

SEMICONDUCTOR PROCESSING TAPE

TECHNICAL FIELD

[0001] The present invention relates to a semiconductor processing tape that shows excellent pickup property.

Background Art

[0002] Conventionally, in the production of semiconductor devices such as integrated circuits (IC: Integrated Circuit), a backgrinding process of grinding the back side of the wafer to thin the wafer after circuit pattern formation, a dicing process of dividing the wafer into chip units after adhering a semiconductor processing tape that shows pressure-sensitive adhesive strength and elasticity on the back side of the wafer, an expand process of expanding the semiconductor processing tape, a pickup process of picking up the divided chips, and a die bonding (mount) process of bonding the picked up chip to a lead frame or package substrate and the like (or in a stacked package, laminating and adhering chips together) are performed.

[0003] In the above-described backgrinding process, a surface protection tape is used to protect the circuit pattern-formed side of the wafer (wafer surface) from contamination. After grinding the back side of the wafer, in peeling off this surface protection tape from the wafer surface, a later-described semiconductor processing tape (dicing-die bonding tape) is adhered to the back side of the wafer, the side with the semiconductor processing tape is fixed on to a suction table, the surface protection tape is subjected to a process that decreases its adhesive strength to the wafer, and the surface protection tape is peeled off. The wafer from which the surface protection tape has been peeled off is then lifted off the suction table with the semiconductor processing tape bonded to its backside, and subjected to the next dicing process. Note that a process that decreases adhesive strength is an energy ray irradiation process when the surface protection tape is composed of an energy ray-curing component such as ultraviolet ray, and is a heating process when the surface protection tape is composed of a heat-curable component.

[0004] In the dicing process to the mount process, following the above-described backgrinding process, a semiconductor processing tape with a pressure-sensitive adhesive layer and an adhesive layer laminated on a substrate film in this order is used. In general, when using such a semiconductor processing tape, first, the wafer is fixed by adhering the adhesive layer of the semiconductor processing tape on the backside of the wafer, and the wafer and the adhesive layer is diced into chips using a dicing blade. Then, by expanding the tape towards a direction of the diameter of the wafer, an expand process of expanding the distance between the chips is performed. This expand process is performed to enhance the recognizability of the chips by CCD cameras and the like, as well as to prevent damages to the chips caused by adjacent chips coming into contact with each other, in the pickup process that follows. Subsequently, the chip is picked up along with the adhesive layer by peeling from the pressure-sensitive adhesive layer in the pickup process, and is directly adhered to the lead frame or package substrate and the like in the mount process. Thus, by using a semiconductor processing tape, chips with an adhesive layer attached thereto can be adhered directly to the lead frame and package substrate, and processes such as an adhesive agent application process, or a process of adhering die-bonding films onto each chip, can be omitted.

[0005] However, in the aforementioned dicing process, as described previously, because the wafer and the adhesive layer are diced together using a dicing blade, cutting wastes from the adhesive layer, as well as cutting waste from the wafer, develop. Further, there was a problem in that when such cutting waste from the adhesive layer blocks the wafer groove, the chips stick to each other and cause pickup failure, which leads to a decrease in semiconductor device yield.

[0006] To solve such problems, a method of dicing only the wafer using the blade in the dicing process, and dividing the adhesive layer for each chip by expanding the semiconductor processing tape in the expand process, has been proposed. (For example, Patent Document 1.) In such a method of dividing the adhesive layer using the tension at expansion, cutting waste from the adhesive agent does not occur, and

harmful effects on the pickup process can be avoided.

[0007] Furthermore, in recent years, as a method of cutting wafer, a method known as the stealth-dicing method, in which a wafer can be cut by a non-contact process using a laser-processing machine, has been proposed. For example, in Patent Document 2, as a stealth-dicing method, a method of cutting semiconductor substrate, which comprises a process of irradiating laser after setting the focus within the semiconductor substrate with a sheet attached thereto, to thereby form a modified region through multi-photon absorption within the semiconductor substrate, which serves as a predetermined cutting part, and a process of cutting the semiconductor substrate and the adhesive layer along the predetermined cutting part by expanding the sheet, is disclosed.

[0008] Further, as another method of cutting wafer using a laser-processing machine, for example, Patent Document 3 discloses a wafer division method that comprises a process of attaching an adhesive layer (adhesive film) for die bonding on the back side of a wafer, a process of adhering an extendable protective adhesive tape on the adhesive layer side of the wafer with the adhesive layer adhered thereto, a process of dividing into individual chips by irradiating laser from the surface of the wafer with the protective adhesive tape adhered thereto along a street, a process of cutting the adhesive layer for each chip by expanding the protective adhesive tape to thereby apply tension to the adhesive layer, and a process of detaching the chip with the cut adhesive layer attached thereto from the protective adhesive tape.

[0009] According to such wafer cutting methods disclosed in Patent Document 2 and Patent Document 3, the wafer is cut by a non-contact method by the irradiation of laser and the expansion of the tape, and thus, the physical load on the wafer is small. Cutting of the wafer can be performed without the development of cutting waste (chipping), as in the presently-common blade dicing. Further, since the adhesive layer is divided by expansion, cutting waste of the adhesive layer does not develop either. Thus, such methods are attracting attention as a superior technology that could replace blade dicing.

[0010] Furthermore, in Patent Document 4, to prevent the slack after expansion from causing it to become difficult to maintain the space between chips stably, a method of maintaining space between the chips (hereinafter referred to as the "kerf width" by shrinking the tape after the cutting process has been proposed.

RELATED ART

Patent Documents

[0011] Patent Document 1: JP2007-A-5530

Patent Document 2: JP2003-A-338467

Patent Document 3: JP2004-A-273895

Patent Document 4: JP2011-A-216508

SUMMARY

[0012] On the other hand, there was a problem in that when the thermal shrinkage stress during thermal shrinkage was large, the tape tends to expand more than the kerf width expanded in the expand process, and thus, the kerf width in the direction with the larger thermal shrinkage stress tends to expand more than necessary. Hence, the kerf width of the direction with the smaller thermal shrinkage stress often became narrower. By having a narrow kerf width, pickup defects occur. More specifically, when the value of the thermal shrinkage rate in the lengthwise direction divided by the thermal shrinkage rate in the widthwise direction is large, the difference between the lengthwise and widthwise directions become excessively large, and the kerf width becomes uneven, causing chip position displacement to occur, which leads to recognition defects during pickup. Further, when the kerf width is too narrow, re-adhering of the adhesive film occurs, causing pickup defects to occur. Note that the kerf width will not become even, even when the value of the thermal shrinkage rate in the lengthwise direction divided by the thermal shrinkage rate in the widthwise direction is a negative value.

[0013] The present invention provides a semiconductor processing tape that

shows low thermal shrinkage rate and shrinks evenly regardless of the direction of the tape so that kerf width extends evenly without wrinkles or displacement in chip position occurring.

[0014] That is, the present invention relates to a semiconductor processing tape, wherein the thermal shrinkage rate of the semiconductor processing tape, when heated at 100 °C for 10 seconds, is 0% or more to 20% or less, and the thermal shrinkage rate in the lengthwise direction divided by the thermal shrinkage rate in the widthwise direction is 0.01 or more to 100 or less

(Note that in the equation, thermal shrinkage rate = (size before heating – size after heating)/size before heating x 100(%).)

[0015] Furthermore, the semiconductor processing tape is characterized in that in that it is utilized in a method for producing a semiconductor device, and the method includes following processes.

- (a) a process of adhering a surface protection tape on a front side of a wafer on which a circuit pattern has been formed;
- (b) a backgrinding process of grinding a back side of the wafer;
- (c) a process of adhering an adhesive layer of the semiconductor processing tape on the back side of the wafer, while heating the wafer;
- (d) a process of peeling the surface protection tape from the front side of the wafer;
- (e) a process of forming a modified region within the wafer through multiple-photon absorption by irradiating laser to a predetermined division part on the wafer;
- (f) an expand process of obtaining a plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the wafer and the adhesive layer of the semiconductor processing tape at a division line;
- (g) a process of maintaining space between the chips, by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and
- (h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

[0016] Further, the semiconductor processing tape is characterized in that it is utilized in a method for producing a semiconductor device, and the method includes following processes.

- (a) a process of adhering a surface protection tape on a front side of a wafer on which a circuit pattern has been formed;
- (b) a backgrinding process of grinding a back side of the wafer;
- (c) a process of adhering an adhesive layer of the semiconductor processing tape on the back side of the wafer, while heating the wafer;
- (d) a process of peeling the surface protection tape from the front side of the wafer;
- (e) a process of dividing the wafer into chips by irradiating laser along a division line on the front side of the wafer;
- (f) an expand process of obtaining the plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the adhesive layer for the each of chips;
- (g) a process of maintaining space between the chips, by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and
- (h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

[0017] Furthermore, the semiconductor processing tape is characterized in that in that it is utilized in a method for producing a semiconductor device, and the method includes following processes.

- (a) a process of adhering a surface protection tape on a front side of a wafer on which a circuit pattern has been formed;
- (b) a backgrinding process of grinding a back side of the wafer;
- (c) a process of adhering an adhesive layer of the semiconductor processing tape on the back side of the wafer, while heating the wafer;
- (d) a process of peeling the surface protection tape from the front side of the wafer;
- (e) a process of dividing the wafer into chips by cutting along a division line using a

dicing blade;

(f) an expand process of obtaining the plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the adhesive layer for the each of chips;

(g) a process of maintaining space between the chips by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and

(h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

[0018] Further, the semiconductor processing tape is characterized in that in that it is utilized in a method for producing a semiconductor device, and the method includes following processes.

(a) a process of cutting a wafer on which a circuit pattern has been formed up to a depth that is smaller than a thickness of the wafer along a predetermined division line using a dicing blade;

(b) a process of adhering a surface protection tape on a front side of the wafer

(c) a backgrinding process of grinding a back side of the wafer to thereby divide the wafer into chips;

(d) a process of adhering the adhesive layer of the semiconductor processing tape on the back side of the wafer that is divided into chips, while heating the wafer;

(e) a process of peeling the surface protection tape from the front side of the wafer that has been divided into the chips;

(f) an expand process of obtaining the plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the adhesive layer for the each of chips;

(g) a process of maintaining space between the chips by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and

(h) a pickup process of picking up the chip with the adhesive layer attached thereto

from the pressure-sensitive adhesive layer of the semiconductor processing tape.

[0019] Further, the semiconductor processing tape is characterized in that in that it is utilized in a method for producing a semiconductor device, and the method includes following processes.

- (a) a process of adhering a surface protection tape on a front side of a wafer on which a circuit pattern has been formed;
- (b) a process of forming a modified region within the wafer through multiple-photon absorption by irradiating laser to a predetermined division part on the wafer;
- (c) a backgrinding process of grinding a back side of the wafer;
- (d) a process of adhering an adhesive layer of the semiconductor processing tape on the back side of the wafer, while heating the wafer;
- (e) a process of peeling the surface protection tape from the front side of the wafer;
- (f) an expand process of obtaining a plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the wafer and the adhesive layer of the semiconductor processing tape along a division line;
- (g) a process of maintaining space between the chips, by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and
- (h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

[0020] Further, the present invention relates to the semiconductor processing tape, wherein either the thermal shrinkage rate of the semiconductor processing tape in either the lengthwise direction or the widthwise direction is 0.1 % or more.

Furthermore, the present invention relates to a semiconductor device that utilizes the semiconductor processing tape.

Effect of the Invention

[0021] By using the semiconductor processing tape provided by the present invention, the even expansion without change in the kerf width is made possible, and thus, a highly reliable semiconductor device so that the chip position does not deviate

and pickup defect does not occur, can be obtained.

BRIEF DESCRIPTION OF DRAWINGS

[0022] FIG. 1 is a cross-sectional diagram that shows the structure of the semiconductor processing tape according to an embodiment of the present invention.

FIG. 2 is a cross-sectional diagram that shows a state in which a surface protection tape is adhered to a wafer.

FIG. 3 is a cross-sectional diagram that describes the process of adhering a wafer and a ring frame to the semiconductor processing tape according to an embodiment of the present invention.

FIG. 4 is a cross-sectional diagram that describes the process of peeling a surface protection tape from a surface of a wafer.

FIG. 5 is a cross-sectional diagram that describes the formation of a modified region in the wafer by laser processing.

FIG. 6(a) is a cross-sectional diagram that shows the semiconductor processing tape according to an embodiment of the present invention, mounted on an expansion machine; FIG. 6 (b) is a cross-sectional diagram that shows the process of dividing the wafer into chips by expanding the semiconductor processing tape; FIG. 6 (c) is a cross-sectional diagram that shows the semiconductor processing tape, the adhesive layer, and the chip after expansion.

