

DESCRIPTION

TITLE OF THE INVENTION: TEMPORARY-ADHESIVE TAPE FOR DICING

FIELD OF THE INVENTION

{0001}

The present invention relates to a temporary-adhesive tape for dicing.

BACKGROUND OF THE INVENTION

{0002}

The process of processing a semiconductor wafer or the like into a semiconductor chip and mounting the semiconductor chip on a semiconductor device such as an IC (Integrated Circuit) includes, for example, steps such as a step of attaching a semiconductor wafer surface protective tape or a back grind substrate to a pattern surface of a semiconductor wafer, a step of grinding a back surface of the semiconductor wafer to reduce a thickness of the semiconductor wafer, a step of mounting the semiconductor wafer whose thickness has been reduced on a temporary-adhesive tape for dicing, a step of peeling off the semiconductor wafer surface protective tape or the back grind substrate from the semiconductor wafer, a step of dividing the semiconductor wafer by dicing, a pickup step of picking up the divided semiconductor chip, a die bonding step of bonding the picked up semiconductor chip to a lead frame, and a molding step of sealing the semiconductor chip with resin after the die bonding step.

The temporary-adhesive tape for dicing functions as a support for a semiconductor chip not only in the dicing step but also in the pickup step.

A method of performing the dicing step by laser irradiation is known. Specifically, a method is known in which a modified region as a starting point of division is formed inside the semiconductor wafer by laser irradiation from a side of the temporary-adhesive tape for dicing, and then the temporary-adhesive tape

for dicing is expanded to divide the modified region and individualize the semiconductor wafer into semiconductor chips, and this dicing method is called stealth dicing. In the stealth dicing, high transparency has been required for the temporary-adhesive tape for dicing in order to irradiate the wafer with a laser with high accuracy and to enable appearance inspection and the like.

{0003}

Patent Literature 1 proposes a temporary-adhesive sheet for stealth dicing, including a substrate and a temporary-adhesive layer laminated on one surface side of the substrate, wherein in a case where the substrate is pulled with a load of 0.2 g while being heated from 25°C to 120°C at a temperature elevation rate of 20°C/min using a thermomechanical analyzer, a relationship of Formula (1): $\Delta L_{90^{\circ}\text{C}} - \Delta L_{60^{\circ}\text{C}} < 0 \text{ }\mu\text{m}$ is satisfied, where an amount of change in the substrate obtained by subtracting an initial length of the substrate from a length of the substrate at 60°C is defined as $\Delta L_{60^{\circ}\text{C}}$, and an amount of change in the substrate obtained by subtracting the initial length of the substrate from a length of the substrate at 90°C is defined as $\Delta L_{90^{\circ}\text{C}}$. According to Patent Literature 1, this temporary-adhesive sheet for stealth dicing is considered to be excellent in heat shrinkability.

Patent Literature 2 proposes a dicing sheet including a substrate and a temporary-adhesive layer laminated on a first surface side of the substrate, in which an arithmetic average roughness (Ra) of a second surface of the substrate is 0.01 μm or more and 0.5 μm or less, and a maximum height roughness (Rz) of the second surface of the substrate is 3 μm or less. The dicing sheet is assumed to have light transmittance suitable for high magnification imaging of a workpiece.

CITATION LIST

PATENT LITERATURE

{0004}

Patent Literature 1: WO 2018/083986

Patent Literature 2: WO 2018/084021

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

{0005}

By the way, flip chip connection is known as a method of mounting a semiconductor chip on a circuit board. In this flip chip connection, resin is filled between the semiconductor chip and the circuit board. In consideration of work efficiency, a resin to be filled is used as an adhesive film such as an NCF (Non Conductive Film), and the adhesive film is bonded to a wafer before dicing, and individualized simultaneously with the wafer.

In a method using such an adhesive film, a temporary-adhesive tape for dicing is bonded to a wafer, and then an adhesive film is bonded to a surface of the wafer to which the temporary-adhesive tape for dicing is not bonded. More specifically, this bonding is performed as follows. A laminate of a temporary-adhesive tape for dicing and a wafer is disposed on a chuck table (CT) heated to about 80°C so that the side of the temporary-adhesive tape for dicing is in contact with the chuck table, and then fixed by vacuum suction. In this fixed state, an adhesive film is bonded to the wafer on a side opposite to a side of the temporary-adhesive tape for dicing. As a result of studies by the present inventor, it has been found that the transmittance of the temporary-adhesive tape for dicing is likely to decrease after the fixing, and when the temporary-adhesive tape for dicing having a reduced transmittance is used, meandering or the like of the modified region occurs in the subsequent stealth dicing step, and the processing accuracy is likely to deteriorate.

It is considered that the above decrease in transmittance is caused by

roughening of the back surface of the temporary-adhesive tape for dicing, which is caused by the unevenness of the surface of the chuck table being transferred to the temporary-adhesive tape for dicing by vacuum suction at a high temperature. This problem can be improved by increasing the heat resistance (melting point or the like) of the substrate film constituting the temporary-adhesive tape for dicing. However, a highly heat resistant material generally has high rigidity, and in the case of a temporary-adhesive tape for dicing, which uses a highly heat resistant material, there is a problem that the expandability (elongation) of the temporary-adhesive tape for dicing at the time of expanding and dividing is deteriorated.

{0006}

The present invention has been made in view of the above-described problems of the prior art, and the present invention provides a temporary-adhesive tape for dicing that exhibits sufficiently high transmittance to laser light even after vacuum suction to a chuck table under heating, and is also excellent in expandability at the time of expanding and dividing.

SOLUTION TO PROBLEM

{0007}

As a result of intensive studies to solve the above problems, the present inventor has found that the above problems can be solved by setting the penetration temperature to a specific temperature or higher and controlling the surface roughness to a specific value or lower even in the case of using a resin having a low melting point for a substrate film of a temporary-adhesive tape for dicing.

That is, the above-described problems of the present invention can be solved by the following means.

{0008}

[1]

A temporary-adhesive tape for dicing, including:

a substrate film; and

a temporary-adhesive layer on the substrate film,

wherein the substrate film has a melting point of 150°C or lower;

wherein a surface A of the substrate film on a side opposite to the temporary-adhesive layer has a surface roughness Ra of 0.10 μm or less; and

wherein the surface A has a penetration temperature of 80°C or higher.

[2]

The temporary-adhesive tape for dicing described in [1], wherein the substrate film has no yield point up to an elongation percentage of 50% in a stress-elongation curve at -15°C.

[3]

The temporary-adhesive tape for dicing described in [1] or [2], wherein in the substrate film, an absolute value of a difference between a stress (MD stress, S1) (MPa) at 30% elongation percentage when the substrate film is stretched in the MD direction and a stress (TD stress, S2) at 30% elongation percentage when the substrate film is stretched in the TD direction in a tensile test at -15°C is 4 MPa or less.

[4]

The temporary-adhesive tape for dicing described in any one of [1] to [3], wherein the substrate film includes at least two or more layers; and wherein a relationship between a penetration temperature (T1) of a surface on which the temporary-adhesive layer is formed and a penetration temperature (T2) of a surface on which the temporary-adhesive layer is not formed satisfies $[(T2) - (T1)] > 0^{\circ}\text{C}$.

