

DESCRIPTION

TAPE FOR SEMICONDUCTOR PROCESSING

TECHNICAL FIELD

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

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 a tape for semiconductor processing having temporary adhesiveness and elasticity to the back surface of the wafer, and then splitting the wafer into chip units; an expansion process of expanding the 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 tape for semiconductor processing (dicing/die bonding tape) that will be described below is laminated to the back surface of the wafer, and then the 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 away from the suction table in a state of having the wafer laminated to the back surface, and is supplied 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 the treatment 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 mounting process after the back grinding process, a tape for semiconductor processing in which a temporary adhesive layer and an adhesive layer are laminated in this order on a substrate film, is used. Generally, in a case in which such a tape for semiconductor processing is

used, first, the adhesive layer of the tape for semiconductor processing is laminated to the back surface of a wafer so as to fix the wafer, and the wafer and the adhesive layer are diced into chip units using a dicing blade. Thereafter, an expansion process of widening the distance between the chips by expanding the tape in the direction of the wafer diameter 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. Subsequently, the chips are detached, together with the adhesive layer, from the temporary adhesive layer and then are picked up during the pick-up process, and the chips are directly adhered to a lead frame, a package substrate, or the like during the mounting process. As such, when a tape for semiconductor processing is used, it is possible to adhere the adhesive layer-attached chips directly to a lead frame, a package substrate, or the like. Therefore, 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 described above, since the wafer and the adhesive layer are diced together using a dicing blade, not only the swarf of the wafer but also the swarf of the adhesive layer are generated. Then, in a case in which the swarf of the adhesive layer clog the dicing grooves of the wafer, chips stick to one another, causing the 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 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, swarf 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-contact 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, the method including 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, proposed in

Patent document 3 is 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 laminating an expandable protective temporary adhesive tape on the adhesive layer side of the wafer, to which the adhesive layer has been laminated; a step of irradiating the protective temporary adhesive tape-laminated 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 temporary adhesive tape 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 laminated thereon, from the protective temporary adhesive tape.

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

[0010] However, in the methods of splitting an adhesive layer by expanding through expansion as described in Patent Documents 1 to 3, in the case of using a conventional tape for

semiconductor processing, there is a problem that along with an increase in the quantity of expansion, the portion pushed up by an expansion ring is elongated, and after expansion is undone, the relevant portion becomes slackened so that the distance between chips (hereinafter, "kerf width") cannot be retained.

[0011] Thus, methods of splitting the adhesive layer by expansion, undoing the expansion, causing the slack portions of the tape for semiconductor processing to heat-shrink, and thereby retaining the kerf width, have been suggested (for example, Patent Documents 4 and 5).

CITATION LIST

PATENT DOCUMENT

- [0012] Patent Document 1: JP 2007-5530 A
Patent Document 2: JP 2003-338467 A
Patent Document 3: JP 2004-273895 A
Patent Document 4: WO 2016/152957 A
Patent Document 5: JP 2015-211081 A

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0013] However, regarding a method of causing the slack of a tape for semiconductor processing induced by expansion to shrink by heating, generally, a method of causing a pair of hot air nozzles to orbit around the ring-shaped portion that has been pushed up by an expansion ring and has sagged, thereby exposing the slack portion to hot air, and heat-shrinking the

slack portion, has been used.

[0014] In the tape for semiconductor processing described in Patent Document 4, when the tape is heated for 10 seconds at 100°C, the thermal shrinkage in both the longitudinal direction and the width direction of the tape is from 0% to 20%. However, in a case in which heating is performed by causing hot air nozzles to orbit around, the temperature near the surface of the tape for semiconductor processing slowly increases. Therefore, there is a problem that a long time is taken in order to eliminate slack at all of annular-shaped sites. Furthermore, when the kerf width is narrow, it is difficult to distinguish the boundary lines with adjacent chips, and misrecognition of chips occurs during image recognition at the time of pickup. Thus, there is a problem that the product yield of the semiconductor component production process is deteriorated.

[0015] Furthermore, the tape for semiconductor processing described in Patent Document 5 has a shrinkage ratio of 0.1% or greater at 130°C to 160°C (see Claim 1 of Patent Document 5), and the temperature inducing shrinkage is high. Therefore, in the case of achieving shrinkage by heating using hot air, a high temperature and a long heating time are needed, and there is a risk that hot air may have influence even on the adhesive layer in the vicinity of the outer periphery of the wafer, and the divided adhesive layer may be fused and fusion-bonded again. Furthermore, when the kerf width is narrow, it is difficult to distinguish the boundary lines with adjacent chips, and misrecognition of chips occurs during image recognition at the time of pickup. Thus, there is a problem that the product yield

of the semiconductor component production process is deteriorated.

[0016] Thus, it is an object of the invention to provide a tape for semiconductor processing, which can be caused to shrink by heating sufficiently in a short time period, and can retain a sufficient kerf width to the extent that the boundaries with adjacent chips can be easily distinguished, and misrecognition of chips during image recognition at the time of pickup can be suppressed.

MEANS FOR SOLVING PROBLEM

[0017] In order to solve the problems described above, the tape for semiconductor processing according to the invention comprises a temporary adhesive tape having a substrate film; and a temporary adhesive layer formed on at least one surface side of the substrate film, in which regarding the temporary adhesive tape, the sum of the average value of the differential value of the thermal deformation rate in the MD direction per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, and the average value of the differential value of the thermal deformation rate in the TD direction per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, is a negative value.

[0018] It is preferable that the tape for semiconductor processing has an adhesive layer and a release film laminated in this order on the temporary adhesive layer side.

[0019] Furthermore, it is preferable that the tape for semiconductor processing is used for full-cut and half-cut blade dicing, full-cut laser dicing, or laser-induced stealth dicing.

EFFECT OF THE INVENTION

[0020] When the tape for semiconductor processing according to the invention is used, the tape for semiconductor processing can be caused to shrink by heating sufficiently in a short time period, and the tape can retain a sufficient kerf width to the extent that the boundaries with adjacent chips can be easily distinguished, and misrecognition of chips during image recognition at the time of pickup can be suppressed.