FIG. 7 is a cross-sectional diagram that describes a heat-shrinking process.

DESCRIPTION OF SOME EMBODIMENTS

[0023] <Semiconductor Processing Tape>

FIG. 1 is a cross-sectional diagram showing a semiconductor processing tape 10 according to an embodiment of the present invention. In the semiconductor processing tape 10 of the present invention, an adhesive layer 13 is divided along the chip when the wafer is divided into chips by expansion. This semiconductor processing tape 10 comprises an adhesive tape 15 made of a substrate film 11 and a pressure-sensitive

adhesive layer 12 provided on the substrate film 11, an adhesive layer 13 provided on the pressure-sensitive adhesive layer 12, and the back side of the wafer is adhered on to the adhesive layer 13. Note that each layer may be cut in a predetermined shape (pre-cut) according to the process or machine to be used. Further, the semiconductor processing tape 10 of the present invention may be in a form that is cut for each wafer, or may be in a roll form, wherein a long sheet with a plurality of tapes cut out for each wafer is rolled.

[0024] The semiconductor processing tape of the present invention has a thermal shrinkage rate of 0% or more to 20% or less, when heated at 100 °C for 10 seconds, and it is required that the condition of thermal shrinkage rate in lengthwise direction/ thermal shrinkage rate in widthwise direction = 0.01 or more to 100 or less, is fulfilled.

(In the equation, thermal shrinkage rate = (size before heating – size after heating)/size before heating x 100(%).)

Specifically, according to the method specified by JIS7162, a test sample of the tape was subjected to an extension distortion of 20 % at a rate of 500 mm/min and maintained for 60 seconds. Subsequently, the test sample was removed from the test equipment and heated at 100 °C for 10 seconds, and the thermal shrinkage rate before and after heating were measured.

[0025] That the thermal shrinkage rate when heated at 100 °C for 10 seconds is 0% or more to 20% or less, while at the same time fulfilling the condition of thermal shrinkage rate in lengthwise direction/thermal shrinkage rate in widthwise direction = 0.01 or more to 100 or less, implies that the thermal shrinkage is small and that the kerf width shrinks evenly regardless of the direction of the tape. Thus, obvious effects of favorable pickup without the formation of wrinkles or displacement in chip position can be obtained.

[0026] When the value of the thermal shrinkage rate in the lengthwise direction/the thermal shrinkage rate in the widthwise direction exceeds 100, or falls below 0.01, the difference between the lengthwise direction and the widthwise direction

becomes too large, and the kerf width become uneven, causing displacement in chip position and recognition defects during pickup. Further, when the kerf width is too narrow, the adhesive film re-adheres, causing pickup defects. Also, when the value of the thermal shrinkage rate in the lengthwise direction/the thermal shrinkage rate in the widthwise direction is a negative value, it implies that one side expands while the other side shrinks, and thus, the kerf width does not become even.

When the thermal shrinkage rate exceeds 20%, the shrinkage rate is too large, and the kerf width tries to expand more than the kerf width expanded in the expand process, which leads to the generation of wrinkles on the tape and displacement in chip position.

Note that when the thermal shrinkage rate of the lengthwise direction and the widthwise direction are both 0 % or more to 0.1 % or less, there is no problem, but when either the thermal shrinkage rate of the lengthwise direction or the widthwise direction is 0.1 % or more, shrinkage proceeds and is preferable.

[0027] Although there are various means of controlling the physical property of the semiconductor processing tape in this range, a method of performing energy ray curing treatment before the expand treatment, or known methods of biaxial co-extrusion and heat set treatment can be applied to suitably control the physical property.

Hereinafter, compositions of each layer of the semiconductor processing tape will be described.

[0028] <Substrate Film>

The material of the substrate film 11 is favorable when it shows uniform and isotropic expandability, since the wafer can be cut without deviation in all directions in the expand process, and its material is not particularly limited. In general, crosslinked resins show larger restoring force against stretching compared to non-crosslinked resins, and shows large shrinkage stress when heated at an expanded state after the expand process. Therefore, they are superior in the heat-shrink process, wherein the slack that occur to the tape after the expand process can be removed by heat-shrinking, to thereby stably maintain the distance between individual chips by applying stress to the tape.

Among crosslinked resins, thermoplastic crosslinked resins are more favorably used. On the other hand, non-crosslinked resins show smaller restoring force against stretching compared to crosslinked resins. Therefore, when they are relaxed after an expand process in a low-temperature range such as -15°C to 0°C and returned to normal temperature, the tape is less likely to shrink while heading for the pickup process and the mount process. Thus, they are superior in that the adhesive layers on the chips can be prevented from coming in contact with each other. Among such non-crosslinked resins, olefin-type non-crosslinked resins are more preferably used.

[0029] As such thermoplastic crosslinked resin, for example, ionomer resins obtained by crosslinking ethylene-(meth)acrylic acid binary copolymers or terpolymers having ethylene-(meth)acrylic acid-(meth)acrylic acid alkyl ester as its main polymer component with metal ions, are exemplified. These resins are suitable for the expand process, since they can be expanded uniformly, and are especially favorable since they show strong restoring force when heated due to crosslinking. The metal ion contained in the above ionomer resin is not particularly limited, but zinc, sodium, and such may be listed. However, zinc ion shows low leachability and is especially preferable from the viewpoint of low contamination. In the meth(acrylic) acid alkyl ester of the above terpolymer, alkyl chains with 1 to 4 carbons show high elastic modulus and is preferable from the point of being able to spread strong force to the wafer. As such meth(acrylic) acid alkyl ester, methyl methacrylate, ethyl methacrylate, propyl methacrylate, butyl methacrylate, methyl acrylate, ethyl acrylate, propyl acrylate, butyl acrylate, and the like may be listed.

[0030] Further, as such thermoplastic crosslinked resin, other than the above-described ionomer resins, those obtained by crosslinking resins selected from low density polyethylene with a specific gravity of 0.910 or more to less than 0.930, ultra low density polyethylene with a specific gravity of less than 0.910, and ethylene-vinyl acetate copolymer, by irradiating energy rays such as electron ray, are also preferable. In such thermoplastic crosslinked resins, crosslinked parts and non-crosslinked parts coexist within the resin, and thus, show constant uniform expandability. Further, since

strong restoring force works when heated, it is also preferable for removing the slack that occur to the tape in the expand process. Also, since the molecular chain composition contains almost no chlorine, even when the unnecessary tape is combusted after used, chlorinated aromatic hydrocarbons such as dioxin and its analogues are not generated, and burden on the environment is low. By appropriately adjusting the amount of energy ray irradiated to the polyethylene or the ethylene-vinyl acetate copolymer, a resin that shows sufficient uniform expandability can be obtained.

[0031] Further, as the non-crosslinked resin, for example, mixed resin composition of polypropylene and styrene-butadiene copolymer may be exemplified.

[0032] As polypropylene, for example, a single polymer of propylene or a block or random-type propylene-ethylene copolymer can be utilized. Random-type propylene-ethylene copolymer show small rigidity and are preferable. When the content of the ethylene constituent unit in the propylene-ethylene copolymer is 0.1 wt% or more, the rigidity of the tape and the compatibility of the resins in the mixed resin composition becomes high and is superior. When the rigidity of the tape is appropriate, the cutting property of the wafer increases and when the solubility of the resin is high, the extrusion rate tends to become stable. More favorable is 1 wt% or more. Further, when the content of the ethylene constituent unit in the propylene-ethylene copolymer is 7 wt% or less, it is preferable in that the polypropylene is easily and steadily polymerizable. More favorable is 5 wt% or less.

[0033] As the styrene-butadiene copolymer, one that is hydrogenated may be used. When styrene-butadiene copolymer is hydrogenated, good compatibility with propylene is obtained and brittleness and color change due to oxidation decomposition caused by the double bond in butadiene can be prevented. Further, when the content of the styrene constituent unit of the styrene-butadiene copolymer is 5 wt% or more, the styrene-butadiene copolymer becomes easy to polymerize and steady, and is thus favorable. Further, at 40 wt% or less, it becomes flexible and expandable and is thus superior. More favorable is 25 wt% or less, and further preferable is 15 wt% or less. As the styrene-butadiene copolymer, a block-type copolymer and random-type

copolymer can both be used. Random-type copolymers are preferable since the styrene phase is dispersed evenly and suppresses the rigidity from becoming too large, therefore enhancing its expandability.

[0034] When the content of polypropylene in the mixed resin composition is 30 wt% or more, it is superior in that irregularities in the thickness of the substrate film can be suppressed. When the thickness is uniform, the expandability tends to become isotropic. Further, it becomes easy to prevent the stress relaxation of the substrate film to become excessively large, thereby causing the distance between the chips to decrease with time and the adhesive layers to come in contact with each other and re-adhere. 50 wt% or more is preferable. Further, when the content of the polypropylene is 90 wt% or less, the rigidity of the substrate film can easily be adjusted appropriately. When the rigidity of the substrate film is excessively large, large force is required to expand the substrate film and burden on the machine becomes large, which may make it impossible to provide sufficient expansion to the wafer and the adhesive layer 13 for division. Thus, appropriate adjustment is important. The minimum content of the styrene-butadiene copolymer in the mixed resin composition is preferably 10 wt% or more, to make it easy to adjust the rigidity of the substrate film to that appropriate for the machine. The maximum content is preferable 70 wt% or less, since the irregularities in the thickness can be suppressed. 50 wt% or less is preferable.

[0035] Note that in the example shown in FIG. 1, the substrate film 11 is of a single layer, but it is not limited to such, and may have a multiple-layered structure with 2 or more types of resins laminated, or with 2 or more layers of 1 type of resin laminated. When using 2 or more types of resins, if they are unified in crosslinked or non-crosslinked resins, it is preferable in that the properties of each resin can be enhanced and expressed. If crosslinked and non-crosslinked resins are laminated in combination, it is preferable in that the disadvantages of each can be supplemented. The thickness of the substrate film 11 is not particularly regulated, and may be in a range that can easily be expanded in the expand process of the semiconductor processing tape 10, while showing sufficient strength to not break. For example, about 50 to 300 μm is

preferable, and 70 to 200 μm is further preferable.

[0036] As the method of producing a substrate film 11 with multiple layers, known methods of extrusion and lamination may be used. When the lamination method is used, adhesives may be interposed between the layers. As such adhesive, known adhesives may be used.

[0037] <Pressure-sensitive Adhesive Layer>

The pressure-sensitive adhesive layer 12 can be formed by applying a pressure-sensitive adhesive composition onto the substrate film 11.

The pressure-sensitive adhesive layer 12 that constitutes the semiconductor processing tape 10 of the present invention may be any type, as long as it does not peel from the adhesive layer 13 during dicing, shows enough retention to avoid defects such as chip displacement, and shows properties that enable easy peeling from the adhesive layer 13 during pickup.

[0038] In the semiconductor processing tape 10 of the present invention, the constituent of the pressure-sensitive adhesive composition that constitutes the pressure-sensitive adhesive layer 12 is not particularly limited. However, to improve the pickup property after dicing, one that is energy ray-curable is preferable, and a material that becomes easy to peel from the adhesive layer 13 after curing is preferable. As one aspect, a pressure-sensitive adhesive composition that comprises, as a base resin, a polymer (A) that contains 60 mol% or more of (meth)acrylate having an alkyl chain of 6 to 12 carbons, and an energy ray-curable carbon-carbon double bond with an iodine value of 5 to 30, is exemplified. Note that in the present application, energy ray refers to light rays such as ultraviolet ray, or ionizing radiation such as electron ray.

[0039] In such polymer (A), when the iodine value of the energy ray-curable carbon-carbon double bond is 5 or more, the decreasing effect of the adhesive force after energy ray irradiation becomes high and is thus favorable. The iodine value is more preferably 10 or more. Further, when the iodine value is 30 or less, the retentivity of the chip until pickup after energy ray irradiation becomes high, and the distance between the chips can easily be expanded before the pickup process, and is thus

superior. When the distance between the chips is sufficiently expanded before the pickup process, image recognition of each chip at pickup becomes easy, and pickup becomes easy, and is thus favorable. Further, when the iodine value is 5 or more to 30 or less, the polymer (A) itself becomes stable, and easy to produce.

[0040] Furthermore, when the polymer (A) has a glass transition temperature of -70°C or higher, its heat resistance during energy ray irradiation becomes excellent, and more favorable is -66°C or higher. Further, when the glass transition temperature is 15°C or lower, the effect of chip-scattering prevention after dicing a wafer with a rough surface becomes excellent. 0°C or lower is more preferable, and -28°C or lower is further preferable.

