

DESCRIPTION

Title of Invention: METHOD FOR MANUFACTURING SEMICONDUCTOR DEVICE, AND DICING/DIE-BONDING INTEGRATED FILM

5 **Technical Field**

[0001] The present disclosure relates to a method for manufacturing a semiconductor device and a dicing/die-bonding integrated film.

Background Art

10 [0002] A dicing/die-bonding integrated film, in which a dicing film having a base film and a pressure-sensitive adhesive layer for immobilizing a semiconductor wafer during singulating the semiconductor wafer, and a die-bonding film for adhering to a substrate or another semiconductor chip are integrated, is sometimes used for manufacturing a semiconductor device (semiconductor package) (for example, Patent Literature 1 and 2).
15 The die-bonding film constituting the dicing/die-bonding integrated film generally often has a thickness of about several tens of μm .

20 [0003] In recent years, as a method for singulating a semiconductor wafer, an SDBG (Stealth Dicing Before Grinding) method, a DBG (Dicing Before Grinding) method, and the like have been put into practical use (for example, Patent Literature 3). The SDBG method is a method of singulating a semiconductor wafer into a plurality of semiconductor chips by forming a modified region inside the semiconductor wafer by irradiation with a laser beam, then grinding (polishing) the semiconductor wafer from the back surface side, and cleaving the semiconductor wafer
25 using the modified region as a starting point for division. The DBG method is a method of singulating a semiconductor wafer into a plurality

of semiconductor chips by forming a groove of a predetermined depth on the front surface of the semiconductor wafer with a dicing blade or the like, and then grinding (polishing) the semiconductor wafer from the back surface side to the groove. The die-bonding film of the dicing/die-bonding integrated film is attached under heating conditions to the plurality of semiconductor chips singulated by these methods. Subsequently, by expanding the dicing film under cooling conditions (cooling expansion), the die-bonding film is singulated, and a semiconductor chip with a die-bonding film piece, which has the semiconductor chip and a die-bonding film piece resulting from the singulation of the die-bonding film, is obtained. Subsequently, a semiconductor device can be manufactured by picking up the obtained semiconductor chip with a die-bonding film piece and mounting it on a substrate or another semiconductor chip.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 2019-175958 A

Patent Literature 2: WO 2018/105613 A1

Patent Literature 3: JP 2022-179420 A

Summary of Invention

Technical Problem

[0005] By the way, according to studies by the present inventors, it has been found that in a method for manufacturing a semiconductor device including producing a semiconductor chip with a die-bonding film piece by singulating a die-bonding film by expanding a dicing film under cooling conditions (for example, 0°C or lower), when a conventional die-bonding film is applied to the die-bonding film of a dicing/die-bonding

integrated film, the die-bonding film tends to be difficult to be cut during cooling expansion. If the die-bonding film is not easily cut, it becomes difficult to pick up the semiconductor chip with a die-bonding film piece, and there is a risk that the yield may decrease in the manufacturing of the semiconductor device.

[0006] Therefore, a main object of the present disclosure is to improve the separability upon cooling of a die-bonding film in a predetermined method for manufacturing a semiconductor device.

Solution to Problem

[0007] The present disclosure includes [1] to [5].

[1] A method for manufacturing a semiconductor device, the method including:

(A) providing a laminate including a dicing/die-bonding integrated film including a dicing film having a base film and a pressure-sensitive adhesive layer provided on the base film, and a die-bonding film provided on the pressure-sensitive adhesive layer, and a plurality of semiconductor chips provided on the die-bonding film of the dicing/die-bonding integrated film, the plurality of semiconductor chips being obtained by singulating a semiconductor wafer; and

(B) producing a semiconductor chip with a die-bonding film piece by expanding the dicing film of the laminate under cooling conditions to singulate the die-bonding film, thereby obtaining the semiconductor chip and a die-bonding film piece resulting from a singulation of the die-bonding film,

wherein a tensile stress of the dicing film at 20% elongation at -15°C in a tensile test is 15 MPa or more, and an elongation at break of the

dicing film at -15°C in the tensile test is 500% or less.

[2] The method according to [1], wherein a surface resistance value at 25°C of a principal surface of the base film on a side opposite to a principal surface on which the pressure-sensitive adhesive layer is provided is $1.0 \times 10^{12} \Omega/\text{sq}$ or less.

[3] The method according to [1] or [2], wherein, in (A), the method for singulating the semiconductor wafer is a stealth dicing method or a half-cut dicing method.

[4] A dicing/die-bonding integrated film including:

a dicing film having a base film and a pressure-sensitive adhesive layer provided on the base film; and

a die-bonding film provided on the pressure-sensitive adhesive layer,

wherein a tensile stress of the dicing film at 20% elongation at -15°C in a tensile test is 15 MPa or more, and an elongation at break of the dicing film at -15°C in the tensile test is 500% or less.

[5] The dicing/die-bonding integrated film according to [4], wherein a surface resistance value at 25°C of a principal surface of the base film on a side opposite to a principal surface on which the pressure-sensitive adhesive layer is provided is $1.0 \times 10^{12} \Omega/\text{sq}$ or less.

Advantageous Effects of Invention

[0008] According to the present disclosure, it is possible to improve the separability upon cooling of a die-bonding film in a predetermined method for manufacturing a semiconductor device. According to one aspect of the method for manufacturing a semiconductor device of the present disclosure, static charge of the base film can be prevented, and the yield

can be further improved.

Brief Description of Drawings

[0009] Fig. 1 is a cross-sectional view schematically showing one embodiment of a dicing/die-bonding integrated film.

5 Fig. 2 is a cross-sectional view schematically showing a method for manufacturing a semiconductor device, and Figs. 2(a), 2(b), and 2(c) are cross-sectional views schematically showing each step.

 Fig. 3 is a cross-sectional view schematically showing a method for manufacturing a semiconductor device, and Figs. 3(a) and 3(b) are cross-sectional views schematically showing each step.

Description of Embodiments

[0010] Hereinafter, embodiments of the present disclosure will be described with reference to the drawings as appropriate. However, the present disclosure is not limited to the following embodiments. In the following embodiments, the constituent elements (including steps and the like) are not essential unless otherwise specified. The size of the constituent elements in each drawing is conceptual, and the relative relationship of the size between the constituent elements is not limited to that shown in each drawing.

20 [0011] The same applies to the numerical values and their ranges in this specification, and they do not limit the present disclosure. In this specification, a numerical range indicated using "to" indicates a range including the numerical values described before and after "to" as the minimum value and the maximum value, respectively. In the numerical ranges described stepwise in this specification, the upper limit value or the lower limit value described in one numerical range may be replaced with

the upper limit value or the lower limit value of another stepwise described numerical range. Further, in the numerical ranges described in this specification, the upper limit value or the lower limit value of the numerical range may be replaced with the value shown in the examples.

