ultraviolet curing agent. These can be used singly or in combination of two or more kinds thereof.

Among these, examples of the boron trifluoride complex compound include boron trifluoride-amine complexes with various amine compounds (preferably, primary amine compounds), and examples of the organic hydrazide compound include isophthalic acid dihydrazide.

[0078] Examples of the phenolic resin 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; a resol type phenolic resin, and polyoxystyrene such as poly(para-oxystyrene). Among them, a phenolic compound having at least two phenolic hydroxyl groups in the molecule is preferred.

[0079] Examples of the phenolic compound having at least two phenolic hydroxyl groups in the molecule include a phenol novolac resin, a cresol novolac resin, a t-butylphenol novolac resin, a dicyclopentadiene cresol novolac resin, a dicyclopentadiene phenol novolac resin, a xylene-modified phenol novolac resin, a naphthol novolac resin, a trisphenol novolac resin, a tetrakisphenol novolac resin, a bisphenol A novolac resin, a poly(p-vinylphenol) resin, and a phenol aralkyl resin. Furthermore, among these phenolic resins, a phenol novolac resin and a phenol aralkyl resin are particularly

preferred, and these can enhance the connection reliability.

[0080] Examples of the amine include chain-like aliphatic amines (diethylenetriamine, triethylenetetramine, hexamethylenediamine, N,N-dimethylpropylamine, benzyldimethylamine, 2-(dimethylamino)phenol, 2,4,6-tris(dimethylaminomethyl)phenol, m-xylenediamine, and the like), cyclic aliphatic amines (N-aminoethylpiperazine, bis(3-methyl-4-aminocyclohexyl)methane, bis(4-aminocyclohexyl)methane, menthenediamine, isophoronediamine, 1,3-bis(aminomethyl)cyclohexane, and the like), heterocyclic amines (piperazine, N,N-dimethylpiperazine, triethylenediamine, melamine, guanamine, and the like), aromatic amines (meta-phenylenediamine, 4,4'-diaminodiphenylmethane, diamino, 4,4'-diaminodiphenylsulfone, and the like), polyamide resins (polyamidoamine is preferred; condensation product of a dimer acid and a polyamine), imidazole compounds (2-phenyl-4,5-dihydroxymethylimidazole, 2-methylimidazole, 2,4-dimethylimidazole, 2-n-heptadecylimidazole, 1-cyanoethyl-2-undecylimidazolium trimellitate, an epoxy-imidazole adduct, and the like), urea or thiourea compounds (an N,N-dialkylurea compound, an N,N-dialkylthiourea compound, and the like), polymercaptan compounds, polysulfide resins having mercapto groups at the ends, acid anhydrides (tetrahydrophthalic anhydride and the

like), and light/ultraviolet curing agents (diphenyliodonium hexafluorophosphate, triphenylsulfonium hexafluorophosphate, and the like).

[0081] The curing accelerator is not particularly limited as long as it is capable of curing a thermosetting resin, and examples thereof include an imidazole, a dicyandiamide derivative, a dicarboxylic acid dihydrazide, triphenylphosphine, tetraphenylphosphonium tetraphenylborate, 2-ethyl-4-methylimidazole-tetraphenylborate, and 1,8-diazabicyclo[5.4.0]undecene-7-tetraphenylborate.

Examples of the imidazole include imidazole, 2-methylimidazole, 2-ethylimidazole, 2-ethyl-4-methylimidazole, 2-phenylimidazole, 2-phenyl-4-methylimidazole, 1-benzyl-2-methylimidazole, 1-benzyl-2-ethylimidazole, 1-benzyl-2-ethyl-5-methylimidazole, 2-phenyl-4-methyl-5-hydroxydimethylimidazole, and 2-phenyl-4,5-dihydroxymethylimidazole.

[0082] The content of the curing agent for an epoxy resin or a curing accelerator in the adhesive layer is not particularly limited, and the optimal content varies depending on the kind of the curing agent or the curing accelerator.

[0083] Regarding the mixing proportions between the epoxy resin and the phenolic resin, for example, it is preferable that the resins are mixed such that the proportion of hydroxyl groups

in the phenolic resin is 0.5 to 2.0 equivalents per equivalent of epoxy groups in the epoxy resin components. The proportion of hydroxyl groups is more preferably 0.8 to 1.2 equivalents. That is, it is because when the mixing proportions of the two components are not in the range described above, the curing reaction does not proceed sufficiently, and the characteristics of the adhesive layer are easily deteriorated. Regarding the other thermosetting resins and the curing agent, according to an embodiment, the mixing proportion of the curing agent is 0.5 parts to 20 parts by mass relative to 100 parts by mass of the thermosetting resins, and according to another embodiment, the proportion of the curing agent is 1 part to 10 parts by mass. It is preferable that the content of the curing accelerator is smaller than the content of the curing agent, and the content of the curing accelerator is preferably 0.001 parts to 1.5 parts by mass, and more preferably 0.01 parts to 0.95 parts by mass, relative to 100 parts by mass of the thermosetting resins. When the content of the curing accelerator is adjusted to the range described above, the curing accelerator can sufficiently assist the progress of the curing reaction. The content of the catalyst is preferably 0.001 parts to 1.5 parts by mass, and more preferably 0.01 parts to 1.0 parts by mass, relative to 100 parts by mass of the thermosetting resins.

[0084] Furthermore, the adhesive layer 13 of the present invention can appropriately have a filler incorporated therein

according to the use. Thereby, enhancement of the diceability of the adhesive layer, enhancement of handleability, adjustment of the melt viscosity, and impartation of thixotropy in an uncured state, impartation of heat conductivity to the adhesive layer and enhancement of the adhesive force in a cured state can be promoted.

The filler used for the present invention is preferably an inorganic filler. The inorganic filler is not particularly limited, and for example, aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate, magnesium silicate, calcium oxide, magnesium oxide, alumina, aluminum nitride, aluminum borate whiskers, boron nitride, crystalline silica, amorphous silica, and antimony oxide can be used. Also, these can be used as single substances or as mixtures of two or more kinds thereof.

[0085] Furthermore, among the inorganic fillers described above, from the viewpoint of enhancing thermal conductivity, it is preferable to use alumina, aluminum nitride, boron nitride, crystalline silica, amorphous silica or the like. Furthermore, from the viewpoint of adjusting the melt viscosity or imparting thixotropy, it is preferable to use aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate, magnesium silicate, calcium oxide, magnesium oxide, alumina, crystalline silica, amorphous silica or the like. Also, from the viewpoint of enhancing diceability, it

is preferable to use alumina or silica.