BRIEF DESCRIPTION OF DRAWINGS

[0021] Fig. 1 is a cross-sectional view schematically illustrating the structure of a tape for semiconductor processing according to an embodiment of the invention;

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

Fig. 3 is a cross-sectional view for describing a process of laminating a wafer and a ring frame to the tape for semiconductor processing according to an embodiment of the invention;

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

Fig. 5 is a cross-sectional view illustrating a state in

which a modified region is formed on a wafer by laser processing;

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

Fig. 7 is a cross-sectional view for describing a heat-shrinking process;

Fig. 8 is an explanatory diagram illustrating the site of measurement of the kerf width for an evaluation of Examples and Comparative Examples; and

Fig. 9 is an example of the measurement results for the thermal deformation rate.

MODE(S) FOR CARRYING OUT THE INVENTION

[0022] Embodiments of the invention will be described in detail below.

[0023] Fig. 1 is a cross-sectional view illustrating a tape for semiconductor processing 10 according to an embodiment of the invention. The tape for semiconductor processing 10 of the invention is intended to be such that when a wafer is split into chips by expansion, an adhesive layer 13 is split along with the chips. This tape for semiconductor processing 10 includes a temporary adhesive tape 15 composed of a substrate film 11 and a temporary adhesive layer 12 provided on the substrate film

11; and an adhesive layer 13 provided on the temporary adhesive layer 12, and the back surface of a wafer is laminated onto the adhesive layer 13. The respective layers may be cut in advance into a predetermined shape (precut) in accordance with the process or apparatus used. Furthermore, the tape for semiconductor processing 10 of the invention may be in the form in which the tape has been cut out for each sheet of wafer, or may be in the form in which a long sheet formed by a plurality of pieces of the 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 described.

[0024] <Substrate film>

When 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 process, 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 process. Therefore, crosslinked resins are excellent from the viewpoint of eliminating the slack produced in the tape after the expansion process, through heating and shrinking, and applying tension to the tape to thereby stably maintain the distances (kerf widths) 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 process in a low temperature region such as a range of from -15°C to 0°C , when the tape is once relaxed and returned to normal temperature, and then is directed to a pick-up process and a mounting process, the tape does not easily shrink. Therefore, it is excellent from the viewpoint that the adhesive layers adhered to the chips can be prevented from coming 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 a metal ion. Such an ionomer resin is appropriate for the expansion process in terms of uniform expansibility, and is particularly suitable from the viewpoint that the restoring force strongly works at the time of heating due to the crosslinking. The metal ion that is to be included in the ionomer resin is not particularly limited; however, examples thereof include zinc and sodium. Zinc ion is less susceptible to elution and is 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 and less than 0.930, an ultralow density polyethylene having a specific gravity of less than 0.910, and other 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, the thermoplastic crosslinked resin has certain uniform expansibility. Furthermore, since restoring force strongly works at the time of heating, a thermoplastic crosslinked resin is also suitable for eliminating the slack of the tape caused by the expansion process. Also, because thermoplastic crosslinked resins hardly contain chlorine in the composition of the molecular chain, even if tapes that have become unnecessary after use are incinerated, the thermoplastic crosslinked resins do not generate chlorinated aromatic hydrocarbons such as dioxin and analogues thereof, and therefore, the resins impose fewer burdens on the environment. When the amount of the energy rays to be radiated 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 may be 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, it is excellent 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, it is excellent 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. Furthermore, the stress relaxing properties of the substrate film become excessively strong, and it can be easily prevented that the distance between chips become smaller over time, and that the adhesive layers come into contact with one another and be 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 as appropriate. If the rigidity of the substrate film becomes too high, the force required to expand the substrate film becomes larger. Accordingly, the load of the apparatus is increased, and there

are occasions in which an expansion sufficient for the splitting of the wafer or the adhesive layer 13 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, it is excellent 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 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 exhibited 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 are made up for one another. The thickness of the substrate film 11 is not particularly defined; however, it is desirable that the substrate film has a strength that is barely sufficient to be easily stretchable and remain unbroken during the expansion process for the 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 70 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, any conventionally known adhesive can be used.

[0033] <Temporary adhesive layer>

The temporary adhesive layer 12 can be formed by applying a temporary adhesive composition on the substrate film 11. It is desirable that the temporary adhesive layer 12 that constitutes the tape for semiconductor processing 10 of the invention does not cause detachment from the adhesive layer 13 at the time of dicing, and has retention properties to the extent that 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 tape for semiconductor processing 10 of the invention, the configuration of the temporary adhesive composition that constitutes the temporary adhesive layer 12 is not particularly limited. However, in order to enhance the pick-up performance after dicing, an energy ray-curable temporary 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 temporary adhesive composition including 60 mol% or more of a (meth)acrylate having an alkyl chain having 6 to 12 carbon atoms

as a base resin, and also including 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), when the amount of introduction of the energy ray-curable carbon-carbon double bonds is 5 or more as an iodine value, it is excellent from the viewpoint that the effect of reducing the temporary adhesive force after irradiation with energy rays is increased. The iodine value is more preferably 10 or more. Furthermore, when the amount of introduction as an iodine value is 30 or less, it is excellent from the viewpoint that superior chip retention power 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 process. When the gaps between the chips can be sufficiently widened before the pick-up process, it is preferable because image recognition of each chip at the time of pick-up is made easy, 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 an 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, it is excellent 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, it is excellent 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 temporary 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 temporary adhesive layer and the adhesive layer. When the adhesive force of the interface between the temporary adhesive layer and the adhesive layer is high, it is preferable at the time of expanding the tape and cutting a wafer, because the interfacial slippage between the temporary 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 temporary adhesive composition having a desired glass transition temperature can be produced by appropriately selecting the monomer (A1-1). Furthermore, for the purpose of enhancing 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 with respect 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, 2-hydroxyalkyl acrylates, 2-hydroxyalkyl methacrylates, glycol monoacrylates, glycol monomethacrylates, N-methylol acrylamide, N-methylol methacrylamide, allyl alcohol, N-alkylaminoethyl acrylates, N-alkylaminoethyl methacrylates, acrylamides, methacrylamides, 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 with regard to 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 temporary 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 temporary adhesive layer after the tape for semiconductor processing of the invention has been expanded, is obtained, which is preferable. When the hydroxyl group value of the polymer (A) is 5 or greater, it is excellent from the viewpoint of the effect of reducing the temporary adhesive force after irradiation with energy rays, and when the hydroxyl group value is 100 or less, it is excellent from the viewpoint of the fluidity of the temporary adhesive after irradiation with energy rays. Furthermore, when the acid value is 0.5 or greater, it is excellent from the viewpoint of the tape restoration properties, and when the acid value is 30 or less, it is excellent from the viewpoint of the fluidity of the temporary 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. Regarding 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 invention, when the molecular weight of the polymer (A) is adjusted to 300,000 or more, it is excellent from the viewpoint of increasing the cohesive force. High cohesive force leads to an effect of suppressing slippage at the interface between the temporary 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, it is excellent from the viewpoint of suppressing gelation at the time of synthesis and at the time of coating. Meanwhile, the molecular weight according to the invention means the mass average molecular weight calculated relative to polystyrene standards.