[5]

The temporary-adhesive tape for dicing described in any one of [1] to [4],

wherein the substrate film contains at least one of an ethylene-(meth)acrylic acid alkyl ester copolymer resin and an ionomer resin.

[6]

The temporary-adhesive tape for dicing described in any one of [1] to [5], which is a temporary-adhesive tape for stealth dicing.

{0009}

In the present invention, the numerical ranges expressed with the term “to” refer to ranges including, as the lower limit and the upper limit, the numerical values before and after the term “to”.

In the present invention, (meth)acryl means either or both of acryl and methacryl. The same applies to (meth)acrylate.

In the present invention, the MD direction is a flow direction at the time of film formation, and the TD direction is a direction perpendicular to the MD direction.

ADVANTAGEOUS EFFECTS OF INVENTION

{0010}

The temporary-adhesive tape for dicing of the present invention exhibits a sufficiently high transmittance to laser light even after vacuum suction to a chuck table under heating, and is also excellent in expandability at the time of expanding and dividing.

BRIEF DESCRIPTION OF DRAWINGS

{0011}

{FIG. 1}

FIG. 1 is a sectional view showing one embodiment of the temporary-adhesive tape for dicing of the present invention.

{FIG. 2}

FIG. 2 is a schematic longitudinal cross-sectional view of an adhesive film bonding step according to a preferred embodiment of a method of producing a semiconductor device using the temporary-adhesive tape for dicing of the present invention.

{FIG. 3}

FIG. 3 is a schematic longitudinal cross-sectional view showing a state after peeling a release film in a preferred embodiment of a method of producing a semiconductor device using the temporary-adhesive tape for dicing of the present invention.

{FIG. 4}

FIG. 4 is a schematic longitudinal cross-sectional view showing a state after carrying out from a chuck table in a preferred embodiment of a method of producing a semiconductor device using the temporary-adhesive tape for dicing of the present invention.

{FIG. 5}

FIG. 5 is a schematic longitudinal cross-sectional view of a modified region forming step according to a preferred embodiment of a method of producing a semiconductor device using the temporary-adhesive tape for dicing of the present invention.

{FIG. 6}

FIG. 6 is a schematic longitudinal cross-sectional view showing a state after heat shrink of a preferred embodiment of a method of producing a semiconductor device using the temporary-adhesive tape for dicing of the present invention.

{FIG. 7}

FIG. 7 is an explanatory view showing measurement points of a kerf width in evaluation of Examples and Comparative Examples.

DESCRIPTION OF EMBODIMENTS

{0012}

A temporary-adhesive tape for dicing of the present invention (hereinafter, also referred to as “temporary-adhesive tape of the present invention”) includes a substrate film and a temporary-adhesive layer. The temporary-adhesive tape of the present invention is used as a so-called dicing film. The temporary-adhesive tape of the present invention is suitable as a temporary-adhesive tape for stealth dicing having expandability and heat shrinkability.

In the temporary-adhesive tape of the present invention, the substrate film has a melting point of 150°C or lower as measured by differential scanning calorimetry (DSC). The substrate film has a surface roughness Ra of 0.10 μm or less on a surface opposite to the temporary-adhesive layer. Further, the penetration temperature of the opposite surface is 80°C or higher.

In the temporary-adhesive tape of the present invention, before dicing, unevenness on the surface of the chuck table is less likely to be transferred even by heating (for example, heating at a temperature of 80°C or higher for several minutes) at the time of bonding the adhesive film to the semiconductor wafer (hereinafter, also simply referred to as “wafer”). Therefore, the laser light transmittance can be sufficiently maintained even after vacuum suction to the chuck table under heating. As a result, the modified region can be formed with high accuracy by laser irradiation from the temporary-adhesive tape side. In addition, the temporary-adhesive tape of the present invention is also excellent in expandability in the expanding step after dicing, and enables further increase in the dividing efficiency of the wafer into wafer chips (semiconductor chips).

Further, according to a preferred embodiment of the present invention, more uniform heat shrinkage is possible at the time of heat shrink, and it is easier to set the kerf width to an appropriate range in the MD and TD directions.

{0013}

FIG. 1 is a sectional view showing one embodiment of a temporary-adhesive tape for dicing 10 according to an embodiment of the present invention. The temporary-adhesive tape 10 of the present invention includes a substrate film 11 and a temporary-adhesive layer 12. When the temporary-adhesive tape 10 of the present invention is used, the back surface of the wafer is bonded onto the temporary-adhesive layer 12. The temporary-adhesive layer 12 may be cut (pre-cut) into a predetermined shape in advance according to a use process or an apparatus. The temporary-adhesive tape 10 of the present invention may have a form of being cut for every one wafer, or may have a form of a roll obtained by winding a long sheet in which a plurality of the temporary-adhesive tapes cut for every one wafer are formed.

In the present invention, the temporary-adhesive layer means a coating layer of a temporary-adhesive composition, and the polymer contained in the temporary-adhesive is in a state of exhibiting adhesive strength or cohesive strength. In a case where the temporary-adhesive layer is energy ray-curable, the temporary-adhesive layer is in a state before being cured by energy ray irradiation.

Hereinafter, the configuration of each layer will be described.

{0014}

<Substrate film>

The substrate film 11 may be a single layer or a laminate composed of a plurality of layers. In the case of a laminate, it is preferable that a material for forming each layer is different.

{0015}

The substrate film 11 has a melting point of 150°C or lower.

The melting point is preferably 140°C or lower, preferably 130°C or lower,

more preferably 120°C or lower, more preferably 110°C or lower, still more preferably 100°C or lower, and particularly preferably 90°C or lower. The lower limit is not particularly limited, but is practically 50°C or higher, preferably 60°C or higher, and more preferably 70°C or higher. Therefore, when the melting point of the substrate film 11 is shown as a preferable range, the melting point is preferably 50 to 150°C, more preferably 50 to 140°C, still more preferably 50 to 130°C, still more preferably 60 to 120°C, still more preferably 60 to 110°C, still more preferably 70 to 100°C, and still more preferably 70 to 90°C.

The melting point of the substrate film 11 can be measured by the method described in Examples by differential scanning calorimetry (DSC).

The melting point of the substrate film 11 can be set within the above range by controlling the material, layer structure, blending with other materials, and the like of the substrate film 11.

{0016}

The surface roughness (arithmetic average roughness) Ra of a surface of the substrate film 11 opposite to a surface on which the temporary-adhesive layer 12 is formed (hereinafter, sometimes referred to as “back surface”) is 0.10 μm or less, preferably 0.08 μm or less, more preferably 0.06 μm or less, and still more preferably 0.04 μm or less. The lower limit of the surface roughness Ra of the back surface is not particularly limited, but is practically 0.01 μm or more.

Therefore, when Ra of the back surface of the substrate film 11 is shown as a preferable range, Ra is preferably 0.01 to 0.10 μm, more preferably 0.01 to 0.08 μm, still more preferably 0.01 to 0.06 μm, and still more preferably 0.01 to 0.04 μm. In a case where the substrate film 11 is composed of a plurality of layers, the surface roughness Ra of the outermost layer on the back surface side of the substrate film 11 may be in the above range.

The surface roughness Ra of the back surface of the substrate film 11 can be controlled by a method of preparing the substrate film 11. For example,

the surface roughness Ra of the back surface can be controlled by adjusting the surface roughness of a cooling roll at the time of film extrusion in the case of a T-die method and a calendering method, or by adjusting the surface roughness of a drum or belt in the case of a solution casting method.