[0041] The above-described polymer (A) may be produced by any method. For example, one that is obtained by mixing an acrylic copolymer with a compound that contains energy ray-curable carbon-carbon double bonds, and one that is obtained by reacting an acrylic copolymer containing a functional group or a methacrylic copolymer containing a functional group (A1) with a compound that contains a functional group that can react with such functional groups and contains energy ray-curable carbon-carbon double bonds (A2), can be used.

[0042] Among these, as the above-described methacrylic copolymer containing a functional group (A1), one that is obtained by copolymerizing a monomer that contains carbon-carbon double bonds (A1-1), as in alkyl acrylates and alkyl methacrylates, with a monomer that contains carbon-carbon double bonds and a functional group (A-2), can be exemplified. As the monomer (A1-1), hexyl acrylate, n-octyl acrylate, isooctyl acrylate, 2-ethylhexyl acrylate, dodecyl acrylate, decyl acrylate, each having alkyl chains of 6 to 12 carbon atoms, or monomers having alkyl chains of 5 or less carbon atoms such as pentyl acrylate, n-butyl acrylate, isobutyl acrylate, ethyl acrylate, and methyl acrylate, as well as similar methacrylates, are listed.

[0043] Note that in the monomer (A1-1), the components with alkyl chains of 6 or more carbon atoms can decrease the peeling force between the pressure-sensitive adhesive layer and the adhesive layer, and thus, the monomer excels in the point of

pickup property. Further, the components with alkyl chains of 12 or less carbon atoms show low elastic modulus at room temperature, and excel in the point of adhesive force at the interface between the pressure-sensitive adhesive layer and the adhesive layer.

When the adhesive force at the interface between the pressure-sensitive adhesive layer and the adhesive layer is high, the interfacial deviation between the pressure-sensitive adhesive layer and the adhesive layer can be suppressed when the wafer is cut by expanding the tape, and thus, preferable since the cutting property is enhanced.

[0044] Further, as the monomer (A1-1), since the glass transition temperature decreases with the use of monomers with larger numbers of carbon atoms in the alkyl chain, by adequately choosing the monomer, a pressure-sensitive adhesive composition with a desired glass transition temperature can be prepared. Further, besides the glass transition temperature, for the purpose of enhancing various performances such as compatibility, low molecular weight compounds containing carbon-carbon double bonds, such as vinyl acetate, styrene, and acrylonitrile, may be added. In this case, such low molecular weight compounds should be added within the range of 5 mass% or less of the entire mass of the monomer (A1-1).

[0045] On the other hand, as the functional group which the monomer (A1-2) contains, carboxyl group, hydroxyl group, amino group, cyclic acid anhydride group, epoxy group, and isocyanate group, and the like, can be listed. Specific examples of the monomer (A1-2) include acrylic acid, methacrylic acid, cinnamic acid, itaconic acid, fumaric acid, phthalic acid, 2-hydroxyalkyl acrylates, 2-hydroxyalkyl methacrylates, glycol monoacrylates, glycol monomethacrylates, N-methylol acrylamide, N-methylol methacrylamide, allyl alcohol, N-alkylaminoethyl acrylates, N-alkylaminoethyl methacrylates, acrylamides, methacrylamides, maleic anhydride, itaconic anhydride, fumaric anhydride, phthalic anhydride, glycidyl acrylate, glycidyl methacrylate, and allyl glycidyl ether.

[0046] Further, when the functional group in compound (A1) is a carboxyl group or a cyclic acid anhydride group, the functional group to be used in compound (A2) include a hydroxyl group, an epoxy group, an isocyanate group, and the like; when

the functional group in compound (A1) is a hydroxyl group, the functional group to be used in compound (A2) include a cyclic acid anhydride group, an isocyanate group, and the like; when the functional group in compound (A1) is an amino group, the functional group to be used in compound (A2) include an epoxy group, an isocyanate group, and the like; and when the functional group in compound (A1) is an epoxy group, the functional group to be used in compound (A2) include a carboxyl group, a cyclic acid anhydride group, an amino group, and the like. Specific examples of compound (A2) include those listed as examples of monomer (A1-2). Further, as compound (A2), polyisocyanate compounds with parts of the isocyanate group urethanized by monomers having a hydroxyl group or a carboxyl group and an energy ray-curable carbon-carbon double bond, can also be used.

[0047] Note that in the reaction of compound (A1) and compound (A2), by leaving some of the functional groups unreacted, products with desired properties, such as the acid value and hydroxyl value, can be produced. By leaving OH groups so that the hydroxyl value of polymer (A) is 5 to 100, the pressure-sensitive adhesive strength after irradiation of energy ray can be reduced to further decrease the risk of pickup mistakes.

Further, by leaving COOH groups so that the acid value of the polymer (A) is 0.5 to 30, the restoration property of the pressure-sensitive adhesive layer after expanding the semiconductor processing tape is effectively improved, and is thus preferable. Here, if the hydroxyl value of the polymer (A) is 5 or more, it excels in the point of the reducing effect of the pressure-sensitive adhesive strength after irradiation of energy ray. If the hydroxyl value of the polymer (A) is 100 or less, it excels in the point of the fluidity of the pressure-sensitive adhesive agent after irradiation of energy ray. Further, if the acid value is 0.5 or more, it excels in the point of the tape recovery property, and if it is 30 or less, it excels in the point of fluidity of the pressure-sensitive adhesive agent.

[0048] In the synthesis of the above-described polymer (A), the organic solvent to be used when carrying out the reaction by solution polymerization may be one of a

ketone-type, ester-type, alcohol-type, or aromatic-type. Among these, those that are generally good solvents for acrylic polymers, with a boiling point of 60 to 120 °C, such as toluene, ethyl acetate, isopropyl alcohol, benzene methyl cellosolve, ethyl cellosolve, acetone, methyl ethyl ketone, and the like, are preferable. As the polymerization initiator, radical generators of azobis-type such as α,α' -azobisisobutyronitrile, and of organic peroxide-type such as benzoylperoxide, are usually used. In such case, catalysts and polymerization inhibitors, and the like may optionally be added as required. By controlling the polymerization temperature and polymerization time, a polymer (A) with a desired molecular weight can be obtained. Further, for controlling the molecular weight, the use of known solvents and chain-transfer agents such as mercaptan and carbon tetrachloride-type solvents is preferable. Note that the reaction is not limited to solution polymerization, and other methods such as bulk polymerization, suspension polymerization, and the like, may be applied.

[0049] Although the polymer (A) can be obtained by the above methods, in the present invention, when the molecular weight of the polymer (A) is preferably 300,000 or more, it is excellent in the point that the cohesive force can be enhanced. Higher cohesive force is effective in suppressing shearing at the interface with the adhesive layer during expansion. Thus, it is preferable in that the division property of the adhesive layer is enhanced, since the tensile force can easily be propagated to the adhesive layer. When the molecular weight of the polymer (A) is 2,000,000 or less, it is excellent in that gelation can be prevented from occurring during synthesis and application. Note that in the present invention, the molecular weight refers to the polystyrene conversion mass-average molecular weight.

[0050] Further, in the semiconductor processing tape 10 of the present invention, the resin composition constituting the pressure-sensitive adhesive layer 12 may contain a compound (B) that serves as a crosslinking agent, along with the polymer (A). For example, polyisocyanate, melamine formaldehyde resins, and epoxy resins may be listed, which may be used independently or by combining two or more. This compound (B) reacts with the polymer (A) or the substrate film, and the resulting crosslinking

construction enhances the cohesive force of the pressure-sensitive adhesive agent, which contains the polymer (A) and the compound (B) as its main component, after applying the pressure-sensitive adhesive composition.

[0051] As the polyisocyanate, there are no particular limits, and aromatic isocyanates such as 4,4'-diphenylmethane diisocyanate, tolylene diisocyanate, xylylene diisocyanate, 4,4'-diphenylether diisocyanate, and 4,4'-[2,2-bis(4-phenoxyphenyl)propane] diisocyanate, as well as hexamethylene diisocyanate, 2,2,4-trimethyl-hexamethylene diisocyanate, isophorone diisocyanate, 4,4'-dicyclohexylmethane diisocyanate, 2,4'-dicyclohexylmethane diisocyanate, lysine diisocyanate, lysine triisocyanate, and the like may be listed. In particular, Colocate L (manufactured by Nippon Polyurethane Industry Co., Ltd.; trade name) and the like, can be used. As the melamine formaldehyde resin, in particular, NIKALAC MX-45 (manufactured by Sanwa Chemical Co. Ltd.; trade name), Melan (manufactured by Hitachi Chemical Co. Ltd.; trade name), and the like, can be used. As the epoxy resin, TETRAD-X (manufactured by Mitsubishi Chemical Co. Ltd., trade name) and the like can be used. In the present invention, the use of polyisocyanates is particularly preferable.

[0052] The pressure-sensitive adhesive layer in which the amount of compound (B) added is 0.1 pts.mass for 100 pts.mass of polymer (A), excels in the point of its cohesive force. 0.5 pts.mass or more is more preferable. Further, the pressure-sensitive adhesive layer in which the amount is 15 pts.mass or less excels in the point of suppressing rapid gelation during application, allowing good workability in the mixing and application of the pressure-sensitive adhesive agent. Further preferable is 5 pts.mass or less.

[0053] Furthermore, in the present invention, the pressure-sensitive adhesive layer 12 may contain a photoinitiator (C). The type of photoinitiator (C) contained in the pressure-sensitive adhesive layer 12 is not particularly limited, and those conventionally known can be used. For example, benzophenones such as benzophenone, 4,4'-dimethylaminobenzophenone, 4,4'-diethyl aminobenzophenone,

4,4'-dichlorobenzophenone, and the like, acetophenones such as acetophenone, diethoxyacetophenone, and the like, anthraquinones such as 2-ethyl anthraquinone, t-butyl anthraquinone, and the like, 2-chlorothioxanthone, benzoin ethyl ether, benzoin isopropyl ether, benzyl, 2,4,5-triarylimidazole dimer (lophine dimer), acridine-type compound, and the like, can be listed. These may be used independently, or by combining 2 or more. The amount of the photoinitiator (C) added is preferably 0.1 pts.mass or more, or more preferably, 0.5 pts.mass or more for 100 pts.mass of polymer (A). Further, its maximum amount is preferably 10 pts.mass or less and more preferably, 5 pts.mass or less.

[0054] Further, in the energy ray-curable pressure-sensitive adhesive agent used in the present invention, a tackifier, an adhesion-regulating agent, a surfactant, and other modifying agents may be added, as required. Moreover, inorganic fillers may also be arbitrarily added.

[0055] The pressure-sensitive adhesive layer 12 may be formed using conventional methods of forming a pressure-sensitive adhesive layer. For example, the pressure-sensitive adhesive layer 12 may be formed on the substrate film 11 by a method of applying the above-described pressure-sensitive adhesive composition on an arbitrary surface of the substrate film 11, or by a method of applying the above-described pressure-sensitive adhesive composition on a separator (for example, a plastic film or sheet on which a release agent has been applied, and such) to form a pressure-sensitive adhesive layer 12, and then transferring the pressure-sensitive adhesive layer 12 on to an arbitrary surface of the substrate. Note that the pressure-sensitive adhesive layer 12 may be in the form of a single layer or may be in the form of a laminate.

[0056] The thickness of the pressure-sensitive adhesive layer 12 is not particularly limited, but when the thickness is 2 μm or more, it is superior in the point of tack strength, and 5 μm or more is further preferable. When the thickness is 20 μm or less, the pickup property becomes excellent and 15 μm or less is further preferable.

[0057] <Adhesive Layer>

In the semiconductor processing tape 10 of the present invention, the adhesive layer 13 is peeled from the pressure-sensitive adhesive layer 12 and attached to the chip, after it is adhered to a wafer, which is diced into chips, and the chip is picked up. Subsequently, it is used as an adhesive agent for fixing the chip on a substrate or lead frame.

[0058] The adhesive layer 13 is not particularly limited, and may be an adhesive agent of film-form that is generally used for wafers. For example, those having thermoplastic resins and thermally polymerizable components may be listed. The thermoplastic resin used in the adhesive layer 13 of the present invention is preferably a resin that shows thermoplasticity or a resin that shows thermoplasticity in the uncured state and forms a crosslinked structure after heating, and is not particularly limited. As one aspect, a thermoplastic resin with a weight-average molecular weight of 5000 to 200,000 and a glass-transition temperature of 0 to 150 °C may be listed. Further, as another aspect, a thermoplastic resin with a weight-average molecular weight of 100,000 to 1,000,000 and a glass-transition temperature of -50 to 20 °C may be listed.

[0059] As the first thermoplastic resin, for example, polyimide resin, polyamide resin, polyether imide resin, polyamide imide resin, polyester resin, polyester imide resin, phenoxy resin, polysulfone resin, polyether sulfone resin, polyphenylene sulfide resin, polyether ketone resin, and the like may be listed. In particular, the use of polyimide resin and phenoxy resin is favorable, and as the second thermoplastic resin, the use of polymers with functional groups is favorable.