5 [0012] In this specification, "(meth)acrylate" means at least one of acrylate and the corresponding methacrylate. The same applies to other similar expressions such as "(meth)acryloyl". Further, "(poly)" means both cases with and without the prefix "poly". Further, "A or B" means that it may include either one of A and B, and may include both. Further, the materials
10 exemplified below may be used alone or in combination of two or more, unless otherwise specified. The content of each component in a composition means the total amount of the plurality of substances corresponding to each component present in the composition, unless otherwise specified, when a plurality of substances corresponding to each
15 component exist in the composition.

[0013] [Dicing/die-bonding integrated film]

Fig. 1 is a cross-sectional view schematically showing one embodiment of a dicing/die-bonding integrated film. A dicing/die-bonding integrated film
10 shown in Fig. 1 includes a die-bonding film 1 (hereinafter, sometimes referred to as an "adhesive layer") and a dicing film 5 having a pressure-sensitive adhesive layer 2 laminated on the die-bonding film 1. The dicing
20 film 5 has a base film 3 and a pressure-sensitive adhesive layer 2 provided on the base film 3.

[0014] The die-bonding film 1 is an adhesive film for adhering a
25 semiconductor chip to a substrate or another semiconductor chip, and is also sometimes referred to as a die attach film (DAF). The die-bonding

film 1 has, for example, a circular principal surface that covers the entire principal surface of a semiconductor wafer.

[0015] The thickness of the die-bonding film 1 (adhesive layer) may be, for example, 100 μm or less. The thickness of the die-bonding film 1 may be, for example, 80 μm or less, 70 μm or less, 60 μm or less, 50 μm or less, 40 μm or less, 30 μm or less, 25 μm or less, or 20 μm or less, and may be 1 μm or more, 2 μm or more, 3 μm or more, 4 μm or more, or 5 μm or more.

[0016] The die-bonding film 1 may be a film formed from an adhesive commonly used for adhering semiconductor chips. The die-bonding film 1 may be a thermosetting adhesive. The thermosetting adhesive constituting the die-bonding film 1 includes, for example, a thermosetting component and a high-molecular-weight resin component (elastomer).

[0017] The thermosetting component is a compound (resin) having a reactive group that forms a crosslinked structure by self-polymerization and/or reaction with a curing agent. The thermosetting component may include, for example, an epoxy resin, and in addition to the epoxy resin, may include a Phenolic Resin that acts as a curing agent for the epoxy resin. The content of the thermosetting component may be 5 to 30 parts by mass with respect to 100 parts by mass of the total amount of the die-bonding film.

[0018] The high-molecular-weight resin component (elastomer) may include, for example, at least one resin selected from the group consisting of acrylic rubber, polyimide, and phenoxy resin, and may include acrylic rubber. The high-molecular-weight resin component may have a reactive group such as an epoxy group. The weight-average molecular weight

(standard polystyrene equivalent value by GPC method) of the high-molecular-weight resin component may be 100,000 to 3,000,000. The content of the high-molecular-weight resin component may be 30 to 80 parts by mass with respect to 100 parts by mass of the total amount of the die-bonding film.

[0019] The thermosetting adhesive may include other components as necessary. Examples of other components include a curing accelerator that promotes the reaction between the epoxy resin and the Phenolic Resin, a coupling agent (for example, a silane coupling agent), and an inorganic filler (for example, silica).

[0020] The dicing film 5 has a base film 3 and a pressure-sensitive adhesive layer 2 provided on the base film 3. The base film 3 has, for example, a rectangular principal surface. The pressure-sensitive adhesive layer 2 has a principal surface 2a in contact with the base film 3 and a principal surface 2b in contact with the die-bonding film 1. The principal surfaces 2a and 2b of the pressure-sensitive adhesive layer 2 may be circular surfaces of a size that covers the entire principal surface of the die-bonding film 1.

[0021] A tensile stress of the dicing film 5 at 20% elongation at -15°C in a tensile test is 15 MPa or more. When the tensile stress is 15 MPa or more, the separability upon cooling of the die-bonding film can be improved. The tensile stress may be 18 MPa or more, 20 MPa or more, or 22 MPa or more. The upper limit of the tensile stress is not particularly limited, but may be, for example, 40 MPa or less or 35 MPa or less.

[0022] A tensile stress of the dicing film 5 at 20% elongation at 25°C in a tensile test may be, for example, 8 MPa or more. When the tensile stress

is 8 MPa or more, there is a tendency that the separability upon cooling of the die-bonding film can be improved. The tensile stress may be 9 MPa or more, 10 MPa or more, or 12 MPa or more. The upper limit of the tensile stress may be, for example, 30 MPa or less or 20 MPa or less from the viewpoint of more excellent pick-up property.

[0023] An elongation at break of the dicing film 5 at -15°C in the tensile test is 500% or less. When the elongation at break is 500% or less, the separability upon cooling of the die-bonding film can be improved. The elongation at break may be 450% or less, 400% or less, 350% or less, or 300% or less. The lower limit of the elongation at break is not particularly limited, but may be, for example, 50% or more or 100% or more.

[0024] In this specification, the tensile stress and the elongation at break mean values measured in accordance with JIS K 7161-1:2014. More specifically, a tensile test is performed using a tensile testing machine (for example, Tensilon (manufactured by A&D Company, Limited, RTF-1250-HS-PL)) with the following sample and measurement conditions to obtain an S-S curve (stress-strain curve). The tensile stress can be determined by reading the stress value at 20% elongation on the obtained S-S curve. The elongation at break can be determined by reading the strain at the time the sample breaks.

(Measurement conditions)

Sample: Dumbbell-shaped No. 1 test piece

Chuck distance: 40 mm

Temperature condition: -15°C ± 2°C or 25°C ± 2°C

Tensile speed: 300 mm/min

[0025] The tensile stress can be increased, for example, by using an

ethylene copolymer, an ionomer resin, or the like as a main component of the base film. Further, the tensile stress can also be increased by mixing an inorganic filler or the like into the base film.

[0026] The elongation at break can be decreased by using an ethylene copolymer, an ionomer resin, or the like as a main component of the base film.

[0027] The pressure-sensitive adhesive layer 2 may be a layer formed by a pressure-sensitive adhesive commonly used in dicing films. The pressure-sensitive adhesive constituting the pressure-sensitive adhesive layer 2 may be an ultraviolet-curable pressure-sensitive adhesive or a non-ultraviolet-curable pressure-sensitive adhesive. The ultraviolet-curable pressure-sensitive adhesive is a pressure-sensitive adhesive having a property of decreasing in adhesiveness upon UV irradiation. By using an ultraviolet-curable pressure-sensitive adhesive, for example, the adhesive strength of the pressure-sensitive adhesive layer 2 can be decreased by UV irradiation before picking up the semiconductor chip to which the die-bonding film piece is attached.