[0086] When the content proportion of the filler is 30% by mass or more, excellent results are obtained in view of wire bondability. At the time of wire bonding, it is preferable that the storage modulus after curing of the adhesive layer adhered to chips that are provided with wires is adjusted to the range of 20 MPa to 1000 MPa at 170°C, and when the content proportion of the filler is 30% by mass or more, the storage modulus after curing of the adhesive layer can be easily adjusted to this range. Furthermore, when the content proportion of the filler is 75% by mass or less, excellent film forming properties, and excellent hot fluidity of the adhesive layer at the time of die bonding are obtained. When the hot fluidity of the adhesive layer at the time of die bonding is enhanced, satisfactory adhesion between the adhesive layer and the adherend is achieved, and the adhesive force can be increased. Furthermore, the surface unevenness of the adherend is embedded, and thus it becomes easy to suppress voids. The content proportion is more preferably 70% by mass or less, and even more preferably 60% by mass or less.

[0087] The adhesive layer of the present invention may contain two or more kinds of fillers having different average particle sizes as the filler. In this case, the viscosity increase in the case in which the content proportion of the filler is higher, or the viscosity decrease in the case in which

the content proportion of the filler is lower in the raw material mixture before film formation comparative to a case in which a single filler is used, can be easily prevented, and satisfactory film forming properties can be easily obtained. The fluidity of the uncured adhesive layer can be optimally controlled, and also, after curing of the adhesive layer, excellent adhesive force is easily obtained.

[0088] Furthermore, in regard to the adhesive layer of the present invention, the average particle size of the filler is preferably 2.0 μm or less, and more preferably 1.0 μm . When the average particle size of the filler is 2.0 μm or less, thickness reduction of the film is easily achieved. Here, a thin film suggests a thickness of 20 μm or less. Also, when the average particle size is 0.01 μm or more, satisfactory dispersibility is obtained.

Moreover, from the viewpoint of preventing any increase or decrease of the viscosity of the raw material mixture before film formation, optimally controlling the fluidity of uncured adhesive layer, and increasing the adhesive force after curing of the adhesive layer, it is preferable that the adhesive layer contains a first filler having an average particle size in the range of 0.1 μm to 1.0 μm , and a second filler having an average particle size of primary particles in the range of 0.005 μm to 0.03 μm . It is preferable that the adhesive layer contains a first filler which has an average particle size in the range

of 0.1 μm to 1.0 μm and in which 99% or more of the particles are distributed within the particle size range of 0.1 μm to 1.0 μm , and a second filler which has an average particle size of primary particles in the range of 0.005 μm to 0.03 μm and in which 99% or more of the particles are distributed within the particle size range of 0.005 μm to 0.1 μm .

The average particle size according to the present invention means the D50 value of a cumulative volume distribution curve, at which 50% by volume of particles have diameters smaller than this value. According to the present invention, the average particle size or the D50 value is measured by a laser diffraction method, for example, using Malvern Mastersizer 2000 manufactured by Malvern Instruments Ltd. According to this technology, the size of particles in a liquid dispersion is measured using the diffraction of laser light based on the application of any one of the Fraunhofer theory or the Mie theory. According to the present invention, the average particle size or the D50 value relates to a scattering analysis measured at 0.02° to 135° with respect to incident laser light, by utilizing the Mie theory or a modified Mie theory for non-spherical particles.

[0089] According to an embodiment of the present invention, the adhesive composition that constitutes the adhesive layer 13 may include 10% to 40% by mass of a thermoplastic resin having a weight average molecular weight of 5000 to 200,000; 10% to

40% by mass of a thermally polymerizable component; and 30% to 75% by mass of a filler, relative to the total amount of the adhesive composition. In this embodiment, the content of the filler may be 30% to 60% by mass, or may be 40% to 60% by mass. Furthermore, the mass average molecular weight of the thermoplastic resin may be 5000 to 150,000, or may be 10,000 to 100,000.

According to another embodiment, the adhesive composition that constitutes the adhesive layer 13 may include 10% to 20% by mass of a thermoplastic resin having a weight average molecular weight of 200,000 to 2,000,000; 20% to 50% by mass of a thermally polymerizable component; and 30% to 75% by mass of a filler, relative to the total amount of the adhesive composition. In this embodiment, the content of the filler may be 30% to 60% by mass, or may be 30% to 50% by mass. Furthermore, the mass average molecular weight of the thermoplastic resin may be 200,000 to 1,000,000 or may be 200,000 to 800,000.

The storage modulus and fluidity after curing of the adhesive layer 13 can be optimized by adjusting the mixing ratio, and there is also tendency that sufficient heat resistance at a high temperature is obtained. Furthermore, control of the rupture strength can also be implemented.

[0090] The adhesive layer 13 has a tear strength (A) according to the right angled tear method defined in JIS K7128-3, of 0.8 MPa or more. When the tear strength (A) is 0.8 MPa or

more, incisions or cracks caused by the impact at the time of transportation are not generated, and in a case in which the adhesive layer 13 is stretched during a precutting step of processing the adhesive layer into a defined size, the occurrence of disintegration of the adhesive layer 13 can be reduced.

[0091] Furthermore, it is preferable for the adhesive layer 13 that the tear strength (B) obtainable when a cutting portion having a length of 1 mm from the tip of the right angled part is incised, on the center line that passes through the tip of a right angled part of a test specimen in the right angled tear method, is 0.5 MPa or more. When the tear strength (B) is 0.5 MPa or more, even if incisions have been inserted due to the impact at the time of transportation or the like, slitting can be suppressed to a minimum level, and with slitting to such an extent, the occurrence of disintegration of the adhesive layer 13 can be reduced even if the adhesive layer 13 is stretched during the precutting step.

[0092] Furthermore, it is preferable for the adhesive layer 13 that the tear strength (C) according to the right angled tear method defined in JIS K7128-3 at -15°C is 0.8 MPa or less, and more preferably 0.67 MPa or less. When the tear strength (C) is 0.8 MPa or less, on the occasion of expanding the adhesive tape for semiconductor processing 10 by expansion in a low temperature range (-15°C to 0°C) and splitting the adhesive

layer 13, the adhesive layer 13 is satisfactorily split.

