

DESCRIPTION

DICING TAPE

TECHNICAL FIELD

[0001] The present invention relates to a dicing tape. Particularly, the invention relates to a dicing tape which is used for fixing an object to be cut such as a semiconductor wafer when the semiconductor wafer or the like is cut and separated (diced) into small element pieces.

BACKGROUND ART

[0002] A semiconductor wafer made of silicon, gallium, arsenic, or the like is conventionally manufactured into a wafer having a large diameter, and is cut and separated (diced) into small element pieces and is further transferred to a mounting step. In this case, the semiconductor wafer is subjected to each of a dicing step, a cleaning step, an expanding step, a pick-up step and a mounting step, in a state of being retained by being affixed to a dicing tape. Regarding the dicing tape, one formed by applying an adhesive layer of an acrylic-based adhesive or the like on a substrate formed from a plastic film is used (see, for example, Patent Document 1).

[0003] As illustrated in Fig. 5, in the pick-up step, a pick-up method has been widely used, in which semiconductor chips 10 are picked up by lifting or rubbing against the dicing

tape 1 at the lower part of the semiconductor chips 10 to be picked, in a dotted manner or in a linear manner by using a push-up pin 12 so as to achieve a condition for promoting detachment of the semiconductor chips 10 from the dicing tape 1, and vacuum-adsorbing the semiconductor chips 10 from above using an adsorption collet 13 or the like.

CITATION LIST

PATENT DOCUMENT

[0004] Patent Document 1: JP 2010-225753 A

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0005] However, as semiconductor elements are becoming thinner, and particularly, when the thickness of a semiconductor wafer is 100 μm or less, a problem arises in the dicing tapes of the related art that if semiconductor chips are picked up therefrom by quickly pushing up the push-up pin in a conventional manner, the semiconductor chips may crack very easily due to the impact caused by pushing-up of the push-pin. For that reason, if the push-up pin is lifted slowly so as to suppress the impact against the semiconductor chips, there is also a problem that the pick-up time may be lengthened. Further, in the dicing tapes of the related art, the release force between the dicing tape and the semiconductor chips becomes larger as

the release rate is higher. Therefore, even if the push-up pin could be pushed up quickly while having the impact against the semiconductor chips suppressed, the release force becomes larger if the speed of progress of release is high when detachment between the dicing tape and the semiconductor chips is promoted by the push-up pin. Therefore, semiconductor chips which are thin and less rigid have a problem that the semiconductor chips are deformed at the edges, and thereby chip cracking is likely to occur. For that reason, the semiconductor chips are picked up by vacuum-adsorption of the adsorption collet, only after a sufficient detached area is ensured by waiting for the detachment of the semiconductor chips from the dicing tape to proceed. Accordingly, there also arises a problem that the pick-up time is prolonged.

[0006] Thus, an object of the invention is to provide a dicing tape which enables picking up of thin semiconductor chips efficiently in a short time, without causing chip cracking, in a pick-up step after a dicing step.

MEANS FOR SOLVING PROBLEM

[0007] The present inventors conducted extensive studies in order to achieve the above object, and as a result, they found that when a dicing tape including an adhesive layer on at least one side of a substrate resin film is used, and various release forces between the dicing tape and a silicon mirror wafer that

has been polished with #2000 are set to a specific value, chips can be picked up while jump-out of chips during dicing of the semiconductor wafer is suppressed, without exerting stress on the chips and causing troubles such as chip cracking even when the chips are pushed up quickly with a pin or the like in the pick-up step, and the duration of the pick-up step can be shortened. The invention was made on the basis of this finding.

[0008] That is, the dicing tape according to the present invention is a dicing tape which includes a radiation-curable adhesive layer on at least one side of a substrate resin film and is used for dicing a wafer by adhering the wafer on the adhesive layer, the adhesive layer including 100 parts by mass of one kind or two or more kinds of polymers selected from the group consisting of an acrylic polymer, a vinyl acetate polymer, and an acrylic-based polymer having a carbon-carbon double bond; and 0.5 to 30 parts by mass of a phthalic acid ester, wherein the release force from a silicon mirror wafer that has been polished with #2000 is 0.5 N/25 mm or more before the adhesive layer is radiation-cured, and 0.05 to 0.4 N/25 mm after the adhesive layer is radiation-cured, under the conditions of 23°C and 50%RH at a release angle of 90° and a release rate of 50 mm/min, and in regard to the release force from the silicon mirror wafer that has been polished with #2000 after the adhesive layer is radiation-cured, under the conditions of 23°C and 50%RH at a release angle of 90°, when the release force at

a release rate of 50 mm/min is designated as (i), and the release force at a release rate of 1,000 mm/min is designated as (ii), the ratio (ii)/(i) is 1 or less.

[0009] Further, in the dicing tape, it is preferable that the solubility of the phthalic acid ester in water be 0.1 mg/L or less.

EFFECT OF THE INVENTION

[0010] According to the invention, it is possible to pick up thin semiconductor chips efficiently in a short time, without causing chip cracking, in a pick-up step after a dicing step.

BRIEF DESCRIPTION OF DRAWINGS

[0011] Fig. 1 is a cross-sectional view schematically illustrating the structure of a dicing tape according to an embodiment of the invention;

Fig. 2 is a cross-sectional view schematically illustrating a dicing step using the dicing tape according to an example of the invention;

Fig. 3 is a cross-sectional view schematically illustrating a dicing step using the dicing tape according to an example of the invention;

Fig. 4 is a cross-sectional view schematically illustrating an expanding step using the dicing tape according to an example of the invention; and

Fig. 5 is a cross-sectional view schematically illustrating a pick-up step using the dicing tape according to an example of the invention.

MODE(S) FOR CARRYING OUT THE INVENTION

[0012] Hereinafter, an embodiment of the invention will be described in detail.

[0013] A dicing tape 1 according to an embodiment of the invention has at least one adhesive layer 3 formed on at least one side of a substrate resin film 2. Fig. 1 is a cross-sectional view schematically illustrating a preferred embodiment of the radiation-curable dicing tape 1 of the invention. The dicing tape 1 has the substrate resin film 2 and the adhesive layer 3 is formed on the substrate resin film 2. Further, a separator 4 which is provided as necessary is formed on the adhesive layer 3. Fig. 1 illustrates the dicing tape 1 in which the adhesive layer 3 is provided on one surface of the substrate resin film 2, but the adhesive layer may also be provided on the other surface of the substrate resin film 2 than the surface provided with the adhesive layer 3 (not illustrated).

[0014] Hereinafter, various constituent components of the dicing tape 1 according to the present embodiment will be described in detail.

