

[DESCRIPTION]

[TITLE OF INVENTION]

SEMICONDUCTOR CHIP PRODUCTION METHOD

[Technical Field]

5 [0001]

The present invention relates to a method for manufacturing a semiconductor chip. More specifically, the present invention relates to a method for manufacturing a semiconductor chip in which a cured resin film is provided as a protective film.

10 [Background Art]

[0002]

In recent years, semiconductor devices have been manufactured using a mounting method, what is called the face-down method. In the face-down method, a semiconductor chip provided with a bump on a circuit surface and a substrate for mounting the semiconductor chip are laminated to allow the circuit surface of the semiconductor chip to face the substrate, and the semiconductor chip is mounted on the substrate accordingly.

The semiconductor chip is typically obtained by segmenting the semiconductor wafer provided with bumps on the circuit surface into individual pieces.

20 [0003]

The semiconductor wafer provided with bumps may be provided with a protective film to protect joint portions (hereinafter also referred to as the “bump neck”) between the bumps and the semiconductor wafer.

For example, in Patent Literature 1 and Patent Literature 2, a laminate in which a supporting substrate, a pressure sensitive adhesive layer, and a thermosetting resin layer are laminated in this order is attached by pressing to a bump-formed surface of a semiconductor wafer provided with bumps using the thermosetting resin layer as the bonding surface, then the thermosetting resin layer is heated to cure, and a protective film is formed accordingly.

[Citation List]

[Patent Literature]

[0004]

10 Patent Literature 1: JP 2015-092594 A

Patent Literature 2: JP 2012-169484 A

[Summary of Invention]

[Technical Problem]

[0005]

15 In recent years, as miniaturization and thinning of IC-embedded products, such as electronic devices, progress, there is also a growing demand for thinner semiconductor chips. However, thinning of semiconductor chips causes reduction of their strength. Thus, semiconductor chips are liable to be damaged, for example, when a post process for conveying semiconductor chips or packaging
20 semiconductor chips is carried out.

A conceivable solution to overcome such a problem is to form a protective film on the bump-formed surface of the semiconductor wafer to protect the bump neck and improve the strength of the semiconductor chip. However, only forming a protective film on the bump-formed surface of the semiconductor wafer is not

sufficient to improve the strength of the semiconductor chip. In addition, peeling of the protective film may occur.

[0006]

The present invention has been made in view of such problems, and an
5 object of the present invention is to provide a method for manufacturing a semiconductor chip having excellent strength and a protective film prevented from peeling.

[Solution to Problem]

[0007]

10 The present inventors conceived that the protective film to be provided to protect the bump neck is provided to a side surface of the semiconductor chip, and this can improve the strength of the semiconductor chip as well as prevent the peeling of the protective film and create a very reasonable configuration. Then, as a result of diligent studies based on the conception, the present inventors found a
15 manufacturing method that can achieve the conception and completed the present invention.

[0008]

That is, the present invention relates to [1] to [14] below.

[1] A method for manufacturing a semiconductor chip, the method
20 including steps (S1) to (S4) below in this order:

(S1) preparing a wafer for producing semiconductor chips, wherein groove parts as predetermined segmentation lines are formed in a bump-formed surface of a semiconductor wafer having the bump-formed surface provided with bumps, the groove parts not reaching a back surface of the semiconductor wafer;

(S2) attaching a first curable resin (x1) by pressing to the bump-formed surface of the wafer for producing semiconductor chips to cover the bump-formed surface of the wafer for producing semiconductor chips with the first curable resin (x1) and to embed the first curable resin (x1) into the groove parts formed in the
5 wafer for producing semiconductor chips;

(S3) curing the first curable resin (x1) to obtain a wafer for producing semiconductor chips with a first cured resin film (r1);

(S4) segmenting the wafer for producing semiconductor chips with the first cured resin film (r1) along the predetermined segmentation lines into individual
10 pieces to obtain semiconductor chips in which at least the bump-formed surface and a side surface are covered with the first cured resin film (r1); and

the method further including step (S-BG) below after step (S2) above and before step (S3) above, after step (S3) above and before step (S4) above, or in step (S4) above:

15 (S-BG) grinding the back surface of the wafer for producing semiconductor chips.

[2] The method for manufacturing a semiconductor chip according to [1] above, wherein step (S2) above is performed by attaching by pressing a first laminate ($\alpha 1$) having a laminated structure in which a first support sheet (Y1) and
20 a layer (X1) of the first curable resin (x1) are laminated to the bump-formed surface of the wafer for producing semiconductor chips using the layer (X1) as an attachment surface.