[0028] The ultraviolet-curable pressure-sensitive adhesive may include, for example, an acrylic copolymer having a (meth)acryloyl group. The acrylic copolymer may have, for example, a hydroxyl group. The acrylic copolymer is a polymer including a (meth)acrylic acid ester as a monomer unit. The ultraviolet-curable pressure-sensitive adhesive may further include other components such as a photopolymerization initiator and a cross-linking agent (for example, a polyisocyanate compound) as necessary. The cross-linking agent is a compound having a reactive group that reacts with the acrylic copolymer. Examples of the cross-linking agent

include a polyisocyanate compound.

[0029] The thickness of the pressure-sensitive adhesive layer 2 may be, for example, 20 μm or less. The thickness of the pressure-sensitive adhesive layer 2 may be, for example, 18 μm or less, 16 μm or less, 14 μm or less, 12 μm or less, or 10 μm or less, and may be 1 μm or more, 2 μm or more, 3 μm or more, 4 μm or more, or 5 μm or more.

[0030] When the pressure-sensitive adhesive constituting the pressure-sensitive adhesive layer 2 is an ultraviolet-curable pressure-sensitive adhesive, the T-peel strength of the pressure-sensitive adhesive layer 2 of the dicing film 5 with respect to the die-bonding film 1 before UV irradiation may be, for example, 0.8 N/25 mm or more. When the T-peel strength is 0.8 N/25 mm or more, scattering of the semiconductor chip with a die-bonding film piece from the pressure-sensitive adhesive layer 2 before UV irradiation can be further suppressed. The T-peel strength may be 0.9 N/25 mm or more. The upper limit of the T-peel strength may be, for example, 5.0 N/25 mm or less or 3.0 N/25 mm or less. The T-peel strength can be measured by the following method. First, a dicing/die-bonding integrated film 10 is provided, a protective tape is attached to the die-bonding film of the dicing/die-bonding integrated film, and a measurement sample is prepared by cutting it into a size of 25 mm width $\times$ 100 mm length. Next, it is set in an Autograph (manufactured by Shimadzu Corporation), and the T-peel strength can be measured by peeling the dicing film from the die-bonding film by T-peel under the conditions of a measurement temperature of 25°C and a peel rate of 300 mm/min.

[0031] The above-mentioned tensile stress and the above-mentioned

elongation at break of the dicing film 5 tend to depend mainly on the base film 3. Therefore, as the base film 3, one having the above-mentioned tensile stress and the above-mentioned elongation at break within a predetermined range can be appropriately selected and used from among base films constituting a dicing/die-bonding integrated film that is commonly used in a method for manufacturing a semiconductor device including producing a semiconductor chip with a die-bonding film piece by singulating a die-bonding film by expanding a dicing film under cooling conditions (for example, 0°C or lower).

[0032] The resin constituting the base film 3 includes homopolymers and copolymers thereof of olefins such as ethylene, propylene, butene, hexene, methylpentene, 4-methyl-1-pentene, and vinyl acetate; polyesters such as polyethylene terephthalate and polyethylene naphthalate; ethylene copolymers such as ethylene-vinyl acetate copolymer, ethylene-(meth)acrylic acid copolymer, ethylene-(meth)acrylic acid ester copolymer, and ethylene-(meth)acrylic acid-(meth)acrylic acid ester copolymer; ionomer resins having an ion cross-linked structure by salt formation between an acid part and a metal ion (sodium ion, zinc ion, etc.) in a copolymer containing an olefin such as ethylene and (meth)acrylic acid; engineering plastics such as polycarbonate, polyamide, polyimide, polyetheretherketone, polyetherimide, wholly aromatic polyamide, and polyphenylsulfide; aramid (paper); glass; glass cloth; fluorine-based resins; chlorine-based resins such as polyvinyl chloride and polyvinylidene chloride; cellulosic resins; silicone-based resins; or mixtures of these with a plasticizer, or cured products obtained by cross-linking by electron beam irradiation. The base film may be composed of

one type of resin alone, or may be composed of a mixed resin in which two or more types of resins are mixed. Further, the base film may be a film having a laminated structure in which two or more types of films are laminated. The surface of the base film may be subjected to a surface roughening treatment such as mat treatment or corona treatment from the viewpoint of controlling adhesion to the pressure-sensitive adhesive layer 2.

[0033] The base film 3 may be a base film including at least one resin selected from the group consisting of polyester, ethylene copolymer, ionomer resin, and engineering plastics. By using such a base film as the base film 3 of the die-bonding film 1, there is a tendency that the above-mentioned tensile stress and the above-mentioned elongation at break of the dicing film 5 are easy to adjust to a predetermined range. The base film 3 may, in one embodiment, be a base film made of a mixed resin including an ionomer resin and a polyamide resin. The mass ratio of the ionomer resin to the polyamide resin (ionomer resin/polyamide resin) may be 50/50 to 95/5.

[0034] The base film 3 can be produced by forming a film by a conventionally known method. For example, it can be produced by adding an additive such as an antistatic agent to a resin raw material for the base as necessary, melt-kneading the mixture to obtain a resin composition, and processing it into a film shape by various molding methods such as a T-die cast molding method, a T-die nip molding method, an inflation molding method, an extrusion lamination method, and a calender molding method. Further, when the base film has a laminated structure, the laminated structure can be produced by separately forming each layer into

a film by means such as a calender molding method, an extrusion method, or an inflation molding method, and laminating them by means such as thermal lamination or adhesion with an adhesive. As the adhesive, an adhesive commonly used when producing a laminated structure can be used. It is also possible to produce a laminated structure by simultaneously extruding the resin compositions of each layer by a co-extrusion lamination method. Further, the surface of the base film on the side opposite to the side in contact with the pressure-sensitive adhesive layer may be subjected to an embossing treatment with an embossing roll or the like for the purpose of stabilizing winding during the production of the base film 3 and preventing blocking after film formation.

[0035] The base film 3 has a principal surface 3b on which the pressure-sensitive adhesive layer 2 is provided, and a principal surface 3a on a side opposite to the principal surface 3b. The surface resistance value at 25°C of the principal surface 3a of the base film 3 may be, for example, $1.0 \times 10^{12} \Omega/\text{sq}$ or less. When the surface resistance value is $1.0 \times 10^{12} \Omega/\text{sq}$ or less, static charge of the base film 3 can be prevented, and adhesion of impurities such as dust is suppressed, so that the yield can be further improved. The surface resistance value may be, for example, $0.8 \times 10^{12} \Omega/\text{sq}$ or less, $0.5 \times 10^{12} \Omega/\text{sq}$ or less, $0.2 \times 10^{12} \Omega/\text{sq}$ or less, or $0.1 \times 10^{12} \Omega/\text{sq}$ or less. The lower limit of the surface resistance value is not particularly limited, but may be, for example, $1.0 \times 10^7 \Omega/\text{sq}$ or more, $1.0 \times 10^8 \Omega/\text{sq}$ or more, or $1.0 \times 10^9 \Omega/\text{sq}$ or more.