[0046] Furthermore, in regard to the tape for semiconductor processing 10 of the invention, the resin composition that constitutes the temporary 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 temporary adhesive containing the polymers (A) and (B) as main components, after the application of the temporary 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, xylylene 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 invention, it is particularly preferable to use a polyisocyanate.

[0048] A temporary adhesive layer in which the amount of addition of the compound (B) has been adjusted to 0.1 parts by mass or more with respect 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 temporary adhesive layer in which the amount of addition of the compound (B) 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 temporary adhesive is obtained. The amount of addition is more preferably 5 parts by mass or less.

[0049] Furthermore, according to the invention, the temporary adhesive layer 12 may also include a photopolymerization initiator (C). The photopolymerization initiator (C) included in the temporary 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, with respect to 100 parts by mass of the polymer (A). Furthermore, the upper limit of 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 temporary adhesive used for the invention, a tackifier, a temporary adhesiveness modifier, a surfactant and the like, or other modifiers can be incorporated as necessary. Furthermore, an inorganic compound filler may also be added thereto as appropriate.

[0051] The temporary adhesive layer 12 can be formed by utilizing a conventional method for forming a temporary adhesive layer. The temporary adhesive layer 12 can be formed

on a substrate film 11 by, for example, a method of forming a temporary adhesive layer by applying the temporary adhesive composition described above on a predetermined surface of the substrate film 11, or a method of applying the temporary adhesive composition on a separator (for example, a plastic film or sheet having a release agent applied thereon) to form the temporary adhesive layer 12, and then transferring the temporary adhesive layer 12 to a predetermined surface of the substrate. Meanwhile, the temporary adhesive layer 12 may be in the form of a single layer, or may have a laminated form.

[0052] The thickness of the temporary adhesive layer 12 is not particularly limited; however, when the thickness is 2 μm or more, it is excellent from the viewpoint 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] Regarding the temporary adhesive tape 15, the sum of the average value of the differential value of the thermal deformation rate in the MD (Machine Direction) direction per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, and the average value of the differential value of the thermal deformation rate in the TD (Transverse Direction) direction per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, is a negative value, that is, less than zero. The MD direction is a direction of flow at the time of film formation, and the TD direction is a direction

perpendicular to the MD direction.

[0054] By adjusting the sum of the average value of the differential value of the thermal deformation rate in the MD direction of the temporary adhesive tape 15 per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, and the average value of the differential value of the thermal deformation rate in the TD direction per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, to a negative value, the tape for semiconductor processing 10 can be caused to shrink by heating at a low temperature in a short period of time. Therefore, even in a case in which a method of heat-shrinking a slack portion of the tape for semiconductor processing 10 by causing a pair of hot air nozzles to orbit around the slack portion is used, the slack produced by expansion in a short time period can be eliminated without heat-shrinking several times while reducing the quantity of expansion, and an appropriate kerf width can be retained.

[0055] The thermal deformation rate can be calculated by the following Formula (1) by measuring the quantity of temperature-induced deformation according to JIS K7197:2012.

Thermal deformation rate TMA (%) = (Quantity of deformation in length of sample/length of sample before measurement) × 100 (1)

Meanwhile, regarding the quantity of deformation, the direction of expansion of the sample is indicated as a positive direction, and the direction of shrinkage is indicated as a

negative direction.

[0056] The differential value of the thermal deformation rate behaves in the manner shown by the curve in the MD direction or the curve in the TD direction in Fig. 9, and when it is said that the sum of the average value of the differential value in the MD direction and the average value of the differential value in the TD direction is a negative value, it is implied that the temporary adhesive tape generally exhibits a behavior of shrinkage between 40°C and 80°C.

 In order to adjust the sum of the average value of the differential value in the MD direction and the average value of the differential value in the TD direction to a negative value, a process of stretching the resin film after film formation may be added, and the thickness of the temporary adhesive tape 15 or the amount of stretch in the MD direction or the TD direction may be adjusted depending on the type of the resin that constitutes the temporary adhesive tape 15. Examples of the method of stretching the temporary adhesive tape in the TD direction include a method of using a tenter, a method involving blow molding (inflation), and a method of using an expanding roll. Examples of the method of stretching the temporary adhesive tape in the MD direction include a method of pulling at the time of extruding from a mold, and a method of pulling within conveying rolls. Regarding the method of obtaining the temporary adhesive tape 15 of the invention, any method may be used.

[0057] <Adhesive layer>

 In regard to the tape for semiconductor processing 10 of

the invention, the adhesive layer 13 is intended to be such that after a wafer is attached to the tape for semiconductor processing 10 and diced, when chips are picked up, the adhesive layer 13 is detached from the temporary 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.

[0058] 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 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.

[0059] 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.

[0060] 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 a 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.