[3] The method for manufacturing a semiconductor chip according to [2] above, the method including step (S-BG) above after step (S2) above and before
25 step (S3) above, wherein

step (S-BG) above is performed by grinding the back surface of the wafer for producing semiconductor chips with the first laminate ($\alpha 1$) attached and then peeling off the first support sheet (Y1) from the first laminate ($\alpha 1$), and

5 step (S4) above is performed by cutting portions of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts, along the predetermined segmentation lines.

[4] The method for manufacturing a semiconductor chip according to [2] above, the method including step (S-BG) above after step (S3) above and before
10 step (S4) above, wherein

step (S3) above is performed without peeling off the first support sheet (Y1) from the first laminate ($\alpha 1$),

step (S-BG) above is performed by grinding the back surface of the wafer for producing semiconductor chips with the first laminate ($\alpha 1$) attached, and then
15 peeling off the first support sheet (Y1) from the first laminate ($\alpha 1$), and

step (S4) above is performed by cutting portions of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts, along the predetermined segmentation lines.

20 [5] The method for manufacturing a semiconductor chip according to [2] above, the method including step (S-BG) above after step (S3) above and before step (S4) above, wherein

the first support sheet (Y1) is peeled off from the first laminate ($\alpha 1$) after step (S2) above and before step (S3) above,

step (S-BG) above is performed by attaching a back grinding sheet (b-BG) to a front surface of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), grinding the back surface of the wafer for producing semiconductor chips with the back grinding sheet (b-BG) attached, and then peeling off the back grinding sheet (b-BG) from the wafer for producing semiconductor chips with the first cured resin film (r1), and

step (S4) above is performed by cutting portions of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts, along the predetermined segmentation lines.

[6] The method for manufacturing a semiconductor chip according to [2] above, the method including step (S-BG) above in step (S4) above, wherein

the first support sheet (Y1) is peeled off from the first laminate ($\alpha 1$) after step (S2) above and before step (S3) above, and

step (S4) above is performed by making cuts in portions of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts, along the predetermined segmentation lines, or forming modified regions along the predetermined segmentation lines, and then performing step (S-BG) above by attaching a back grinding sheet (b-BG) to a front surface of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), and grinding the back surface of the wafer for producing semiconductor chips with the back grinding sheet (b-BG) attached.

[7] The method for manufacturing a semiconductor chip according to any of [1] to [6] above, further including step (T) below:

(T) forming a second cured resin film (r2) on the back surface of the wafer for producing semiconductor chips.

[8] The method for manufacturing a semiconductor chip according to any of [1] to [7], further including step (U) below:

5 (U) removing the first cured resin film (r1) covering a top part of the bump or the first cured resin film (r1) adhering to a portion of the top part of the bump to expose the top part of the bump.

[9] The method for manufacturing a semiconductor chip according to [8] above, wherein step (U) above is performed by plasma etching treatment.

10 [10] The method for manufacturing a semiconductor chip according to any of [1] to [9] above, wherein a shear modulus of elasticity G' is from 5.0×10 Pa to 1.0×10^6 Pa when a strain dispersion measurement is performed to measure a shear modulus of elasticity G' of a test piece of the layer (X1) by causing a 400% strain on the test piece of the layer (X1) under conditions of a temperature of 90°C
15 and a frequency of 1 Hz.

[11] The method for manufacturing a semiconductor chip according to any of [1] to [10] above, wherein a thickness of the layer (X1) is 10 μm or greater and 200 μm or less.

[12] The method for manufacturing a semiconductor chip according to any
20 of [1] to [11] above, wherein a width of the groove part is from 10 μm to 2000 μm .

[13] The method for manufacturing a semiconductor chip according to any of [1] to [12] above, wherein a depth of the groove part is from 30 μm to 700 μm .

[14] The method for manufacturing a semiconductor chip according to any
25 of [1] to [13] above, wherein the first cured resin film (r1) is transparent.

[Advantageous Effects of Invention]

[0009]

The present invention makes it possible to provide the method for manufacturing a semiconductor chip having excellent strength and a protective
5 film prevented from peeling.

[Brief Description of Drawings]

[0010]

Fig. 1 is a process schematic diagram of a method for manufacturing a semiconductor chip of the present invention.

10 Fig. 2 is a top view illustrating an example of a wafer for producing semiconductor chips to be prepared in step (S1).

Fig. 3 is a schematic cross-sectional view illustrating an example of the wafer for producing semiconductor chips to be prepared in step (S1).

Fig. 4 is a diagram illustrating an outline of step (S2).

15 Fig. 5 is a diagram illustrating an outline of a manufacturing method according to a first embodiment.

Fig. 6 is a diagram illustrating an outline of a manufacturing method according to a second embodiment.