[0093] In order to adjust the tear strengths (A) and (B) respectively to the ranges described above, for example, when the content of the filler is adjusted to 70% by mass or less, or a thermoplastic resin is included in an amount of 5% or more, the tear propagation strength can be increased. Furthermore, when the adhesive composition includes a silane coupling agent, or a filler having a substantially spherical shape is used, the compatibility between the filler and the resins and the adhesiveness are improved, and therefore, the tear propagation strength can be increased. Furthermore, in order to adjust the tear strength (C) to the range described above, it is preferable to adjust the glass transition point of the thermoplastic resin to be 15°C or higher, and to adjust the molecular weight of the thermoplastic resin to 260,000 or less.

[0094] In regard to the adhesive tape for semiconductor processing 10 of the present invention, the adhesive layer 13 may be formed by laminating a layer that has been formed into a film in advance (hereinafter, referred to as an adhesive film) directly or indirectly on the substrate film 11. It is preferable that the temperature at the time of lamination is adjusted to the range of 10°C to 100°C, and a linear pressure of 0.01 N/m to 10 N/m is applied to the laminate. Meanwhile, such an adhesive film may be an adhesive layer 13 formed on a release film, and in that case, the release film may be peeled

off after lamination, or may be directly used as a cover film for the adhesive tape for semiconductor processing 10 and peeled off at the time of attaching a wafer thereto.

[0095] The adhesive film may be laminated over the entire surface of the tacky adhesive layer 12; however, in many cases, an adhesive film that has been cut out in advance to a shape corresponding to the shape of the wafer to be attached (precut) is laminated on the tacky adhesive layer 12. As such, in a case in which an adhesive film cut correspondingly to the shape of a wafer is laminated, as illustrated in Fig. 3, in the area where a wafer W is to be attached, the adhesive layer 13 is available, and in the area where a ring frame 20 is to be attached, only the tacky adhesive layer 12 is available, without the adhesive layer 13. Generally, since the adhesive layer 13 is not easily detached from an adherend, when a precut adhesive film is used, the ring frame 20 can be attached to the tacky adhesive layer 12. Thus, an effect that adhesive residue is not likely to be generated on the ring frame 20 at the time of peeling of the adhesive tape after use, is obtained.

[0096] <Applications>

 The adhesive tape for semiconductor processing 10 of the present invention is to be used for a method for producing a semiconductor device, which includes at least an expansion step of splitting an adhesive layer 13 by expanding the adhesive layer. Therefore, there are no limitations on other additional

steps, the order of the steps, and the like. For example, the adhesive tape for semiconductor processing 10 can be suitably used for the methods (A) to (E) for producing a semiconductor device.

[0097] Method (A) for producing semiconductor device

A method for producing a semiconductor device, the method including:

(a) a step of attaching a surface protective tape on the front surface of a wafer having a circuit pattern formed thereon;

(b) a back grinding step of grinding the back surface of the wafer;

(c) a step of attaching the adhesive layer of the adhesive tape for semiconductor processing to the back surface of the wafer in a state in which the wafer has been heated to 70°C to 80°C;

(d) a step of detaching the surface protective tape from the wafer surface;

(e) a step of irradiating planned division parts of the wafer with laser light, and forming regions modified by multiphoton absorption in the interior of the wafer;

(f) an expansion step of splitting the wafer and the adhesive layer of the adhesive tape for semiconductor processing along splitting lines by expanding the adhesive tape for semiconductor processing, and obtaining plural chips having

the adhesive layer adhered thereon;

(g) a step of eliminating any slack produced during the expansion step, by thermally shrinking the parts that do not overlap with the chips in the adhesive tape for semiconductor processing after expanding the adhesive tape, and maintaining the distances between the chips; and

(h) a step of picking up the chips having the adhesive layer adhered thereon, from the tacky adhesive layer of the adhesive tape for semiconductor processing.

[0098] Method (B) for producing semiconductor device

A method for producing a semiconductor device, the method including:

(a) a step of attaching a surface protective tape to the front surface of a wafer having a circuit pattern formed thereon;

(b) a back grinding step of grinding the back surface of the wafer;

(c) a step of attaching the adhesive layer of the adhesive tape for semiconductor processing to the back surface of the wafer in a state in which the wafer has been heated to 70°C to 80°C;

(d) a step of detaching the surface protective tape from the wafer surface;

(e) a step of irradiating the wafer surface along splitting lines with laser light, and splitting the wafer into

chips;

(f) an expansion step of splitting the adhesive layer for each of the chips by expanding the adhesive tape for semiconductor processing, and obtaining plural chips having the adhesive layer adhered thereon;

(g) a step of eliminating any slack produced during the expansion step, by thermally shrinking the parts that do not overlap with the chips in the adhesive tape for semiconductor processing after expanding the adhesive tape, and maintaining the distances between the chips; and

(h) a step of picking up the chips having the adhesive layer adhered thereon, from the tacky adhesive layer of the adhesive tape for semiconductor processing.

[0099] Method (C) for producing a semiconductor device

A method for producing a semiconductor device, the method including:

(a) a step of attaching a surface protective tape to the front surface of a wafer having a circuit pattern formed thereon;

(b) a back grinding step of grinding the back surface of the wafer;

(c) a step of attaching the adhesive layer of the adhesive tape for semiconductor processing to the back surface of the wafer in a state in which the wafer has been heated to 70°C to 80°C;

(d) a step of detaching the surface protective tape from the wafer surface;

(e) a step of cutting the wafer along splitting lines using a dicing blade, and splitting the wafer into chips;

(f) an expansion step of splitting the adhesive layer for each of the chips by expanding the adhesive tape for semiconductor processing, and obtaining plural chips each having the adhesive layer adhered thereon;

(g) a step of eliminating any slack produced during the expansion step, by thermally shrinking the parts that do not overlap with the chips in the adhesive tape for semiconductor processing after expanding the adhesive tape, and maintaining the distances between the chips; and

(h) a step of picking up the chips having the adhesive layer adhered thereon, from the tacky adhesive layer of the adhesive tape for semiconductor processing.