[0061] The tetracarboxylic acid dianhydride used as a raw material of a polyimide resin is not particularly limited, and for example, 1,2-(ethylene)bis(trimellitic anhydride), 1,3-(trimethylene)bis(trimellitic anhydride), 1,4-(tetramethylene)bis(trimellitic anhydride), 1,5-(pentamethylene)bis(trimellitic anhydride), 1,6-(hexamethylene)bis(trimellitic anhydride), 1,7-(heptamethylene)bis(trimellitic anhydride), 1,8-(octamethylene)bis(trimellitic anhydride),

1,9-(nonamethylene)bis(trimellitic anhydride),
 1,10-(decamethylene)bis(trimellitic anhydride),
 1,12-(dodecamethylene)bis(trimellitic anhydride),
 1,16-(hexadecamethylene)bis(trimellitic anhydride),
 1,18-(octadecamethylene)bis(trimellitic 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-tetramethyldicyclohexa
 ne dianhydride, p-phenylenebis(trimellitic 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-tetra
 carboxylic 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

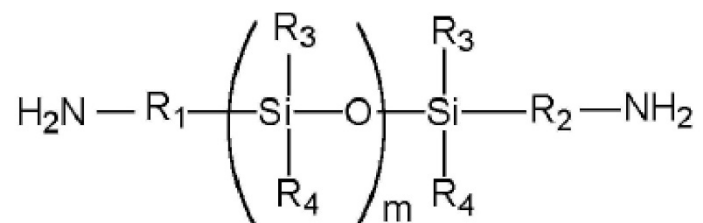
dianhydride,
 2,2-bis[4-(3,4-dicarboxyphenyl)phenyl]hexafluoropropane
 dianhydride, 4,4'-bis(3,4-dicarboxyphenoxy)diphenyl sulfide
 dianhydride,
 1,4-bis(2-hydroxyhexafluoroisopropyl)benzenebis(trimellitic
 anhydride),
 1,3-bis(2-hydroxyhexafluoroisopropyl)benzenebis(trimellitic
 anhydride),
 5-(2,5-dioxotetrahydrofuryl)-3-methyl-3-cyclohexene-1,2-dic
 arboxylic 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.

[0062] The diamine used as a raw material of a 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 General
 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]

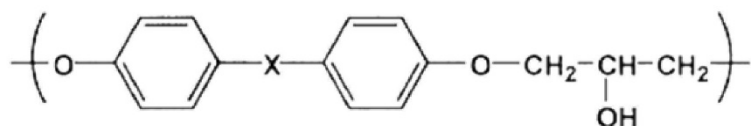


wherein R1 and R2 each represent a divalent hydrocarbon group having 1 to 30 carbon atoms, while R1's and R2's may be respectively identical or different; R3 and R4 each represent a monovalent hydrocarbon group, while R3's and R4's may be respectively identical or different; and m represents an integer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

[0063] 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 with epichlorohydrin, or a method of reacting a liquid epoxy resin with 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, a phenoxy resin has high compatibility with epoxy resins and is suitable for imparting satisfactory adhesiveness to an adhesive film.

[0064] An example of the phenoxy resin used for the invention is a resin having a repeating unit represented by the following General Formula (2):

[Chemical Formula 2]



[0065] In General 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; -C(CH₃)₂-, -CH(CH₃)-, and -CH₂- are more preferred; and -C(CH₃)₂- is particularly preferred.

[0066] When the phenoxy resin represented by General Formula (2) has repeating units, the phenoxy resin may be a resin having a plurality of repeating units with different X's of the above-described General Formula (2), or the phenoxy resin may

be composed only of repeating units with identical X's.

According to the invention, a resin composed only of repeating units with identical X's is preferred.

[0067] Furthermore, when a polar substituent such as a hydroxyl group or a carboxyl group is incorporated into the phenoxy resin represented by General Formula (2), compatibility with a thermally polymerizable component is enhanced, and a uniform external appearance or uniform characteristics can be imparted.

[0068] When the mass average molecular weight of the phenoxy resin is 5,000 or more, it is excellent from the viewpoint 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 thermal pressure bonding, and 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, it is excellent from the viewpoint of 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.

[0069] On the other hand, examples of the functional group

for the polymer containing a functional group 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.

[0070] 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.

[0071] 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.

[0072] 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.

[0073] 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 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, it is excellent from the viewpoint 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.

[0074] 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. Above all, pearl polymerization is preferred.

[0075] According to the invention, when the weight average molecular weight of the high molecular weight component

containing a functional monomer is 100,000 or more, it is excellent from the viewpoint 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, it is excellent 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.

[0076] 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 an accelerator. 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.

[0077] 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 ring-containing epoxy resin, and an alicyclic epoxy resin can be applied.

[0078] 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 Co.; 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 Co. 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 Corp.; and DENACOL EX-611, EX-614, EX-614B, 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 ring-containing epoxy resin include ARALDITE PT810 manufactured by Ciba Specialty Chemicals Corp.; 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.

[0079] In order to cure the thermosetting resin, additives can be added thereto as appropriate. 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.

[0080] 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 terminals, 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.

[0081] 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 a polyoxystyrene such as poly(para-oxystyrene). Among them, a phenolic compound having at least two phenolic hydroxyl groups in the molecule is preferred.

[0082] 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 xylylene-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.

[0083] 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), polymercaptopan compounds, polysulfide resins having mercapto groups at the terminals, acid anhydrides (tetrahydrophthalic anhydride and the like), and light/ultraviolet curing agents (diphenyliodonium hexafluorophosphate, triphenylsulfonium hexafluorophosphate, and the like).

[0084] 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.

[0085] 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 type of the curing agent or the curing accelerator.

[0086] Regarding the mixing proportions of 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 to 20 parts by mass with respect to 100 parts by mass of the thermosetting resins, and according to another embodiment, the proportion of the curing agent is 1 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 to 1.5 parts by mass, and more preferably 0.01 to 0.95 parts by mass, with respect 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 to 1.5 parts by mass, and more preferably 0.01 to 1.0 part by mass, with respect to 100 parts by mass of the thermosetting resins.