[0060] Polyimide resins can be obtained by subjecting tetracarboxylic dianhydride and diamine to a known method of condensation reaction. That is, about equimolar amounts of tetracarboxylic dianhydride and diamine are subjected to addition reaction in an organic solvent (the order of addition of each component is arbitrary), at a reaction temperature of 80 °C or lower, preferably 0 to 60 °C. As the reaction proceeds, the viscosity of the reaction solution slowly increases, and polyamic acid, a precursor of polyimide, is generated. The molecular weight of this polyamic acid can be controlled by subjecting to depolymerization by heating at a temperature of 50 to 80 °C.

Polyimide resin can be obtained by cyclodehydration of the above reactant (polyamic acid). Cyclodehydration can be performed by heat cyclization, in which heat treatment is performed, or by chemical cyclization, which utilizes a dehydrating agent.

[0061] The tetracarboxylic dianhydride used as the raw material for the polyimide resin is not particularly limited, and for example, 1,2-(ethylene) bis (trimellitate anhydride), 1,3-(trimethylene) bis (trimellitate anhydride), 1,4-(tetramethylene) bis (trimellitate anhydride), 1,5-(pentamethylene) bis (trimellitate anhydride), 1,6-(hexamethylene) bis (trimellitate anhydride), 1,7-(heptamethylene) bis (trimellitate anhydride), 1,8-(octamethylene) bis (trimellitate anhydride), 1,9-(nonamethylene) bis (trimellitate anhydride), 1,10-(decamethylene) bis (trimellitate anhydride), 1,12-(dodecamethylene) bis (trimellitate anhydride), 1,16-(hexadecamethylene) bis (trimellitate anhydride), 1,18-(octadecamethylene) bis (trimellitate anhydride), pyromellitic dianhydride, 3,3',4,4'-biphenyltetracarboxylic acid dianhydride, 2,2',3,3'-biphenyltetracarboxylic acid dianhydride, 2,2-bis(3,4-dicarboxyphenyl) propane dianhydride, 2,2-bis(2,3-dicarboxyphenyl) propane dianhydride, 1,1-bis(2,3-dicarboxyphenyl) ethane dianhydride, 1,1-bis(3,4-dicarboxyphenyl) ethane dianhydride, bis(2,3-dicarboxyphenyl) methane dianhydride, bis(3,4-dicarboxyphenyl) methane dianhydride, bis(3,4-dicarboxyphenyl) sulfone dianhydride, 3,4,9,10-perylene tetracarboxylic acid dianhydride, bis(3,4-dicarboxyphenyl) ether dianhydride, benzene-1,2,3,4- tetracarboxylic acid dianhydride, 3,4,3',4'-benzophenone tetracarboxylic acid dianhydride, 2,3,2',3'-benzophenone tetracarboxylic acid dianhydride, 3,3,3',4'-benzophenone tetracarboxylic acid dianhydride, 1,2,5,6-naphthalene tetracarboxylic acid dianhydride, 1,4,5,8-naphthalene tetracarboxylic acid dianhydride, 2,3,6,7-naphthalene tetracarboxylic acid dianhydride, 1,2,4,5-naphthalene tetracarboxylic acid dianhydride, 2,6-dichloronaphthalene-1,4,5,8- tetracarboxylic acid dianhydride, 2,7-dichloronaphthalene-1,4,5,8- tetracarboxylic acid dianhydride, 2,3,6,7-tetrachloronaphthalene-1,4,5,8- tetracarboxylic acid dianhydride, phenanthrene-1,8,9,10-tetracarboxylic acid dianhydride,

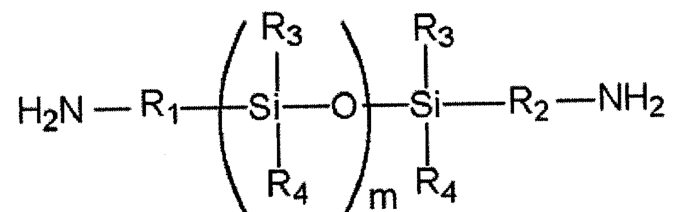
pyrazine-2,3,5,6-tetracarboxylic acid dianhydride, thiophene-2,3,5,6-tetracarboxylic acid dianhydride, 2,3,3',4-biphenyltetracarboxylic acid dianhydride, 3,4,3',4'-biphenyltetracarboxylic acid dianhydride, 2,3,2',3'-biphenyltetracarboxylic acid dianhydride, bis (3,4-dicarboxyphenyl) dimethylsilane dianhydride, bis (3,4-dicarboxyphenyl) methylphenylsilane dianhydride, bis (3,4-dicarboxyphenyl) diphenylsilane dianhydride, 1,4-bis (3,4-dicarboxyphenyl dimethylsilyl) benzene dianhydride, 1,3-bis (3,4-dicarboxyphenyl)-1,1,3,3-tetramethyl dicyclohexane dianhydride, p-phenylene bis (trimellitate anhydride), ethylene tetracarboxylic acid dianhydride, 1,2,3,4-butane tetracarboxylic acid dianhydride, decahydronaphthalene-1,4,5,8- tetracarboxylic acid dianhydride, 4,8-dimethyl-1,2,3,5,6,7-hexahydro naphthalene-1,2,5,6- tetracarboxylic acid dianhydride, cyclopentane-1,2,3,4- tetracarboxylic acid dianhydride, pyrrolidine-2,3,4,5- tetracarboxylic acid dianhydride, 1,2,3,4-cyclobutane tetracarboxylic acid dianhydride, bis(exobicyclo[2,2,1]heptane-2,3-dicarboxylic acid dianhydride, bicyclo-[2,2,2]-oct-7-ene-2,3,5,6-tetracarboxylic acid dianhydride, 2,2-bis(3,4-dicarboxyphenyl) hexafluoropropane dianhydride, 2,2-bis[4-(3,4-dicarboxyphenyl) phenyl] hexafluoropropane dianhydride, 4,4-bis(3,4-dicarboxyphenoxy) diphenylsulfide dianhydride, 1,4-bis(2-hydroxyhexafluoroisopropyl) benzene bis (trimellitic acid anhydride), 1,3-bis(2-hydroxyhexafluoroisopropyl) benzene bis (trimellitic acid anhydride), 5-(2,5-dioxotetrahydrofuryl)-3-methyl-3-cyclohexene-1,2-dicarboxylic acid dianhydride, tetrahydrofuran-2,3,4,5-tetracarboxylic acid dianhydride, and the like, may be used. One of these may be used, or two or more types may be used in combination.

[0062] Further, the diamine used as the raw material for polyimide is not particularly limited. For example, o-phenylenediamine, m-phenylenediamine, p-phenylenediamine, 3,3'-diaminodiphenyl ether, 3,4'-diaminodiphenyl ether, 4,4'-diaminodiphenyl ether, 3,3'-diaminodiphenylmethane, 3,4'-diaminodiphenylmethane, 4,4'-diaminodiphenylether methane, bis(4-amino-3,5-dimethylphenyl)methane, bis(4-amino-3,5-diisopropylphenyl)methane, 3,3'-diaminodiphenyldifluoro methane,

3,4'-diaminodiphenyldifluoro methane, 4,4'-diaminodiphenyldifluoro methane,
 3,3'-diaminodiphenylsulfone, 3,4'-diaminodiphenylsulfone,
 4,4'-diaminodiphenylsulfone, 3,3'-diaminodiphenylsulfide, 3,4'-diaminodiphenyl sulfide,
 4,4'-diaminodiphenyl sulfide, 3,3'-diaminodiphenylketone, 3,4'-diaminodiphenylketone,
 4,4'-diaminodiphenylketone, 2,2-bis(3-aminophenyl) propane,
 2,2'-(3,4'-diaminodiphenyl)propane, 2,2-bis(3-aminophenyl) propane,
 2,2-(3,4'-diaminodiphenyl)propane, 2,2-bis(4-aminophenyl) propane,
 2,2-bis(3-aminophenyl)hexafluoropropane, 2,2-(3,4'-diaminodiphenyl)
 hexafluoropropane, 2,2-bis(4-aminophenyl)hexafluoropropane,
 1,3-bis(3-aminophenoxy) benzene, 1,4-bis(3-aminophenoxy) benzene,
 1,4-bis(4-aminophenoxy) benzene, 3,3'-(1,4-phenylene bis (1-methylethylidene)) bis
 aniline, 3,4'-(1,4-phenylene bis (1-methylethylidene)) bis aniline, 4,4'-(1,4-phenylene
 bis (1-methylethylidene)) bis aniline, 2,2-bis(4-(3-aminophenoxy)phenyl) propane,
 2,2-bis(4-(4-aminophenoxy)phenyl) propane, 2,2-bis(4-(3-aminophenoxy)phenyl)
 hexafluoropropane, 2,2-bis(4-(4-aminophenoxy)phenyl) hexafluoropropane,
 bis(4-(3-aminophenoxy)phenyl) sulfide, bis(4-(4-aminophenoxy)phenyl) sulfide,
 bis(4-(3-aminophenoxy)phenyl) sulfone, bis(4-(4-aminophenoxy)phenyl) sulfone,
 aromatic diamines such as 3,5-diaminobenzoic acid, 1,2-diaminoethane,
 1,3-diaminopropane, 1,4-diaminobutane, 1,5-diaminopentane, 1,6-diaminohexane,
 1,7-diaminoheptane, 1,8-diaminooctane, 1,9-diaminononane, 1,10-diaminodecane,
 1,11-diamino undecane, 1,12-diaminododecane, 1,2-diaminocyclohexane,
 diaminopolysiloxane expressed by the following general formula (1),
 1,3-bis(aminomethyl)cyclohexane, polyoxyalkylenediamine such as JEFFAMINE D-230,
 D-400, D-2000, D-4000, ED-600, ED-900, ED-2001, and EDR-148 manufactured by
 Sun Techno Chemicals, Inc., and the like, may be used. One of these may be used, or
 two or more types may be used in combination. As the glass transition temperature of
 such polyimide resin, 0 to 200 °C is preferable and the weight-average molecular weight
 is preferably 10,000 to 200,000.

[0063] General Formula (1)

[Chemical Formula 1]



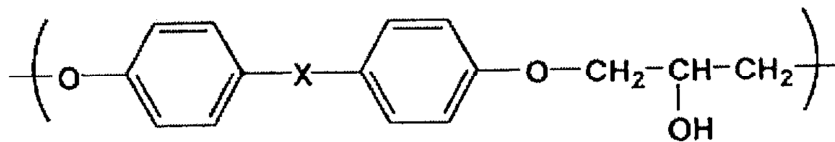
(in the formula, R_1 and R_2 are divalent hydrocarbon groups with 1 to 30 carbon atoms, which may be the same or different, and R_3 and R_4 are monovalent hydrocarbon groups, which may be the same or different, and m is an integer of 1 or larger.)

[0064] Other than the above, phenoxy resin is one favorable thermoplastic resin. Those that can be obtained by reacting various bisphenols with epichlorohydrin, or by reacting liquid epoxy resins with bisphenols are preferable. As the bisphenol, bisphenol A, bisphenol AF, bisphenol AD, bisphenol F, bisphenol S may be listed. Since phenoxy resins are similar in structure with epoxy resins, they are highly compatible with epoxy resins and are favorable in adding good adhesive strength to the adhesive film.

[0065] As a phenoxy resin that is used in the present invention, for example, a resin having the repeating units expressed by the following general formula (2) may be listed.

[0066] General Formula (2)

[Chemical Formula 2]



[0067] In the above general formula (2), X is a single bond or a divalent connecting group. As a divalent connecting group, alkylene group, phenylene group, $-\text{O}-$, $-\text{S}-$, $-\text{SO}-$ or $-\text{SO}_2-$ may be listed. Here, the alkylene group is preferably an alkylene group with 1 to 10 carbon atoms, and $-\text{C}(\text{R}_5)(\text{R}_6)-$ is further preferable. R_5 and R_6 are hydrogen atoms or alkyl groups, and as such alkyl group, linear or branched

alkyl groups of 1 to 8 carbons are preferable. For example, methyl, ethyl, n-propyl, isopropyl, isooctyl, 2-ethylhexyl, 1,3,3-trimethylbutyl, and the like, may be listed. Further, such alkyl groups may be substituted with a halogen atom, an example of which is a trifluoromethyl group. X is preferably an alkylene group, -O-, -S-, fluorene group or -SO₂-, and more preferably an alkylene group or -SO₂-. In particular, -C(CH₃)₂-, -CH(CH₃)-, -CH₂-, -SO₂- are preferable. -C(CH₃)₂-, -CH(CH₃)- and -CH₂- are more preferable, and -C(CH₃)₂- is particularly preferable.