20 Fig. 7 is a diagram illustrating an outline of a manufacturing method according to a third embodiment.

Fig. 8 is a diagram illustrating an outline of a manufacturing method according to a fourth embodiment.

Fig. 9 is a schematic cross-sectional view illustrating a configuration of a first laminate ($\alpha 1$) to be used in a manufacturing method of the present invention.

Fig. 10 is a schematic cross-sectional view illustrating an example of a specific configuration of the first laminate ($\alpha 1$).

Fig. 11 is a schematic cross-sectional view illustrating another example of a specific configuration of the first laminate ($\alpha 1$).

5 Fig. 12 is a schematic cross-sectional view illustrating yet another example of a specific configuration of the first laminate ($\alpha 1$).

Fig. 13 is a substitute photograph of a drawing illustrating an observation result of a back surface in the example.

Fig. 14 is a substitute photograph of a drawing illustrating an observation
10 result of a ground cross section in the example.

[Description of Embodiments]

[0011]

In the present specification, “active components” refer to components excluding a diluent solvent, such as water or an alcohol, from components
15 contained in a target composition.

In addition, in the present specification, “(meth)acrylic acid” means both “acrylic acid” and “methacrylic acid”, and the same also applies to other similar terms.

Furthermore, in the present specification, “weight average molecular
20 weight and number average molecular weight” is a value calibrated with polystyrene as measured by a gel permeation chromatography (GPC) method.

Moreover, in the present specification, the lower and upper limits of a preferred numerical range (e.g., a range of content) described in series can each be independently combined. For example, from the description “preferably from 10

to 90, more preferably from 30 to 60”, the “preferred lower limit (10)” and the “preferred upper limit (60)” can be combined as “from 10 to 60”.

[0012]

Method for manufacturing semiconductor chip of present invention

5 A process schematic diagram of a method for manufacturing a semiconductor chip of the present invention is illustrated in Fig. 1.

The method for manufacturing a semiconductor chip of the present invention roughly includes:

- (S1) preparing a wafer for producing semiconductor chips;
- 10 (S2) attaching a first laminate ($\alpha 1$);
- (S3) curing a first curable resin (x1);
- (S4) segmenting into individual pieces; and
- further includes:
- (S-BG) grinding a back surface of the wafer for producing semiconductor
- 15 chips.

[0013]

In detail, the method for manufacturing a semiconductor chip of the present invention includes steps (S1) to (S4) below in this order:

- (S1) preparing a wafer for producing semiconductor chips, in which groove
- 20 parts as predetermined segmentation lines are formed in a bump-formed surface of a semiconductor wafer having the bump-formed surface provided with bumps, the groove parts not reaching a back surface of the semiconductor wafer;
- (S2) attaching the first curable resin (x1) by pressing to the bump-formed surface of the wafer for producing semiconductor chips to cover the bump-formed
- 25 surface of the wafer for producing semiconductor chips with the first curable resin

(x1) and to embed the first curable resin (x1) into the groove parts formed in the wafer for producing semiconductor chips;

(S3) curing the first curable resin (x1) to obtain a wafer for producing semiconductor chips with a first cured resin film (r1);

5 (S4) segmenting the wafer for producing semiconductor chips with the first cured resin film (r1) along the predetermined segmentation lines into individual pieces to obtain semiconductor chips in which at least the bump-formed surface and a side surface are covered with the first cured resin film (r1); and

further includes step (S-BG) below after step (S2) above and before step
10 (S3) above, after step (S3) above and before step (S4) above, or in step (S4) above:

(S-BG) grinding the back surface of the wafer for producing semiconductor chips.

[0014]

15 The manufacturing method including the steps described above produces semiconductor chips with excellent strength in which not only the bump-formed surface but also the side surface are covered with the first cured resin film (r1), and the first cured resin film (r1) as a protective film is less likely to peel off.

“Covered” here means that the first cured resin film (r1) is formed along
20 the shape of the semiconductor chip on at least the bump-formed surface and side surface of one semiconductor chip. That is, the present invention clearly differs from the sealing technique, which confines a plurality of semiconductor chips in a resin.

[0015]

Hereinafter, the method for manufacturing a semiconductor chip of the present invention will be described in detail for each step.

In the following description, the “semiconductor chip” is also referred to simply as the “chip”, and the “semiconductor wafer” is also referred to simply as the “wafer”.

[0016]

Step (S1)

For an example of the semiconductor wafer to be prepared in step (S1), a top view is illustrated in Fig. 2, and a schematic cross-sectional view is illustrated in Fig. 3.