[0036] The surface resistance value at 25°C can be measured in accordance with JIS K6911:2006. In the measurement, the following test piece is provided, and the test piece is conditioned under the measurement

environment for 24 hours in advance. The measurement can be performed by measuring three locations in the width direction under the following conditions and calculating the average value thereof to obtain the surface resistance value at 25°C.

5 (Measurement conditions)

Test piece size: 100 mm × 100 mm

Measurement surface: Principal surface on a side opposite to a principal surface on which the pressure-sensitive adhesive layer is provided

10 Measurement environment: $25 \pm 3^{\circ}\text{C}$ (temperature), $50 \pm 10\%$ RH (humidity)

Applied voltage: 500 V

Application time: 60 seconds

[0037] The thickness of the base film 3 may be, for example, 20 to 200 μm . When the thickness of the base film 3 is 20 μm or more, sufficient process resistance can be ensured, and when the thickness of the base film 3 is 200 μm or less, it is economically advantageous. The thickness of the base film 3 may be 25 μm or more or 30 μm or more, and may be 150 μm or less or 100 μm or less.

20 [0038] The shape of the base film 3 may have a rectangular principal surface, but is not limited thereto. The base film 3 may be a long film, and for example, a plurality of pressure-sensitive adhesive layers 2 may be arranged on one long base film 3.

[0039] The dicing/die-bonding integrated film of the present disclosure can be suitably used in a method for manufacturing a semiconductor device including producing a semiconductor chip with a die-bonding film piece by singulating a die-bonding film by expanding a dicing film under

cooling conditions (for example, 0°C or lower).

[0040] [Method for Manufacturing Semiconductor Device]

5 Figs. 2 and 3 are cross-sectional views schematically showing a method for manufacturing a semiconductor device. The method for manufacturing a semiconductor device shown in Figs. 2 and 3 includes (A) providing a laminate 40 including a dicing/die-bonding integrated film 10 including a dicing film 5 having a base film 3 and a pressure-sensitive adhesive layer 2 provided on the base film 3, and a die-bonding film 1 provided on the pressure-sensitive adhesive layer 2, and a plurality of semiconductor chips 10 C provided on the die-bonding film 1 of the dicing/die-bonding integrated film 10, the plurality of semiconductor chips being obtained by singulating a semiconductor wafer; and (B) producing a semiconductor chip with a die-bonding film piece 30 by expanding the dicing film 5 of the laminate 40 under cooling conditions to singulate the die-bonding film 1, thereby obtaining the semiconductor chip C and a die-bonding film piece 1a resulting from the singulation of the die-bonding film 1. The method for manufacturing a semiconductor device may further include (C) picking up the semiconductor chip with a die-bonding film piece 30 from the pressure-sensitive adhesive layer 2, and (D) mounting the picked-up semiconductor chip with a die-bonding film piece 30 on a substrate or another semiconductor chip.

25 [0041] The semiconductor chip C is obtained by singulating a semiconductor wafer. The semiconductor wafer may be a silicon wafer, and the semiconductor chip C may be a silicon chip. The semiconductor chip C has a principal surface F1 and a principal surface F2, and for example, the principal surface F1 may be a circuit surface (front surface)

and the principal surface F2 may be a back surface on the opposite side of the circuit surface.

[0042] The thickness of the semiconductor wafer may be, for example, 50 to 3000 μm , 100 to 2000 μm , or 200 to 1500 μm .

5 [0043] The method for singulating the semiconductor wafer may be a stealth dicing method such as an SDBG (Stealth Dicing Before Grinding) method, or a half-cut dicing method such as a DBG (Dicing Before Grinding) method.

10 [0044] The stealth dicing method may be a method including, for example, attaching a protective tape (back-grind tape) to the circuit surface of a semiconductor wafer, forming a modified region inside the semiconductor wafer by irradiation with a laser beam, and grinding the semiconductor wafer from the back surface side and cleaving the semiconductor wafer using the modified region as a starting point for division.

15 [0045] The half-cut dicing method may be a method including, for example, forming a groove on the front surface of a semiconductor wafer with a dicing blade, attaching a protective tape (back-grind tape) to the circuit surface of the semiconductor wafer, and grinding the semiconductor wafer from the back surface side to the groove.

20 [0046] By such a method for singulating a semiconductor wafer, a laminate 20 including a protective tape 7 (back-grind tape) and a plurality of semiconductor chips C provided on the protective tape 7 can be obtained (see Fig. 2(a)). In the laminate 20, the semiconductor chips C are provided on the protective tape 7.

25 [0047] The thickness of the semiconductor chip C is smaller than the thickness of the semiconductor wafer, and may be, for example, 10 to 200

μm. The thickness of the semiconductor chip C may be 15 μm or more or 20 μm or more, and may be 150 μm or less, 100 μm or less, or 50 μm or less.

5 [0048] Subsequently, the die-bonding film 1 is attached to the semiconductor chips C under heating conditions, with the die-bonding film 1 of the dicing/die-bonding integrated film 10 in contact with the principal surface F2 of the semiconductor chips C (see Fig. 2(a)). The temperature of the heating conditions may be, for example, 60 to 80°C. Thereby, a laminate 40 including the dicing/die-bonding integrated film 10 and a plurality of semiconductor chips C obtained by singulating a semiconductor wafer, provided on the die-bonding film 1 of the dicing/die-bonding integrated film 10, can be obtained. Subsequently, a dicing ring DR is attached to the principal surface 2b of the pressure-sensitive adhesive layer 2 on the die-bonding film 1 side so as to surround the plurality of semiconductor chips C (see Fig. 2(b)). That is, the laminate 40 may include a dicing ring DR on the principal surface 2b of the pressure-sensitive adhesive layer 2 on the die-bonding film 1 side. The protective tape 7 is peeled off from the semiconductor chips C at an appropriate timing.

20 [0049] Subsequently, under cooling conditions, the dicing film 5 is expanded (stretched) by pushing up a region inside the dicing ring DR of the dicing film 5 with a cooling stage S (see Fig. 2(c)). The temperature of the cooling conditions may be, for example, -15 to 0°C. By expanding the dicing film 5, the die-bonding film 1 is cut. By this cutting, a semiconductor chip with a die-bonding film piece 30, which has the semiconductor chip C and a die-bonding film piece 1a resulting from the

singulation of the die-bonding film 1, is formed on the pressure-sensitive adhesive layer 2.

[0050] After the cooling stage S is lowered, in the dicing film 5, a region between the dicing ring DR and the semiconductor chip with a die-bonding film piece 30 is heated by a heater H (see Fig. 3(a)). Due to the thermal shrinkage of the heated portion of the dicing film 5, the kerf width between the semiconductor chips with a die-bonding film piece 30 tends to further widen.