[0015] (Substrate resin film 2)

The substrate resin film 2 is not particularly limited, and any substrate resin film 2 of the related art can be appropriately selected and used as the substrate resin film 2. Since a radiation-curable resin is used as an adhesive used in the adhesive layer 3, the substrate resin film 2 needs to transmit the radiation such that the adhesive force of the adhesive layer 3 can be reduced to enable picking up of semiconductor chips 10 (see Fig. 3) obtained by cutting after dicing. Preferred examples of the substrate resin film 2 to be used include polyolefins such as polyethylene, polypropylene, an ethylene-propylene copolymer, and polybutene; thermoplastic elastomers such as a styrene-hydrogenated isoprene-styrene block copolymer, a styrene-isoprene-styrene copolymer, a styrene-hydrogenated butadiene-styrene copolymer, and a styrene-hydrogenated isoprene/butadiene-styrene copolymer; ethylene copolymers such as an ethylene-vinyl acetate copolymer, an ethylene-(meth)acrylic acid copolymer, an ethylene-(meth)acrylic ester copolymer, and an ionomer of ethylene-(meth)acrylic acid metal salt; engineering plastics such as polyethylene terephthalate, polybutylene terephthalate, polycarbonate, and polymethylmethacrylate; and polymeric materials such as soft polyvinyl chloride, semi-rigid polyvinyl chloride, polyester, polyurethane, polyamide, polyimide, natural rubber, and synthetic rubber. In addition, two or more kinds selected from these groups may be mixed or

multi-layered. Alternatively, these can be optionally selected according to the adhesiveness with the adhesive layer 3.

[0016] The thickness of the substrate resin film 2 is, although not particularly limited, preferably 10 to 500 μm , more preferably 40 to 400 μm , and particularly preferably 70 to 250 μm .

[0017] The surface, which is in contact with the adhesive layer 3, of the substrate resin film 2 may be subjected to corona treatment or treatment of primer and the like in order to improve the adhesion property.

[0018] (Adhesive layer 3)

The adhesive layer 3 is the radiation-curable adhesive layer 3, and a resin composition constituting the adhesive layer 3 is not particularly limited as long as it has a predetermined release force. However, it is preferable that the resin composition be a resin composition formed from a polymer having a carbon-carbon double bond in a side chain or a main chain, or at a main chain terminus of a polymer, or a resin composition obtained by mixing an ultraviolet curable resin such as an ultraviolet curable monomer component or an ultraviolet curable oligomer component with a general adhesive. Further, it is preferable that the resin composition contain, as a main component, at least one adhesive selected from the group consisting of urethane acrylate, epoxy acrylate, polyester

acrylate, polyether acrylate, a (meth)acrylic acid oligomer, an itaconic acid oligomer, and vinyl acetate.

[0019] As the resin composition formed from a polymer having a carbon-carbon double bond in a side chain or a main chain, or at a main chain terminus of a polymer, an adhesive composition including an acrylic polymer (A) and/ or a vinyl acetate polymer (B), a cross-linking agent (C), and as necessary, a photopolymerization initiator (D) may be used. Further, in the present embodiment, a phthalic acid ester (E) is included.

[0020] (A) Acrylic polymer

Examples of the acrylic polymer (A) include those having a (meth)acrylic acid ester component as a main monomer component (mass% in the polymer exceeds 50%) and obtained by copolymerizing the (meth)acrylic acid ester component with a monomer (hydroxyl group-containing monomer) component which is copolymerizable to the (meth)acrylic acid ester component and has a hydroxyl group in its molecule. In this specification, the (meth)acrylic acid ester includes both of acrylic acid ester and methacrylic acid ester.

[0021] Examples of the (meth)acrylic acid ester component as a main monomer component in the acrylic polymer (A) may include (meth)acrylic acid alkyl esters such as methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, isopropyl (meth)acrylate, butyl (meth)acrylate, isobutyl (meth)acrylate, s-butyl (meth)acrylate, t-butyl

(meth)acrylate, pentyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, octyl (meth)acrylate, isooctyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, nonyl (meth)acrylate, isononyl (meth)acrylate, decyl (meth)acrylate, isodecyl (meth)acrylate, undecyl (meth)acrylate, dodecyl (meth)acrylate, tridecyl (meth)acrylate, tetradecyl (meth)acrylate, pentadecyl (meth)acrylate, hexadecyl (meth)acrylate, heptadecyl (meth)acrylate, and octadecyl (meth)acrylate; (meth)acrylic acid cycloalkyl esters such as cyclohexyl (meth)acrylate; and (meth)acrylic acid aryl esters such as phenyl (meth)acrylate. These (meth)acrylic acid esters can be used singly or in a combination of two or more.

[0022] It is preferable that the acrylic polymer (A) be caused to react with polyether polyol via polyisocyanate of the cross-linking agent (C) and an urethane bond and be cross-linked by a cross-linking agent so as to improve the mass average molecular weight (Mw) of the acrylic polymer (A). In this case, the acrylic polymer (A) needs to be bonded to a hydroxyl group in the main chain. The acrylic polymer (A) bonded to a hydroxyl group in the main chain can be copolymerized with respect to the (meth)acrylic acid ester and can be obtained by copolymerization of a monomer having a hydroxyl group. Examples of the monomer which is copolymerizable to the (meth)acrylic acid ester and has a hydroxyl group include 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl

(meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate, polyethylene glycol mono(meth)acrylate, polypropylene glycol mono(meth)acrylate, and glycerin mono(meth)acrylate.

[0023] In the acrylic polymer (A), a hydroxyl group may be bonded (pendanted) to the main chain, and a functional group such as a carboxyl group or a glycidyl group may also be pendanted to the main chain. The acrylic polymer (A) having a functional group other than a hydroxyl group can be obtained by copolymerizing the (meth)acrylic acid ester with a monomer which is copolymerizable to the (meth)acrylic acid ester and has a functional group other than a hydroxyl group. Examples of a monomer which is copolymerizable to the (meth)acrylic acid ester and has a carboxyl group include (meth)acrylic acid (acrylic acid and methacrylic acid), itaconic acid, maleic acid, fumaric acid, crotonic acid, and isocrotonic acid. Examples of a monomer which is copolymerizable to the (meth)acrylic acid ester and has a glycidyl group include glycidyl (meth)acrylate.