[0068] The phenoxy resin expressed by the above general formula (2) may be a resin having repeating units of general formula (2) with different Xs, or may be composed entirely of repeating units having the same Xs, as long as it contains the repeating unit. In the present invention, resins composed entirely of repeating units with the same Xs are preferable.

[0069] Further, by adding polar substituents such as hydroxyl group and carboxyl group, to the phenoxy resin expressed by the above general formula (2), its compatibility with the thermally polymerizable components is enhanced, thereby allowing an even appearance and property.

[0070] When the mass-average molecular weight of the phenoxy resin is 5000 or larger, it becomes excellent in film formation property. More preferable is 10,000 or larger, and further preferable is 30,000 or larger. Further, the mass-average molecular weight is preferably 150,000 or smaller from the point of fluidity during thermal press-bonding and compatibility with other resins. More preferable is 100,000 or smaller. Further, when the glass transition temperature is -50 °C or higher, it becomes excellent in film formation property. More preferable is 0 °C or higher, and further preferable is 50 °C or higher. When the glass transition temperature is 150 °C, excellent adhesive strength in the adhesive layer 13 during die bonding is obtained. 120 °C or lower is more preferable, and 110 °C or lower is further preferable.

[0071] On the other hand, as the functional group in the above polymer containing a functional group, for example, glycidyl group, acryloyl group, methacryloyl group, hydroxyl group, carboxyl group, isocyanurate group, amino group,

amide group, and the like may be listed. Among these, glycidyl group is especially preferable.

[0072] As the high molecular weight component containing a functional group, for example, (meth)acrylic copolymers containing functional groups such as glycidyl group, hydroxyl group, carboxyl group, and the like, may be listed.

[0073] As such (meth)acrylic copolymers, for example, (meth)acrylic ester copolymers, acrylic rubbers, and the like, may be used. Among these, acrylic rubber is preferable. Acrylic rubbers are rubbers that contain acrylates as the main component, and mainly comprise copolymers of butyl acrylate and acrylonitrile and the like, or copolymers of ethyl acrylate and acrylonitrile and the like.

[0074] When the polymer contains glycidyl group as the functional group, the content of the glycidyl group-containing repeating units is preferably 0.5 to 6.0 wt%, and 0.5 to 5.0 wt% is further preferable. Especially preferable is 0.8 to 5.0 wt%. The glycidyl group-containing repeating units refer to the monomer composing the (meth)acrylic copolymer that contains glycidyl group, and specifically refers to glycidyl acrylate or glycidyl methacrylate. When the amount of the glycidyl group-containing repeating units is in this range, adhesive strength is secured and gelation can be prevented.

[0075] As the monomer component constituting the above (meth)acrylic copolymer other than glycidyl acrylate and glycidyl methacrylate, for example, ethyl (meth)acrylate, butyl (meth)acrylate and the like may be listed. These may be used independently or as a combination of 2 or more types. Note that in the present invention, ethyl (meth)acrylate refers to ethyl acrylate and/or ethyl methacrylate. When using functional monomers in combination, the mixing ratio may be decided to take in consideration the glass transition temperature of the (meth)acrylic copolymer. When the glass transition temperature is -50 °C or higher, it becomes excellent in film formation property and is preferable in that excessive tackiness at normal temperature can be suppressed. When the tackiness at normal temperature is excessive, the handling of the adhesive layer becomes difficult. More preferable is -20 °C or higher,

and further preferable is 0 °C or higher. Further, when the glass transition temperature is 30 °C or lower, it becomes excellent in the point of adhesive strength of the adhesive layer during die bonding. Further preferable is 20 °C or lower.

[0076] When producing a high molecular weight component with functional monomers by polymerizing the above monomers, the method of polymerization is not particularly limited, and for example, methods such as pearl polymerization, solution polymerization, and the like may be applied. In particular, pearl polymerization is preferable.

[0077] In the present invention, when the weight-average molecular weight of the high molecular weight component containing functional monomers is 100,000 or more, it becomes excellent in the point of film formation property. More preferable is 200,000 or more and further preferable is 500,000 or more. Further, when the weight-average molecular weight is adjusted to 2,000,000 or smaller, the heated fluidity of the adhesive layer during die bonding increases, and is thus superior. When the heated fluidity of the adhesive layer during die bonding increases, the adhesion between the adhesive layer and the adherend becomes good and the adhesive strength can be enhanced. Further, the roughness on the adherend can be filled and voids can be controlled more easily. More preferable is 1,000,000 or smaller and further preferable is 800,000 or smaller. When the weight-average molecular weight is 500,000 or smaller, larger effects can be obtained.

[0078] Further, the thermal polymerization component is not particularly limited, as long as it can be polymerized by heat, and compounds having functional groups such as glycidyl group, acryloyl group, methacryloyl group, hydroxyl group, carboxyl group, isocyanurate group, amino group, or amide group, as well as trigger materials may be listed. These may be used independently or as a combination of two or more types. However, from the point of heat resistance of the adhesive layer, it is preferable that a thermosetting resin, which is cured with heat and provides adhesive function, is added along with a curing agent and an accelerator. As the thermosetting resin, for example, epoxy resin, acrylic resin, silicone resin, phenol resin, thermosetting

polyimide resin, polyurethane resin, melamine resin, urea resin, and the like may be listed. In particular, from the point of obtaining an adhesive layer with heat resistance, workability, and high reliability, it is most preferable to use epoxy resins.

[0079] The above epoxy resin is not particularly limited, as long as it can be cured to show adhesive function, and bifunctional epoxy resins such as bisphenol A-type epoxy, novolak-type epoxy resins such as phenol novolak-type epoxy resin and cresol novolak-type epoxy resin, may be used. Further, generally known epoxy resins such as multifunctional epoxy resins, glycidyl amine-type epoxy resins, heterocyclic epoxy resins, or alicyclic epoxy resins may be applied.

[0080] As the above bisphenol A-type epoxy resin, the EPIKOTE series manufactured by Mitsubishi Chemical Corporation (EPIKOTE 807, EPIKOTE 815, EPIKOTE 825, EPIKOTE 827, EPIKOTE 828, EPIKOTE 834, EPIKOTE 1001, EPIKOTE 1004, EPIKOTE 1007, EPIKOTE1009), DER-330, DER-301, DER-361 manufactured by Dow Chemical Company, and YD8125, YDF8170 manufactured by Nippon Steel and Sumikin Chemical Corporation, and the like, may be listed. As the above phenol novolak-type epoxy resin, EPIKOTE 152, EPIKOTE154 manufactured by Mitsubishi Chemical Corporation, EPPN-201 manufactured by Nippon Kayaku Corporation, DEN-438 manufactured by Dow Chemical Company, and the like, as the above o-cresol novolak-type epoxy resin, EOCN-102S, EOCN-103S, EOCN-104S, EOCN-1012, EOCN-1025, EOCN-1027 manufactured by Nippon Kayaku Corporation and YDCN701, YDCN702, YDCN703, YDCN704 manufactured by Nippon Steel and Sumikin Chemical Corporation, and the like, may be listed. As the above multifunctional epoxy resin, Epon 1031S manufactured by Mitsubishi Chemical Corporation, Araldite 0163 manufactured by Ciba Specialty Chemicals, Denacol EX-611, EX-614, EX-614B, EX-622, EX-512, EX-521, EX-421, EX-411, EX-321 manufactured by Nagase Chemtex Corporation, and the like, may be listed. As the above amine-type epoxy resin, EPIKOTE 604 manufactured by Mitsubishi Chemical Corporation, YH-434 manufactured by Tohto Chemical Industry Co. Ltd., TETRAD-X and TETRAD-C manufactured by Mitsubishi Gas Chemical Corporation, ELM-120 manufactured by

Sumitomo Chemical Co., Ltd., and the like, may be listed.

As the heterocyclic epoxy resin, Araldite PT810 manufactured by Ciba Specialty Chemicals, ERL4234, ERL4299, ERL4221, ERL4206 by UCC Corporation, and the like, may be listed. These epoxy resins may be used independently or may be used as a combination of two or more types.

[0081] In order to cure the above thermosetting resin, an arbitrary additive may be added. As such additive, for example, a curing agent, a curing accelerator, a catalyst, and the like, may be listed, and when adding a catalyst, a promoter may be used as required.

[0082] When epoxy resin is used as the above thermosetting resin, it is preferable to use an epoxy resin curing agent or a curing accelerator, and it is preferable to use them in combination. As the curing agent, for example, phenol resins, dicyandiamides, boron trifluoride complex compounds, organic hydrazide compounds, amines, polyamide resins, imidazoles compounds, urea or thiourea compounds, polymercaptan compounds, polysulfide resins having a mercapto group on the terminal, acid anhydrides, as well as photo and thermal curing agents may be listed. These may be used independently or as a combination of two or more types.

Among these, as the boron trifluoride complex compound, boron trifluoride-amine complexes with various amine compounds (preferably primary amine compounds) may be listed and as the organic hydrazide compounds, isophthalic acid dihydrazide may be listed.

[0083] As the phenol resin, for example, novolak-type phenol resins such as phenol novolak resin, phenol aralkyl resin, cresol novolak resin, tert-butyl phenol novolak resin, and nonylphenol resin, resol-type phenol resin, polyoxystyrene such as polyparaoxystyrene, and the like may be listed. Among these, phenol-type resins with at least two phenolic hydroxyl groups are preferable.

[0084] As the phenol-type resin having at least two phenolic hydroxyl groups, for example, phenol novolak resin, cresol novolak resin, t-butyl phenol novolak resin, dicyclopentadiene cresol novolak resin, dicyclopentadiene phenol novolak resin,

xylylene-modified phenol novolak resin, naphthol novolak resin, tris phenol novolak resin, tetrakis phenol novolak resin, bisphenol A novolak resin, poly-p-vinylphenol resin, phenol aralkyl resin, and the like, may be listed. Further, among these phenol resins, phenol novolak resin and phenol aralkyl resin are especially preferable and can enhance the connection reliability.

[0085] As the amine, linear aliphatic amines (diethylene triamine, triethylene tetramine, hexamethylene diamine, N,N-dimethylpropyl amine, benzyldimethyl amine, 2-(dimethyl amino)phenol, 2,4,6-tris(dimethylaminomethyl)phenol, m-xylene diamine, and the like), cyclic aliphatic amines (N-aminoethyl piperazine, bis(3-methyl-4-aminocyclohexyl) methane, bis(4-aminocyclohexyl) methane, menthene diamine, isophorone diamine, 1,3-bis(amino methyl)cyclohexane, and the like), heterocyclic amines (piperazine, N,N-dimethyl piperazine, triethylene diamine, melamine, guanamine, and the like), aromatic amines (meta-phenylene diamine, 4,4'-diaminodiphenyl methane, diamino,4,4'-diaminodiphenyl sulfone, and the like), polyamide resin (condensation product of dimer acid and polyamine, in which polyamide amine is preferable), imidazole compounds (2-phenyl-4,5-dihydroxymethyl imidazole, 2-methyl imidazole, 2,4-dimethyl imidazole, 2-n-heptadecyl imidazole, 1-cyanoethyl- 2-undecyl imidazolium trimellitate, epoxy-imidazole adduct, and the like), urea or thiourea compounds (N,N-dialkyl urea compounds, N,N-dialkyl thiourea compound, and the like), polymercaptan compounds, polysulfide resin having a mercapto group on its terminal, acid anhydrides (tetrahydrophthalic anhydride, and the like), photo and ultraviolet ray curing agent (diphenyliodonium hexafluorophosphate, triphenylsulfonium hexafluorophosphate, and the like) may be exemplified.

[0086] The curing accelerator is not particularly limited as long as it can cure the thermosetting resin, and may be, for example, imidazoles, dicyandiamide derivatives, dicarboxylic acid dihydrazide, triphenylphosphine, tetraphenyl phosphonium tetraphenylborate, 2-ethyl-4-methylimidazole-tetraphenylborate, 1,8-diazabicyclo[5,4,0]undecene-7-tetraphenylborate, and the like, may be listed.

As the imidazole, imidazole, 2-methylimidazole, 2-ethylimidazole,

2-ethyl-4-methylimidazole, 2-phenyl imidazole, 2-phenyl-4-methylimidazole, 1-benzyl-2-methylimidazole, 1-benzyl-2-ethylimidazole, 1-benzyl-2-ethyl-5-methylimidazole, 2-phenyl-4-methyl-5-hydroxydimethylimidazole, 2-phenyl-4,5-dihydroxy methylimidazole, and the like, may be listed.

[0087] The amount of the curing agent or the curing accelerator for the epoxy resin in the adhesive layer is not particularly limited, and the optimum amount differs with the type of curing agent or curing accelerator used.