[0087] Furthermore, the adhesive layer 13 of the invention can have a filler incorporated therein as appropriate according to the use. Thereby, enhancement of the diceability, enhancement of handleability, adjustment of the melt viscosity, and impartation of thixotropy for the adhesive layer in an uncured state, and impartation of thermal conductivity and enhancement of the adhesive force for the adhesive layer in a cured state, can be promoted.

The filler used for the 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.

[0088] 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.

[0089] When the content proportion of the filler is 30% by mass or more, it is excellent from the viewpoint 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 to 1,000 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.

[0090] The adhesive layer of the invention may contain two or more kinds of fillers having different average particle sizes as the filler. In this case, compared to the case of using a single filler, a viscosity increase in the case in which the content proportion of the filler is high in the raw material mixture before film formation, or a viscosity decrease in the case in which the content proportion of the filler is low, can be easily prevented, and satisfactory film forming properties can be easily obtained. The fluidity of an uncured adhesive layer can be optimally controlled, and also, after curing of the adhesive layer, excellent adhesive force is easily obtained.

[0091] Furthermore, in regard to the adhesive layer of the invention, the average particle size of the filler is preferably 2.0 μm or less, and more preferably 1.0 μm or less. 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 an 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 to 1.0 μm , and a second filler having an average particle size of the primary particle size in the range of 0.005 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 to 1.0 μm and in which 99% or more of the particles are distributed within the particle size range of 0.1 to 1.0 μm , and a second filler which has an average particle size of the primary particle size in the range of 0.005 to 0.03 μm and in which 99% or more of the particles are distributed within the particle size range of 0.005 to 0.1 μm .

The average particle size according to the 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 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 invention, the average particle size or the D50 value relates to a scattering analysis measured in the range of 0.02° to 135° .

with respect to incident laser light, by utilizing the Mie theory or a modified Mie theory for non-spherical particles.

[0092] According to an embodiment of the invention, the temporary 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 5,000 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 temporary 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 5,000 to 150,000, or may be 10,000 to 100,000.

According to another embodiment, the temporary 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, with respect to the total amount of the temporary 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 high temperature is obtained.

[0093] In regard to the tape for semiconductor processing 10 of the 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 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 the release film may be used directly as a cover film for the tape for semiconductor processing 10 and peeled off at the time of laminating a wafer thereto.

[0094] The adhesive film may be laminated over the entire surface of the temporary adhesive layer 12; however, an adhesive film that has been cut out in advance to a shape corresponding to the shape of the wafer to be laminated (precut) may be laminated on the temporary 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 laminated, the adhesive layer 13 is available. In the area where a ring frame 20 is to be laminated, only the temporary 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 laminated to the temporary 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.

[0095] <Use applications>

The tape for semiconductor processing 10 of the invention is to be used for a method for producing a semiconductor device, the method including at least an expansion process of splitting an adhesive layer 13 through expansion. Therefore, there are no particular limitations on other additional processes, the order of the processes, and the like. For example, the tape for semiconductor processing 10 can be suitably used for the following methods (A) to (E) for producing a semiconductor device.

[0096] Method (A) for producing semiconductor device

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

(a) a step of laminating 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 laminating the adhesive film laminated to the temporary adhesive layer of the 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 front 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) a step of splitting the wafer and the adhesive film along splitting lines by expanding the tape for semiconductor processing, and obtaining a plurality of adhesive film-attached chips;

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

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

The present method for producing a semiconductor device is a method of using stealth dicing.

[0097] Method (B) for producing semiconductor device

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

(a) a step of laminating 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 laminating the adhesive film attached to temporary adhesive layer of the 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 front surface;

(e) a step of irradiating the front surface of the wafer

along splitting lines with laser light, and splitting the wafer into individual chips;

(f) a step of splitting the adhesive film correspondingly to the chips by expanding the tape for semiconductor processing, and obtaining a plurality of adhesive film-attached chips;

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

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

The present method for producing a semiconductor device is a method of using full-cut laser dicing.

[0098] Method (C) for producing semiconductor device

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

(a) a step of laminating 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 laminating the adhesive film laminated to the temporary adhesive layer of the 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 front surface;

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

(f) a step of splitting the adhesive film correspondingly to the chips by expanding the tape for semiconductor processing, and obtaining a plurality of adhesive film-attached chips;

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

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

The present method for producing a semiconductor device is a method of using full-cut blade dicing.

[0099] Method (D) for producing semiconductor device

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

(a) a step of cutting a wafer having a circuit pattern formed thereon, to a depth smaller than the thickness of the wafer, along planned splitting lines using a dicing blade;

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

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

(d) a step of laminating the adhesive film laminated to the temporary adhesive layer of the tape for semiconductor processing to the back surface of the 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 wafer front surface;

(f) a step of splitting the adhesive film correspondingly to the chips by expanding the tape for semiconductor processing, and obtaining a plurality of adhesive film-attached chips;

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

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

The present method for producing a semiconductor device is a method of using half-cut blade dicing.

[0100] Method (E) for producing semiconductor device

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

(a) a step of laminating 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 laminating the adhesive layer of the 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 front surface;

(f) a step of splitting the wafer and the adhesive layer along splitting lines by expanding the tape for semiconductor processing, and obtaining a plurality of adhesive film-attached chips;

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

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

The present method for producing a semiconductor device is a method of using stealth dicing.

[0101] <Method of use>

The method of using the tape for semiconductor processing 10 of the invention in a case in which the tape is applied to the method (A) for producing a semiconductor device as described above, will be described 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 temporary adhesive, is laminated 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.