[0024] (B) Vinyl acetate polymer

As the vinyl acetate polymer (B), a homopolymer obtained by polymerizing only vinyl acetate monomer can also be used. The monomer component, which is copolymerized with a vinyl acetate monomer, in the vinyl acetate polymer is not particularly limited as long as it does not inhibit the above-described effect. Examples of the monomer component

include the above-described acrylic acid esters; vinyl ethers such as lauryl vinyl ether, octadecyl vinyl ether, perfluoropropyl vinyl ether, 2-chloroethyl vinyl ether, cyclohexyl vinyl ether, and methyl vinyl ether; vinyl versatate; vinyl stearate; acrylamide; methacrylamide; N,N-dimethylacrylamide; acrylic acid; crotonic acid; maleic acid; fumaric acid; itaconic acid; vinyl sulfonic acid; acryl sulfonic acid; dimethylaminoethyl methacrylate; vinylimidazole; vinylpyridine; vinylsuccinimide; vinylene carbonate; allyl alcohol; and allyl acetate.

[0025] In the synthesis of the acrylic polymer (A) and the vinyl acetate polymer (B), examples of an organic solvent used when copolymerization is carried out by solution polymerization include a ketone-based, ester-based, alcohol-based, or aromatic-based organic solvent. Among these, a preferred solvent is generally a good solvent for an acrylic-based polymer, which solvent has a boiling point of 60 to 120°C. Examples of the preferred solvent include toluene, ethyl acetate, isopropyl alcohol, benzene methylcellosolve, ethylcellosolve, acetone, and methyl ethyl ketone. As a polymerization initiator, use may be generally made of a radical generating agent of azobis-based, such as α,α' -azobisisobutyronitrile, and organic peroxide-based, such as benzoylperoxide. At this time, a catalyst or a polymerization inhibitor can be concurrently used, as necessary. It is possible to obtain the acrylic

polymer (A) and the vinyl acetate polymer (B) with a desired molecular weight by controlling a polymerization temperature and a polymerization time and then carrying out an addition reaction at a functional group. Further, as for the control of the molecular weight, it is preferable to use a mercaptan-based or carbon tetrachloride-based solvent.

Incidentally, this copolymerization is not limited to solution polymerization, but it may also be performed in other ways such as bulk polymerization or suspension polymerization.

[0026] It is preferable that the acrylic polymer (A) and the vinyl acetate polymer (B) be those having a small content of a low molecular weight substance, from the viewpoint of preventing the processed object such as a semiconductor wafer 6 from being contaminated. From this viewpoint, the mass average molecular weight (M_w) of each of the acrylic polymer (A) and the vinyl acetate polymer (B) is preferably 100,000 or more, and more preferably 200,000 to 2,000,000. Incidentally, when the mass average molecular weight (M_w) of each of the acrylic polymer (A) and the vinyl acetate polymer (B) is too small, the contamination prevention performance with respect to the processed object such as the semiconductor wafer 6 is lowered. When the mass average molecular weight (M_w) thereof is too large, the viscosity of an adhesive composition for forming the radiation-curable adhesive layer 3 is extremely increased and thus the dicing tape 1 is difficult to be

manufactured.

[0027] From the viewpoint of exerting the adherence property, the glass transition temperature of each of the acrylic polymer (A) and the vinyl acetate polymer (B) is preferably -70°C to 0°C , and more preferably -65°C to -20°C . When the glass transition temperature thereof is too low, the viscosities of the acrylic polymer (A) and the vinyl acetate polymer (B) become too low and thus it is difficult to stably form a coating film. When the glass transition temperature thereof is too high, the adhesive becomes too hard and thus wettability with respect to an adherend is deteriorated.

[0028] (C) Cross-linking agent

It is preferable that cross-linking be carried out before the radiation curing, by using, as the cross-linking agent (C), at least polyisocyanate serving as a cross-linking agent. The polyisocyanate cross-linking agent is not particularly limited as long as it is a cross-linking agent having an isocyanate group. Examples thereof may include tolylene diisocyanate, diphenylmethane diisocyanate, hexamethylene diisocyanate, and isophorone diisocyanate, or various multimers such as a biuret type, isocyanurate type, adduct type, or block type thereof. When polyisocyanate having reactivity to a hydroxyl group is used as a cross-linking agent, polyether polyol can be incorporated into a cross-linking structure, and the polyether polyol is transferred to the surface of the semiconductor wafer

6 such that the surface of the wafer 6 can be prevented from being contaminated. In addition, a cross-linking agent other than polyisocyanate can be concurrently used as a cross-linking agent. However, it is necessary to contain a functional group having reactivity to a cross-linking agent in the acrylic polymer (A) or the vinyl acetate polymer (B). Examples of such a cross-linking agent which can be appropriately selected and used include an epoxy-based cross-linking agent, an aziridine-based cross-linking agent, a melamine resin-based cross-linking agent, a urea resin-based cross-linking agent, an acid anhydride compound-based cross-linking agent, a polyamine-based cross-linking agent, and a carboxyl group-containing polymer-based cross-linking agent.

[0029] (D) Photopolymerization initiator

In order to effectively polymerize and cure the acrylic-based polymer having a carbon-carbon double bond in its molecule (or a radiation-curable component) at the time of irradiation of the radiation, a photopolymerization initiator can be contained in the radiation-curable adhesive layer 3. Examples of the photopolymerization initiator include benzoine alkyl ether-based initiators such as benzoine methyl ether, benzoine ethyl ether, benzoine propyl ether, benzoine isopropyl ether, and benzoine isobutyl ether; benzophenone-based initiators such as benzophenone, benzoylbenzoate, 3,3'-dimethyl-4-methoxybenzophenone, and polyvinyl

benzophenone; aromatic ketone-based initiators such as α -hydroxy cyclohexyl phenyl ketone, 4-(2-hydroxy ethoxy)phenyl (2-hydroxy-2-propyl)ketone, α -hydroxy- α,α' -dimethyl acetophenone, methoxyacetophenone, 2,2-dimethoxy-2-phenyl acetophenone, 2,2-diethoxyacetophenone, and 2-methyl-1-[4-(methylthio)-phenyl]-2-morpholinopropanone-1; aromatic ketal-based initiators such as benzyl dimethyl ketal; thioxanthone-based initiators such as thioxanthone, 2-chlorothioxanthone, 2-methylthioxanthone, 2-ethylthioxanthone, 2-isopropylthioxanthone, 2-dodecylthioxanthone, 2,4-dichlorothioxanthone, 2,4-dimethylthioxanthone, 2,4-diethylthioxanthone, and 2,4-diisopropylthioxanthone; benzyl-based initiators such as benzyl; benzoin-based initiators such as benzoin; α -ketol-based compounds (for example, 2-methyl-2-hydroxypropiophenone); aromatic sulfonyl chloride-based compounds (for example, 2-naphthalene sulfonyl chloride); photoactive oxime compounds (for example, 1-phenon-1,1-propanedione-2-(o-ethoxycarbonyl)oxime); camphorquinone; ketone halide; acyl phosphin oxide; and acyl phosphonate. These photopolymerization initiators can be used singly or in a combination of two or more.