The surface roughness Ra of the surface of the substrate film 11 on which the temporary-adhesive layer 12 is formed is not particularly limited.

The surface roughness Ra of the substrate film 11 can be measured in accordance with JIS B0601:2001 by the method described in Examples.

{0017}

The penetration temperature of the back surface of the substrate film 11 is 80°C or higher, preferably 83°C or higher, more preferably 85°C or higher, more preferably 88°C or higher, still more preferably 90°C or higher, and particularly preferably 92°C or higher. The upper limit of the penetration temperature of the back surface of the substrate film 11 is preferably 100°C or lower, more preferably 98°C or lower, and still more preferably 95°C or lower. Therefore, when the penetration temperature of the back surface of the substrate film 11 is shown as a preferable range, the penetration temperature is preferably 80 to 100°C, more preferably 83 to 98°C, still more preferably 85 to 98°C, still more preferably 88 to 98°C, still more preferably 90 to 95°C, and particularly preferably 92 to 95°C.

The penetration temperature can be measured by the method described in Examples by Thermomechanical Analysis (TMA) in accordance with JIS K7196:2012.

The penetration temperature can be controlled by selecting a material constituting the substrate film, forming the substrate film by laminating a plurality of layers of different materials, controlling the thickness of the resin layer constituting the laminate, and the like. For example, when a material having a high softening start temperature is used as a material constituting the substrate

film, the penetration temperature tends to increase. In addition, when a material having a high softening start temperature is laminated on the back surface side of the substrate film and the thickness thereof is increased, the penetration temperature tends to increase. Even in a case where a material having a high softening start temperature is laminated on the back surface side of the substrate film, the penetration temperature tends to decrease in a case where the thickness of the layer is thin or in a case where the softening start temperature of the resin of another layer is low.

When the penetration temperature of the back surface of the substrate film 11 is 80°C or higher, even when a material having a relatively low melting point and low rigidity is used as a constituent material of the substrate film, it is possible to effectively prevent the unevenness of the surface of the chuck table from being transferred to the substrate film by vacuum suction or the like at a high temperature.

{0018}

In a case where the substrate film 11 is a laminate composed of at least two or more layers, the relationship between the penetration temperature (T1) of the surface on which the temporary-adhesive layer 12 is formed and the penetration temperature (T2) of the surface (back surface) on which the temporary-adhesive layer 12 is not formed is preferably $[(T2) - (T1)] > 0^{\circ}\text{C}$ (that is, $T2 > T1$). Such a substrate film is excellent in heat shrinkability at the time of heat shrink. The relationship between T1 and T2 is more preferably $[(T2) - (T1)] > 20^{\circ}\text{C}$, still more preferably $[(T2) - (T1)] > 30^{\circ}\text{C}$, still more preferably $[(T2) - (T1)] > 40^{\circ}\text{C}$, and particularly preferably $[(T2) - (T1)] > 50^{\circ}\text{C}$. The relationship between T1 and T2 can also be $[(T2) - (T1)] > 80^{\circ}\text{C}$. The upper limit of $[(T2) - (T1)]$ is not particularly limited, but is practically 100°C . Therefore, the relationship between T1 and T2 is preferably $100^{\circ}\text{C} > [(T2) - (T1)] > 0^{\circ}\text{C}$, more preferably $100^{\circ}\text{C} > [(T2) - (T1)] > 20^{\circ}\text{C}$, still more preferably $100^{\circ}\text{C} > [(T2) - (T1)]$

$> 30^{\circ}\text{C}$, still more preferably $100^{\circ}\text{C} > [(T2) - (T1)] > 40^{\circ}\text{C}$, and still more preferably $100^{\circ}\text{C} > [(T2) - (T1)] > 50^{\circ}\text{C}$.

{0019}

It is preferable that the substrate film 11 has no yield point between the elongation percentage of 0% and the elongation percentage of 50% in a stress-elongation curve at -15°C . Such a substrate film can be expanded (particularly cool expanding) more uniformly, the temporary-adhesive tape is less likely to be broken, and a sufficient kerf width can be maintained after heat shrink.

The yield point can be determined by the method described in Examples. In the present invention, the stress-elongation curve is a curve obtained by elongation in the TD direction.

{0020}

In the substrate film 11, an absolute value of a difference between a stress (MD stress, $S1$) (MPa) at an elongation percentage of 30% when the substrate film is stretched in the MD direction and a stress (TD stress, $S2$) (MPa) at an elongation percentage of 30% when the substrate film is stretched in the TD direction in a tensile test at -15°C is preferably 4 MPa or less (satisfying $4\text{ MPa} \geq |(S1) - (S2)|$). When $S1$ and $S2$ satisfy the above relationship, the difference in kerf width between the MD direction and the TD direction after heat shrink can be made smaller, which is preferable. The absolute value of the difference between $S1$ and $S2$ is more preferably 3 MPa or less.

{0021}

The constituent material of the substrate film 11 is not particularly limited as long as the above melting point, surface roughness Ra , and penetration temperature can be achieved.

When the substrate film 11 has uniform and isotropic expandability, it is preferable from the viewpoint that the wafer can be evenly cut in all directions in the expanding step.

From these viewpoints, the constituent material of the substrate film 11 is preferably selected from a polyolefin resin and a polyvinyl chloride resin.

{0022}

Examples of the polyolefin resin include resins of homopolymers or copolymers of α -olefins, such as polyethylene, polypropylene, an ethylene-propylene copolymer, polybutene-1, poly-4-methylpentene-1, an ethylene-vinyl acetate copolymer, an ethylene-(meth)acrylic acid alkyl ester copolymer (an ethylene-ethyl acrylate copolymer, an ethylene-methyl acrylate copolymer, an ethylene-methyl methacrylate copolymer, and the like), an ethylene-acrylic acid copolymer, and an ionomer, and mixtures thereof.

{0023}

In particular, an ionomer resin, which is a synthetic resin of polymer aggregates formed using the cohesive strength due to metal ions, is preferable, and examples thereof include ionomer resins obtained by crosslinking an ethylene-(meth)acrylic acid binary copolymer or an ethylene-(meth)acrylic acid-(meth)acrylic acid alkyl ester ternary copolymer with metal ions. These are suitable for the expanding step in terms of uniform expandability. The metal ion contained in the ionomer resin is not particularly limited, and examples thereof include a zinc ion and a sodium ion. The zinc ion is preferable from the viewpoint of low elutability and less contamination.

In general, an ionomer resin has a large restoring strength against tension and has a large shrinkage stress when heat is applied to a stretched state after the expanding step, as compared with a resin without metal ions. Therefore, the ionomer resin is preferable in that a heat shrink step of eliminating a slack generated in the tape after the expanding step by heat shrinkage, and stably maintaining a space between individual wafer chips due to tension given to the tape can be performed.

{0024}

In addition to the ionomer resin, a thermoplastic crosslinked resin 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 ultra-low-density polyethylene having a specific gravity of less than 0.910, and an ethylene-vinyl acetate copolymer is also suitable.