[0088] The blending ratio of the epoxy resin and the phenol resin may preferably be, for example, to 1 equivalent of epoxy group in the above epoxy resin, 0.5 to 2.0 equivalents of hydroxyl groups in the phenol resin. More preferable is 0.8 to 1.2 equivalent. That is, when the blending ratio deviates from the above range, the curing reaction does not proceed sufficiently, and the property of the adhesive layer tends to deteriorate. For other thermosetting resins and curing agents, in one aspect, for 100 pts.mass of the thermosetting resin, the curing agent is 0.5 to 20 pts.mass, and in another aspect, the curing agent is 1 to 10 pts.mass. The content of the curing accelerator is preferably smaller than the content of the curing agent, and is preferably 0.001 to 1.5 pts.mass of curing accelerator in 100 pts.mass of the thermosetting resin. More preferably, it is 0.01 to 0.95 pts.mass. By adjusting to the above-described ranged, the curing reaction can be supported sufficiently. The content of the catalyst is preferably 0.001 to 1.5 pts.mass in 100 pts.mass of the thermosetting resin. More preferably, it is 0.01 to 1.0 pts.mass.

[0089] Further, the adhesive layer 13 of the present invention may arbitrarily contain a filler, depending on its use. Such filler enables improvement in the dicing property and the handlebility of the adhesive layer, adjustment of the melt viscosity, and addition of thixotropic property prior to curing. Further, it enables the addition of thermal conductivity and improvement of adhesive strength for the cured adhesive layer.

As the filler used in the present invention, inorganic fillers are preferable. The inorganic fillers are not particularly limited, and for example, aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate,

magnesium silicate, calcium oxide, magnesium oxide, alumina, aluminum nitride, aluminum borate whisker, boron nitride, crystalline silica, amorphous silica, and antimony oxide may be used. Further, these may be used independently, or as a mixture of two or more types.

[0090] Further, among the above inorganic fillers, from the point of enhancement of thermal conductivity, the use of alumina, aluminum nitride, boron nitride, crystalline silica, amorphous silica, and the like, is preferable. Further, from the point of adjusting melt viscosity and providing thixotropic property, the use of aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate, magnesium silicate, calcium oxide, magnesium oxide, alumina, crystalline silica, amorphous silica, and the like, is preferable. Further, from the viewpoint of enhancing dicing property, the use of alumina and silica is preferable.

[0091] When the content of filler is 30 mass% or more, excellent wire bonding property is obtained.

During wire bonding, it is preferable that the storage modulus after curing of the adhesive layer, which adheres the chip to which the wire is attached, is adjusted in the range of 20 to 1000 MPa at 170 °C. When the ratio of content of the filler is 30 mass% or more, the storage modulus after curing of the adhesive layer can easily be adjusted to this range. Further, when the ratio of content of the filler is 75 mass% or less, the film formation property and the heated fluidity of the adhesive layer at die bonding becomes superior. When the heated fluidity of the adhesive layer at die bonding increases, the adhesion between the adhesive layer and the adherend is improved and the adhesive strength can be enhanced. Further, the roughness on the adherend can be filled and voids can be suppressed more easily. More preferable is 70 mass% or less and further preferable is 60 mass% or less.

[0092] The adhesive layer of the present invention may contain two or more types of fillers with different average particle sizes as such filler. In such case, compared to the case where a single filler is used, it becomes easier to prevent the viscosity of the material mixture prior to film-formation from increasing when the ratio

of content of the filler is high, or from decreasing when the ratio of content of the filler is low, and the film formation property is improved. Thus, the fluidity of the uncured adhesive layer can be optimally controlled, while excellent adhesive strength is obtained after curing of the adhesive layer.

[0093] Further, in the adhesive layer of the present invention, the average particle size of the filler is preferably 2.0 μm or smaller, and is more preferably 1.0 μm . When the average particle size of the filler is 2.0 μm or smaller, the film can easily be thinned. Here, a thin film refers to that with a thickness of 20 μm or smaller. Further, when it is 0.01 μm or larger, the dispersibility is improved.

Furthermore, from the view point of preventing the viscosity of the material mixture prior to film-formation from increasing or decreasing, optimally controlling the fluidity of the uncured adhesive layer, and enhancing the adhesive force of the adhesive layer after curing, it is preferable that the adhesive layer comprises a first filler with an average particle size in the range of 0.1 to 1.0 μm and a second filler with an average particle size of the primary particle in the range of 0.005 to 0.03 μm . It is preferable that the adhesive layer comprises a first filler with an average particle size in the range of 0.1 to 1.0 μm , with 99% or more of the particles distributed in a particle size range of 0.1 to 1.0 μm , and a second filler with an average particle size of the primary particle in the range of 0.005 to 0.03 μm , with 99% or more of the particles distributed in the size range of 0.005 to 0.1 μm .

The average particle size in the present invention refers to the D50 value of the cumulative volume distribution curve, in which the 50 volume% of the particles have smaller diameters than this volume. In the present invention, the average particle size or the D50 value is obtained by the laser diffraction method, which is performed using, for example, the Malvern Mastersizer 2000 of Malvern Instruments Ltd. In this technology, the size of the particle in a suspension is measured by the diffraction of laser ray, based on the application of either the Fraunhofer or the Mie theory. In the present invention, the Mie theory or the modified Mie theory for non-spherical particles is used, and the average particle size or D50 value is related to the scattering

measurement at 0.02 to 135° against the incident laser ray.

[0094] In the present invention, in one aspect, the total pressure-sensitive adhesive composition constituting the adhesive layer 13 may contain 10 to 40 mass% of a thermosetting resin with a weight-average molecular weight of 5000 to 200,000, 10 to 40 mass% of thermally polymerizable component, and 30 to 75 mass% of fillers. In this embodiment, the content of the filler may be 30 to 60 mass% or 40 to 60 mass%.

Further, the mass-average molecular weight of the thermosetting resin may be 5000 to 150,000 or 10,000 to 100,000.

In another aspect, the total pressure-sensitive adhesive composition constituting the adhesive layer 13 may contain 10 to 20 mass% of a thermosetting resin with a weight-average molecular weight of 200,000 to 2,000,000, 20 to 50 mass% of a thermally polymerizable component, and 30 to 75 mass% of fillers. In this embodiment, the content of the filler may be 30 to 60 mass% or 30 to 50 mass%. Further, the mass-average molecular weight of the thermosetting resin may be 200,000 to 1,000,000 or 200,000 to 800,000.

By adjusting the combination ratio, the storage modulus and fluidity of the adhesive layer 13 after curing can be optimized and the heat resistance at high temperature tends to become sufficient.

[0095] In the semiconductor processing tape 10 of the present invention, the adhesive layer 13 may be made into film form in advance (hereinafter referred to as adhesive film) and may be formed by directly or indirectly laminating onto the substrate film 11. The laminating temperature may be in the range of 10 to 100 °C and it is preferable to add a linear pressure of 0.01 to 10 N/m. Note that such adhesive film may be obtained by forming an adhesive layer 13 on a separator film, in which case, the separator film may be peeled after lamination, or may be used as a cover film for the semiconductor processing tape 10 and peeled when adhering to the wafer.

[0096] The aforementioned adhesive film may be laminated on the entirety of the pressure-sensitive adhesive layer 12, or the adhesive film may be cut into a shape that is in accordance to the wafer to be adhered beforehand (precut) and laminated onto

the pressure-sensitive adhesive layer 12. When an adhesive film that is in accordance to the wafer is laminated, as shown in FIG. 3, the adhesive layer 13 exists on the part where the wafer W is adhered, but the adhesive layer 13 does not exist on the part where the ring frame 20 is adhered, and only the pressure-sensitive adhesive layer 12 exists. Since in general, the adhesive layer 13 is difficult to peel off from the adherend, using an adhesive film that is precut can be effective in that, the ring frame 20 can be adhered with the pressure-sensitive adhesive layer 12, and when the tape is peeled after use, adhesive residues are less likely to remain on the ring frame 20.

[0097] <Use>

The semiconductor processing tape 10 of the present invention is used in a method of producing semiconductor device, which comprises at least an expand process of dividing the adhesive layer 13 by expansion. Thus, other processes and order of the processes are not particularly limited. For example, it can suitably be used in the following methods of producing semiconductor device (A) to (E).

[0098] Method of Producing Semiconductor Device (A)

A method of producing a semiconductor device, the method includes following processes.

- (a) a process of adhering a surface protection tape on a front side of a wafer on which a circuit pattern has been formed;
- (b) a backgrinding process of grinding a back side of the wafer;
- (c) a process of adhering an adhesive layer of the semiconductor processing tape on the back side of the wafer, while heating the wafer;
- (d) a process of peeling the surface protection tape from the front side of the wafer;
- (e) a process of forming a modified region within the wafer through multiple-photon absorption by irradiating laser to a predetermined division part on the wafer;
- (f) an expand process of obtaining a plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the wafer and the adhesive layer of the semiconductor processing tape at a division line;
- (g) a process of maintaining space between the chips, by heat-shrinking a part of the

expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and

(h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

[0099] Method of Producing Semiconductor Device (B)

A method of producing a semiconductor device, the method includes following processes.

- (a) a process of adhering a surface protection tape on a front side of a wafer on which a circuit pattern has been formed;
- (b) a backgrinding process of grinding a back side of the wafer;
- (c) a process of adhering an adhesive layer of the semiconductor processing tape on the back side of the wafer, while heating the wafer;
- (d) a process of peeling the surface protection tape from the front side of the wafer;
- (e) a process of dividing the wafer into chips by irradiating laser along a division line on the front side of the wafer;
- (f) an expand process of obtaining the plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the adhesive layer for the each of chips;
- (g) a process of maintaining space between the chips, by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and
- (h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

[0100] Method of Producing Semiconductor Device (C)

A method of producing a semiconductor device, the method includes following processes.

- (a) a process of adhering a surface protection tape on a front side of a wafer on which a circuit pattern has been formed;
- (b) a backgrinding process of grinding a back side of the wafer;

- (c) a process of adhering an adhesive layer of the semiconductor processing tape on the back side of the wafer, while heating the wafer;
- (d) a process of peeling the surface protection tape from the front side of the wafer;
- (e) a process of dividing the wafer into chips along a division line by using a dicing blade;
- (f) an expand process of obtaining the plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the adhesive layer for the each of chips;
- (g) a process of maintaining space between the chips, by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and
- (h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

[0101] Method of Producing Semiconductor Device (D)

A method of producing a semiconductor device, the method includes following processes.

- (a) a process of adhering a dicing tape on the back side of a wafer on which a circuit pattern has been formed and cutting the wafer to a depth that is smaller than a thickness of the wafer along a predetermined division line using a dicing blade;
- (b) a process of adhering a surface protection tape on a front side of the wafer
- (c) a backgrinding process of peeling off the dicing tape and grinding a back side of the wafer to thereby divide the wafer into chips;
- (d) a process of adhering the adhesive layer of the semiconductor processing tape on the back side of the wafer that is divided into chips, while heating the wafer;
- (e) a process of peeling the surface protection tape from the surface of the wafer that has been divided into the chips;
- (f) an expand process of obtaining the plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the adhesive layer for the each of chips;

(g) a process of maintaining space between the chips by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occur during the expand process; and

(h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

[0102] Method of Producing Semiconductor Device (E)

A method of producing a semiconductor device, the method includes following processes.

(a) a process of adhering a surface protection tape on a front side of the wafer on which a circuit pattern has been formed;

(b) a process of forming a modified region within the wafer through multiple-photon absorption by irradiating laser to a predetermined division part on the wafer;

(c) a backgrinding process of grinding a back side of the wafer;

(d) a process of adhering an adhesive layer of the semiconductor processing tape on the back side of the wafer, while heating the wafer;

(e) a process of peeling the surface protection tape from the front side of the wafer;

(f) an expand process of obtaining a plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the wafer and the adhesive layer of the semiconductor processing tape at the division line;

(g) a process of maintaining space between the chips by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and

(h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

[0103] <Method of Use>

The method of use of the tape when the semiconductor processing tape 10 of the present invention is applied to the aforementioned method of producing semiconductor device (A) will be describe with reference to FIG. 2 to FIG. 5. First, as shown in FIG. 2, on the front side of a wafer W on which a circuit pattern has been formed, a surface

protection film 14 for protecting the circuit pattern, which comprises a pressure-sensitive adhesive agent that contains an ultraviolet-curable component, is adhered and a backgrinding process for grinding the back side of the wafer is performed.