In step (S1), a wafer 10 for producing semiconductor chips is prepared, where in the wafer 10, groove parts 13 as predetermined segmentation lines are formed in a bump-formed surface 11a of a semiconductor wafer 11 having the bump-formed surface 11a provided with bumps 12, the groove parts 13 not reaching a back surface 11b of the semiconductor wafer 11.

In Fig. 2, the bumps are not illustrated. In addition, in figures used in the following descriptions, a main part may be enlarged for convenience to facilitate understanding of features of the present invention, and a dimension ratio or the like of each component is not necessarily identical to the actual one.

[0017]

The shape of the bump 12 is not particularly limited and may be any shape that can be brought into contact with an electrode or the like on the substrate for mounting a chip and be fixed.

For example, the bump 12 is spherical in Fig. 3, but the bump 12 may be a spheroid. The spheroid may be, for example, a spheroid extending in the direction

perpendicular to the bump-formed surface 11a of the wafer 11 or may be a spheroid extending in the direction horizontal to the bump-formed surface 11a of the wafer 11. In addition, the bump 12 may be pillar (column)-shaped.

[0018]

- 5 The height of the bump 12 is not particularly limited and is appropriately changed according to a design requirement.

The height is, for example, from 30 μm to 300 μm , preferably from 60 μm to 250 μm , and more preferably from 80 μm to 200 μm .

- “The height of the bump 12” means, when attention is focused on one
10 bump, the height at the site present at the highest position from the bump-formed surface 11a.

[0019]

The number of bumps 12 is also not particularly limited and is appropriately changed according to a design requirement.

- 15 [0020]

The wafer 11 is a semiconductor wafer in which, for example, a circuit, such as wiring, a capacitor, a diode, and a transistor, is formed on the front surface. The material of the wafer is not particularly limited, and examples include silicon wafers, silicon carbide wafers, compound semiconductor wafers, glass
20 wafers, and sapphire wafers.

[0021]

- The size of the wafer 11 is not particularly limited but is typically 8 inches (200 mm in diameter) or greater and preferably 12 inches (300 mm in diameter) or greater from the viewpoint of increasing batch processing efficiency. The shape of
25 the wafer is not limited to a circle and may be, for example, a quadrangle shape,

such as a square or a rectangle. In the case of a quadrangle-shaped wafer, for the size of the wafer 11, the length of the longest side is not shorter than the size (diameter) described above from the viewpoint of increasing batch processing efficiency.

5 [0022]

The thickness of the wafer 11 is not particularly limited but is preferably from 100 μm to 1000 μm , more preferably from 200 μm to 900 μm , and even more preferably from 300 μm to 800 μm from the viewpoint of facilitating the prevention of warpage associated with shrinkage when the first curable resin (x1) is cured and from the viewpoint of reducing the grinding amount of the back surface 11b of the wafer 11 to shorten the time required to grind the back surface in a subsequent process.

[0023]

In the bump-formed surface 11a of the wafer 10 for producing semiconductor chips, prepared in step (S1), a plurality of groove parts 13 is formed in a grid pattern as the predetermined segmentation lines when the wafer 10 for producing semiconductor chips is segmented into individual pieces. The plurality of groove parts 13 is cut grooves formed when the dicing before grinding method is applied and is formed at a depth smaller than the thickness of the wafer 11, and thus the deepest portion of the groove parts 13 does not reach the back surface 11b of the wafer 11. The plurality of groove parts 13 can be formed by dicing using a wafer dicing device equipped with a dicing blade known in the art or the like. The plurality of groove parts 13 can also be formed by dicing using laser or the like instead of a blade.

The plurality of groove parts 13 is formed to allow the semiconductor chips to be manufactured in a desired size and shape, and the groove parts 13 do not necessarily have to be formed in a grid pattern as illustrated in Fig. 2. In addition, the size of the semiconductor chip is typically approximately from 0.5 mm x 0.5 mm to 1.0 mm x 1.0 mm but is not limited to this size.

[0024]

The width of the groove part 13 is preferably from 10 μm to 2000 μm , more preferably from 50 μm to 1000 μm , even more preferably from 100 μm to 500 μm , and still more preferably from 100 μm to 300 μm from the viewpoint of allowing the first curable resin (x1) to have a good embedding property.

[0025]

The depth of the groove part 13 is adjusted according to the thickness of the wafer to be used and the required chip thickness and is preferably from 30 μm to 700 μm , more preferably from 60 μm to 600 μm , and even more preferably from 100 μm to 500 μm .

[0026]

The wafer 10 for producing semiconductor chips, prepared in step (S1), is subjected to step (S2).

[0027]

20 Step (S2)

Step (S2) is schematically illustrated in Fig. 4.