[0102] 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 a tape for semiconductor processing 10 is laminated to the back surface of the wafer W. The tape for semiconductor processing 10 used herein is an adhesive tape obtained by laminating adhesive films that have been cut in advance (precut) into the shape corresponding to the shape of the wafer W to be laminated, and on the surface that is laminated to the wafer W, a temporary adhesive layer 12 is exposed in the periphery of the region where an adhesive layer 13 is exposed. This part in which the adhesive layer 13 of the tape for semiconductor processing 10 is exposed, and the back surface of the wafer W are laminated together, and also, the part in which the temporary adhesive layer 12 is exposed in the periphery of the adhesive layer 13 and a ring frame 20 are laminated together. At this time, the heater table 25 is set to 70°C to 80°C, and thereby laminating by heating is carried out. In the present embodiment, a tape for semiconductor processing 10 having a temporary adhesive tape 15 composed of a substrate film 11 and a temporary adhesive layer 12 provided on the substrate film 11; and an adhesive layer 13 provided on the temporary adhesive layer 12, is used; however, it is also acceptable to use a temporary adhesive tape and a film-like adhesive separately. In this case, first, a film-like adhesive is laminated to the back surface of a wafer to form an adhesive layer, and a temporary adhesive layer of a temporary adhesive tape is laminated to this adhesive layer. At this time, the temporary adhesive tape 15 according to the invention is used as the temporary adhesive tape.

[0103] Next, the wafer W having the tape for semiconductor processing 10 laminated 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 tape for semiconductor processing 10 side facing downward. Then, the substrate surface side of the surface protective tape 14 is irradiated with, for example, ultraviolet radiation at a dose of 1,000 mJ/cm² 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.

[0104] 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.

[0105] Next, as illustrated in Fig. 6(a), the tape for semiconductor processing 10, with which the wafer W and the ring frame 20 are laminated, is placed on a stage 21 of an expansion apparatus, with the substrate film 11 side facing downward.

[0106] 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 tape for semiconductor processing 10 is expanded (expansion). Regarding the conditions for expanding, the rate of expansion is, for example, 5 to 500 mm/sec, and the quantity of expansion (thrust quantity) is, for example, 5 to 25 mm. As the 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 starting points. At this time, in the adhesive layer 13, elongation (deformation) caused by expansion 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 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, a plurality of chips 34 having the adhesive layer 13 adhered thereto can be obtained.

[0107] 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 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 heat-shrinking region 28 between the ring frame 20 and the region where a chip 34 exists in the tape for semiconductor processing 10, is exposed to hot air at 40°C to 120°C using a hot air nozzle 29, thereby the substrate film 11 is heated to shrink, and the tape for semiconductor processing 10 is brought into a taut state. Subsequently, the temporary adhesive layer 12 is subjected to an energy ray curing treatment, a thermal curing treatment, or the like, and the adhesive force of the temporary adhesive layer 12 to the adhesive layer 13 is weakened. Then, the chips 34 are picked up.

[0108] The tape for semiconductor processing 10 according

to the present embodiment is configured to include an adhesive layer 13 on a temporary adhesive layer 12; however, the tape for semiconductor processing 10 may also be configured not to include an adhesive layer 13. In this case, the tape for semiconductor processing may be used in order to split a wafer only by laminating the wafer onto the temporary adhesive layer 12, or it is also acceptable that at the time of using the tape for semiconductor processing, an adhesive film produced in the same manner as in the case of the adhesive layer 13 is laminated onto the temporary adhesive layer 12 together with the wafer, and the wafer and the adhesive film are split.

<EXAMPLES>

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

[0109] [Production of tape for semiconductor processing]

(1) Production of substrate film

<Substrate film A>

Resin beads of a zinc ionomer of an ethylene-methacrylic acid-ethyl methacrylate copolymer synthesized by a radical polymerization method (methacrylic acid content: 15%, ethyl methacrylate content: 5%, softening point: 72°C, melting point: 90°C, density: 0.96 g/cm³, zinc ion content: 5% by mass) were melted at 230°C, and the molten resin beads were molded into a long film having a thickness of 150 μm using an extruder. Subsequently, the long film was stretched in the TD direction

so as to adjust the thickness to 90 μm , and thereby, substrate film A was produced.

[0110] <Substrate film B>

Substrate film B was produced in the same manner as in the case of substrate film A, except that the long film was produced to have a thickness of 180 μm , and the long film was stretched in the TD direction so as to adjust the thickness to 90 μm .

[0111] <Substrate film C>

Substrate film C was produced in the same manner as in the case of substrate film A, except that the long film was produced to have a thickness of 215 μm , and the long film was stretched in the TD direction so as to adjust the thickness to 90 μm .

[0112] <Substrate film D>

Resin beads of a zinc ionomer of an ethylene-methacrylic acid-isobutyl methacrylate copolymer synthesized by a radical polymerization method (methacrylic acid content: 11%, isobutyl methacrylate content: 9%, softening point: 64°C, melting point: 83°C, density: 0.95 g/cm³, zinc ion content: 4% by mass) were melted at 230°C, and the molten resin beads were molded into a long film having a thickness of 150 μm using an extruder. Subsequently, the long film was stretched in the TD direction so as to adjust the thickness to 90 μm , and thereby, substrate film D was produced.

[0113] <Substrate film E>

Resin beads obtained by mixing a hydrogenated styrene-based thermoplastic elastomer and homopropylene (PP)

at a mixing ratio of 52:48 were melted at 200°C, and the molten resin beads were molded into a long film having a thickness of 150 μm using an extruder. Subsequently, the long film was stretched in the TD direction so as to adjust the thickness to 90 μm , and thereby, substrate film E was produced.

[0114] <Substrate film F>

Resin beads obtained by mixing a hydrogenated styrene-based thermoplastic elastomer and homopropylene (PP) at a mixing ratio of 64:36 were melted at 200°C, and the molten resin beads were molded into a long film having a thickness of 150 μm using an extruder. Subsequently, the long film was stretched in the TD direction so as to adjust the thickness to 90 μm , and thereby, substrate film F was produced.

[0115] <Substrate film G>

Substrate film G was produced in the same manner as in the case of substrate film A, except that the long film was produced to have a thickness of 150 μm , and the long film was stretched in the MD direction so as to adjust the thickness to 90 μm .

[0116] <Substrate film H>

Substrate film H was produced in the same manner as in the case of substrate film D, except that the long film was produced to have a thickness of 150 μm , and the long film was stretched in the MD direction so as to adjust the thickness to 90 μm .

[0117] <Substrate film I>

Substrate film I was produced in the same manner as in the case of substrate film A, except that the long film was

produced to have a thickness of 90 μm , and the long film was not subjected to a stretching treatment.