[0051] When the pressure-sensitive adhesive layer 2 is a layer formed by an ultraviolet-curable pressure-sensitive adhesive, the adhesive strength of the pressure-sensitive adhesive layer 2 can be decreased by UV irradiation. After decreasing the adhesive strength of the pressure-sensitive adhesive layer 2, the individual semiconductor chips with a die-bonding film piece 30 pushed up by the push-up jig 42 are picked up by a suction collet 44 (see Fig. 3(b)).

[0052] The picked-up semiconductor chip with a die-bonding film piece 30 is mounted on a substrate or another semiconductor chip. By laminating a plurality of semiconductor chips, for example, a 3D NAND flash memory can be manufactured.

Examples

[0053] Hereinafter, the present disclosure will be described more specifically based on examples, but the present disclosure is not limited to these examples. Note that unless otherwise specified, all chemicals used were reagents (commercially available products).

[0054] Example 1

1. Synthesis of ultraviolet-curable pressure-sensitive adhesive (Production

Example 1-1)

As copolymer monomer components, 2-ethylhexyl acrylate (EHA) and 2-hydroxyethyl acrylate (HEA) were provided. These copolymer monomer components were mixed so that the copolymerization ratio of EHA/HEA = 75 parts by mass/25 parts by mass, and using ethyl acetate as a solvent and 0.08 parts by mass of azobisisobutyronitrile (AIBN) as an initiator, an acrylic copolymer was obtained by solution radical polymerization. To this acrylic copolymer, 0.05 parts by mass of hydroquinone monomethyl ether was used as a polymerization inhibitor, and 16 parts by mass of 2-methacryloyloxyethyl isocyanate (trade name: Karenz MOI, molecular weight: 155.15, manufactured by Resonac Corporation) was reacted to synthesize an ultraviolet-curable acrylic copolymer having a carbon-carbon double bond (methacryloyl group). The weight-average molecular weight (standard polystyrene equivalent value by GPC method) of the ultraviolet-curable acrylic copolymer was 350,000. The hydroxyl value of the ultraviolet-curable acrylic copolymer, measured in accordance with the method described in JIS K0070:1992, was 37.6 mgKOH/g.

[0055] 100 parts by mass in terms of solid content of the obtained ultraviolet-curable acrylic copolymer, 1.0 part by mass of an α -hydroxyalkylphenone-based photopolymerization initiator (trade name: Omnirad 184, manufactured by IGM Resins B.V.), 0.2 parts by mass of an acylphosphine oxide-based photopolymerization initiator (trade name: Omnirad 819, manufactured by IGM Resins B.V.), and 4.0 parts by mass in terms of solid content of a TDI-based polyisocyanate-based cross-linking agent (trade name: Coronate L-45E, manufactured by Tosoh Corporation) as a cross-linking agent were blended in this ratio, diluted

with ethyl acetate, and stirred to prepare a solution of the ultraviolet-curable pressure-sensitive adhesive of Production Example 1-1.

[0056] 2. Production of base film (Production Example 2-1)

An ionomer resin A, in which molecules of an ethylene-methacrylic acid copolymer were cross-linked with metal ions, was provided. Subsequently, an ionomer resin B was obtained by adding 30 parts by mass or less of an antistatic agent to the ionomer resin A, where the total amount of the ionomer resin A was taken as 100 parts by mass. The base film of Production Example 2-1 was obtained by adjusting with an extruder so that the thickness ratio of the layer made of ionomer resin A / the layer made of ionomer resin B = 65/15, and the total thickness of the layer made of ionomer resin A and the layer made of ionomer resin B was 80 μm . Note that the pressure-sensitive adhesive layer was formed on the layer made of ionomer resin A.

[0057] 3. Production of dicing film (Production Example 3-1)

The solution of the ultraviolet-curable pressure-sensitive adhesive of Production Example 1-1 was applied onto a polyethylene terephthalate film (thickness: 38 μm) with one surface subjected to a release treatment, so that the thickness after drying would be 10 μm , and dried at 80°C for 3 minutes to produce a pressure-sensitive adhesive layer on the polyethylene terephthalate film. Thereafter, the base film of Production Example 2-1 produced above, with one surface subjected to a corona discharge treatment, was laminated onto the pressure-sensitive adhesive layer. The laminated body was subjected to an aging treatment in a constant temperature bath at 23°C for 96 hours to obtain the dicing film of Production Example 3-1 having a base film and a pressure-sensitive

adhesive layer provided on the base film.

[0058] 4. Production of die-bonding film (Production Example 4-1)

A mixture including the following components and cyclohexanone was stirred and then kneaded for 90 minutes using a bead mill.

- 5 • Epoxy resin (trade name: N500P-10, DIC Corporation, cresol novolac type epoxy resin, epoxy equivalent: 200, softening point: 85°C): 55 parts by mass
- Phenolic Resin (trade name: MEH-7800M, manufactured by Meiwa Plastic Industries, Ltd. (UBE Corporation), hydroxyl equivalent: 175): 45
- 10 parts by mass
- Silane coupling agent A (trade name: NUC A-189, manufactured by Nippon Unicar Company Limited (ENEOS NUC Co., Ltd.), γ -mercaptopropyltrimethoxysilane): 1.7 parts by mass
- Silane coupling agent B (trade name: NUC A-1160, manufactured by
- 15 Nippon Unicar Company Limited (ENEOS NUC Co., Ltd.), γ -ureidopropyltriethoxysilane): 0.2 parts by mass
- Filler (trade name: Aerosil R972, manufactured by Nippon Aerosil Co., Ltd., silica, average particle size 0.016 μm): 32 parts by mass

20 Note that "Aerosil R972" is silica particles having organic groups (for example, methyl groups) on the surface.

[0059] The following components were added to the kneaded mixture, and the mixture was further stirred. Thereafter, a varnish for forming a die-bonding film was obtained by vacuum deaeration.

- 25 • Acrylic rubber having an epoxy group (trade name: HTR-860P-3, manufactured by Nagase ChemteX Corporation, content of glycidyl acrylate or glycidyl methacrylate: 3% by mass, weight-average molecular

weight: 800,000): 280 parts by mass

- Curing accelerator (trade name: Curezol 2PZ-CN, "Curezol" is a registered trademark, manufactured by Shikoku Chemicals Corporation, 1-cyanoethyl-2-phenylimidazole): 0.5 parts by mass

5 [0060] A polyethylene terephthalate film having a release surface (thickness: 38 μm , manufactured by Teijin DuPont Films, Teijin Teton Film A-31) was provided as a carrier film. The varnish for forming a die-bonding film was applied to the release surface of the carrier film, and the coating film was heat-dried at 140°C for 5 minutes. Thereby, a laminated
10 film having the carrier film and the die-bonding film of Production Example 4-1 in a B-stage state (adhesive layer with a thickness of 20 μm) formed thereon was obtained.