Examples of the crosslinking method include a method of irradiating the resin with an energy ray such as an electron beam. Such a thermoplastic crosslinked resin has certain uniform expandability because a crosslinking site and a non-crosslinking site coexist in the resin. In addition, such a thermoplastic crosslinked resin contains almost no chlorine atom in the structure of the molecular chain, and therefore, even when a tape that becomes unnecessary after use is incinerated, the tape does not generate chlorinated aromatic hydrocarbons such as dioxin and an analog thereof, which also results in reduction in the environmental load. A resin having sufficient uniform expandability can be obtained by appropriately preparing the amount of energy rays with which the polyethylene or the ethylene-vinyl acetate copolymer is irradiated.

{0025}

In the example shown in FIG. 1, the substrate film 11 is a single layer, but is not limited thereto, and may be a plurality of layers. The plurality of layers may be a plurality of layers in which two or more kinds of layers made of different resins are laminated, or may be a plurality of layers in which layers made of one kind of resin are laminated. It is preferable that the two or more kinds of resins are crosslinked resins or non-crosslinked resins from the viewpoint that the characteristics of each resin are further enhanced and expressed, and a case where a crosslinked resin and a non-crosslinked resin are laminated in combination is preferable in that defects of each resin are compensated.

As a method of producing the substrate film 11 composed of plurality of

layers, an ordinary extrusion method, a lamination method, or the like can be used. In a case where the lamination method is used, an adhesive may be interposed between layers. As the adhesive, an ordinary adhesive can be used.

{0026}

The substrate film 11 preferably contains at least one of an ethylene-(meth)acrylic acid alkyl ester copolymer resin and an ionomer resin. The substrate film 11 is also preferably a laminate in which a layer containing an ethylene-(meth)acrylic acid alkyl ester copolymer resin and a layer containing an ionomer resin are laminated.

{0027}

The thickness of the substrate film 11 is not particularly limited, but is preferably 50 to 200 μm , more preferably 70 to 160 μm , still more preferably 100 to 150 μm , still more preferably 100 to 140 μm , and still more preferably 100 to 120 μm .

{0028}

<Temporary-adhesive layer>

The temporary-adhesive layer 12 constituting the temporary-adhesive tape 10 of the present invention is not particularly limited as long as it has a holding property to such an extent that peeling from the wafer does not occur in the dicing step, a property of transmitting stress due to expansion to the modified region of the wafer, and a property of being capable of peeling from the wafer chip at the time of pickup.

The temporary-adhesive constituting the temporary-adhesive layer 12 is not particularly limited as long as it exhibits the above characteristics, and is preferably an energy ray-curable temporary-adhesive. When the energy ray-curable temporary-adhesive is cured before the pickup step, the pickup is facilitated. Here, the energy ray refers to a light ray such as an ultraviolet ray or an ionizing radiation such as an electron beam.

As the temporary-adhesive constituting the temporary-adhesive layer 12, an ordinary temporary-adhesive used as a temporary-adhesive of a temporary-adhesive tape for dicing can be used without particular limitation. As the components, characteristics, and production method of the temporary-adhesive, for example, paragraphs [0039] to [0076] of Japanese Patent No. 6928852, the description of paragraphs [0033] to [0052] of Japanese Patent No. 6989561, the description of paragraphs [0031] to [0057] of JP-A-2023-13022 (“JP-A” means an unexamined published Japanese patent application), and the like can be referred to.

{0029}

The temporary-adhesive constituting the temporary-adhesive layer 12 is preferably an acrylic temporary-adhesive containing a (meth)acrylic resin as a base polymer or the like, more preferably an acrylic temporary-adhesive containing a (meth)acrylic acid alkyl ester as a constituent component. In the (meth)acrylic acid alkyl ester, it is preferable that a radiation-curable group is further introduced into the side chain, and it is more preferable that a (meth)acrylic acid ester having an isocyanate group is added. The temporary-adhesive may further contain a radiation-curable oligomer, and for example, may contain a urethane (meth)acrylate oligomer or the like.

{0030}

The thickness of the temporary-adhesive layer 12 is not particularly limited, but when the thickness is 2 μm or more, it is excellent in terms of tack strength, and is more preferably 5 μm or more, still more preferably 10 μm or more. When the thickness is 35 μm or less, the pickup property is excellent, and the thickness is more preferably 30 μm or less. Therefore, the thickness of the temporary-adhesive layer 12 is preferably 2 to 35 μm , more preferably 5 to 35 μm , still more preferably 5 to 30 μm , and still more preferably 10 to 30 μm .

{0031}

<Application>

The temporary-adhesive tape 10 of the present invention is suitably used in a method of producing a semiconductor device, including at least an adhesive film bonding step including fixing the temporary-adhesive tape 10 on a heated chuck table by vacuum suction, a modified region forming step of forming a modified region in a wafer by irradiation with a laser light from a temporary-adhesive tape side, and an expanding step of dividing the wafer by expansion. Therefore, other steps and the order of the steps are not particularly limited. For example, the temporary-adhesive tape 10 of the present invention can be suitably used in the following production method (A) of a semiconductor device.

{0032}

Production method (A) of semiconductor device

A method of producing a semiconductor device, including:

- (a) a step of bonding a back grind substrate to a front surface of a wafer on which a circuit pattern is formed;
- (b) a back grinding step of grinding a back surface of the wafer;
- (c) bonding a temporary-adhesive tape of the present invention to the back surface of the wafer and fixing the temporary-adhesive tape to a ring frame;
- (d) peeling off the back grind substrate from the wafer;
- (e) an adhesive film bonding step of fixing the temporary-adhesive tape of the present invention to which the wafer is bonded to a heated chuck table by vacuum suction from a substrate film side of the temporary-adhesive tape, and bonding an adhesive film to a surface of the wafer on a side opposite to the temporary-adhesive tape;
- (f) a modified region forming step of irradiating a portion to be divided in the wafer with a laser light from a temporary-adhesive tape side to form a modified region by multiphoton absorption inside the wafer;
- (g) an expanding step of expanding the temporary-adhesive tape to

divide the wafer and the adhesive film along a division line, thereby obtaining a plurality of wafer chips with an adhesive layer;

(h) a heat shrink step of eliminating a slack generated in the expanding step by subjecting, to heat shrinkage, an outer peripheral portion of a portion of the temporary-adhesive tape where the wafer chips are disposed, thereby maintaining a space between the chips; and

(i) a pickup step of picking up the wafer chips with an adhesive layer from the temporary-adhesive layer of the temporary-adhesive tape.

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

{0033}

<Usage>

A method of using the temporary-adhesive tape in a case where the temporary-adhesive tape 10 of the present invention is applied to the production method (A) of a semiconductor device will be described with reference to FIGS. 2 to 5.

{0034}

First, a back grind substrate is bonded to the front surface of a wafer 30 on which a circuit pattern 31 is formed (step (a)), and a back grinding step of grinding the back surface of the wafer 30 is performed (step (b)) (not illustrated). As the back grind substrate, an ordinary back grind substrate can be used, and for example, a glass substrate can be used.

{0035}

After completion of the back grinding step, the temporary-adhesive tape 10 of the present invention is bonded to the back surface of the wafer 30, and is further bonded and fixed to a ring frame 20 (step (c)). At this time, the temporary-adhesive layer 12 of the temporary-adhesive tape 10 of the present invention is disposed so as to be in contact with the back surface of the wafer 30,

and the ring frame 20 is disposed at a portion where the temporary-adhesive layer 12 is exposed around the wafer 30.