[0100] Method (D) for producing semiconductor device

A method for producing a semiconductor device, the method including:

(a) a step of attaching a dicing tape on the back surface of a wafer having a circuit pattern formed thereon, and cutting the wafer to a depth less than the thickness of the wafer, along planned splitting lines using a dicing blade;

(b) a step of attaching a surface protective tape to the front surface of the wafer;

(c) a back grinding step of peeling the dicing tape, grinding the back surface of the wafer, and then splitting the wafer into chips;

(d) a step of attaching the adhesive layer of the adhesive tape for semiconductor processing to the back surface of the wafer that has been split into chips, in a state in which the wafer has been heated to 70°C to 80°C;

(e) a step of detaching the surface protective tape from the surface of the wafer that has been split into chips;

(f) an expansion step of splitting the adhesive layer for each of the chips by expanding the adhesive tape for semiconductor processing, and obtaining plural chips having the adhesive layer adhered thereon;

(g) a step of eliminating any slack produced during the expansion step, by thermally shrinking the parts that do not overlap with the chips in the adhesive tape for semiconductor processing after expanding the adhesive tape, and maintaining the distances between the chips; and

(h) a step of picking up the chips having the adhesive layer adhered thereon, from the tacky adhesive layer of the adhesive tape for semiconductor processing.

[0101] Method (E) for producing semiconductor device

A method for producing a semiconductor device, the method including:

(a) a step of attaching a surface protective tape to the

front surface of a wafer having a circuit pattern formed thereon;

(b) a step of irradiating planned division parts of the wafer with laser light, and forming regions modified by multiphoton absorption in the interior of the wafer;

(c) a back grinding step of grinding the back surface of the wafer;

(d) a step of attaching the adhesive layer of the adhesive tape for semiconductor processing to the back surface of the wafer, in a state in which the wafer has been heated to 70°C to 80°C;

(e) a step of detaching the surface protective tape from the wafer surface;

(f) an expansion step of splitting the wafer and the adhesive layer of the adhesive tape for semiconductor processing along splitting lines by expanding the adhesive tape for semiconductor processing, and obtaining plural chips having the adhesive layer adhered thereon;

(g) a step of eliminating any slack produced during the expansion step, by thermally shrinking the parts that do not overlap with the chips in the adhesive tape for semiconductor processing after expanding the adhesive tape, and maintaining the distances between the chips; and

(h) a step of picking up the chips having the adhesive layer adhered thereon, from the tacky adhesive layer of the

adhesive tape for semiconductor processing.

[0102] <Method of use>

The method of using the adhesive tape for semiconductor processing 10 of the present invention in a case in which the adhesive tape is applied to the method (A) for producing a semiconductor device, will be explained with reference to Fig. 2 to Fig. 5. First, as illustrated in Fig. 2, a surface protective tape 14 for protecting a circuit pattern, which contains an ultraviolet-curable component in the tacky adhesive, is attached to the front surface of a wafer W having a circuit pattern formed thereon, and a back grinding step of grinding the back surface of the wafer W is carried out.

[0103] After completion of the back grinding step, as illustrated in Fig. 3, the wafer W is placed on a heater table 25 of a wafer mounter, with the front surface side facing downward, and then an adhesive tape for semiconductor processing 10 is attached to the back surface of the wafer W. Here, the adhesive tape for semiconductor processing 10 used is an adhesive tape obtained by laminating adhesive films that have been cut (precut) in advance into the shape corresponding to the shape of the wafer W to be attached, and on the surface that is attached to the wafer W, a tacky adhesive layer 12 is exposed in the periphery of the region where an adhesive layer 13 is exposed. The back surface of the wafer W is bonded with this part in which the adhesive layer 13 of the adhesive tape

for semiconductor processing 10 is exposed, and also, a ring frame 20 is bonded with the part in which the tacky adhesive layer 12 in the periphery of the adhesive layer 13 is exposed. At this time, the heater table 25 is set to 70°C to 80°C, and thereby attachment by heating is carried out.

[0104] Next, the wafer W having the adhesive tape for semiconductor processing 10 attached thereon is taken out from the heater table 25, and as illustrated in Fig. 4, the wafer W is placed on a suction table 26, with the adhesive tape for semiconductor processing 10 side facing downward. The substrate surface side of the surface protective tape 14 is irradiated with, for example, 1000 mJ/cm² of ultraviolet radiation using an energy ray source 27, through the upper side of the wafer W that has been fixed by suction to the suction table 26. The adhesive force of the surface protective tape 14 to the wafer W is decreased, and the surface protective tape 14 is detached from the surface of the wafer W.

[0105] Next, as illustrated in Fig. 5, planned division parts of the wafer W are irradiated with laser light, and thereby regions 32 modified by multiphoton absorption are formed in the interior of the wafer W.

[0106] Next, as illustrated in Fig. 6(a), the adhesive tape for semiconductor processing 10 with which the wafer W and the ring frame 20 are bonded, is placed on a stage 21 of the expansion apparatus, with the substrate film 11 side facing downward.

[0107] Next, as illustrated in Fig. 6(b), a hollow cylindrical-shaped thrust member 22 of the expansion apparatus is raised, in a state of having the ring frame 20 fixed, and the adhesive tape for semiconductor processing 10 is expanded (expansion). Regarding the conditions for expanding, the rate of expansion is, for example, 5 mm/sec to 500 mm/sec, and the amount of expansion (thrust quantity) is, for example, 5 mm to 25 mm. As the adhesive tape for semiconductor processing 10 is stretched in the diameter direction of the wafer W as such, the wafer W is split into individual units of chips 34, with the modified regions 32 acting as the starting points. At this time, in the adhesive layer 13, elongation caused by expansion (deformation) is suppressed in the part that is adhered to the back surface of the wafer W, and fracture does not occur; however, at the positions between the chips 34, tension caused by expansion of the adhesive tape is concentrated, and fracture occurs. Therefore, as illustrated in Fig. 6(c), the adhesive layer 13 is also split together with the wafer W. Thereby, plural chips 34 having the adhesive layer 13 adhered thereto can be obtained.

[0108] Next, as illustrated in Fig. 7, the thrust member 22 is returned to the original position, and a process for eliminating any slack in the adhesive tape for semiconductor processing 10 produced during the previous expansion step and thereby stably maintaining the distances between the chips 34,

is carried out. In this process, for example, an annular-shaped thermal shrinkage region 28 between the ring frame 20 and the region in the adhesive tape for semiconductor processing 10 having the chip 34 thereon, is exposed to hot air at 90°C to 120°C using a hot air nozzle 29, thereby the substrate film 11 is thermally shrunk, and the adhesive tape for semiconductor processing 10 is brought into a taut state. Thereafter, the tacky adhesive layer 12 is subjected to an energy ray curing treatment, a thermal curing treatment, or the like, the adhesive force of the tacky adhesive layer 12 to the adhesive layer 13 is weakened, and then the chips 34 are picked up.