[0061] 5. Production of dicing/die-bonding integrated film

The laminated film having the die-bonding film of Production Example 4-
15 1 was cut into a circular shape (diameter: 312 mm). The dicing film of Production Example 3-1, from which the polyethylene terephthalate film had been peeled, was attached to the circular die-bonding film in such a manner that the pressure-sensitive adhesive layer was in contact with the die-bonding film, to obtain a laminate. The obtained laminate was left to
20 stand at room temperature (25°C) for one day. Thereafter, in the dicing film, the outside of the portion laminated to the die-bonding film was cut to obtain the dicing/die-bonding integrated film of Example 1, including the circular die-bonding film and a circular (diameter: 370 mm) dicing film that covers the die-bonding film and has a portion protruding from
25 the die-bonding film. By the same operation, a plurality of dicing/die-bonding integrated films of Example 1 were produced to be subjected to

various evaluation tests described later.

[0062] Example 2

5 A plurality of dicing/die-bonding integrated films of Example 2 were produced in the same procedure as in Example 1, except that the die-bonding film of Production Example 4-1 (adhesive layer with a thickness of 20 μm) was changed to the following die-bonding film of Production Example 4-2 (adhesive layer with a thickness of 60 μm).

[0063] • Production of die-bonding film (Production Example 4-2)

10 A mixture including the following components and cyclohexanone was stirred and then kneaded for 90 minutes using a bead mill.

- Epoxy resin (trade name: N500P-10, DIC Corporation, cresol novolac type epoxy resin, epoxy equivalent: 200, softening point: 85°C): 29 parts by mass
- Epoxy resin (trade name: EXA-830CRP, manufactured by DIC Corporation, bisphenol F type epoxy resin, epoxy equivalent: 159, liquid at 25°C): 27 parts by mass
- Phenolic Resin (trade name: MEH-7800M, manufactured by Meiwa Plastic Industries, Ltd. (UBE Corporation), hydroxyl equivalent: 175): 45 parts by mass
- 20 • Silane coupling agent A (trade name: NUC A-189, manufactured by Nippon Unicar Company Limited (ENEOS NUC Co., Ltd.), γ -mercaptopropyltrimethoxysilane): 0.2 parts by mass
- Silane coupling agent B (trade name: NUC A-1160, manufactured by Nippon Unicar Company Limited (ENEOS NUC Co., Ltd.), γ -ureidopropyltriethoxysilane): 0.3 parts by mass
- 25 • Filler (trade name: SC2050-HLG, manufactured by Admatechs

Company Limited, silica, average particle size 0.50 μm): 32 parts by mass
[0064] The following components were added to the kneaded mixture, and the mixture was further stirred. Thereafter, a varnish for forming a die-bonding film was obtained by vacuum deaeration.

- 5 • Acrylic rubber having an epoxy group (trade name: HTR-860P-3, manufactured by Nagase ChemteX Corporation, content of glycidyl acrylate or glycidyl methacrylate: 3% by mass, weight-average molecular weight: 800,000): 55 parts by mass

- Curing accelerator (trade name: Curezol 2PZ-CN, "Curezol" is a
10 registered trademark, manufactured by Shikoku Chemicals Corporation, 1-cyanoethyl-2-phenylimidazole): 0.1 parts by mass

[0065] A polyethylene terephthalate film having a release surface (thickness: 38 μm , manufactured by Teijin DuPont Films, Teijin Tetonon Film A-31) was provided as a carrier film. The varnish for forming a die-bonding film was applied to the release surface of the carrier film, and the
15 coating film was heat-dried at 140°C for 5 minutes. Thereby, a laminated film having the carrier film and the die-bonding film of Production Example 4-2 in a B-stage state (adhesive layer with a thickness of 60 μm) formed thereon was obtained.

20 [0066] Example 3

A dicing film of Production Example 3-2 was produced in the same procedure as in Example 1, except that the base film of Production Example 2-1 was changed to the following base film of Production Example 2-2. A plurality of dicing/die-bonding integrated films of
25 Example 3 were produced in the same procedure as in Example 1, except that the dicing film of Production Example 3-1 was changed to the dicing

film of Production Example 3-2.

[0067] • Production of base film (Production Example 2-2)

5 An ionomer resin, in which molecules of an ethylene-methacrylic acid copolymer were cross-linked with metal ions, was adjusted with an extruder to have a thickness of 90 μm to obtain the base film of Production Example 2-2.

[0068] Comparative Example 1

10 A dicing film of Production Example 3-3 was obtained in the same procedure as in Example 1, except that the ultraviolet-curable pressure-sensitive adhesive of Production Example 1-1 was changed to the following ultraviolet-curable pressure-sensitive adhesive of Production Example 1-2, and the base film of Production Example 2-1 was changed to the following base film of Production Example 2-3. A plurality of dicing/die-bonding integrated films of Comparative Example 1 were
15 produced in the same procedure as in Example 1, except that the dicing film of Production Example 3-1 was changed to the dicing film of Production Example 3-3.

[0069] • Synthesis of ultraviolet-curable pressure-sensitive adhesive (Production Example 1-2)

20 As copolymer monomer components, 2-ethylhexyl acrylate (EHA), 2-hydroxyethyl acrylate (HEA), and methyl methacrylate (MMA) were provided. These copolymer monomer components were mixed so that the copolymerization ratio of EHA/HEA/MMA = 78 parts by mass/21 parts by mass/1 part by mass, and using ethyl acetate as a solvent and 0.08 parts
25 by mass of azobisisobutyronitrile (AIBN) as an initiator, an acrylic copolymer was obtained by solution radical polymerization. Next, using

0.05 parts by mass of hydroquinone monomethyl ether as a polymerization inhibitor, 16 parts by mass of 2-methacryloyloxyethyl isocyanate (trade name: Karenz MOI, molecular weight: 155.15, manufactured by Resonac Corporation) was reacted with this acrylic copolymer to synthesize an ultraviolet-curable acrylic copolymer having a carbon-carbon double bond (methacryloyl group). The weight-average molecular weight (standard polystyrene equivalent value by GPC method) of the ultraviolet-curable acrylic copolymer was 350,000. The hydroxyl value and acid value of the ultraviolet-curable acrylic copolymer, measured in accordance with the method described in JIS K0070:1992, were 37.6 mgKOH/g and 6.5 mgKOH/g, respectively.

[0070] 100 parts by mass in terms of solid content of the obtained ultraviolet-curable acrylic copolymer, 1.0 part by mass of an α -hydroxyalkylphenone-based photopolymerization initiator (trade name: Omnirad 184, manufactured by IGM Resins B.V.), 0.2 parts by mass of an acylphosphine oxide-based photopolymerization initiator (trade name: Omnirad 819, manufactured by IGM Resins B.V.), and 4.0 parts by mass in terms of solid content of a TDI-based polyisocyanate-based cross-linking agent (trade name: Coronate L-45E, manufactured by Tosoh Corporation) as a cross-linking agent were blended in this ratio, diluted with ethyl acetate, and stirred to prepare a solution of the ultraviolet-curable pressure-sensitive adhesive of Production Example 1-2.