[0118] <Substrate film J>

Substrate film J was produced in the same manner as in the case of substrate film D, except that the long film was produced to have a thickness of 90 μm , and the long film was not subjected to a stretching treatment.

[0119] <Substrate film K>

Substrate film K was produced in the same manner as in the case of substrate film E, except that the long film was produced to have a thickness of 90 μm , and the long film was not subjected to a stretching treatment.

[0120] <Substrate film L>

Substrate film K was produced in the same manner as in the case of substrate film F, except that the long film was produced to have a thickness of 90 μm , and the long film was not subjected to a stretching treatment.

[0121] <Substrate film M>

Substrate film M was produced in the same manner as in the case of substrate film A, except that the long film was produced to have a thickness of 110 μm , and the long film was stretched in the TD direction so as to adjust the thickness to 90 μm .

[0122] <Substrate film N>

Substrate film N was produced in the same manner as in the case of substrate film A, except that the long film was produced to have a thickness of 120 μm , and the long film was stretched in the TD direction so as to adjust the thickness to

90 μm .

[0123] (2) Production of acrylic copolymer

As an acrylic copolymer (A1) having functional groups, a copolymer formed from 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate, and methacrylic acid, the copolymer having a proportion of 2-ethylhexyl acrylate of 60 mol% and a mass average molecular weight of 700,000, was produced. Next, 2-isocyanatoethyl methacrylate was added thereto so as to obtain an iodine value of 25, and thereby an acrylic copolymer 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.

[0124] (3) Production of adhesive composition

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: $0.5\ \mu\text{m}$); and 3 parts by mass of a silica filler, "AEROSIL R972" (manufactured by Nippon Aerosil Co., Ltd., trade name, average particle size of primary particle size: $0.016\ \mu\text{m}$), 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 Co., 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. Thus, a varnish of an adhesive composition was obtained.

[0125] <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, was dissolved in ethyl acetate, and the solution was stirred. Thus, a temporary adhesive composition was produced.

Next, this temporary 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 temporary adhesive composition was dried for 3 minutes at 110°C, and then this was laminated with a substrate film. Thus, a temporary adhesive sheet in which a temporary adhesive layer was formed on a substrate film was produced.

[0126] Next, the aforementioned adhesive composition 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.

[0127] The temporary adhesive sheet was cut into the shape shown in Fig. 3 and the like, such that the temporary adhesive sheet could be attached to a ring frame so as to cover the opening. Also, the adhesive film was cut into the shape shown in Fig. 3 and the like, such that the adhesive film could cover the back surface of a wafer. Then, the temporary adhesive layer side of the temporary adhesive sheet and the adhesive layer side of the adhesive film were laminated together such that parts where the temporary adhesive layer 12 was exposed in the periphery of the adhesive film as illustrated in Fig. 3 and the like, and thus a tape for semiconductor processing was produced.

[0128] <Examples 2 to 8 and Comparative Examples 1 to 6>

Tapes for semiconductor processing related to Examples 2 to 8 and Comparative Examples 1 to 6 were produced by the same technique as that used in Example 1, except that the substrate films described in Table 1 were used.

[0129] Each of the temporary adhesive tapes of the tapes for semiconductor processing related to Examples and Comparative Examples was cut into a length of 24 mm (direction in which the quantity of deformation is to be measured) and a width of 5 mm (direction orthogonally intersecting the direction in which the quantity of deformation is to be measured), and the cut tape was used as a specimen. For the

specimens thus obtained, temperature-induced deformation in two directions, namely, MD and TD, was measured using a thermomechanical characteristics testing machine (manufactured by Rigaku Corp., trade name: TMA8310) by a tensile loading method under the following measurement conditions.

(Measurement conditions)

Measurement temperature: -60°C to 100°C

Rate of temperature increase: 5°C/min

Measurement load: 19.6 mN

Atmosphere gas: nitrogen atmosphere (100 ml/min)

Sampling: 0.5 s

Distance between chucks: 20 mm

[0130] Then, the thermal deformation rate was calculated by the following Formula (1), and the differential values of the thermal deformation rates in the MD direction and the TD direction, respectively, per 1°C between 40°C and 80°C were determined. Thus, the sum of the differential values was calculated. The results are presented in Tables 1 and 2.

Thermal deformation rate TMA (%) = (Displacement in length of sample/sample length before measurement) × 100
(1)

[0131] [Evaluation of chip misrecognition]

For the various tapes for semiconductor processing of the Examples and the Comparative Examples described above, a wafer was split into chips, and chip misrecognition was evaluated by the method described below.

[0132] The following steps were carried out:

(a) a step of laminating 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 laminating the adhesive layer of the 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 front surface;

(f) a step of splitting the wafer and the adhesive layer along splitting lines by expanding the tape for semiconductor processing, and obtaining a plurality of adhesive film-attached chips;

(g) a step of eliminating any slack produced in the expansion step of (f), by heating and shrinking parts that do not overlap with the chips in the tape for semiconductor processing (annular-shaped regions each formed between the ring frame and the region where a chip exists), and maintaining the distances between the chips; and

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

[0133] In step (d), the wafer was laminated to the tape for semiconductor processing such that the splitting lines of the wafer conformed to the MD direction and the TD direction

of the substrate film.

[0134] In step (f), expansion was performed with DDS2300 manufactured by Disco Corp., by pressing down a ring frame for dicing that was laminated to the tape for semiconductor processing, using an expansion ring of DDS2300 manufactured by Disco Corp., and thus pressing the part that did not overlap with the wafer in the outer periphery of the wafer-laminated site of the tape for semiconductor processing, against a circular-shaped thrust member. Furthermore, regarding the conditions for step (f), the quantity of expansion was adjusted so as to obtain a rate of expansion of 300 mm/sec and a height of expansion of 10 mm. Here, the quantity 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. The chip size was adjusted to be 1 × 1 mm on the sides.

[0135] In step (g), expansion was performed again under the conditions of a rate of expansion of 1 mm/sec and a height of expansion of 10 mm at room temperature, and then a thermal shrinkage treatment was carried out under the following conditions.