[0109] <EXAMPLES>

Next, in order to further clarify the effects of the present invention, Examples and Comparative Examples will be explained in detail, but the present invention is not intended to be limited to these Examples.

[0110] [Production of adhesive tape for semiconductor processing]

(1) Production of substrate film

<Substrate film 1>

Resin beads of a zinc ionomer of an ethylene-methacrylic acid copolymer synthesized by a radical polymerization method (content of methacrylic acid: 13%, softening point: 72°C, melting point: 90°C) were melted at 140°C, and the molten resin beads were molded into a long film form having a thickness of

100 μm using an extruder. Thus, a substrate film 1 was produced.

<Substrate film 2>

Resin pellets of low-density polyethylene (LDPE, density: 0.92 g/cm³, melting point: 110°C) were melted at 230°C, and the molten resin pellets were molded into a long film form having a thickness of 100 μm using an extruder. The film thus obtained was irradiated with an electron beam at 100 kGy, and thus a substrate film 2 was produced.

<Substrate film 3>

Resin pellets of a styrene-butadiene copolymer (DYNARON 1320P manufactured by JSR Corporation., styrene content: 10%, density: 0.89, MFR: 3.5) and polypropylene (random polypropylene, ethylene content: 1.4%, Mw: 400,000, melting point: 154°C, density: 0.91) were dry blended at a ratio of 35 : 65, and then were melted at 200°C. The molten resin pellets were molded into a long film form having a thickness of 100 μm using an extruder, and thus a substrate film 3 was produced.

[0111] (2) Production of acrylic copolymer

(a-1)

As an acrylic copolymer (A1) having functional groups, a copolymer having a mass average molecular weight of 700,000, which was composed of 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate and methacrylic acid and had a proportion of 2-ethylhexyl acrylate of 60 mol%, was produced. Next, 2-isocyanatoethyl methacrylate was added thereto so as to

obtain an iodine value of 20, and thereby a an acrylic copolymer (a-1) having a glass transition temperature of -50°C , a hydroxyl group value of 10 mg KOH/g, and an acid value of 5 mg KOH/g was produced.

[0112] (a-2)

As an acrylic copolymer (A1) having functional groups, a copolymer having a mass average molecular weight of 800,000, which was composed of lauryl acrylate, 2-hydroxyethyl acrylate and methacrylic acid and had a proportion of lauryl acrylate of 60 mol%, was produced. Next, 2-isocyanatoethyl methacrylate was added thereto so as to obtain an iodine value of 20, and thereby a an acrylic copolymer (a-2) having a glass transition temperature of -5°C , a hydroxyl group value of 50 mg KOH/g, and an acid value of 5 mg KOH/g was produced.

[0113] As an acrylic copolymer (A1) having functional groups, a copolymer having a mass average molecular weight of 800,000, which was composed of butyl acrylate, 2-hydroxyethyl acrylate and methacrylic acid and had a proportion of butyl acrylate of 60 mol%, was produced. Next, 2-isocyanatoethyl methacrylate was added thereto so as to obtain an iodine value of 20, and thereby a an acrylic copolymer (a-3) having a glass transition temperature of -40°C , a hydroxyl group value of 30 mg KOH/g, and an acid value of 5 mg KOH/g was produced.

[0114] (3) Production of adhesive composition

(b-1)

To a composition including 6.2 parts by mass of an epoxy resin, "1002" (manufactured by Mitsubishi Chemical Corp., solid bisphenol A type epoxy resin, epoxy equivalent: 600); 51.8 parts by mass of a phenolic resin, "MEH-7851SS" (manufactured by Meiwa Plastic Industries, Ltd., trade name, biphenyl novolac phenolic resin, hydroxyl group equivalent: 201); 41.9 parts by mass of an epoxy resin, "806" (manufactured by Mitsubishi Chemical Corp., trade name, bisphenol F type epoxy resin, epoxy equivalent: 160, specific gravity: 1.20); 81.5 parts by mass of a silica filler, "SO-C2" (manufactured by Admatechs Co., Ltd., trade name, average particle size: 0.5 μm); and 2.9 parts by mass of a silica filler, "AEROSIL R972" (manufactured by NIPPON AEROSIL CO., LTD., trade name, average particle size of primary particles: 0.016 μm), MEK was added, and the mixture was stirred and mixed. Thus, a uniform composition was obtained.

To this, 23.0 parts by mass of an acrylic copolymer (weight average molecular weight: 260,000) containing 3% by mass of a monomer unit derived from glycidyl acrylate or glycidyl methacrylate, as a polymer containing functional groups; 0.6 parts by mass of "KBM-802" (manufactured by Shin-Etsu Silicone, Ltd., trade name, mercaptopropyltrimethoxysilane) as a coupling agent; and 0.1 parts by mass of "CUREZOL 2PHZ-PW" (manufactured by Shikoku Chemicals Corp., trade name, 2-phenyl-4,5-dihydroxymethylimidazole, decomposition temperature: 230°C) as a curing accelerator were added, and the

mixture was stirred and mixed until a uniform state was obtained. This was further filtered with a 100-mesh filter, and was subjected to vacuum defoaming. Thereby, a varnish of an adhesive composition b-1 was obtained.

[0115] (b-2)

To a composition including 40 parts by mass of an epoxy resin, "1002" (manufactured by Mitsubishi Chemical Corp., solid bisphenol A type epoxy resin, epoxy equivalent: 600); 100 parts by mass of an epoxy resin, "806" (manufactured by Mitsubishi Chemical Corp., trade name, bisphenol F type epoxy resin, epoxy equivalent: 160, specific gravity: 1.20); 5 parts by mass of a curing agent, "DYHARD 100SF" (manufactured by Degussa AG, trade name, dicyandiamide); 200 parts by mass of a silica filler, "SO-C2" (manufactured by Admatechs Co., Ltd., trade name, average particle size: 0.5 μm); and 3 parts by mass of a silica filler, "AEROSIL R972" (manufactured by NIPPON AEROSIL CO., LTD., trade name, average particle size of primary particles: 0.016 μm), MEK was added, and the mixture was stirred and mixed. Thus, a uniform composition was obtained.