[0030] The amount of the photopolymerization initiator to be introduced can be appropriately selected from a range of 0.5

to 30 parts by mass, and preferably 1 to 20 parts by mass, with respect to 100 parts by mass of the acrylic polymer (A) or the vinyl acetate polymer (B).

[0031] (E) Phthalic acid ester

Examples of the phthalic acid ester (E) include dimethyl phthalate, diethyl phthalate, diallyl phthalate, dibutyl phthalate, di-n-hexyl phthalate, dioctyl phthalate, di-n-octyl phthalate, diisononyl phthalate, dinonyl phthalate, diisodecyl phthalate, and butyl benzyl phthalate. In terms of good compatibility with the adhesive and low solubility in water, dioctyl phthalate, di-n-octyl phthalate, diisononyl phthalate, and dinonyl phthalate are preferable. The reasons are as follows. When the compatibility with the adhesive is poor, the phthalic acid ester is easily precipitated on the surface due to the bleed-out and thus there is a concern that this becomes a contamination factor and it is not possible to perform stable manufacturing. Further, when the solubility in water is high, the phthalic acid ester is dissolved by cutting water during dicing and thus there is a concern that this becomes a contamination factor of the surface of the wafer 6. The range of the solubility in water is 0 mg/L to 0.1 mg/L, and preferably 0 mg/L to 0.05 mg/L.

[0032] In the present embodiment, since the adhesive layer 3 includes the phthalic acid ester (E), the adhesive layer is excellent in flexibility and jump-out of chips during dicing

can be suppressed. Also, after the adhesive layer 3 is cured by irradiation of radiation, the semiconductor chips 10 can be easily picked up while the chip cracking is favorably suppressed, since the release force is equal to or less than a constant value regardless of the release rate. This effect is remarkably exerted, particularly, in a case where the dicing tape 1 is adhered on the grounded surface of the wafer 6 present in an unstable state where a natural oxide film is not entirely formed immediately after polishing the wafer 6, for example, within 1 hour after the completion of polishing.

[0033] The amount of the phthalic acid ester to be introduced can be appropriately selected from a range of 0.5 to 30 parts by mass, preferably 1 to 20 parts by mass, and more preferably 5 to 10 parts by mass, with respect to 100 parts by mass of the acrylic polymer (A) or the vinyl acetate polymer (B). When the added amount thereof is small, the effect is not exerted. When the added amount thereof is too large, the compatibility with the adhesive becomes poor and the phthalic acid ester is bled out, which becomes a contamination factor.

[0034] (F) Other compounding agents

The adhesive composition for forming the adhesive layer 3 may include, for example, known additives such as tackifiers, anti-aging agents, fillers, coloring agents, flame retardants, antistatic agents, softeners, ultraviolet absorbing agents, antioxidants, plasticizers, and surfactants, as necessary.

[0035] Incidentally, instead of the acrylic polymer (A) and/or the vinyl acetate polymer (B), an acrylic-based polymer (A2) having a carbon-carbon double bond in its molecule may be used in the adhesive composition, in such a manner that an acrylic-based polymer containing a functional group is prepared, and then a compound having a functional group, which can be reacted with the functional group in the acrylic-based polymer containing a functional group, and a carbon-carbon double bond is subjected to condensation reaction or addition reaction in the acrylic-based polymer containing a functional group while the radiation curable property (radiation polymerizable property) of the carbon-carbon double bond is maintained. As the acrylic-based polymer containing a functional group, the acrylic polymer (A) can be used. Further, the acrylic-based polymer (A2) having a carbon-carbon double bond in its molecule can also be used together with the acrylic polymer (A) and/or the vinyl acetate polymer (B).

[0036] As the compound having a functional group, which can be reacted with the functional group in the acrylic-based polymer containing a functional group, and a carbon-carbon double bond, glycidyl (meth)acrylate or the like is exemplified in a case where a side chain as a reaction target is a carboxyl group or an acid anhydride; (meth)acrylic acid or the like is exemplified in a case where a side chain as a reaction target is an epoxy group; and 2-isocyanate alkyl (meth)acrylate or the

like is exemplified in a case where a side chain as a reaction target is a hydroxyl group.

[0037] Further, when the compound having a functional group and a carbon-carbon double bond is subjected to condensation reaction or addition reaction in the acrylic-based polymer containing a functional group, the reaction can be allowed to proceed effectively by using a catalyst. Such a catalyst is not particularly limited, but is preferably a tin-based catalyst (in particular, dibutyl tin dilaurate). The amount of the catalyst to be used is not particularly limited, but is preferably, for example, about 0.05 to 1 part by mass with respect to 100 parts by mass of the acrylic-based polymer containing a functional group.

[0038] The adhesive layer 3 can be formed by using a conventional method of forming an adhesive layer 3. For example, the adhesive layer 3 can be formed on the substrate resin film 2 by using a method of applying the adhesive composition to a predetermined face of the substrate resin film 2 to form an adhesive layer 3, or a method of applying the adhesive composition to a separator (for example, a plastic film or sheet coated with a mold release agent) to form an adhesive layer 3 and then transferring the adhesive layer 3 onto a predetermined face of a substrate. Incidentally, the adhesive layer 3 may have a single-layered form or a laminated form.

[0039] The thickness of the adhesive layer 3 is not

particularly limited, but is preferably 3 to 20 μm . When the thickness of the adhesive layer 3 is too thin, the processed object is easily detached during dicing. Therefore, the semiconductor chips 10 which have been subjected to the cutting process cannot be held and jump-out of chips may occur in some cases. When the adhesive layer 3 is too thick, the amplitude of vibration generated when the semiconductor wafer 6 is diced becomes large. Therefore, a defect called chipping may occur or the chips may be contaminated by the attachment of adhesive scraps which are blown up during dicing to the side surfaces or front surfaces of chips.

[0040] (Separator 4)

The separator 4 is provided as necessary for the purpose of protecting the adhesive layer 3, easily performing the label processing of cutting the dicing tape 1 into a predetermined shape, or smoothing an adhesive. Examples of a material constituting the separator 4 include paper and synthetic resin films such as polyethylene, polypropylene, and polyethylene terephthalate. The surface of the separator 4 may be subjected to release treatment such as silicone treatment, long chain alkyl treatment, or fluorine treatment, as necessary, in order to improve the peeling property from the adhesive layer 3. Further, as necessary, anti-ultraviolet treatment may be performed such that an adhesive sheet does not react to environmental ultraviolet rays. The thickness of the

separator 4 is usually 10 to 100 μm , and preferably about 25 to 50 μm .