[Conditions 1]

Set temperature of heater: 220°C

Amount of hot air: 40 L/min

Distance between heater and tape for semiconductor processing: 20 mm

Speed of heater rotation: 7°/sec

[Conditions 2]

Set temperature of heater: 220°C

Amount of hot air: 40 L/min

Distance between heater and tape for semiconductor processing: 20 mm

Speed of heater rotation: 5°/sec

[0136] In regard to the tapes for semiconductor processing of Examples 1 to 8 and Comparative Examples 1 to 6, pickup was performed after the step (g), and chip misrecognition was defined such that chips could not be properly recognized because the boundaries with adjacent chips could not be distinguished, and chips could not be picked up. The frequency of occurrence of this chip misrecognition was evaluated. A tape in which the frequency of occurrence of chip misrecognition under both the conditions 1 and the conditions 2 of the above-described step (g) was 0%, was considered as an excellent product and was rated as "◎"; a tape in which the frequency of occurrence of chip misrecognition under the conditions 2 was lower than 1%, was considered as a good product and was rated as "○"; a tape in which the frequency of occurrence of chip misrecognition under the conditions 2 was 1% or higher and lower than 3%, was considered as an acceptable product and was rated as "△"; and a tape in which the frequency of occurrence of chip misrecognition under both the conditions 1 and conditions 2 was 3% or higher, was considered as a defective product and was rated as "×". The results are presented in Tables 1 and 2. During the evaluation, as shown in Fig. 8, one hundred chips were picked up for evaluation from each site in the vicinity of a flawless chip 50a at the right-most end in the MD direction of the

temporary adhesive tape in Fig. 8, and similarly, in the vicinity of a flawless chip 50b at the left-most end in the MD direction of the temporary adhesive tape in Fig. 8, in the vicinity of flawless chips 51 at the two farthest ends in the TD direction of the temporary adhesive tape, and in the vicinity of a chip 52 positioned at the center.

	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8
Substrate film	A	B	C	D	E	F	G	H
Thickness before processing [μm]	150	180	215	150	150	150	150	150
Thickness after processing [μm]	90	90	90	90	90	90	90	90
Average value of differential value of thermal deformation rate in MD direction	-0.21	-0.13	-0.08	0.02	0.05	0.03	-0.28	-0.17
Average value of differential value of thermal deformation rate in TD direction	-0.32	-0.31	-0.3	-0.32	-0.28	-0.19	0.24	0.14
Sum of average values of differential value of thermal deformation rate in MD and TD directions	-0.53	-0.44	-0.38	-0.3	-0.23	-0.16	-0.04	-0.03
Frequency of occurrence of chip misrecognition evaluation results	⊙	⊙	⊙	○	△	△	○	△

	Comparative Example 1 I	Comparative Example 2 J	Comparative Example 3 K	Comparative Example 4 L	Comparative Example 5 M	Comparative Example 6 N
Substrate film						
Thickness before processing [μm]	90	90	90	90	110	120
Thickness after processing [μm]	90	90	90	90	90	90
Average value of differential value of thermal deformation rate in MD direction	-0.22	-0.06	0	0.02	-0.22	-0.22
Average value of differential value of thermal deformation rate in TD direction	0.25	0.15	0.03	0.03	0.24	0.23
Sum of average values of differential value of thermal deformation rate in MD and TD directions	0.03	0.09	0.03	0.05	0.02	0.01
Frequency of occurrence of chip misrecognition evaluation results	×	×	×	×	×	×

[0139] As shown in Table 1, with regard to the tapes for semiconductor processing related to Examples 1 to 8, the sum of the average value of the differential value of the thermal deformation rate in the MD direction of the temporary adhesive tape per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, and the average value of the differential value of the thermal deformation rate in the TD direction per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, was a negative value. Therefore, the boundaries with adjacent chips could be easily distinguished, and the frequency of occurrence of chip misrecognition during image recognition at the time of pickup was low. Thus, satisfactory results were obtained.

[0140] On the other hand, with regard to the tapes for semiconductor processing related to Comparative Examples 1 to 6, as shown in Table 2, the sum of the average value of the differential value of the thermal deformation rate in the MD direction of the temporary adhesive tape per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, and the average value of the differential value of the thermal deformation rate in the TD direction per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, was not a negative value. Therefore, the frequency of occurrence of chip misrecognition was high, and poor results were obtained.

EXPLANATIONS OF LETTERS OR NUMERALS

[0141]	10	TAPE FOR SEMICONDUCTOR PROCESSING
	11	SUBSTRATE FILM
	12	TEMPORARY ADHESIVE LAYER
	13	ADHESIVE LAYER
	22	THRUST MEMBER
	28	HEAT-SHRINKING REGION
	29	HOT AIR NOZZLE

CLAIMS

1. A tape for semiconductor processing, comprising a temporary adhesive tape having a substrate film; and a temporary adhesive layer formed on at least one surface side of the substrate film,

wherein regarding the temporary adhesive tape, the sum of the average value of the differential value of the thermal deformation rate in the MD direction per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, and the average value of the differential value of the thermal deformation rate in the TD direction per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, is a negative value, and

the tape for semiconductor processing is used for semiconductor processing including an expansion process of expanding the temporary adhesive tape.

2. A tape for semiconductor processing, comprising a temporary adhesive tape having a substrate film; and a temporary adhesive layer formed on at least one surface side of the substrate film,

wherein the substrate film is formed from an ionomer resin or a mixed resin composition of polypropylene and styrene-butadiene copolymer, and

regarding the temporary adhesive tape, the sum of the average value of the differential value of the thermal

deformation rate in the MD direction per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, and the average value of the differential value of the thermal deformation rate in the TD direction per 1°C between 40°C and 80°C measured at the time of raising temperature by means of a thermomechanical characteristics testing machine, is a negative value.

3. The tape for semiconductor processing according to claim 1 or 2, wherein an adhesive layer is laminated on the temporary adhesive layer side.

4. The tape for semiconductor processing according to any one of claims 1 to 3, wherein the tape for semiconductor processing is used for full-cut and half-cut blade dicing, laser dicing, or stealth dicing using a laser.