To this, 100 parts by mass of a phenoxy resin, "PKHH" (manufactured by InChem Corp., trade name, mass average molecular weight: 52,000, glass transition temperature: 92°C); 0.6 parts by mass of "KBM-802" (manufactured by Shin-Etsu Silicone, Ltd., trade name, mercaptopropyltrimethoxysilane) as a coupling agent; and 0.5 parts by mass of "CUREZOL 2PHZ-PW"

(manufactured by Shikoku Chemical Corp., trade name, 2-phenyl-4,5-dihydroxymethylimidazole, decomposition temperature: 230°C) as a curing accelerator were added, and the mixture was stirred and mixed until a uniform state was obtained. This was further filtered with a 100-mesh filter, and was subjected to vacuum defoaming. Thus, a varnish of an adhesive composition b-2 was obtained.

[0116] (b-3)

To a composition including 40 parts by mass of an epoxy resin, "1002" (manufactured by Mitsubishi Chemical Corp., solid bisphenol A type epoxy resin, epoxy equivalent: 600); 30 parts by mass of an epoxy resin, "EPIKOTE 828" (manufactured by Mitsubishi Chemical Corp., trade name, bisphenol A type epoxy resin, epoxy equivalent: 190); 10 parts by mass of a curing agent, "DYHARD 100SF" (manufactured by Degussa AG, trade name, dicyandiamide); and 180 parts by mass of a silica filler, "SO-C2" (manufactured by Admatechs Co., Ltd., trade name, average particle size: 0.5 μm), MEK was added, and the mixture was stirred and mixed. Thus, a uniform composition was obtained.

To this, 30 parts by mass of a phenoxy resin, "PKHH" (manufactured by InChem Corp., trade name, mass average molecular weight: 52,000, glass transition temperature: 92°C); 0.6 parts by mass of "KBM-802" (manufactured by Shin-Etsu Silicone, Ltd., trade name, mercaptopropyltrimethoxysilane)

as a coupling agent; and 0.5 parts by mass of "CUREZOL 2PHZ-PW" (manufactured by Shikoku Chemical Corp., trade name, 2-phenyl-4,5-dihydroxymethylimidazole, decomposition temperature: 230°C) as a curing accelerator were added, and the mixture was stirred and mixed until a uniform state was obtained. This was further filtered with a 100-mesh filter, and was subjected to vacuum defoaming. Thus, a varnish of an adhesive composition b-3 was obtained.

[0117] (b-4)

To a composition including 15.0 parts by mass of an epoxy resin, "YX4000" (manufactured by Mitsubishi Chemical Corp., biphenylnovolac type epoxy resin, epoxy equivalent: 185); 40.0 parts by mass of a phenolic resin, "LF-6161" (manufactured by DIC Corp., trade name, novolac phenolic resin, hydroxyl group equivalent: 118); 45.0 parts by weight of an epoxy resin, "EPIKOTE 828" (manufactured by Mitsubishi Chemical Corp., trade name, bisphenol A type epoxy resin, epoxy equivalent: 190); and 5 parts by mass of a silica filler, "AEROSIL R972" (manufactured by NIPPON AEROSIL CO., LTD., trade name, average particle size of primary particles: 0.016 μm), MEK was added, and the mixture was stirred and mixed. Thus, a uniform composition was obtained.

To this, 66.7 parts by mass of an acrylic copolymer (weight average molecular weight: 850,000, Tg: 12°C) containing a monomer unit derived from glycidyl acrylate or glycidyl

methacrylate as a polymer containing functional groups; 0.6 parts by mass of "KBM-802" (manufactured by Shin-Etsu Silicone, Ltd., trade name, mercaptopropyltrimethoxysilane) as a coupling agent; and 0.1 parts by mass of "CUREZOL 2PHZ-PW" (manufactured by Shikoku Chemical Corp., trade name, 2-phenyl-4,5-dihydroxymethylimidazole, decomposition temperature: 230°C) as a curing accelerator were added, and the mixture was stirred and mixed until a uniform state was obtained. This was further filtered with a 100-mesh filter, and was subjected to vacuum defoaming. Thus, a varnish of an adhesive composition b-4 was obtained.

[0118] (b-5)

To a composition including 50 parts by mass of an epoxy resin, "1002" (manufactured by Mitsubishi Chemical Corp., solid bisphenol A type epoxy resin, epoxy equivalent: 600); 20 parts by mass of an epoxy resin, "EPIKOTE 828" (manufactured by Mitsubishi Chemical Corp., trade name, bisphenol A type epoxy resin, epoxy equivalent: 190); 10 parts by mass of a curing agent, "DYHARD 100SF" (manufactured by Degussa AG, trade name, dicyandiamide); and 250 parts by mass of a silica filler, "SO-C2" (manufactured by Admatechs Co., Ltd., trade name, average particle size: 0.5 μm), MEK was added, and the mixture was stirred and mixed. Thus, a uniform composition was obtained.

To this, 20 parts by mass of a phenoxy resin, "PKHH"

(manufactured by InChem Corp., trade name, mass average molecular weight: 52,000, glass transition temperature: 92°C); 0.6 parts by mass of a coupling agent, "KBM-802" (manufactured by Shin-Etsu Silicone, Ltd., trade name, mercaptopropyltrimethoxysilane); and 0.5 parts by mass of "CUREZOL 2PHZ-PW" (manufactured by Shikoku Chemical Corp., trade name, 2-phenyl-4,5-dihydroxymethylimidazole, decomposition temperature: 230°C) as a curing accelerator were added, and the mixture was stirred and mixed until a uniform state was obtained. This was further filtered through a 100-mesh filter and was subjected to vacuum defoaming, and thereby a varnish of an adhesive composition b-5 was obtained.

[0119] (b-6)

To a composition including 20 parts by mass of an epoxy resin, "1002" (manufactured by Mitsubishi Chemical Corp., solid bisphenol A type epoxy resin, epoxy equivalent: 600); 20 parts by mass of an epoxy resin, "EPIKOTE 828" (manufactured by Mitsubishi Chemical Corp., trade name, bisphenol A type epoxy resin, epoxy equivalent: 190); 10 parts by mass of a curing agent, "DYHARD 100SF" (manufactured by Degussa AG, dicyandiamide); and 250 parts by mass of a silica filler, "SO-C2" (manufactured by Admatechs Co., Ltd., trade name, average particle size: 0.5 μ m), MEK was added, and the mixture was stirred and mixed. Thus, a uniform composition was obtained.