[0041] The release force of the dicing tape 1 according to an embodiment of the invention, which force is obtainable under the conditions of 23°C and 50%RH after a silicon mirror face that has been polished with #2000 is adhered on the adhesive layer 3 and after 1 hour elapses under the conditions of 23°C and 50%RH, is such that the release force before the adhesive layer 3 is radiation-cured (against the silicon mirror face, under the conditions of a release angle of 90°, a release rate of 50 mm/min, 23°C, and 50%RH) is 0.5 N/25 mm or more, preferably 10 N/25 mm or less, and more preferably 2 N/25 mm or less. The dicing tape 1 having an adhesive force within the above range can effectively hold the cut-processed semiconductor chips 10 at the time of dicing, and the effect of preventing the jump-out of chips or the infiltration of cutting dust to the rear surface of the semiconductor chip 10 can be achieved.

[0042] Further, the release force after the adhesive layer 3 is radiation-cured (against the silicon mirror face, under the conditions of a release angle of 90°, a release rate of 50 mm/min, 23°C, and 50%RH), which is measured in the same manner as described above, is 0.05 to 0.4 N/25 mm, preferably 0.1 to 0.3 N/25 mm, and more preferably 0.1 to 0.2 N/25 mm. When the release force exceeds 0.4 N/25 mm, release is difficult at an interface between the adhesive layer 3 and the semiconductor

wafer 6 (see Fig. 2) at the time of picking up and thus picking up cannot be carried out. Alternatively, even if picking up can be carried out, there is a concern that the semiconductor wafer 6 may be cracked. Meanwhile, when the release force is too low as much as 0.05 N/25 mm or less, there is a concern that neighboring semiconductor chips 10 (see Fig. 4) may fly off during picking up.

[0043] Moreover, the release force after the adhesive layer 3 is radiation-cured (against the silicon mirror face, under the conditions of a release angle of 90°, 23°C, and 50%RH), which is measured at a release rate of 1,000 mm/min in the same manner as described above, is 0.4 N/25 mm or less. Further, in regard to the release force after the adhesive layer 3 is radiation-cured, when the release force at a release rate of 50 mm/min is designated as (i), and the release force at a release rate of 1,000 mm/min is designated as (ii), the ratio (ii)/(i) is 1 or less, preferably 0.9 or less, and more preferably 0.8 or less. When the ratio exceeds 1, in a case where the pushing-up rate of a push-up pin 12 (see Fig. 5) is slow during picking up, the release force becomes low so that there is no obstacle to the picking up; however, in a case where the pushing-up rate is fast, the release force becomes high so that there is a concern that a problem such as chip cracking may occur particularly in the thin semiconductor wafer 6. Further, the value of the ratio (ii)/(i) is preferably 0.2 or more.

[0044] <Using method>

Next, a method of using the dicing tape 1 of the invention will be described.

[0045] After the mounting step in which the dicing tape 1 of the invention is adhered on a semiconductor component that is an object to be cut, the dicing tape undergoes the dicing step according to an ordinary method, and further transferred to a step of irradiating radiation and the pick-up step.

Examples of the semiconductor component include a silicon semiconductor, a compound semiconductor, a semiconductor package, glass, and ceramics.

[0046] In general, the mounting step can be carried out subsequent to a step of grinding the rear surface of the semiconductor wafer 6 or a step of removing a fractured layer which is performed subsequent to the step of grinding the rear surface of the semiconductor wafer 6 (immediately after the step of grinding the rear surface of the semiconductor wafer 6 or the step of removing a fractured layer), or in a short period of time (within a few hours after the step of grinding the rear surface of the semiconductor wafer 6 or the step of removing a fractured layer is completed).

[0047] In the mounting step, as illustrated in Fig. 2, generally, the processed object such as the semiconductor wafer 6 and the dicing tape 1 are superimposed in a state where the grounded surface of the processed object comes in contact with

the adhesive layer 3, and the processed object and the dicing tape 1 are adhered on each other while being pressed by a conventional pressing means such as a pressing means using a pressing roll (not illustrated). Further, a ring frame 7 for holding the dicing tape 1 in each step is adhered on the outside of the adhesive layer 3 relative to the adhering position of the processed object (the semiconductor wafer 6).

[0048] In the dicing step, as illustrated in Fig. 3, the dicing tape 1 having an object to be cut affixed thereon is placed on an adsorption stage 8 and the object to be cut is cut into a predetermined size by rotating a blade 9 at a high speed. A cutting method called a full-cut or the like can be adopted in the dicing, in which the cutting is performed up to a part of the dicing tape 1. After the dicing, the adhesive layer 3 is cured by the irradiation of radiation, and particularly preferably ultraviolet rays, and thus the adherence property is lowered. Therefore, it is easy to obtain cut pieces, which are the diced semiconductor chips 10 or the like, from the dicing tape 1.

[0049] After the irradiation of radiation, and particularly preferably, after the irradiation of ultraviolet rays, the dicing tape undergoes the pick-up step. In the pick-up step, as illustrated in Fig. 4, an expanding step can be provided. In the expanding step, the dicing tape 1 is elongated in the circumferential direction and the radial

direction by moving a cylindrical pushing-up member 11 upward from the lower side of the dicing tape 1 to be struck between the ring frame 7 and cut pieces. The pick-up method is not particularly limited, but various pick-up methods of the related art can be employed. For example, as illustrated in Fig. 5, a method is exemplified in which each of cut pieces (the semiconductor chips 10) is pushed up from the lower side of the dicing tape 1 by the push-up pin 12 and the pushed-up cut pieces (the semiconductor chips 10) are picked up by using a pick-up device such as an adsorption collet 13.

[0050] Next, the invention will be described in more detail on the basis of examples. Hereinafter, the invention will be described by means of examples, but the invention is not limited to these examples.

[0051] (Example 1)

A solution containing the acrylic polymer (A) having a hydroxyl group bonded to the main chain (acrylic copolymer-containing solution Aa) was obtained by copolymerizing ethyl acrylate, butyl acrylate, and 2-hydroxyethyl acrylate at a mass ratio of 7 : 2 : 1 in ethyl acetate by an ordinary method. Subsequently, 5 parts by mass of dioctyl phthalate, 30 parts by mass of "UV3000" (trade name, manufactured by The Nippon Synthetic Chemical Industry Co., Ltd.) as a radiation curing agent, 2.5 parts by mass of "IRGACURE 651" (trade name, manufactured by BASF) as a

photopolymerization initiator, and 1 part by mass of a polyisocyanate compound (trade name: "Coronate L", manufactured by Nippon Polyurethane Industry Co., Ltd.) as a cross-linking agent were added with respect to 100 parts by mass of the acrylic polymer (A), thereby obtaining an ultraviolet curable acrylic-based adhesive solution X1.