The back grind substrate (not illustrated) is peeled off from the wafer 30 (step (d)).

As shown in FIG. 2, an adhesive film 40 with a release film, which includes an adhesive film 41 and a release film 42, is bonded to the front surface of the wafer 30 while the temporary-adhesive tape 10 of the present invention, to which the wafer 30 is bonded, is fixed to a heated chuck table 70 by vacuum suction from the substrate film 11 side (step e). The heating temperature of the chuck table 70 at this time can be set to 80°C or higher in consideration of bonding with an adhesive film such as NCF.

{0036}

The release film 42 is peeled off from the adhesive film 41. A state after peeling of the release film 42 is shown in FIG. 3.

{0037}

Next, as shown in FIG. 4, the wafer 30 to which the temporary-adhesive tape 10 is bonded is carried out from the chuck table 70. At this time, in a case where a temporary-adhesive tape that is not the temporary-adhesive tape of the present invention is used, unevenness on the surface of the chuck table is transferred to the back surface of the substrate film 11, and the transmittance of laser light is reduced. However, when the temporary-adhesive tape 10 of the present invention is used, this transfer can be effectively suppressed, and the transmittance of laser light can be sufficiently maintained.

{0038}

Next, as shown in FIG. 5, a portion to be divided in the wafer 30 is irradiated with a laser light 60 from the temporary-adhesive tape 10 side, to form a modified region 32 by multiphoton absorption inside the wafer 30 (step (f)). In FIG. 5, the modified regions 32 are intermittently formed at four locations.

{0039}

Next, the temporary-adhesive tape 10 of the present invention to which the wafer 30 and the ring frame 20 are bonded is placed on a stage of an expanding apparatus with the substrate film 11 side facing downward.

Next, a push-up member having a hollow cylindrical shape in the expanding apparatus is uplifted in a state in which the ring frame 20 is fixed, to thereby extend (expand) the temporary-adhesive tape 10 (step (g)). As expanding conditions, the expanding speed is, for example, 5 to 500 mm/sec, and the expanding amount (push-up amount) is, for example, 5 to 25 mm. By stretching the temporary-adhesive tape 10 in the radial direction of the wafer 30 in this manner, the wafer 30 is divided into units of chips 33, originating from the modified region 32 as a starting point. At this time, at a portion of the adhesive film 41 bonded to the wafer 30, elongation (deformation) due to expansion is suppressed and breakage does not occur, but at a position between the chips 33, tension is concentrated thereon due to expansion of the film, and breakage occurs. Therefore, the adhesive film 41 is also divided together with the wafer 30. As a result, as shown in FIG. 6, a plurality of chips 33 with the adhesive film pieces 43 can be obtained.

{0040}

Next, a step of returning the push-up member to the original position and eliminating a slack of the temporary-adhesive tape 10 generated in the previous expanding step to stably maintain a space between the chips 33 is performed. In this step, for example, the substrate film 11 is subjected to heat shrinkage by blowing hot air at 40 to 120°C to an annular heat-shrinkable region located between a region of the temporary-adhesive tape 10 where the chips 33 are present and the ring frame 20 using a hot air nozzle, thereby restoring the temporary-adhesive tape 10 to a stretched state (step (h)). Thereafter, the temporary-adhesive layer 12 is subjected to an energy ray curing treatment, a

heat curing treatment or the like to weaken the adhesive strength of the temporary-adhesive layer 12 to the chip 33, and then the chips 33 are picked up (step (i)).

EXAMPLES

{0041}

Hereinafter, the present invention will be described in more detail based on Examples and Comparative Examples. However, the present invention is not limited to the following Examples.

{0042}

The following components were used.

(Temporary-adhesive)

Base resin A: To an acrylic copolymer (glass transition temperature: -65°C) containing 70 mass% of 2-ethylhexyl acrylate, 29 mass% of 2-hydroxyethyl acrylate, and 1 mass% of methacrylic acid as constituent units, 2-methacryloyloxyethyl isocyanate was added so that the double bond amount was 0.9 (meq/g). To 100 parts by mass of the acrylic copolymer, 0.3 parts by mass of a urethane acrylate oligomer having a weight average molecular weight of 850 was added to obtain a base resin A.

Photopolymerizable initiator: Irgacure 184 (trade name: manufactured by Ciba-Geigy Japan Ltd.)

Curing agent: Coronate L (isocyanate-based curing agent, trade name, manufactured by Tosoh Corporation)

Surface modifier: TEGORad2200N (trade name: manufactured by Tego Chemie)

{0043}

(Substrate film)

EMMA: Ethylene-methyl methacrylate copolymer (AN4214C (trade name) manufactured by Dow-Mitsui Polychemicals)

ION (1): Ionomer (HIMILAN 1855 (trade name), manufactured by Dow-Mitsui Polychemicals)

ION (2): Ionomer (HIMILAN 1652 (trade name), manufactured by Dow-Mitsui Polychemicals)

ION (3): Ionomer (HIMILAN AM7326 (trade name), manufactured by Dow-Mitsui Polychemicals)

PP: Polypropylene (F724P (trade name), manufactured by Prime Polymer Co., Ltd.)

{0044}

<Examples>

1) Preparation of substrate film

(Substrate film 1)

EMMA was melt-kneaded and subjected to extrusion molding at 220°C with a multilayer T-die extruder, and one surface was extruded onto a mirror-finished metal roll (hereinafter, also referred to as “mirror surface roll (1)”). In this way, the substrate film 1 having a thickness of 100 μm was formed on the mirror surface roll (1). The surface shape of the metal roll is transferred to the surface of the substrate film 1 on the mirror surface roll (1) side. The surface roughness Ra of the surface of the obtained substrate film 1 on the mirror surface roll (1) side was 0.03 μm.

{0045}

(Substrate film 2)

A substrate film 2 was prepared in the same manner as in the substrate film 1 except that a mirror surface roll (2) was used in place of the mirror surface roll (1) in the preparation of the substrate film 1.

{0046}

(Substrate film 3)

A substrate film 3 was prepared in the same manner as in the substrate

film 1 except that ION (3) was used in place of EMMA in the preparation of the substrate film 1.

{0047}

(Substrate film 4)

A substrate film 4 including an ION (1) layer and an EMMA layer and having a total thickness of 100 μm was prepared in the same manner as in the substrate film 1 except that ION (1) and EMMA were co-extruded in place of EMMA with a multilayer T-die extruder such that EMMA was on the mirror surface roll (1) side in the preparation of the substrate film 1. The amount of ION (1) was 50 mass% and the amount of EMMA was 50 mass% in the total amount of the resin components of the substrate film 4. The ION (1) layer had a thickness of 50 μm , and the EMMA layer had a thickness of 50 μm .

{0048}

(Substrate film 5)

A substrate film 5 was prepared in the same manner as in the substrate film 4 except that the amount of ION (1) was 20 mass% and the amount of EMMA was 80 mass% in the total amount of the resin components of the substrate film in the preparation of the substrate film 4. The ION (1) layer had a thickness of 20 μm and the EMMA layer had a thickness of 80 μm .

{0049}

(Substrate film 6)

A substrate film 6 was prepared in the same manner as in the substrate film 5 except that the total thickness was 150 μm in the preparation of the substrate film 5. The ION (1) layer had a thickness of 30 μm and the EMMA layer had a thickness of 120 μm .