To this, 30 parts by mass of an acrylic copolymer (weight

average molecular weight: 150,000) containing a monomer unit derived from glycidyl acrylate or glycidyl methacrylate as a polymer containing functional groups; 0.6 parts by mass of "KBM-802" (manufactured by Shin-Etsu Silicone, Ltd., trade name, mercaptopropyltrimethoxysilane) as a coupling agent; and 0.5 parts by mass of "CUREZOL 2PHZ-PW" (manufactured by Shikoku Chemical Corp., trade name, 2-phenyl-4,5-dihydroxymethylimidazole, decomposition temperature: 230°C) as a curing accelerator were added, and the mixture was stirred and mixed until a uniform state was obtained. This was further filtered through a 100-mesh filter and was subjected to vacuum defoaming, and thus, a varnish of an adhesive composition b-6 was obtained.

[0120] <Example 1>

A mixture obtained by adding 5 parts by mass of CORONATE L (manufactured by Nippon Polyurethane Industry Co., Ltd.) as a polyisocyanate and 3 parts by mass of ESACURE KIP 150 (manufactured by Lamberti S.p.A.) as a photopolymerization initiator to 100 parts by mass of the acrylic copolymer (a-1), was dissolved in ethyl acetate and was stirred. Thus, a tacky adhesive composition was prepared.

Next, this tacky adhesive composition was applied on a release liner formed from a release-treated polyethylene terephthalate film to obtain a thickness after drying of 10 μm . The tacky adhesive composition was dried for 3 minutes at 110°C,

and then a substrate film 1 was bonded therewith. Thus, a tacky adhesive sheet in which a tacky adhesive layer was formed on a substrate film was produced.

[0121] Next, the adhesive composition (b-1) was applied on a release liner formed from a release-treated polyethylene terephthalate film to obtain a thickness after drying of 20 μm , and the adhesive composition was dried for 5 minutes at 110°C. Thus, an adhesive film in which an adhesive layer was formed on a release liner was produced.

[0122] The tacky adhesive sheet was cut into the shape illustrated in Fig. 3 and the like such that the tacky adhesive sheet could be bonded with a ring frame so as to cover the opening. Also, the adhesive film was cut into the shape illustrated in Fig. 3 and the like such that the adhesive film could cover the back surface of a wafer. Then, the tacky adhesive layer side of the tacky adhesive sheet was bonded with the adhesive layer side of the adhesive film such that parts where the tacky adhesive layer 12 was exposed in the periphery of the adhesive film as illustrated in Fig. 3 and the like, and thus an adhesive tape for semiconductor processing was produced.

[0123] <Examples 2 to 6 and Comparative Example 1>

Adhesive tapes for semiconductor processing were produced by the same technique as that of Example 1, except that the combinations of the acrylic copolymer, the tacky adhesive composition and the adhesive composition were changed to the

combinations described in Tables 1 and 2.

[0124] Analyses and evaluations were carried out as described below for the tear strengths (A) to (C) and the precutting processability of the adhesive tapes for semiconductor processing related to the Examples and Comparative Examples, and the splittability of the adhesive layers. The results are presented in Tables 1 and 2.

[0125] (1) Measurement of tear strengths (A) to (C)

A test specimen 100 as illustrated in Fig. 8(a) was collected according to JIS K 7128-3 by stacking the adhesive film used for the adhesive tape for semiconductor processing related to each of the Examples and the Comparative Examples, through the adhesive layer obtained by peeling the release liner of the adhesive film, so as to form a thickness of 100 μm . The test specimen was subjected to a tensile test using a tensile tester (TCL-NL type, manufactured by Shimadzu Corp.) equipped with a constant temperature tank capable of temperature regulation, and the tear strength (A) at 23°C and the tear strength (C) at -15°C were respectively measured. Furthermore, the tear strength (B) at 23°C was measured in the same manner for a test specimen 110 in which a cutting portion 115 having a length of 1 mm was incised, on the center line that passed through the tip of a right angled part A as illustrated in Fig. 8(b), from the tip of the right angled part A.

[0126] (2) Evaluation of precutting processability

In regard to the evaluation of precutting processability, each of the adhesive films used for the various adhesive tapes for semiconductor processing related to Examples 1 to 7 and the adhesive film used for the adhesive tape for semiconductor processing related to Comparative Example 1 was wound into a 50-m roll form to form a cylindrical shape, and under the presumption of the impact at the time of transportation or the like, the adhesive film roll was dropped three times from a height of 50 cm such that the adhesive film roll would land on one of the circular surfaces of the cylindrical shape. After it was checked by visual inspection whether slits were generated in the adhesive layer as a result of dropping, for the use with 12-inch wafers, circular incisions each having a diameter of 320 mm were inserted at an interval of 58.5 mm, and the adhesive layer on the outer side of the incisions was detached from the release liner and was wound for 100 m at a processing speed of 10 m/min. Thus, precutting processing was carried out. In a case in which no fracture occurred at the time of winding, the sample was rated as "○" as a superior product; in a case in which fracture occurred only when slits had been incised in the adhesive layer, the sample was rated as "△" as an acceptable product; and in a case in which fracture occurred, the sample was rated as "×" as a defective product.

[0127] (3) Measurement of elongation percentage

The elongation percentage of an adhesive tape for

semiconductor processing and the elongation percentage after heating to 120°C were measured by a tensile test such as described below, using a tensile testing apparatus (JIS B 7721). A test specimen was produced by punching each of the adhesive tapes for semiconductor processing related to the Examples and the Comparative Examples into the No. 1 dumbbell shape (JIS K 6301). The gauge length at a gauge length of 40 mm and a tensile rate of 1000 mm/min was measured, and the elongation percentage was determined. Furthermore, an adhesive tape for semiconductor processing related to each of the Examples and the Comparative Examples that had been stretched to 200% by the method described above, was placed for 15 seconds on a hot plate that had been heated to 120°C, and then the gauge length was measured. Thus, the elongation percentage after heating to 120°C was determined.

[0128] (4) Evaluation of splittability

For the various adhesive tapes for semiconductor processing of the Examples and the Comparative Examples, a suitability test for a semiconductor processing process such as described below was carried out by the method described below.

[0129] (a) A surface protective tape was attached to the front surface of a wafer, on which a circuit pattern was formed thereon.