[0071] • Production of base film (Production Example 2-3)

A mixed resin C of polypropylene/ethylene-vinyl acetate copolymer was provided. A resin D was obtained by adding 30 parts by mass or less of an antistatic agent to polypropylene, where the total amount of polypropylene

was taken as 100 parts by mass. The base film of Production Example 2-3 was obtained by adjusting with an extruder so that the thickness ratio of the layer made of mixed resin C / the layer made of resin D = 65/15, and the total thickness of the layer made of mixed resin C and the layer made of resin D was 100 μm . Note that the pressure-sensitive adhesive layer was formed on the layer made of mixed resin C of the base film.

[0072] • Production of dicing film (Production Example 3-3)

The solution of the ultraviolet-curable pressure-sensitive adhesive of Production Example 1-2 was applied onto a polyethylene terephthalate film (thickness: 38 μm) with one surface subjected to a release treatment, so that the thickness after drying would be 10 μm , and dried at 80°C for 3 minutes to produce a pressure-sensitive adhesive layer on the polyethylene terephthalate film. Thereafter, the base film of Production Example 2-3 produced above, with one surface subjected to a corona discharge treatment, was laminated onto the pressure-sensitive adhesive layer. The laminated body was subjected to an aging treatment in a constant temperature bath at 23°C for 96 hours to obtain the dicing film of Production Example 3-3 having a base film and a pressure-sensitive adhesive layer provided on the base film.

[0073] Comparative Example 2

A dicing film of Production Example 3-4 was obtained in the same procedure as in Example 1, except that the base film of Production Example 2-1 was changed to the following base film of Production Example 2-4. A plurality of dicing/die-bonding integrated films of Comparative Example 2 were produced in the same procedure as in Example 1, except that the dicing film of Production Example 3-1 was

changed to the dicing film of Production Example 3-4.

[0074] • Production of base film (Production Example 2-4)

5 An ionomer resin, in which molecules of an ethylene-methacrylic acid copolymer were cross-linked with metal ions, and an ethylene-vinyl acetate copolymer were provided. The base film of Production Example 2-4 was obtained by adjusting with an extruder so that the thickness of the ionomer resin/vinyl acetate resin/ionomer resin was 80 μm .

[0075] Evaluation

(1) Characteristic evaluation of dicing film

10 (1-1) Measurement of tensile stress and elongation at break

For each dicing film of the dicing/die-bonding integrated films of Examples 1 to 3 and Comparative Examples 1 and 2, a tensile test was performed in accordance with JIS K 7161-1:2014 using a Tensilon (manufactured by A&D Manufacturing, Inc., RTF-1250-HS-PL) with the
15 following sample and measurement conditions to obtain an S-S curve (stress-strain curve). The tensile stress was determined by reading the stress value at 20% elongation on the obtained S-S curve. The elongation at break was determined by reading the strain at the time the sample broke. The results are shown in Table 1.

20 (Measurement conditions)

Sample: Dumbbell-shaped No. 1 test piece

Chuck distance: 40 mm

Temperature condition: $-15^{\circ}\text{C} \pm 2^{\circ}\text{C}$ or $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$

Tensile speed: 300 mm/min

25 [0076] (1-2) Measurement of surface resistance

For the principal surface on the side opposite to the principal surface on

which the pressure-sensitive adhesive layer is provided of the base films (base films of Production Examples 2-1 to 2-4) of the dicing/die-bonding integrated films of Examples 1 to 3 and Comparative Examples 1 and 2, measurement was performed in accordance with JIS K6911:2006. In the measurement, the following test piece was provided, and the test piece was conditioned under the measurement environment for 24 hours in advance. The measurement was performed by measuring three locations in the width direction under the following conditions and calculating the average value thereof to obtain the surface resistance value at 25°C. The results are shown in Table 1.

(Measurement conditions)

Test piece size: 100 mm × 100 mm

Measurement surface: Principal surface on a side opposite to a principal surface on which the pressure-sensitive adhesive layer is provided

Measurement environment: 25 ± 3°C (temperature), 50 ± 10% RH (humidity)

Applied voltage: 500 V

Application time: 60 seconds

[0077] (2) Characteristic evaluation of dicing/die-bonding integrated film (2-1) Measurement of T-peel strength

A protective tape was attached to the die-bonding film of the dicing/die-bonding integrated films of Examples 1 to 3 and Comparative Examples 1 and 2, and a measurement sample was prepared by cutting it into a size of 25 mm width × 100 mm length. Next, it was set in an Autograph (manufactured by Shimadzu Corporation), and the T-peel strength was measured by peeling the dicing film from the die-bonding film by T-peel

under the conditions of a measurement temperature of 25°C and a peel rate of 300 mm/min. The results are shown in Table 1.

[0078] (3) Evaluation of processability

(3-1) Production of sample for processability evaluation

5 A sample for processability evaluation was produced according to the following procedure. A protective tape was attached to the front surface of a silicon wafer (diameter: 12 inches, thickness: 775 μm). Thereafter, the silicon wafer was singulated by stealth dicing. That is, a modified region was formed inside the silicon wafer by irradiating the surface (back
10 surface) of the silicon wafer on the side opposite to the side to which the protective tape was attached with a laser beam under the following conditions.

(Stealth dicing conditions)

- Stealth dicing apparatus: DFL7361 (manufactured by DISCO
15 Corporation)
- Laser oscillator type: Semiconductor laser-pumped Q-switched solid-state laser
- Wavelength: 1342 nm
- Frequency: 60 kHz
- 20 • Output: 0.8 W
- Number of passes: 2
- Chip size: 3 mm $\times$ 12 mm
- Dicing speed: 800 mm/sec

[0079] Subsequently, the surface of the silicon wafer opposite to the
25 protective tape was ground (polished) using a grinder polisher apparatus (DGP8761, manufactured by DISCO Corporation) until the thickness of

the silicon wafer became 30 μm , and the silicon wafer was singulated to obtain silicon chips. The die-bonding film of the dicing/die-bonding integrated film was attached to the surface of the silicon chips opposite to the protective tape under the following attachment conditions. At this time, the orientation of the attachment was adjusted so that the direction of the division lines of the silicon chips was aligned with the MD direction (Machine Direction, the direction parallel to the longitudinal direction (flow direction) in the original roll providing the base film) and the TD direction (Transverse Direction, the direction orthogonal to the MD direction (perpendicular direction)) of the base film of the dicing/die-bonding integrated film. Furthermore, the portion of the pressure-sensitive adhesive layer protruding from the die-bonding film was attached to a dicing ring, and then the protective tape was peeled off from the silicon wafer.