In step (S2), the first curable resin (x1) is attached by pressing to the bump-formed surface 11a of the wafer 10 for producing semiconductor chips.

Here, from the viewpoint of the handling properties of the first curable resin (x1), the first curable resin (x1) is preferably laminated on the first support sheet (Y1) and used.

Thus, in step (S2), the first laminate ($\alpha 1$) having a laminated structure in which the first support sheet (Y1) and the layer (X1) of the first curable resin (x1) are laminated is preferably attached by pressing to the bump-formed surface 11a of the wafer 10 for producing semiconductor chips using the layer (X1) as an attachment surface.

As illustrated in Fig. 4, step (S2) allows the bump-formed surface 11a of the wafer 10 for producing semiconductor chips to be covered with the first curable resin (x1) and the first curable resin (x1) to be embedded into the groove parts 13 formed in the wafer 10 for producing semiconductor chips.

[0028]

The first curable resin (x1) is embedded into the groove parts 13 formed in the wafer 10 for producing semiconductor chips, and thus, the portions, which is the side surfaces of the semiconductor chips when the wafer 10 for producing semiconductor chips is segmented into individual pieces in step (S4), are covered with the first curable resin (x1). That is, through step (S2), excellent strength is provided to the semiconductor chip, and a covering material to be necessary to prevent the peeling of the first cured resin film (r1) as the protective film and to serve as a precursor of the first cured resin film (r1) for covering the side surface of the semiconductor chip.

[0029]

The pressing force when the first laminate ($\alpha 1$) is attached to the wafer 10 for producing semiconductor chips is preferably from 1 kPa to 200 kPa, more

preferably from 5 kPa to 150 kPa, and even more preferably from 10 kPa to 100 kPa from the viewpoint of allowing the first curable resin (x1) to have a good embedding property into the groove parts 13.

The pressing force when the first laminate ($\alpha 1$) is attached to the wafer 10 for producing semiconductor chips may be appropriately changed in a period from the initial stage to the final stage of the attachment. For example, from the viewpoint of allowing the first curable resin (x1) to have a better embedding property into the groove parts 13, the pressing force is preferably low at the initial stage of the attachment and gradually increased.

10 [0030]

In addition, in attaching the first laminate ($\alpha 1$) to the wafer 10 for producing semiconductor chips, when the first curable resin (x1) is a thermosetting resin, heating is preferably performed from the viewpoint of allowing the first curable resin (x1) to have a good embedding property into the groove parts 13. When the first curable resin (x1) is a thermosetting resin, the fluidity of the first curable resin (x1) is temporarily increased by heating, and the first curable resin (x1) is cured by continued heating. Thus, heating within a range improving the fluidity of the first curable resin (x1) allows the first curable resin (x1) to be easily distributed in the entire groove parts 13, and this further improves the embedding property of the first curable resin (x1) into the groove parts 13.

Specific heating temperature (attachment temperature) is preferably from 50°C to 150°C, more preferably from 60°C to 130°C, and even more preferably from 70°C to 110°C.

The heating treatment performed on the first curable resin (x1) is not included in the curing treatment of the first curable resin (x1).

[0031]

Furthermore, when the first laminate ($\alpha 1$) is attached to the wafer 10 for producing semiconductor chips, the attachment is preferably performed in a reduced pressure environment. This creates a negative pressure in the groove parts 13 and allows the first curable resin (x1) to be easily distributed in the entire groove parts 13. As a result, this allows the first curable resin (x1) to have a better embedding property into the groove parts 13. The specific pressure of the reduced pressure environment is preferably from 0.001 kPa to 50 kPa, more preferably from 0.01 kPa to 5 kPa, and even more preferably from 0.05 kPa to 1 kPa.

[0032]

In addition, the thickness of the layer (X1) of the first curable resin (x1) in the first laminate ($\alpha 1$) is preferably 10 μm or greater, more preferably 20 μm or greater, even more preferably 30 μm or greater, and still more preferably greater than 30 μm from the viewpoint of allowing the first curable resin (x1) to have a better embedding property into the groove parts 13. In addition, the thickness is preferably 200 μm or less, more preferably 150 μm or less, even more preferably 130 μm or less, still more preferably 100 μm or less, and yet more preferably 80 μm or less.

Here, the “thickness of the layer (X1) of the first curable resin (x1)” means the thickness of the entire layer (X1); for example, the thickness of the layer (X1) composed of multiple layers means the total thickness of all layers composing the layer (X1).