{0050}

(Substrate film 7)

A substrate film 7 was prepared in the same manner as in the substrate

film 1 except that PP was used in place of EMMA in the preparation of the substrate film 1.

{0051}

(Substrate film 8)

A substrate film 8 was prepared in the same manner as in the substrate film 1 except that ION (1) was used in place of EMMA in the preparation of the substrate film 1.

{0052}

(Substrate film 9)

A substrate film 9 was prepared in the same manner as in the substrate film 1 except that ION (2) was used in place of EMMA in the preparation of the substrate film 1.

{0053}

(Substrate film 10)

A substrate film 10 including an EMMA layer and an ION (1) layer and having a total thickness of 100 μm was prepared in the same manner as in the substrate film 1 except that EMMA and ION (1) were co-extruded in place of EMMA such that ION (1) was on the mirror surface roll (1) side in the preparation of the substrate film 1. The amount of EMMA was 50 mass%, and the amount of ION (1) was 50 mass% in the total amount of the resin components of the substrate film 10. The EMMA layer had a thickness of 50 μm , and the ION (1) layer had a thickness of 50 μm .

{0054}

(Substrate film 11)

A substrate film 11 was prepared in the same manner as in the substrate film 1 except that an embossed roll (1) was used in place of the mirror surface roll (1) in the preparation of the substrate film 1.

{0055}

(Substrate film 12)

A substrate film 12 was prepared in the same manner as in the substrate film 1 except that an embossed roll (2) was used in place of the mirror surface roll (1) in the preparation of the substrate film 1.

{0056}

2) Preparation of temporary-adhesive composition

Into 100 parts by mass of the base resin A, 3 parts by mass of a photopolymerizable initiator, 1 part by mass of a curing agent, and 0.6 parts by mass of a surface modifier were blended. In this way, a temporary-adhesive composition containing an acrylic resin as a base polymer was obtained.

{0057}

3) Preparation of temporary-adhesive tape

The temporary-adhesive composition obtained above was applied to a release liner formed of a release-treated polyethylene-terephthalate film so that the thickness after drying was 20 μm , and dried at 110°C for 3 minutes to obtain a temporary-adhesive film with a release liner. Subsequently, the temporary-adhesive layer of the temporary-adhesive film with a release liner was bonded to the surface of each of the substrate films 1 to 12 on a side not in contact with the roll, and the release liner was peeled off to obtain temporary-adhesive tapes of Examples 1 to 6 and Comparative Examples 1 to 6 in which the temporary-adhesive layer was formed on each of the substrate films 1 to 12.

At this time, in the substrate films 4 to 6 and 10 having a two-layer structure, the arrangement of each layer constituting the substrate film was as shown in Table 1.

{0058}

The melting point, surface roughness Ra, and penetration temperature of each substrate film used in each of the temporary-adhesive tapes of Examples and Comparative Examples were measured as follows.

{0059}

(Melting point of substrate film)

The melting peak temperature of the substrate film was measured in accordance with the DSC method (JIS K 7121:2001), and the melting peak temperature was defined as the melting point. As a sample, each of the substrate films 1 to 12 obtained as described above was used.

When a plurality of melting peaks were confirmed, the temperature of the lowest melting peak was defined as the melting point.

{0060}

(Penetration temperature of back surface of substrate film)

The temporary-adhesive layer of each temporary-adhesive tape obtained above was attached to a quartz pedestal, and the back surface of the substrate film was measured.

The measurement was performed in accordance with JIS K7196:2012 by applying a load of 500 mN to the tip of the indenter having a diameter of 1 mm at a temperature elevation rate of 5°C/min. A TMA curve (horizontal axis: temperature, vertical axis: deformation amount) was obtained, and the penetration temperature was determined.

Measurement was performed in penetration mode using TMA8311 (trade name, manufactured by Rigaku Corporation) as a measurement apparatus.

For the substrate films 4 to 6 and 10 composed of a plurality of layers, the penetration temperature was also measured for the surface (front surface) of the substrate film on which the temporary-adhesive layer was formed. At this time, a temporary-adhesive tape was formed in the same manner as in 3) Preparation of temporary-adhesive tape except that a temporary-adhesive layer was formed on the back surface of the substrate film, and measurement was performed.

The penetration temperature (T2) of the back surface of the substrate film is shown in the column of “penetration temperature of substrate film” in Table 1,

and the difference $((T_2) - (T_1))$ between the penetration temperature (T_2) of the back surface of the substrate film and the penetration temperature (T_1) of the front surface of the substrate film is shown in the column of “penetration temperature difference $(T_2) - (T_1)$ ($^{\circ}\text{C}$)” in Table 1. “-” indicates that the measurement is not performed.

{0061}

(Surface roughness R_a of back surface of substrate film)

As for the surface roughness R_a of the back surface of the substrate film, the temporary-adhesive layer of each temporary-adhesive tape obtained as described above was bonded and fixed to a smooth silicon mirror wafer, measurement was performed at arbitrary five positions (about 5 mm in length $\times$ five positions) on the back surface of the substrate film, and the average value was taken as the surface roughness R_a of the back surface.

For the measurement, measurement apparatus: “Surftest SJ-310” (manufactured by Mitutoyo Corporation) JIS B0601 was used. The measurement conditions were as follows.

-Measurement conditions-

Curve: R

Parameter: 2

Filter: GAUSS

λ_c : 0.8 mm

λ_s : 2.5 μm

Number of sections: 5

{0062}

(Yield point up to elongation percentage of 50% at the time of tension at -15°C)

A stress-elongation curve at -15°C was obtained as follows, and the

presence or absence of the yield point up to an elongation percentage of 50% (1.5 times the initial length) was confirmed.

Using a tensile tester in accordance with JIS B7721:2018, the stress and elongation percentage of each substrate film were measured by a tensile test under the following measurement conditions, and a stress-elongation curve was each obtained using the results. The presence or absence of the yield point up to an elongation percentage of 50% (elongation percentage in a range from 0 to 50%) was confirmed from the obtained stress-elongation curve. A piece having a width of 5 mm (MD direction) and a length of 60 mm (TD direction) was cut out from each substrate film to prepare a test piece.

-Measurement conditions-

Measurement temperature: -15°C

A low-temperature thermostat was used, and measurement was started 5 minutes after the sample was set and the temperature reached -15°C

Distance between chucks: 20 mm

Tensile speed: 300 mm/min

{0063}

(Stress)

A stress-elongation curve was prepared under the same measurement conditions as in the yield point test, and the stress value (MPa) at 30% tension (elongation percentage of 30%) was obtained. As the test piece, the following was used.

Test piece A: a test piece having a width of 5 mm in the MD direction and a length of 60 mm in the TD direction

Test piece B: a test piece having a width of 5 mm in the TD direction and a length of 60 mm in the MD direction

The stress value of the test piece A was defined as TD stress (S2), the stress value of the test piece B was defined as MD stress (S1), and $S1 - S2$ was calculated.

{0064}

The transmittance after heating and suction, meandering of the modified region at the time of stealth dicing, tape breakage at the time of cool expanding, and kerf width of each of the temporary-adhesive tapes of Examples and Comparative Examples were evaluated as follows.