(Attachment conditions)

- Attachment apparatus: DFM2800 (manufactured by DISCO Corporation)
- Attachment temperature: 65°C
- Attachment speed: 10 mm/s
- Attachment tension level: Level 5

[0080] Next, using a die separator (DDS2300, manufactured by DISCO Corporation), the dicing film of the dicing/die-bonding integrated film was stretched by cooling expansion under the following cooling expansion conditions, thereby dividing the die-bonding film. Thereafter, the dicing film was shrunk by heating (thermal shrinkage) under the following heating conditions.

(Cooling expansion conditions)

- Cooling temperature: 0°C
- Cooling time: 120 seconds
- Push-up amount: 10 mm
- Push-up speed: 120 mm/sec
- Holding time after push-up: 10 seconds

(Heating conditions)

- Heater temperature: 250°C
- Heater rotation speed: 10°/sec

- Push-up amount: 8 mm
- Tape cooling waiting time: 10 seconds

[0081] After the shrinkage of the dicing film, the pressure-sensitive adhesive layer was irradiated with ultraviolet rays under the following conditions, thereby decreasing the adhesive strength of the pressure-sensitive adhesive layer.

(UV irradiation conditions)

- UV illuminance: 100 mW/cm²
- UV irradiation dose: 150 mJ/cm²

[0082] (3-2) Evaluation

(a) Evaluation of separability

In "(3-1) Production of sample for processability evaluation," for the sample after dividing the die-bonding film by cooling expansion, five dicing lines at the center of the silicon wafer, both ends in the MD direction of the silicon wafer, and both ends in the TD direction of the silicon wafer were observed using an optical microscope. The case where no die-bonding film remained was evaluated as "A" indicating excellent

separability, and the case where the die-bonding film remained was evaluated as "B". The results are shown in Table 1.

[0083] (b) Evaluation of pick-up property

- 5 Using the sample for processability evaluation produced in "(3-1)
Production of sample for processability evaluation," the pick-up of
semiconductor chips with a die-bonding film piece was examined under
the following conditions. The case where 10 chips could be picked up
consecutively was evaluated as "A" indicating excellent pick-up property,
and the case where 10 chips could not be picked up consecutively was
10 evaluated as "B". The results are shown in Table 1.

Pick-up height: 150 μm

Speed: 1 mm/s

[0084] [Table 1]

		Exam. 1	Exam. 2	Exam. 3	Comp. Exam. 1	Comp. Exam. 2
	Type	Manu. Exam. 1-1	Manu. Exam. 1-1	Manu. Exam. 1-1	Manu. Exam. 1-2	Manu. Exam. 1-1
pressure-sensitive adhesive layer	Thickness (μm)	10	10	10	10	10
base film	Type	Manu. Exam. 2-1	Manu. Exam. 2-1	Manu. Exam. 2-2	Manu. Exam. 2-3	Manu. Exam. 2-4
	Thickness (μm)	80	80	90	100	80
dicing film	Type	Manu. Exam. 3-1	Manu. Exam. 3-1	Manu. Exam. 3-2	Manu. Exam. 3-3	Manu. Exam. 3-4
die bonding film	Type	Manu. Exam. 4-1	Manu. Exam. 4-2	Manu. Exam. 4-1	Manu. Exam. 4-1	Manu. Exam. 4-1
	Thickness (μm)	20	60	20	20	20
Tensile stress @ -15°C	MPa	25	25	25	15	11
Tensile stress @ 25°C	MPa	12	12	12	5.3	6.0
Elongation at break @ -15°C	%	255	255	160	536	290
Surface resistance @ 25°C	Ω/sq	0.6×10^{11}	0.6×10^{11}	5.0×10^{11}	$>10^{15}$	$>10^{15}$
T-peel strength @ 25°C	N/25mm	0.98	0.83	0.96	0.75	0.96
Cuttability		A	A	A	B	B
Pick-up property		A	A	A	B	B

[0085] As shown in Table 1, the dicing/die-bonding integrated films of Examples 1 to 3, in which the tensile stress of the dicing film at 20% elongation at -15°C in a tensile test is 15 MPa or more and the elongation at break of the dicing film at -15°C in the tensile test is 500% or less, were superior in terms of separability and pick-up property compared to the dicing/die-bonding integrated films of Comparative Examples 1 and 2, which do not satisfy these requirements.

[0086]

From the above, it was confirmed that according to the present disclosure, the separability upon cooling of a die-bonding film can be improved in a predetermined method for manufacturing a semiconductor device.

Reference Signs List

[0087]

1... die-bonding film, 1a... die-bonding film piece, 2... pressure-sensitive adhesive layer, 3... base film, 5... dicing film, 7... protective tape, 10... dicing/die-bonding integrated film, 30... semiconductor chip with a die-bonding film piece, C... semiconductor chip.

CLAIMS

[Claim 1] A method for manufacturing a semiconductor device, the method comprising:

5 (A) providing a laminate comprising a dicing/die-bonding integrated film including a dicing film having a base film and a pressure-sensitive adhesive layer provided on the base film, and a die-bonding film provided on the pressure-sensitive adhesive layer, and a plurality of semiconductor chips provided on the die-bonding film of the dicing/die-bonding integrated film, the plurality of semiconductor chips being
10 obtained by singulating a semiconductor wafer; and

(B) producing a semiconductor chip with a die-bonding film piece by expanding the dicing film of the laminate under cooling conditions to singulate the die-bonding film, thereby obtaining the semiconductor chip and a die-bonding film piece resulting from a singulation of the die-bonding film,
15

wherein a tensile stress of the dicing film at 20% elongation at -15°C in a tensile test is 15 MPa or more, and an elongation at break of the dicing film at -15°C in the tensile test is 500% or less.

[Claim 2] The method according to claim 1, wherein a surface
20 resistance value at 25°C of a principal surface of the base film on a side opposite to a principal surface on which the pressure-sensitive adhesive layer is provided is $1.0 \times 10^{12} \Omega/\text{sq}$ or less.

[Claim 3] The method according to claim 1 or 2, wherein, in (A), the
25 method for singulating the semiconductor wafer is a stealth dicing method or a half-cut dicing method.

[Claim 4] A dicing/die-bonding integrated film comprising:

a dicing film having a base film and a pressure-sensitive adhesive layer provided on the base film; and

a die-bonding film provided on the pressure-sensitive adhesive layer,

5 wherein a tensile stress of the dicing film at 20% elongation at -15°C in a tensile test is 15 MPa or more, and an elongation at break of the dicing film at -15°C in the tensile test is 500% or less.

[Claim 5] The dicing/die-bonding integrated film according to claim 4, wherein a surface resistance value at 25°C of a principal surface of the
10 base film on a side opposite to a principal surface on which the pressure-sensitive adhesive layer is provided is $1.0 \times 10^{12} \Omega/\text{sq}$ or less.