[0033]

Furthermore, from the viewpoint of allowing the first curable resin (x1) to have a better embedding property into the groove parts 13, the layer (X1) of the first curable resin (x1) has a shear modulus of elasticity G' of 5.0×10 Pa to 1.0×10^6 Pa, more preferably of 1.0×10^2 Pa to 1.0×10^5 Pa, and even more preferably of 1.0×10^2 Pa to 1.0×10^4 Pa when a strain dispersion measurement is performed to measure a shear modulus of elasticity G' of a test piece of the layer (X1) by causing a 400% strain on the test piece of the layer (X1) under conditions of a temperature of 90°C and a frequency of 1 Hz.

The shear modulus of elasticity G' of the layer (X1) of the first curable resin (x1) is a value to be measured before curing the first curable resin (x1).

The shear modulus of elasticity G' can be adjusted by adjusting the composition of the first curable resin (x1) or the like.

[0034]

Here, the first support sheet (Y1) included in the first laminate ($\alpha 1$) supports the first curable resin (x1) and preferably also has a function as a back grinding sheet.

In this case, when the back surface 11b of the wafer 11 with the first laminate ($\alpha 1$) attached is ground, the first support sheet (Y1) functions as a back grinding sheet and can facilitate the back grinding process.

[0035]

Step (S3), step (S4), and step (S-BG)

Through the process up to step (S2) described above, a laminate is formed in which the first laminate ($\alpha 1$) is laminated by attaching to the wafer 10 for producing semiconductor chips. The laminate is preferably subjected to a process

according to any of first to fourth embodiments described below according to the timing of performing step (S-BG).

Hereinafter, steps (S3) and (S4) will be described with respect to the first to fourth embodiments with an explanation regarding the timing of performing step (S-BG).

[0036]

First embodiment

In the first embodiment, step (S-BG) is performed after step (S2) and before step (S3) as illustrated in Fig. 1.

Fig. 5 illustrates a schematic view regarding the first embodiment.

[0037]

First embodiment: step (S-BG)

In the first embodiment, first, step (S-BG) is performed. Specifically, as illustrated in Fig. 5 (1-a), the back surface 11b of the wafer 10 for producing semiconductor chips with the first laminate ($\alpha 1$) attached is ground. The “BG” in Fig. 5 means back grinding, and the same also applies to the drawings below. Then, as illustrated in Fig. 5 (1-b), the first support sheet (Y1) is peeled off from the first laminate ($\alpha 1$).

The amount of grinding when the back surface 11b of the wafer 10 for producing semiconductor chips is ground is an amount that at least the bottoms of the groove parts 13 of the wafer 10 for producing semiconductor chips are exposed, but further grinding may be performed to grind the first curable resin (x1) embedded in the groove parts 13 together with the wafer 10 for producing semiconductor chips.

In the first embodiment, the first support sheet (Y1) is peeled off before performing step (S3), and thus the first support sheet (Y1) is not required to be heat resistant even when the first curable resin (x1) is a thermosetting resin and heat treatment for curing is performed in step (S3). Thus, this improves the degree of freedom of design of the first support sheet (Y1).

[0038]

First embodiment: step (S3)

After performing step (S-BG), step (S3) is performed. Specifically, as illustrated in Fig. 5 (1-c), the first curable resin (x1) is cured to obtain the wafer 10 for producing semiconductor chips with the first cured resin film (r1).

The first cured resin film (r1) formed by curing the first curable resin (x1) is stronger than the first curable resin (x1) at ordinary temperature. Thus, the bump neck is well protected by forming the first cured resin film (r1). In addition, in step (S4) illustrated in Fig. 5 (1-d), the wafer 10 for producing semiconductor chips with the first cured resin film (r1) is segmented into individual pieces, and this can produce semiconductor chips with a side surface also covered with the first cured resin film (r1), producing semiconductor chips with excellent strength. Furthermore, the peeling of the first cured resin film (r1) as a protective film is also prevented.

[0039]

First embodiment: curing method

Curing of the first curable resin (x1) can be performed by any of the curing of thermal curing and energy ray irradiation according to the type of curable component contained in the first curable resin (x1).

In the present specification, “energy rays” means electromagnetic waves or charged particle beams having energy quanta; their examples include ultraviolet light and electron beams, and ultraviolet light is preferred.

For the conditions in case of the thermal curing, the curing temperature is preferably from 90°C to 200°C, and the curing time is preferably from 1 hour to 3 hours.

The conditions for curing by energy ray irradiation are appropriately set according to the type of energy ray to be used; for example, when ultraviolet light is used, the illuminance is preferably from 170 mW/cm² to 250 mw/cm², and the amount of light is preferably from 300 mJ/cm² to 3000 mJ/cm².