[0052] A low-density polyethylene film (thickness: 100 μm), one surface of which has been subjected to corona discharge treatment, was used as the substrate resin film. The ultraviolet curable acrylic-based adhesive solution X1 was applied to the corona-discharge-treated surface and heat crosslinking was carried out by heating at 80°C for 10 minutes. Therefore, an ultraviolet curable adhesive layer (thickness: 10 μm) as a radiation-curable adhesive layer was formed on the substrate resin film. Next, a separator was adhered on the surface of the ultraviolet curable adhesive layer to prepare an ultraviolet curable dicing tape according to Example 1.

[0053] (Example 2)

An ultraviolet curable dicing tape according to Example 2 was prepared in the same manner as in Example 1, except that the content of dioctyl phthalate was changed to 0.5 part by mass.

[0054] (Example 3)

An ultraviolet curable dicing tape according to Example 3 was prepared in the same manner as in Example 1, except that the content of dioctyl phthalate was changed to 30 parts by mass.

[0055] (Example 4)

An ultraviolet curable dicing tape according to Example 4 was prepared in the same manner as in Example 1, except that 5 parts by mass of diisononyl phthalate was added instead of dioctyl phthalate.

[0056] (Example 5)

An ultraviolet curable dicing tape according to Example 5 was prepared in the same manner as in Example 1, except that 5 parts by mass of dibutyl phthalate was added instead of dioctyl phthalate.

[0057] (Example 6)

A solution containing the vinyl acetate polymer (B) (vinyl acetate polymer-containing solution Ba) was obtained by polymerizing vinyl acetate in ethyl acetate by an ordinary method. Subsequently, 5 parts by mass of dioctyl phthalate, 30 parts by mass of "UV3000" (trade name, manufactured by The Nippon Synthetic Chemical Industry Co., Ltd.) as a radiation curing agent, 2.5 parts by mass of "IRGACURE 651" (trade name, manufactured by BASF) as a photopolymerization initiator, and 1 part by mass of a polyisocyanate compound (trade name: "Coronate L", manufactured by Nippon Polyurethane Industry Co., Ltd.) as a cross-linking agent were added with respect to 100 parts by mass of the vinyl acetate polymer (B) (polyvinyl acetate), thereby obtaining an ultraviolet curable vinyl acetate-based adhesive solution X2.

[0058] Thereafter, an ultraviolet curable dicing tape according to Example 6 was prepared in same manner as in Example 1 by forming an ultraviolet curable adhesive layer on the substrate resin film and adhering a separator on the surface of the ultraviolet curable adhesive layer.

[0059] (Example 7)

A solution containing the acrylic polymer (A) having a hydroxyl group bonded to the main chain (acrylic copolymer-containing solution Ab) was obtained by copolymerizing 2-ethylhexyl acrylate and 2-hydroxyethyl acrylate as monomer components at a mass ratio of 8 : 2 in ethyl acetate. Next, 2-methacryloyloxyethyl isocyanate as a compound having a photopolymerizable carbon-carbon double bond and a functional group, and dibutyl tin dilaurate as a catalyst were added to the acrylic copolymer-containing solution Ab, and the resultant mixture was allowed to react at 50°C for 24 hours, thereby obtaining a solution containing an acrylic-based polymer (A2) having a carbon-carbon double bond at a side chain terminus (acrylic copolymer-containing solution A2b). A hydroxyl value of the acrylic-based polymer (A2) having a carbon-carbon double bond at a side chain terminus was measured based on acetylation with pyridine-acetic anhydride described in JIS K 0070 and the hydroxyl value was 9.8 mgKOH/g. Subsequently, 5 parts by mass of dioctyl phthalate, 2.5 parts by mass of "IRGACURE 651" (trade name, manufactured by BASF)

as a photopolymerization initiator, and 1 part by mass of a polyisocyanate compound (trade name: "Coronate L", manufactured by Nippon Polyurethane Industry Co., Ltd.) were added with respect to 100 parts by mass of the acrylic-based polymer (A2) having a carbon-carbon double bond at the side chain terminus, thereby obtaining an ultraviolet curable acrylic-based adhesive solution X3.

[0060] A low-density polyethylene film (thickness: 100 μm), one surface of which has been subjected to corona discharge treatment, was used as the substrate resin film. The ultraviolet curable acrylic-based adhesive solution X3 was applied to the corona-discharge-treated surface and heat crosslinking was carried out by heating at 80°C for 10 minutes. Therefore, an ultraviolet curable adhesive layer (thickness: 10 μm) as a radiation-curable adhesive layer was formed on the substrate resin film. Next, a separator was adhered on the surface of the ultraviolet curable adhesive layer to prepare an ultraviolet curable dicing tape according to Example 7.

[0061] (Comparative Example 1)

An ultraviolet curable dicing tape according to Comparative Example 1 was prepared in the same manner as in Example 1, except that dioctyl phthalate was not added.

[0062] (Comparative Example 2)

An ultraviolet curable dicing tape according to Comparative Example 2 was prepared in the same manner as in

Example 1, except that the content of dioctyl phthalate was changed to 0.45 part by mass.

[0063] (Comparative Example 3)

An ultraviolet curable dicing tape according to Comparative Example 3 was prepared in the same manner as in Example 1, except that the content of dioctyl phthalate was changed to 35 parts by mass.

[0064] (Comparative Example 4)

An ultraviolet curable dicing tape according to Comparative Example 4 was prepared in the same manner as in Example 6, except that dioctyl phthalate was not added.

[0065] (Comparative Example 5)

An ultraviolet curable dicing tape according to Comparative Example 5 was prepared in the same manner as in Example 7, except that dioctyl phthalate was not added.

[0066] <Compatibility>

As for each ultraviolet curable acrylic-based adhesive solution introduced when Examples 1 to 7 and Comparative Examples 2 and 3 were prepared, the compatibility of phthalic acid ester was visually evaluated. A case where the transparent state was maintained even after 10 hours elapsed was denoted as $\odot$, a case where an example was opaque after 7 hours elapsed was denoted as $\bigcirc$, a case where an example was opaque after 3 hours elapsed was denoted as Δ , and a case where an example was opaque after 1 hour elapsed was denoted as $\times$. The results

thereof are presented in Table 1 and Table 2.