[0104] After the backgrinding process, as shown in FIG. 3, the wafer W is mounted with the front side down on a heater table 25 of the wafer mounter, after which the semiconductor processing tape 10 is adhered onto the back side of the wafer W. Here, the semiconductor processing tape 10 used is one with an adhesive film, which has been cut in accordance with the shape of the wafer W on which it is to be adhered (precut), laminated thereto. Further, on the side that is adhered to the wafer W, the pressure-sensitive adhesive layer 12 is exposed around the area where the adhesive layer 13 is exposed. The part where the adhesive layer 13 of the semiconductor processing tape 10 is exposed is adhered together with the back side of the wafer W, and the part where the pressure-sensitive adhesive layer 12 around the adhesive layer 13 is exposed is adhered with the ring frame 20. Here, the heater table 25 is set to 70 to 80 °C, and heat lamination is performed by it. Note that, although a semiconductor processing tape 10, which comprises a pressure-sensitive adhesive tape 15 composed of a substrate film 11, a pressure-sensitive adhesive layer 12 formed on the substrate film 11, and an adhesive layer 13 formed on top of the pressure-sensitive adhesive layer 12 was used in the present embodiment, it is also possible to use a pressure-sensitive adhesive tape and a film-form adhesive separately. In such case, first, a film-form adhesive is adhered to the back side of the wafer to form an adhesive layer, and the pressure-sensitive adhesive layer of the pressure-sensitive adhesive tape is adhered to the adhesive layer. Here, the pressure-sensitive adhesive tape 15 of the present invention is used as the pressure-sensitive adhesive tape.

[0105] Next, the wafer W with the semiconductor processing tape 10 adhered thereto is removed from the heater table 25, and mounted onto a suction table 26 with the semiconductor processing tape 10 side facing the bottom, as shown in FIG. 4. Then, using an energy ray source 27, for example, an ultraviolet ray of 1000 mJ/cm² is

irradiated on the substrate side of the surface protection tape 14 from above the wafer W fixed on the suction table 26. The adhesive strength of the surface protection tape 14 to the wafer W is thus decrease, and the surface protection tape 14 is peeled from the front side of the wafer W.

[0106] Next, as shown in FIG. 5, laser is irradiated onto a predetermined division part of the wafer W, and a modified region 32 is formed within the wafer W through multiple-photon absorption.

[0107] Subsequently, as shown in FIG. 6(a), the semiconductor processing tape 10 with the wafer W and the ring frame 20 adhered thereto is mounted on the stage 21 of an expand machine with the substrate film 11 side on the bottom.

[0108] Next, as shown in FIG. 6(b), while the ring frame 20 is fixed, a hollow cylindrical push-up member 22 of the expand machine is raised to extend (expand) the semiconductor processing tape 10. The expand condition is, an expand speed of, for example, 5 to 500 mm/sec, and an expand amount (push-up amount) of, for example, 5 to 25 mm. By extending the semiconductor processing tape 10 in the direction of the diameter of the wafer W, the wafer W is divided into individual chip 34 units, beginning at the modified region 32. In this case, the adhesive layer 13 is not divided at the part where it is adhered to the back side of the wafer W, since stretching (deformation) by expansion is suppressed. However, at the part between each chip 34, the tensile strength by expansion of the tape is focused, and breakage occurs. Thus, as shown in FIG. 6 (c), the adhesive layer 13 is divided along with the wafer W. By such process, a plurality of chips 34 with the adhesive layer 13 attached thereto, are obtained.

[0109] Next, as shown in FIG. 7, the push-up member 22 is returned to its original position, and a process to remove the slack that occurred to the semiconductor processing tape 10 during the previous expand process, to thereby maintain the distance between each chip 34, is performed. In this process, for example, a heated air of about 90 to 120 °C is blown from a warm air nozzle 29 onto the ring-shaped heat-shrinking region 28, which is the area between the part where the chip 34 exists on the semiconductor processing tape 10 and the ring frame 20. The substrate film 11 is

heat-shrunk, and the semiconductor processing tape 10 is strained.

[0110] Subsequently, energy ray-curing or heat-curing is performed to the pressure-sensitive adhesive layer 12, to thereby decrease the adhesive strength of the pressure-sensitive adhesive layer 12 to the adhesive layer 13, and the chips 34 are picked up.

Note that, as described previously, it is also possible to perform energy ray-curing treatment, prior to performing the expand treatment.

EXAMPLE

[0111] Next, in order to further clarify the effects of the present invention, Examples and Comparative Examples will be described in detail. However, the present invention is not limited to these Examples.

[0112] [Preparation of the Semiconductor Processing Tape]

(1) Preparation of the Substrate Film

<Substrate Film 1>

Resin beads of zinc ionomer a (density 0.96 g/cm³, zinc ion content 4 mass%, chlorine content less than 1 mass%, Vicat softening temperature 56 °C, melting point 86 °C), a ternary copolymer of ethylene-methacrylic acid-ethyl methacrylate (mass ratio 8:1:1) synthesized by radical polymerization, was melted at 140 °C. Using an extruder, a long film with a thickness of 100 μm was formed to obtain substrate film 1.

<Substrate Film 2>

A styrene-hydrogenated isoprene-styrene block copolymer (SEPS) (“SEPTON KF-2104” manufactured by Kuraray Co., Ltd.) and homopropylene (PP) (“J-105G” manufactured by Ube Industries, Ltd.) were blended at a compounding ratio of 40:60 and subjected to film extrusion at about 200 °C using a biaxial kneader, to thereby obtain substrate film 2 with a thickness of 100 μm.

<Substrate Film 3>

A styrene-hydrogenated isoprene-styrene block copolymer (SEPS) (“SEPTON KF-2104” manufactured by Kuraray Co., Ltd.) and homopropylene (PP) (“J-105G”

manufactured by Ube Industries, Ltd.) were blended at a compounding ratio of 40:60. Using an extruder, a long film with a thickness of 100 μm was formed to obtain substrate film 3.

[0113] (2) Preparation of Pressure-sensitive Adhesive Composition

(a-1)

As an acrylic copolymer (A1) having a functional group, a copolymer composed of 2-ethylhexyl acrylate, 2-hydroxyethyl acrylate, and methacrylic acid, wherein the ratio of 2-ethylhexyl acrylate was 55 mol% and the mass-average molecular weight was 750,000 was prepared. Subsequently, 2-isocyanatoethyl methacrylate was added so that the iodine value became 30, and an acrylic copolymer (a-1) with a glass transition temperature of $-50\text{ }^{\circ}\text{C}$, a hydroxyl value of 30 mg KOH/g, and an acid value of 5 mg KOH/g was prepared.

(a-2)

As an acrylic copolymer (A1) having a functional group, a copolymer composed of butyl acrylate, 4-hydroxybutyl acrylate, and acrylic acid, wherein the ratio of butyl acrylate was 60 mol% and the mass-average molecular weight was 500,000 was prepared. Subsequently, 2-isocyanatoethyl methacrylate was added so that the iodine value became 30, and an acrylic copolymer (a-2) with a glass transition temperature of $-56\text{ }^{\circ}\text{C}$, a hydroxyl value of 30 mg KOH/g, and an acid value of 5 mg KOH/g was prepared.

[0114] (3) Preparation of Adhesive Composition

(b-1)

To a composition consisting of 50 pts.mass of epoxy resin "1002" (manufactured by Mitsubishi Chemical, solid bisphenol A-type epoxy resin, epoxy equivalent 600), 100 pts.mass of epoxy resin "806" (manufactured by Mitsubishi Chemical, bisphenol F-type epoxy resin, epoxy equivalent 160, specific gravity 1.20), 5 pts.mass of curing agent "Dyhard 100SF" (manufactured by Degussa AG, trade name, dicyandiamide), 150 pts.mass of a silica filler "SO-C2" (manufactured by ADMAFINE, trade name, average particle size 0.5 μm), and 5 pts.mass of a silica filler "Aerosil R972" (manufactured by

Nippon Aerosil Co., Ltd., trade name, average particle size of primary particle size 0.016 μm), MEK was added, mixed, and agitated to prepare a uniform composition.

To this composition, 100 pts.mass of phenoxy resin "PKHH" (manufactured by INCHEM, trade name, mass-average molecular weight 52,000, glass transition temperature 92 °C), 0.4 pts.mass of "KBM-802" (manufactured by Shin-Etsu Silicone, trade name, mercaptopropyl trimethoxysilane) as a coupling agent, and 0. 5 pts.mass of "CUREZOL 2PHZ-PW" (manufactured by Shikoku Chemicals Corporation, trade name, 2-phenyl-4,5-dihydroxymethyl imidazole, decomposition temperature 230 °C) were added, mixed, and agitated until uniform. Further, this mixture was filtrated through a filter of 100 mesh and vacuum deaerated to obtain a varnish of the adhesive composition (b-1).

(b-2)

To a composition consisting of 20.0 pts.mass of epoxy resin "YX4000" (manufactured by Mitsubishi Chemical, biphenyl novolak-type epoxy resin, epoxy equivalent 185), 50.0 pts.mass of phenol resin "LF-6161" (manufactured by DIC Corporation, trade name, novolak phenol resin, hydroxyl equivalent 118), 45.0 pts.wt of epoxy resin "EPIKOTE 828" (manufactured by Mitsubishi Chemical, trade name, bisphenol A-type epoxy resin, epoxy equivalent 190) and 5 pts.mass of a silica filler "Aerosil R972" (manufactured by Nippon Aerosil Co., Ltd., trade name, average particle size of primary particle size 0.016 μm), MEK was added, mixed, and agitated to prepare a uniform composition.

To this composition, 70 pts.mass of an acrylic copolymer that contains monomer units derived from glycidyl acrylate of glycidyl methacrylate (weight-average molecular weight 850,000, Tg 12°C), 0.5 pts.mass of "KBM-802" (manufactured by Shin-Etsu Silicone, trade name, mercaptopropyl trimethoxy silane) as a coupling agent, and 0. 1 pts.mass of "CUREZOL 2PHZ-PW" (manufactured by Shikoku Chemicals Corporation, trade name, 2-phenyl-4,5-dihydroxymethyl imidazole, decomposition temperature 230 °C) were added, mixed, and agitated until uniform. Further, this mixture was filtrated through a filter of 100 mesh and vacuum deaerated to obtain a varnish of the adhesive

composition (b-2).

[0115] (Preparation of Semiconductor Processing Tape)

A mixture of 100 pts. mass of acrylic copolymer (a-1), 3 pts. mass of P301-75E (manufactured by Asahi Kasei Chemicals) as a polyisocyanate, and 3 pts. mass of Esacure KIP150 (manufactured by Lamberti S.p.A) as a photopolymerization initiator was dissolved in ethyl acetate and stirred to prepare pressure-sensitive adhesive composition.

Subsequently, this pressure-sensitive adhesive composition was applied to a release liner composed of polyethylene-terephthalate film subjected to a release treatment, so that the thickness after drying became 10 μm , and dried at 110 °C for 2 minutes. Then it was adhered to the substrate film 1 to prepare a pressure-sensitive adhesive sheet with a pressure-sensitive adhesive layer formed on the substrate film 1.

Next, to a release liner composed of polyethylene-terephthalate film subjected to a release treatment, the adhesive composition (b-1) was applied, so that the thickness after drying became 20 μm , and was dried at 130 °C for 3 minutes, to prepare an adhesive film with an adhesive layer formed on the release liner.

[0116]

The pressure-sensitive adhesive sheet was cut into a shape similar to that shown in FIG. 3 and the like, which enables it to be adhered to the ring frame so that the opening can be covered. Further, the adhesive film was cut into a shape similar to that shown in FIG. 3 and the like, so that it can cover the back side of the wafer. Moreover, the pressure-sensitive adhesive layer side of the pressure-sensitive adhesive sheet and the adhesive layer side of the adhesive film were adhered together so that the pressure-sensitive adhesive layer 12 was exposed around the adhesive film, as shown in FIG. 3 and the like, to prepare the semiconductor processing tape 1.

[0117] Other than using the acrylic copolymer, pressure-sensitive adhesive composition, crosslinking agent, and adhesive composition in the combinations shown in Table 1, semiconductor processing tapes 2 to 9 were prepared by the same method as that of semiconductor processing tape 1.

[0118] <Example 1>

A surface protection tape was adhered on the front side of a wafer on which a circuit pattern was formed;

a modified region was formed within the wafer through multiple-photon absorption by irradiating laser to a predetermined division part on the wafer;

a backgrinding process of grinding the back side of the wafer was performed;

the adhesive layer of the semiconductor processing tape 1 was adhered on the back side of the wafer, while heating the wafer at a temperature of 70 to 80 °C;

the surface protection tape was peeled from the front side of the wafer;

the semiconductor processing tape 1 was subjected to ultraviolet irradiation treatment at an output of 200 mJ/cm²;

the semiconductor processing tape 1 was expanded to thereby divide the wafer and the adhesive layer of the semiconductor processing tape along the division line, to obtain a plurality of chips with the adhesive layer attached thereto;

the part of the semiconductor processing tape 1 that does not overlap with the chips (the ring-formed region between the region where the chips exist and the ring frame) was heated at 100 °C and shrunk, to thereby remove the slack that occurred during the expand process, and the following physical properties of the semiconductor processing tape 1 subjected to a process of maintaining the distance between the chips, as well as the pickup property, were evaluated.