Here, in the process of curing the first curable resin (x1) to form the first cured resin film (r1), the first curable resin (x1) is preferably a thermosetting resin from the viewpoint of removing an air bubble or the like that may enter when the groove parts 13 are embedded with the first curable resin (x1) in step (S2). That is, when the first curable resin (x1) is a thermosetting resin, heating increases the fluidity of the first curable resin (x1) temporarily, and the first curable resin (x1) is cured by continuous heating. Utilizing this phenomenon allows removal of an air bubble or the like that may enter when the groove parts 13 are embedded with the first curable resin (x1) and when the fluidity of the first curable resin (x1) is increased. This allows the first curable resin (x1) to be cured while the embedding property of the first curable resin (x1) into the groove parts 13 is in a better state.

In addition, from the viewpoint of shortening the curing time, the first curable resin (x1) is preferably an energy ray-curable resin.

Details of the first curable resin (x1) for forming the first cured resin film (r1) will be described later.

[0040]

First embodiment: step (S4)

After performing step (S3), step (S4) is performed. Specifically, as illustrated in Fig. 5 (1-d), portions of the first cured resin film (r1) of the wafer 10 for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts, are cut along the predetermined segmentation lines.

The cutting can be appropriately performed by employing a known method, such as blade dicing or laser dicing.

This can produce semiconductor chips 40 in which at least the bump-formed surface 11a and a side surface are covered with the first cured resin film (r1).

The semiconductor chips 40 have the bump-formed surface 11a and side surface covered with the first cured resin film (r1) and thus have excellent strength. In addition, the bump-formed surface 11a and side surface are continuously covered with the first cured resin film (r1) without a break, and thus the joint surface (interface) between the bump-formed surface 11a and the first cured resin film (r1) is not exposed on the side surface of the semiconductor chip 40. Of the joint surface (interface) between the bump-formed surface 11a and the first cured resin film (r1), the exposed portion exposed on the side surface of the semiconductor chip 40 is likely to be the starting point of the film peeling. For the semiconductor chip 40 of the present invention, the exposed portion is not present, and thus the film peeling from the exposed portion is unlikely to occur in the process of cutting the wafer 10 for producing semiconductor chips to manufacture the semiconductor chip 40 and after manufacturing. Thus, this produces the

semiconductor chip 40 in which the peeling of the first cured resin film (r1) as a protective film is prevented.

[0041]

When portions of the first cured resin film (r1) of the wafer 10 for
5 producing semiconductor chips with the first cured resin film (r1), the portions
being formed in the groove parts, are cut along the predetermined segmentation
lines in step (S4), the first cured resin film (r1) is preferably transparent. The first
cured resin film (r1) is transparent, and this allows the semiconductor wafer 11 to
be seen through it, thus ensuring the visibility of the predetermined segmentation
10 lines. Thus, this facilitates the cutting along the predetermined segmentation lines.

[0042]

Second embodiment

In the second embodiment, as illustrated in Fig. 1, step (S-BG) is
performed after step (S3) and before step (S4).

15 Fig. 6 illustrates a schematic view regarding the second embodiment.

[0043]

Second embodiment: step (S3)

In the second embodiment, first, step (S3) is performed. Specifically, as
illustrated in Fig. 6 (2-a), the first curable resin (x1) is cured in a state where the
20 first laminate ($\alpha 1$) is attached, to obtain the wafer 10 for producing semiconductor
chips with the first cured resin film (r1).

The first cured resin film (r1) formed by curing the first curable resin (x1)
is stronger than the first curable resin (x1) at ordinary temperature. Thus, the
bump neck is well protected by forming the first cured resin film (r1). In addition,
25 in step (S4), the wafer 10 for producing semiconductor chips with the first cured

resin film (r1) is segmented into individual pieces, and this can produce semiconductor chips with a side surface also covered with the first cured resin film (r1), producing semiconductor chips with excellent strength. Furthermore, this also prevents the peeling of the first cured resin film (r1) as a protective film.

5 The curing method includes the same method as the curing method described in the first embodiment.

 The thermal curing treatment is performed without peeling off the first support sheet (Y1), thus the first support sheet (Y1) can prevent a flow of the first curable resin (x1) on the front surface, which temporarily occurs when the first
10 curable resin (x1) is cured during the thermal curing, and this can improve the flatness of the first cured resin film (r1) on the bump-formed surface.
 Furthermore, the first curable resin (x1) is cured before grinding the back surface 11b of the wafer 10 for producing semiconductor chips, and this prevents the warpage of the wafer 10 for producing semiconductor chips.