[0067] <Release force>

(1) Release force before radiation curing

The dicing tapes obtained in Examples 1 to 7 and Comparative Examples 1 to 5 were affixed to the mirror face of a silicon wafer that has been polished with #2000, under the conditions of 23°C and 50%RH. After 1 hour elapsed under the conditions of 23°C and 50%RH, the release force (against the silicon mirror face, release angle: 90°, tension rate: 50 mm/min, 23°C, 50%RH) before the adhesive layer was radiation-cured was measured. The results thereof are presented in Table 1 and Table 2. Incidentally, various release forces were measured according to JIS Z 0237.

[0068] (2) Release force after radiation curing

The dicing tapes obtained in Examples 1 to 7 and Comparative Examples 1 to 5 were affixed to the mirror face of the silicon wafer that has been polished with #2000, under the conditions of 23°C and 50%RH. After 1 hour elapsed under the conditions of 23°C and 50%RH, ultraviolet rays were irradiated from the rear surface of the dicing tape at 200 mJ/cm², and then the release force (against the silicon mirror face, release angle: 90°, tension rate: 50 mm/min and 1,000 mm/min, respectively, 23°C, 50%RH) after the adhesive layer was radiation-cured was measured. Further, each of the ratio ((ii)/(i)) of the release force (ii) at a tension rate of 1,000

mm/min to the release force (i) at a tension rate 50 mm/min was calculated. These results are presented in Table 1 and Table 2.

[0069] <Pick-up efficiency>

The dicing tapes obtained in Examples 1 to 7 and Comparative Examples 1 to 5 were tested according to the following procedures for evaluating the pick-up efficiency.

[0070] (1) The rear surface of a silicon wafer having a diameter of 8 inch was ground by 30 μm in two-axis mode, and then ground until the final thickness of the silicon wafer became 50 μm or 300 μm . The polishing conditions are as follows.

(Polishing conditions)

Grinder: "DFG-840" (trade name) manufactured by DISCO Corporation

First axis: #600 Grinding stone (rotation speed: 4800 rpm, down speed; P1: 3.0 $\mu\text{m}/\text{sec}$, P2: 2.0 $\mu\text{m}/\text{sec}$)

Second axis: #2000 Grinding stone (rotation speed: 5500 rpm, down speed; P1: 0.8 $\mu\text{m}/\text{sec}$, P2: 0.6 $\mu\text{m}/\text{sec}$)

[0071] (2) Within 5 minutes after the completion of grinding of the procedure (1), the dicing tape of each example was adhered to the ground surface of the semiconductor wafer obtained in the above procedure (1) and fixed to a ring frame.

[0072] (3) The semiconductor wafer fixed to the ring frame in the procedure (2) was fully cut along a predetermined line to be divided under the following dicing conditions by using

a dicing device.

(Dicing condition 1: silicon wafer 300 μm thick)

Dicer: "DFD-340" (trade name) manufactured by DISCO Corporation

Blade: "27HEEE" (trade name) manufactured by DISCO Corporation

Blade rotation speed: 40,000 rpm

Dicing speed: 100 mm/sec

Dicing depth: 25 μm

Cutting mode: down cutting

Dicing size: 5.0 $\times$ 5.0 mm

(Dicing condition 2: silicon wafer 50 μm thick)

Dicer: "DFD-340" (trade name) manufactured by DISCO Corporation

Blade: "27HECC" (trade name) manufactured by DISCO Corporation

Blade rotation speed: 40,000 rpm

Dicing speed: 100 mm/sec

Dicing depth: 25 μm

Cutting mode: down cutting

Dicing size: 15.0 $\times$ 10.0 mm

[0073] (4) After 7 days elapsed from when the dicing tape was adhered, ultraviolet rays were radiated from the substrate resin film side of the dicing tape at 200 mJ/cm² to cure the adhesive layer. Thereafter, the singulated semiconductor chips were picked up by using a dice picker device. Arbitrary 50 of semiconductor chips were picked up under pick-up conditions to be described below. Then, the number of semiconductor chips which have been picked up successfully

without occurring chip cracking or jump-out of chips was counted for evaluating the success rate of picking up. The results thereof are presented in Table 1 and Table 2. Incidentally, a case where the success rate of picking up is 90% or higher can be determined as "pass".

(Pick-up condition 1: silicon wafer 300 μm thick)

Die bonder: "CAP-300II" manufactured by Canon Machinery Inc.

Number of pins: 4

Distance between pins: 3.8 $\times$ 3.8 mm

Curvature of pin tip: 0.25 mm

Pin pushing-up amount: 0.40 mm

Pin pushing-up rate: 50 mm/min

Holding time of pin pushing-up: 1,000 ms

(Pick-up condition 2: silicon wafer 50 μm thick)

Die bonder: "CAP-300II" manufactured by Canon Machinery Inc.

Number of pins: 4

Distance between pins: 7.8 $\times$ 7.8 mm

Curvature of pin tip: 0.25 mm

Pin pushing-up amount: 0.40 mm

Pin pushing-up rate: 800 mm/min

Holding time of pin pushing-up: 100 ms

[0074] <Wafer surface contamination>

The surfaces, which were adhered on the dicing tape, of the picked-up chips were measured by XPS (X-ray Photoelectron Spectroscopy) under the following measurement conditions, and

an increase amount of carbon derived from a contaminant generated from the dicing tape was compared with the wafer which was not adhered on the dicing tape to be determined in terms of mol%. The results thereof are presented in Table 1 and Table 2. A case where an increase amount of carbon is less than 5 mol% is evaluated as an excellent-quality product and denoted as $\odot$, a case where an increase amount of carbon is less than 5 to 10 mol% is evaluated as a good-quality product and denoted as $\circ$, a case where an increase amount of carbon is less than 10 to 30 mol% is evaluated as an acceptable-quality product and denoted as Δ , and a case where an increase amount of carbon is 30 mol% or more is evaluated as a defective product and denoted as $\times$.