Note that the chip size was 5 mm x 5mm.

[0119] <Evaluation of Shrinkage Rate>

According to the method prescribed by JIS7162, a test sample was subjected to 20% of extension and strain at 500 mm/min for 60 seconds. Then, the test sample was removed from the testing machine and heated at 100 °C for 10 seconds, after which the thermal shrinkage rate was measured.

Further, the shrinkage rate in the widthwise direction and the lengthwise direction were measured, too.

[0120] <Evaluation of Pickup Property>

A process of picking up semiconductor chips from the pressure-sensitive adhesive layer of the semiconductor processing tape was performed to evaluate the pickup property.

Specifically, a pickup test was performed for 1000 arbitrary chips, using a dice picker machine (manufactured by Canon Machinery Inc., trade name CAP-300II), and those for which the adhesive layer remained after peeling from the pressure-sensitive adhesive layer was evaluated as successful pickup, and the pickup success rate was calculated to thereby evaluate the pickup property.

Those with a pickup success rate of 100% were marked "◎" for Excellent Product.

Those with a pickup success rate of 98% or more were marked "○" for Good Product.

Those with a pickup success rate of 95% or more to less than 98% were marked "△" for Tolerable Products.

Those with a pickup success rate of less than 95% were marked "X" for Inferior Product. The pickup rate showed 100%.

[0121] <Evaluation Kerf Width Evenness>

The evenness of the Kerf Width was evaluated according to the following methods and standards.

In a wafer of 12 inches, the kerf width in the lengthwise direction and widthwise direction at five points, the top-most part, the bottom-most part, the center, the left-most part, and the right-most part, of effective chips (5 mm x 5 mm) were measured, and the values obtained by the equation:

$$\text{Kerf Width Evenness} = (\text{Smallest Measured Value Among the Five Points} - \text{Average Value}) / \text{Average Value}$$

were evaluated as follows.

- 0.3 or more "◎";
- 0.5 or more to less than -0.3 "○";
- 0.7 or more to less than -0.5 "△";
- less than -0.7 "X". An evaluation of "◎" was obtained.

[0122] <Example 2>

In the semiconductor processing tape 2, other than changing the output of the ultraviolet irradiation to $30\text{mJ}/\text{cm}^2$, the same treatments as those of Example 1 were performed and the shrinkage rate and pickup property were evaluated.

[0123] <Example 3>

In the semiconductor processing tape 3, other than performing a heat set treatment, the same treatments as those of Example 1 were performed and the shrinkage rate and pickup property were evaluated.

[0124] <Example 4>

In the semiconductor processing tape 4, the same treatments as those of Example 1 were performed and the shrinkage rate and pickup property were evaluated.

[0125] (Comparative Example 1)

A surface protection tape was adhered on the front side of a wafer on which a circuit pattern was formed;

a modified region was formed within the wafer through multiple-photon absorption by irradiating laser to a predetermined division part on the wafer;

a backgrinding process of grinding the back side of the wafer was performed;

the adhesive layer of the semiconductor processing tape 11 was adhered on the back side of the wafer, while heating the wafer at a temperature of 70 to 80 °C;

the surface protection tape was peeled from the front side of the wafer;

the semiconductor processing tape 5 was expanded to thereby divide the wafer and the adhesive layer of the semiconductor processing tape along the division line, to obtain a plurality of chips with the adhesive layer attached thereto;

the part of the semiconductor processing tape 5 that does not overlap with the chips (the ring-formed region between the region where the chips exist and the ring frame) was heated at 120 °C and shrunk, to thereby remove the slack that occurred during the expand process and maintain the distance between the chips; and

the semiconductor processing tape 5 was subjected to ultraviolet irradiation at an output of $200\text{ mJ}/\text{cm}^2$. The physical properties and pickup property of the semiconductor processing tape 5 were evaluated as in Example 1.

[0126] (Comparative Example 2)

In the semiconductor processing tape 6, the same treatments as those of Comparative Example 1 were performed and the shrinkage rate and pickup property were evaluated.

[0127] (Comparative Example 3)

In the semiconductor processing tape 7, other than changing the output of the ultraviolet irradiation to 20 mJ/cm^2 , the same treatments as those of Example 1 were performed and the shrinkage rate and pickup property were evaluated.

[0128] (Comparative Example 4)

In the semiconductor processing tape 8, other than changing the addition amount of the curing agent to 20 pts.mass, the same treatments as those of Comparative Example 1 were performed and the shrinkage rate and pickup property were evaluated.

[0129] (Comparative Example 5)

In the semiconductor processing tape 9, other than performing the heat set treatment at a temperature of 50°C , the same treatments as those of Comparative Example 1 were performed and the shrinkage rate and pickup property were evaluated.

[0130] The shrinkage rate, pickup properties, and evaluation results of the kerf width evenness for Examples 1 to 4 and Comparative Examples 1 to 5 are shown in Table 2.

[0131]

[Table 1]

	Semiconductor Processing Tape 1	Semiconductor Processing Tape 2	Semiconductor Processing Tape 3	Semiconductor Processing Tape 4	Semiconductor Processing Tape 5	Semiconductor Processing Tape 6	Semiconductor Processing Tape 7	Semiconductor Processing Tape 8	Semiconductor Processing Tape 9
Substrate Film	1	1	2	1	1	3	1	1	1
Material	(a-1)	(a-1)	(a-2)	(a-2)	(a-1)	(a-1)	(a-1)	(a-1)	(a-1)
Pressure- sensitive adhesive	3	3	3	15	3	3	3	20	3
Adhesive	(b-1)	(b-2)	(b-1)	(b-1)	(b-1)	(b-1)	(b-2)	(b-1)	(b-1)

[0132]

[Table 2]

	Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5
(Thermal Shrinkage Rate)									
Thermal Shrinkage Rate in Widthwise Direction (TD)	0.3	0.2	1	0.1	-7	-17	-0.6	0.1	0.7
Thermal Shrinkage Rate in Lengthwise Direction (MD)	9	20	0.01	7	27	35	3	10.2	-0.02
Thermal Shrinkage Rate in Lengthwise Direction / Thermal Shrinkage Rate in Widthwise Direction	30	100	0.01	70	-3.9	-2.1	-5	102	-0.03
(Evaluation of Physical Property)									
Kerf Width Evenness	◎	△	○	△	x	x	x	x	x
Pickup Property Evaluation	◎	△	◎	○	x	x	x	x	x

[0133] <Evaluation Results>

As shown in Table 2, in Examples 1 to 5, wherein the thermal shrinkage rates are 0% or more to 20% or less, and wherein the condition of thermal shrinkage rate in lengthwise direction/thermal shrinkage rate in widthwise direction = 0.01 or more to 100 or less is fulfilled, the kerf width expanded sufficiently and evenly, and showed excellent pickup properties unseen in prior art.

On the other hand, in Comparative Examples 1 to 5, which did not fulfill the above condition, the kerf width was narrow and uneven, and the pickup property was evaluated as being inferior.

DESCRIPTION OF NOTATIONS

[0134] 10: semiconductor processing tape

11: substrate film

12: pressure-sensitive adhesive layer

13: adhesive layer

14: surface protection tape

15: supporting tape

20: ring frame

21: stage

22: push-up member

25: heater table

26: suction table

27: ultraviolet (energy ray) source

28: heat-shrinking region

29: warm air nozzle

32: modified region

34: chip

Claims

1. A semiconductor processing tape, a thermal shrinkage rate in a lengthwise direction and a thermal shrinkage rate in a widthwise direction of the semiconductor processing tape are 0% or more and 20% or less when the semiconductor processing tape is heated at 100 °C for 10 seconds, and a ratio of the thermal shrinkage rate in the lengthwise direction to the thermal shrinkage rate in the widthwise direction is 0.01 or more and 100 or less, wherein the thermal shrinkage rate is obtained from an equation the thermal shrinkage rate(%) = (size before heating – size after heating) / size before heating x 100.

2. The semiconductor processing tape according to claim 1, wherein the semiconductor processing tape is utilized in a method for producing a semiconductor device, the method comprises:
 - (a) a process of adhering a surface protection tape on a front side of a wafer on which a circuit pattern has been formed;
 - (b) a backgrinding process of grinding a back side of the wafer;
 - (c) a process of adhering an adhesive layer of the semiconductor processing tape on the back side of the wafer, while heating the wafer;
 - (d) a process of peeling the surface protection tape from the front side of the wafer;
 - (e) a process of forming a modified region within the wafer through multiple-photon absorption by irradiating laser to a predetermined division part on the wafer;
 - (f) an expand process of obtaining a plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the wafer and the adhesive layer of the semiconductor processing tape at a division line;
 - (g) a process of maintaining space between the chips, by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and
 - (h) a pickup process of picking up the chip with the adhesive layer attached thereto

from a pressure-sensitive adhesive layer of the semiconductor processing tape.

3. The semiconductor processing tape according to claim 1, wherein the semiconductor processing tape is utilized in a method for producing a semiconductor device, the method comprises:

- (a) a process of adhering a surface protection tape on a front side of a wafer on which a circuit pattern has been formed;
- (b) a backgrinding process of grinding a back side of the wafer;
- (c) a process of adhering an adhesive layer of the semiconductor processing tape on the back side of the wafer, while heating the wafer;
- (d) a process of peeling the surface protection tape from the front side of the wafer;
- (e) a process of dividing the wafer into chips by irradiating laser along a division line on the front side of the wafer;
- (f) an expand process of obtaining the plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the adhesive layer for the each of chips;
- (g) a process of maintaining space between the chips, by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and
- (h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

4. The semiconductor processing tape according to claim 1, wherein the semiconductor processing tape is utilized in a method for producing a semiconductor device, the method comprises:

- (a) a process of adhering a surface protection tape on a front side of a wafer on which a circuit pattern has been formed;
- (b) a backgrinding process of grinding a back side of the wafer;
- (c) a process of adhering an adhesive layer of the semiconductor processing tape on

the back side of the wafer, while heating the wafer;

(d) a process of peeling the surface protection tape from the front side of the wafer;

(e) a process of dividing the wafer into chips by cutting along a division line using a dicing blade;

(f) an expand process of obtaining the plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the adhesive layer for the each of chips;

(g) a process of maintaining space between the chips by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and

(h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

5. The semiconductor processing tape according to claim 1, wherein the semiconductor processing tape is utilized in a method for producing a semiconductor device, the method comprises:

(a) a process of cutting a wafer on which a circuit pattern has been formed up to a depth that is smaller than a thickness of the wafer along a predetermined division line using a dicing blade;

(b) a process of adhering a surface protection tape on a front side of the wafer

(c) a backgrinding process of grinding a back side of the wafer to thereby divide the wafer into chips;

(d) a process of adhering the adhesive layer of the semiconductor processing tape on the back side of the wafer that is divided into chips, while heating the wafer;

(e) a process of peeling the surface protection tape from the front side of the wafer that has been divided into the chips;

(f) an expand process of obtaining the plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the adhesive layer for the each of chips;

- (g) a process of maintaining space between the chips by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and
- (h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

6. The semiconductor processing tape according to claim 1, wherein the semiconductor processing tape is utilized in a method for producing a semiconductor device, the method comprises:

- (a) a process of adhering a surface protection tape on a front side of a wafer on which a circuit pattern has been formed;
- (b) a process of forming a modified region within the wafer through multiple-photon absorption by irradiating laser to a predetermined division part on the wafer;
- (c) a backgrinding process of grinding a back side of the wafer;
- (d) a process of adhering an adhesive layer of the semiconductor processing tape on the back side of the wafer, while heating the wafer;
- (e) a process of peeling the surface protection tape from the front side of the wafer;
- (f) an expand process of obtaining a plurality of chips with the adhesive layer attached thereto, by expanding the semiconductor processing tape to thereby divide the wafer and the adhesive layer of the semiconductor processing tape along a division line;
- (g) a process of maintaining space between the chips, by heat-shrinking a part of the expanded semiconductor processing tape that does not overlap with the chips, to thereby remove a slack that occurs during the expand process; and
- (h) a pickup process of picking up the chip with the adhesive layer attached thereto from the pressure-sensitive adhesive layer of the semiconductor processing tape.

7. The semiconductor processing tape according to claim 1, wherein the thermal shrinkage rate in either the lengthwise direction or the widthwise direction is 0.1 % or more.

8. A semiconductor device that utilizes the semiconductor processing tape according to any one of claims 1 to 7.