{0065}

(Transmittance after heating and suction)

Each of the temporary-adhesive tapes obtained in Examples and Comparative Examples was attached to a ring frame (inner diameter: 350 mm). Thereafter, each temporary-adhesive tape was placed on a porous chuck table (porous chuck (trade name), manufactured by Yoshioka Seiko Inc., material: alumina, 12 inch wafer size, porous average pore diameter: 55 μm) heated to 80°C such that the back surface (surface on which the temporary-adhesive was not applied) was on the chuck table side, and then fixed by suction at a vacuum pressure of 90 kPa, and this state was maintained for 5 minutes. Thereafter, each temporary-adhesive tape was removed from the chuck table, and then irradiated with light from the back surface side of each temporary-adhesive tape, and the transmittance was measured using a UV-VIS spectrophotometer (manufactured by Shimadzu Corporation, trade name: UV-1800). The transmittance was measured at arbitrary 5 positions of each temporary-adhesive tape, and the average value of the transmittance at 650 nm was determined and taken as the transmittance after heating and suction.

Photometric mode: %T

Scan range: 1100 to 200 nm

Recording range: 0.0 to 100.0%

Scan speed: high speed

Scan pitch: AUTO

Number of scans: 1

In the above test, the heating temperature of the chuck table was set to 80°C, which is a temperature usually employed when the adhesive film is bonded to the wafer.

A wavelength of 650 nm is a typical wavelength of a laser included in an autofocus unit used to determine the processing depth of the modified region by laser irradiation of the dicing apparatus.

{0066}

(Meandering of modified region at the time of stealth dicing)

1) Stealth dicing

A silicon mirror wafer (diameter: 12 inch, thickness: 100 μm) and a ring frame were attached to the temporary-adhesive layer of the temporary-adhesive tape to obtain a laminated structure. The obtained laminated structure was fixed by suction at a vacuum pressure of 90 kPa from the back surface of each temporary-adhesive tape (surface on which the temporary-adhesive was not applied) with a porous chuck table heated to 80°C in the same manner as in the test for transmittance after heating and suction described above, and this state was maintained for 5 minutes. Thereafter, the laminated structure was set in a laser dicer (product name “DF-7362” manufactured by DISCO Corporation), and then the laminated structure was irradiated with a laser light for stealth dicing from the back surface side of the temporary-adhesive tape to form modified regions at regular intervals in the silicon mirror wafer. More specifically, laser irradiation was performed such that dotted modified regions were formed on a straight line along a scheduled line A in the cross section of the wafer chip

obtained by stealth dicing. The width of the scheduled line A in the thickness direction of the wafer chip coincides with the length of the modified region 32 in the thickness direction in the cross section of the wafer 30 shown in FIG. 5. In this evaluation, the width of the scheduled line A was set to 20 μm .

Thereafter, the laminated structure was placed in a die separator (product name “DDS2300” manufactured by DISCO Corporation), and expansion (cool expansion) was performed at -15°C under the conditions of an expanding speed (drawdown speed) of 300 mm/sec and an expanding amount of 12 mm to obtain chips of 8 mm $\times$ 8 mm. Thereafter, expansion was further performed under the conditions of an expanding speed of 5 mm/sec and an expanding amount of 10 mm at normal temperature. Thereafter, heat shrink (heat shrinkage) treatment was performed under the following conditions. Here, the expanding amount refers to an amount of change in the relative position between the ring frame and the push-up member before and after the push-up. In this way, wafer chips were obtained on the temporary-adhesive tape attached to the ring frame by cool expansion division and heat shrink, and then the wafer chips were picked up.

[Conditions]

Heater setting temperature: 220°C

Hot air volume: 40 L/min

Interval between heater and temporary-adhesive tape: 20 mm

Heater rotation speed: $7^{\circ}/\text{sec}$

2) Meandering of modified region during stealth dicing

A cross section (side surface formed by the division) (arbitrary one surface) of the wafer chip obtained by the stealth dicing was observed with a digital microscope (VHX-5000 (trade name), manufactured by Keyence Corporation) to confirm the modified region of the wafer chip cross section. In

this cross section, dotted modified regions are observed at intervals in the length direction of the wafer chip. In the cross section, a width a_1 of a rectangle having the minimum area including all the modified regions formed above the upper end of the scheduled line A in the thickness direction of the wafer chip (the length in the thickness direction of the wafer chip) and a width a_2 of a rectangle having the minimum area including all the modified regions formed below the lower end of the scheduled line A in the thickness direction of the wafer chip were measured, and a larger one of a_1 and a_2 was taken as the meandering amount of the modified region in the cross section. When the meandering amount is zero, the widths a_1 and a_2 of the rectangles are zero. The obtained meandering amount was applied to the following evaluation ranks and evaluated.

When the meandering amount of the modified region is large above and below the wafer chip in the thickness direction, the chip may not be divided with high processing accuracy.

-Evaluation ranks-

- ⊙: less than 10 μm
- : 10 μm or more and less than 20 μm
- △: 20 μm or more and less than 30 μm
- ×: 30 μm or more

{0067}

(Tape breakage at the time of cool expanding)

The above 1) stealth dicing was performed on 10 temporary-adhesive tapes. The presence or absence of breakage of the temporary-adhesive tape at the time of cool expanding was confirmed, and evaluation was performed according to the following evaluation ranks.

When the temporary-adhesive tape breaks at the time of cool expanding,

the next step cannot be performed and the yield is deteriorated, which is not preferable.

-Evaluation ranks-

×: Breakage of the temporary-adhesive tape occurred in any of the 10 temporary-adhesive tapes.

○: No breakage of the temporary-adhesive tape occurred in any of the 10 temporary-adhesive tapes.

{0068}

(Kerf width)

As shown in FIG. 7, a kerf width X (MD direction kerf width) between a chip 50a having no chipping and located at the rightmost end in FIG. 7 in the MD direction of the temporary-adhesive tape and an adjacent chip on the center side in the MD direction, and a kerf width Y (TD direction kerf width) between the chip 50a and an adjacent chip on the center side in the TD direction are measured. Similarly, the MD direction kerf width and the TD direction kerf width are measured for a chip 50b having no chipping and located at the leftmost end in FIG. 7 in the MD direction of the temporary-adhesive tape. In addition, the MD direction kerf width and the TD direction kerf width are also measured for outermost end chips 51 having no chipping in the TD direction of the temporary-adhesive tape and a chip 52 located at the center. The average value of the MD direction kerf widths at the five points and the average value of the TD direction kerf widths at the five points are calculated. The obtained kerf width (μm) was evaluated by applying it to the following evaluation ranks.

-Evaluation ranks-

⊙: 30 μm or more

○: 20 to 29 μm

△: 9 to 19 μm

×: 8 μm or less

{0069}

The results obtained are shown collectively in the following Table 1.