(b) A back grinding step of grinding the back surface of

the surface was carried out.

(c) The adhesive layer of the adhesive tape for semiconductor processing was bonded with the back surface of the wafer in a state in which the wafer was heated to 70°C, and at the same time, a ring frame for semiconductor processing was attached to the part in which the tacky adhesive layer of the adhesive tape for semiconductor processing was exposed without overlapping with the adhesive layer.

(d) The surface protective tape was detached from the wafer surface.

(e) Planned division parts of the wafer were irradiated with laser light, and thereby regions modified by multiphoton absorption were formed in the interior of the wafer.

(f) The wafer and the adhesive layer were split along splitting lines by expanding the adhesive tape for semiconductor processing by 10%, and plural chips having the adhesive layer attached thereto were obtained.

(g) The slack produced during the expansion step of (f) was eliminated by heating the part in which the adhesive tape for semiconductor processing and the chip did not overlap (annular region between the ring frame and the region having the chip thereon), to 120°C and shrinking the part, and the distances between the chips were maintained.

(h) The chips attached with the adhesive layer were picked up from the tacky adhesive layer of the adhesive tape for

semiconductor processing.

[0130] Meanwhile, in step (f), expansion was implemented on DDS-2300 manufactured by Disco Corp., by pressing down a ring frame for dicing that was bonded with the adhesive tape for semiconductor processing, using an expansion ring of DDS-2300 manufactured by Disco Corp., and thus pressing the part that did not overlap with the wafer in the outer periphery of the wafer-bonded site of the adhesive tape for semiconductor processing, against a circular thrust member. Furthermore, the conditions for steps (f) and (g) were set to a rate of expansion of 300 mm/sec and an amount of expansion (thrust quantity) of 20 mm. Here, the amount of expansion refers to the amount of change in the relative positions between the ring frame and the thrust member before pressing down and after pressing down.

[0131] For the adhesive tapes for semiconductor processing of Examples 1 to 6 and Comparative Example 1, the success or failure of splitting of arbitrary 100 chips immediately after step (g) was visually observed, and the splitting ratio of the adhesive layer in the step (f) was calculated.

[0132] [Table 1]

	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6
Substrate film	1	1	1	2	2	3
Acrylic copolymer	a-1	a-1	a-1	a-2	a-2	a-3
Adhesive composition	b-1	b-2	b-3	b-4	b-5	b-3
Tear (A) without incision at normal temperature	2.7	2.28	1.11	5.17	1.16	1.11
Tear (B) with incision at normal temperature	2.14	0.96	0.6	2.6	0.42	0.6
Precutting processability	○	○	○	○	△	○
Tear (C) without incision at -15°C	0.16	0.29	0.67	1.25	0.50	0.67
Tear (D) with incision at -15°C	0.16	0.11	0.16	0.43	0.25	0.16
Elongation percentage	240%	240%	240%	290%	290%	700%
Elongation percentage after heating	101%	101%	101%	108%	108%	123%
Splitting ratio	100%	100%	100%	30%	100%	50%

[0133] [Table 2]

	Comparative Example 1
Substrate film	1
Acrylic copolymer	a-1
Adhesive composition	b-6
Tear (A) without incision at normal temperature	0.71
Tear (B) with incision at normal temperature	0.35
Precutting processability	×
Tear (C) without incision at -15°C	0.12
Tear (D) with incision at -15°C	0.12
Elongation percentage	240%
Elongation percentage after heating	101%
Splitting ratio	100%

[0134] As shown in Table 1, in the adhesive tapes for semiconductor processing related to Examples 1 to 6, since the tear strength (A) of the adhesive layer according to the right angled tear method defined in JIS K7128-3 was 1.11 or more, which was greater than or equal to 0.8 MPa as defined in the claims, the adhesive tapes exhibited satisfactory precutting processability. Particularly, in the adhesive tapes for semiconductor processing related to Examples 1 to 4 and 6, the tear strength (B) of the adhesive layer obtainable when a cutting portion having a length of 1 mm was incised, on the center line that passed through the tip of a right angled part of a test specimen according to the right angled tear method, from the tip of the right angled part, was 0.5 MPa or more. Thus, superior results were obtained in view of the precutting processability.

[0135] On the contrary, in the adhesive tape for semiconductor processing related to Comparative Example 1, since the tear strength (A) of the adhesive layer was less than

0.8 MPa as shown in Table 2, poor results were obtained in view of the precutting processability.

EXPLANATIONS OF LETTERS OR NUMERALS

[0136] 10: Adhesive tape for semiconductor processing

11: Substrate film

12: Tacky adhesive layer

13: Adhesive layer

14: Surface protective tape

15: Tacky adhesive sheet

20: Ring frame

21: Stage

22: Thrust member

25: Heater table

26: Suction table

27: Energy ray source

28: Thermal shrinkage region

29: Hot air nozzle

32: Modified region

34: Chip

W: Wafer

CLAIMS

1. An adhesive tape for semiconductor processing, comprising an adhesive layer and a tacky adhesive sheet laminated together,

wherein the adhesive layer has a tear strength (A) according to the right angled tear method defined in JIS K7128-3, of 0.8 MPa or more, and has a tear strength (C) according to the right angled tear method defined in JIS K7128-3 at -15°C, of 0.8 MPa or less.

2. The adhesive tape for semiconductor processing according to claim 1, wherein in the adhesive layer, a tear strength (B) obtainable when a cutting portion having a length of 1 mm from the tip of the right angled part is incised, on the center line passing through the tip of a right angled part of a test specimen according to the right angled tear method, is 0.5 MPa or more.

3. The adhesive tape for semiconductor processing according to claim 1 or 2, wherein the tacky adhesive sheet has an elongation percentage of 200% or higher.

4. The adhesive tape for semiconductor processing according to any one of claims 1 to 3, wherein when the tacky adhesive sheet is stretched to an elongation percentage of 200% and then is heated to 120°C, the elongation percentage becomes 120% or less.

5. The adhesive tape for semiconductor processing according to any one of claims 1 to 4, wherein the adhesive tape for semiconductor

processing is used in order to split the wafer attached on the adhesive layer and the adhesive layer, or only the adhesive layer, correspondingly to the individual chips by expanding the tacky adhesive sheet.

6. A method of manufacturing a semiconductor device produced using the adhesive tape for semiconductor processing according to any one of claims 1 to 5.