(Measurement conditions)

X-ray source: $\text{MgK}\alpha$

X-ray: Take off angle 45°

Measurement area: $1.1 \text{ mm}\Phi$

[0075] [Table 1]

				Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7
Phthalic acid ester (added amount (part by mass))				Diocetyl phthalate (5 phr)	Diocetyl phthalate (0.5 phr)	Diocetyl phthalate (30 phr)	Diisononyl phthalate (5 phr)	Dibutyl phthalate (5 phr)	Diocetyl phthalate (5 phr)	Diocetyl phthalate (5 phr)
Compatibility				⊙	⊙	○	△	⊙	⊙	⊙
Wafer surface contamination				⊙	⊙	⊙	⊙	△	⊙	⊙
Release force	Before irradiation of radiation	Release rate 50 mm/min	N/25 mm	1.80	2.00	0.80	1.85	1.90	0.85	0.95
	After irradiation of radiation	Release rate (i) 50 mm/min	N/25 mm	0.28	0.35	0.22	0.33	0.32	0.21	0.40
		Release rate (ii) 1000 mm/min	N/25 mm	0.18	0.34	0.05	0.16	0.17	0.13	0.25
		(ii)/(i)	-	0.64	0.97	0.23	0.48	0.53	0.62	0.63
Pick-up efficiency	Pick-up condition 1	Success rate of picking up (%)		100	100	100	100	100	100	100
		Chip cracking (number)		0	0	0	0	0	0	0
		Jump-out of neighboring chips (number)		0	0	0	0	0	0	0
	Pick-up condition 2	Success rate of picking up (%)		100	98	100	98	98	100	100
		Chip cracking (number)		0	1	0	1	1	0	0
		Jump-out of neighboring chips (number)		0	0	0	0	0	0	0

[0076]

[Table 2]

				Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5
Phthalic acid ester		Added amount (part by mass)		-	Dioctyl phthalate (0.45 phr)	Dioctyl phthalate (35 phr)	-	-
Compatibility				-	⊙	×	-	-
Wafer surface contamination				⊙	⊙	○	⊙	⊙
Release force	Before irradiation of radiation	Release rate 50 mm/min	N/25 mm	2.15	2.10	0.45	1.05	1.25
	After irradiation of radiation	Release rate (i) 50 mm/min	N/25 mm	0.43	0.40	0.04	0.38	0.40
		Release rate (ii) 1000 mm/min	N/25 mm	0.68	0.45	0.02	0.52	0.45
		(ii)/(i)	-	1.58	1.13	0.50	1.37	1.13
Pick-up efficiency	Pick-up condition 1	Success rate of picking up (%)		96	98	44	96	96
		Chip cracking (number)		2	1	0	2	2
		Jump-out of neighboring chips (number)		0	0	28	0	0
	Pick-up condition 2	Success rate of picking up (%)		50	75	60	50	60
		Chip cracking (number)		25	15	0	25	20
		Jump-out of neighboring chips (number)		0	0	20	0	0

[0077] As presented in Table 1, in the dicing tapes of Examples 1 to 7 in which the release force from a silicon mirror wafer that has been polished with #2000 was 0.5 N/25 mm or more before the adhesive layer was radiation-cured, and 0.05 to 0.4 N/25 mm after the adhesive layer was radiation-cured, under the conditions of 23°C and 50%RH at a release angle of 90° and a release rate of 50 mm/min. In regard to the release force from the silicon mirror wafer that has been polished with #2000 after the adhesive layer was radiation-cured, under the conditions of 23°C and 50%RH at a release angle of 90°, when the release force at a release rate of 50 mm/min was designated as (i), and the release force at a release rate of 1,000 mm/min was designated as (ii), the ratio (ii)/(i) was 1 or less, the pick-up efficiency was favorable under both the pick-up conditions 1 and 2. That is, it was possible to pick up the thin semiconductor chips efficiently in a short time, while chip cracking or jump-out of chips was favorably suppressed.

[0078] On the other hand, as presented in Table 2, in the dicing tapes of Comparative Examples 1, 2, 4, and 5 in which the ratio (ii)/(i) exceeded 1, the pick-up efficiency was favorable under the pick-up condition 1, but the pick-up efficiency was poor under the pick-up condition 2. That is, there is no problem in picking up of semiconductor chips having a conventional thickness. However, when thin semiconductor chips were picked up while a pin was pushed up at a rapid pushing-up rate, the release force between the adhesive layer and the semiconductor chips became large and, as a result, chip

cracking occurred. Further, in Comparative Example 3 in which, while the ratio (ii)/(i) was 1 or less, the release force before the adhesive layer was radiation-cured at a release rate of 50 mm/min was less than 0.5 N/25 mm, and the release force after the adhesive layer was radiation-cured at a release rate of 50 mm/min was less than 0.05 N/25 mm, chip cracking did not occur during picking up under both the pick-up conditions 1 and 2, but jump-out of chips in which neighboring chips jumped out during picking up frequently occurred. Therefore, the pick-up efficiency was poor.

[0079] Incidentally, in Comparative Example 3 in which the content of phthalic acid ester was more than 30 parts by mass with respect to 100 parts by mass of the acrylic polymer (A), the compatibility with the adhesive was poor, and the wafer contamination was slightly inferior as compared with a case where the added amount of phthalic acid ester was 0.5 to 30 parts by mass. Further, in Example 4 in which diisononyl phthalate was added, the compatibility was inferior as compared with a case where the phthalic acid ester other than diisononyl phthalate was added, but there was no problem in practical use. In Example 5 in which dibutyl phthalate having the solubility in water of more than 0.1 mg/L was added, dibutyl phthalate was dissolved in cutting water during dicing and thus the wafer surface contamination became worse. However, this was within the acceptable range.

EXPLANATIONS OF LETTERS OR NUMERALS

[0080] 1: DICING TAPE
 2: SUBSTRATE RESIN FILM
 3: ADHESIVE LAYER
 4: SEPARATOR
 6: SEMICONDUCTOR WAFER
 10: SEMICONDUCTOR CHIP

CLAIMS

1. A dicing tape comprising a radiation-curable adhesive layer on at least one side of a substrate resin film, used for dicing a wafer by adhering the wafer on the adhesive layer,

the adhesive layer including 100 parts by mass of one kind or two or more kinds of polymers selected from the group consisting of an acrylic polymer, a vinyl acetate polymer, and an acrylic-based polymer having a carbon-carbon double bond; and 0.5 to 30 parts by mass of a phthalic acid ester,

wherein the release force from a silicon mirror wafer that has been polished with #2000 is 0.5 N/25 mm or more before the adhesive layer is radiation-cured, and 0.05 to 0.4 N/25 mm after the adhesive layer is radiation-cured, under the conditions of 23°C and 50%RH at a release angle of 90° and a release rate of 50 mm/min, and

in regard to the release force from the silicon mirror wafer that has been polished with #2000 after the adhesive layer is radiation-cured, under the conditions of 23°C and 50%RH at a release angle of 90°, when the release force at a release rate of 50 mm/min is designated as (i), and the release force at a release rate of 1,000 mm/min is designated as (ii), the ratio (ii)/(i) is 1 or less.

2. The dicing tape according to claim 1, wherein the solubility of the phthalic acid ester in water is 0.1 mg/L or less.