{0070}

Table 1

		Ex. 1	Ex. 2	Ex. 3	Ex. 4	Ex. 5	Ex. 6
Temporary-adhesive layer	Thickness (μm)	20	20	20	20	20	20
Substrate film	Thickness (μm)	100	100	100	100	100	150
	Temporary-adhesive layer side	EMAA	EMAA	ION (3)	ION (1) 50%	ION (1) 20%	ION (1) 20%
	Tape back surface side	100%	100%	100%	EMAA 50%	EMAA 80%	EMAA 80%
	Substrate film No.	1	2	3	4	5	6
Melting point (°C) of substrate film		105	105	101	86	86	86
Penetration temperature of substrate film back surface (°C)		95	95	83	85	92	92
Roll used in film formation		MR1	MR2	MR1	MR1	MR1	MR1
Surface roughness Ra of substrate film back surface (μm)		0.03	0.08	0.03	0.03	0.03	0.03
Yield point (MD) up to elongation percentage of 50% at the time of tension at -15°C		Exist	Exist	Absent	Absent	Absent	Absent
Stress (S1) - (S2) (MPa)		-5	-5	3	4	3	3
Penetration temperature difference (T2) - (T1) (°C)		-	-	-	31	51	51
Evaluation	Transmittance after heating and suction (%) 650 nm	87	84	85	84	86	89
	Meandering of modified region at the time of stealth dicing	○	○	○	○	○	⊙
	Tape breakage at the time of cool expanding	○	○	○	○	○	○
	MD direction kerf width (μm)	22	22	28	36	34	33
		○	○	○	⊙	⊙	⊙
	TD direction kerf width (μm)	8	8	24	32	31	30
		×	×	○	⊙	⊙	⊙

Remarks: 'Ex.' means Example according to this invention.

Table 1 (continued)

		CEx. 1	CEx 2	CEx. 3	CEx. 4	CEx. 5	CEx. 6
Temporary-adhesive layer	Thickness (μm)	20	20	20	20	20	20
Substrate film	Thickness (μm)	100	100	100	100	100	100
	Temporary-adhesive layer side	PP 100%	ION (1) 100%	ION (2) 100%	EMAA 50%	EMAA 100%	EMAA 100%
	Tape back surface side				ION (1) 50%		
	Substrate film No.	7	8	9	10	11	12
Melting point (°C) of substrate film		155	86	98	86	105	105
Penetration temperature of substrate film back surface (°C)		95	56	73	72	95	95
Roll used in film formation		MR1	MR1	MR1	MR1	ER1	ER2
Surface roughness Ra of substrate film back surface (μm)		0.03	0.03	0.03	0.03	0.7	0.3
Yield point (MD) up to elongation percentage of 50% at the time of tension at -15°C		Exist	Absent	Absent	Absent	Exist	Exist
Stress (S1) - (S2) (MPa)		0	5	3	4	-5	-5
Penetration temperature difference (T2) - (T1) (°C)		-	-	-	-30	-	-
Evaluation	Transmittance after heating and suction (%) 650 nm	87	69	77	78	57	72
	Meandering of modified region at the time of stealth dicing	○	×	△	△	×	×
	Tape breakage at the time of cool expanding	×	○	○	○	○	○
	MD direction kerf width (μm)	7	38	32	20	22	22
		×	⊙	⊙	○	○	○
	TD direction kerf width (μm)	6	33	26	10	7	7
		×	⊙	○	△	×	×

Remarks:'CEx.' means Comparative Example.

{0071}

(Notes in Table 1)

The column of “roll used in film formation” shows the roll used in the production of each substrate film. “MR1” represents a mirror surface roll (1), “MR2” represents a mirror surface roll (2), “ER1” represents an embossed roll (1), and “ER2” represents an embossed roll (2).

{0072}

The following is clear from Table 1.

The temporary-adhesive tape of Comparative Example 1 has a substrate film using PP having a high melting point (155°C). The temporary-adhesive tape of Comparative Example 1 was broken in the cool expanding.

The temporary-adhesive tapes of Comparative Examples 2 to 4 have a substrate film having a low penetration temperature on the back surface of the substrate film. In all of the temporary-adhesive tapes of Comparative Examples 2 to 4, after vacuum suction to the chuck table under heating, the transmittance after heating and suction was less than 80%, and meandering of the modified region of 20 μm or more occurred in the stealth dicing.

The temporary-adhesive tapes of Comparative Examples 5 and 6 have a substrate film having a large surface roughness Ra of the back surface of the substrate film. In the temporary-adhesive tapes of Comparative Examples 5 and 6, the transmittance after heating and suction was less than 80%, and meandering of the modified region occurred in the stealth dicing. Further, the kerf width was too narrow after heat shrink.

In contrast, the temporary-adhesive tapes of Examples 1 to 6 have a substrate film having a melting point of 150°C or lower, a surface roughness Ra of the back surface of 0.10 μm or less, and a penetration temperature of 80°C or higher. In all the temporary-adhesive tapes of Examples 1 to 6, the transmittance after heating and suction was 84% or more, the laser light was

sufficiently transmitted, and the meandering of the modified region in the stealth dicing was reduced to less than 20 μm . Further, no breakage occurred in the cool expanding. It can be seen that the temporary-adhesive tape of the present invention exhibits sufficient transmittance to laser light after vacuum suction to the chuck table under heating while using a resin having a relatively low melting point, and is excellent in expansion at the time of expanding and dividing.

Further, it is found that the kerf width can be appropriately maintained after heat shrink by forming a substrate film in which the yield point in the stress-elongation curve at -15°C does not exist up to an elongation percentage of 50% (Examples 3 to 6).

{0073}

The present invention has been described together with embodiments thereof. It is our intention that the invention should not be limited by any of the details of the description unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the attached claims.

{0074}

The present application claims priority of Patent Application No. 2023-053186, filed in Japan on March 29, 2023, which is herein incorporated by reference as part of the present specification.

DESCRIPTION OF SYMBOLS

{0075}

- 10 Temporary-adhesive tape for dicing
- 11 Substrate film
- 12 Temporary-adhesive layer
- 20 Ring frame
- 30 Wafer
- 31 Circuit surface

32	Modified region
33	Chip
40	Adhesive film with release film
41	Adhesive film
42	Release film
60	Laser light
70	Chuck table

CLAIMS

[Claim 1]

A temporary-adhesive tape for dicing, comprising:
a substrate film; and
a temporary-adhesive layer on the substrate film,
wherein the substrate film has a melting point of 150°C or lower;
wherein a surface A of the substrate film on a side opposite to the temporary-adhesive layer has a surface roughness Ra of 0.10 μm or less; and
wherein the surface A has a penetration temperature of 80°C or higher.

[Claim 2]

The temporary-adhesive tape for dicing according to claim 1, wherein the substrate film has no yield point up to an elongation percentage of 50% in a stress-elongation curve at -15°C.

[Claim 3]

The temporary-adhesive tape for dicing according to claim 1 or 2, wherein in the substrate film, an absolute value of a difference between a stress (MD stress, S1) (MPa) at 30% elongation percentage when the substrate film is stretched in the MD direction and a stress (TD stress, S2) at 30% elongation percentage when the substrate film is stretched in the TD direction in a tensile test at -15°C is 4 MPa or less.

[Claim 4]

The temporary-adhesive tape for dicing according to any one of claims 1 to 3,
wherein the substrate film includes at least two or more layers; and
wherein a relationship between a penetration temperature (T1) of a surface on

which the temporary-adhesive layer is formed and a penetration temperature (T2) of a surface on which the temporary-adhesive layer is not formed satisfies $[(T2) - (T1)] > 0^{\circ}\text{C}$.

[Claim 5]

The temporary-adhesive tape for dicing according to any one of claims 1 to 4, wherein the substrate film contains at least one of an ethylene-(meth)acrylic acid alkyl ester copolymer resin and an ionomer resin.

[Claim 6]

The temporary-adhesive tape for dicing according to any one of claims 1 to 5, which is a temporary-adhesive tape for stealth dicing.