15 [0044]

Second embodiment: step (S-BG)

 After performing step (S3), step (S-BG) is performed. As illustrated in Fig. 6 (2-b), the back surface 11b of the wafer 10 for producing semiconductor chips with the first laminate (α 1) attached is ground.

20 The amount of grinding when the back surface 11b of the wafer 10 for producing semiconductor chips is ground is an amount at which at least the bottoms of the groove parts 13 of the wafer 10 for producing semiconductor chips are exposed, but further grinding may be performed to grind the first cured resin film (r1) embedded in the groove parts 13 together with the wafer 10 for
25 producing semiconductor chips.

Then, as illustrated in Fig. 6 (2-c), the first support sheet (Y1) is peeled off from the first laminate ($\alpha 1$).

[0045]

Second embodiment: step (S4)

5 After performing step (S-BG), step (S4) is performed in the same manner as in the first embodiment. Specifically, as illustrated in Fig. 6 (2-d), portions of the first cured resin film (r1) of the wafer 10 for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts, are cut along the predetermined segmentation lines.

10 The cutting can be appropriately performed by employing a known method, such as blade dicing or laser dicing.

This can produce semiconductor chips 40 in which at least the bump-formed surface 11a and a side surface are covered with the first cured resin film (r1).

15 The semiconductor chips 40 have the bump-formed surface 11a and side surface covered with the first cured resin film (r1) and thus have excellent strength. In addition, for the reason described above, the method produces the semiconductor chips 40 in which the peeling of the first cured resin film (r1) as a protective film is prevented.

20 [0046]

Third embodiment

As illustrated in Fig. 1, the third embodiment is common to the second embodiment in that step (S-BG) is performed after step (S3) and before step (S4).

However, the third embodiment is different from the second embodiment in that

25 the back grinding sheet (b-BG) is separately used.

Fig. 7 illustrates a schematic view regarding the third embodiment.

[0047]

Third embodiment: step (S3)

In the third embodiment, first, step (S3) is performed, but before that, as
5 illustrated in Fig. 7 (3-a), the first support sheet (Y1) is peeled off from the first
 laminate ($\alpha 1$). Step (S3) is then performed. Specifically, as illustrated in Fig. 7 (3-
 b), the first curable resin (x1) is cured to obtain the wafer 10 for producing
 semiconductor chips with the first cured resin film (r1).

The curing method includes the same method as the curing method
10 described in the first embodiment.

The first support sheet (Y1) is peeled off before performing step (S3), and
 thus the first support sheet (Y1) is not required to be heat resistant even when the
 first curable resin (x1) is a thermosetting resin and heat treatment for curing is
 performed in step (S3). Thus, this improves the degree of freedom of design of the
15 first support sheet (Y1).

In addition, the first curable resin (x1) is cured before grinding the back
 surface 11b of the wafer 10 for producing semiconductor chips, and this prevents
 the warpage of the wafer 10 for producing semiconductor chips.

[0048]

20 Third embodiment: step (S-BG)

After performing step (S3), step (S-BG) is performed. Specifically, as
 illustrated in Fig. 7 (3-c), the back grinding sheet (b-BG) is attached to the front
 surface of the first cured resin film (r1) of the wafer 10 for producing
 semiconductor chips with the first cured resin film (r1). Then, as illustrated in Fig.
25 7 (3-d), the back surface 11b of the wafer 10 for producing semiconductor chips

with the back grinding sheet (b-BG) attached is ground, and then, as illustrated in Fig. 7 (3-e), the back grinding sheet (b-BG) is peeled off from the wafer 10 for producing semiconductor chips with the first cured resin film (r1).

5 The back grinding sheet (b-BG) is not used in step (S3), and thus the back grinding sheet (b-BG) is not required to be heat resistant even when the first curable resin (x1) is a thermosetting resin and heat treatment for curing is performed in step (S3). Thus, this improves the degree of freedom of design of the back grinding sheet (b-BG).

10 The amount of grinding when the back surface 11b of the wafer 10 for producing semiconductor chips is ground is an amount at which at least the bottoms of the groove parts 13 of the wafer 10 for producing semiconductor chips are exposed, but further grinding may be performed to grind the first cured resin film (r1) embedded in the groove parts 13 together with the wafer 10 for producing semiconductor chips.

15 [0049]

Third embodiment: step (S4)

After performing step (S-BG), step (S4) is performed in the same manner as in the first and second embodiments. Specifically, as illustrated in Fig. 7 (3-f), portions of the first cured resin film (r1) of the wafer 10 for producing
20 semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts, are cut along the predetermined segmentation lines.

The cutting can be appropriately performed by employing a known method, such as blade dicing or laser dicing.

This can produce semiconductor chips 40 in which at least the bump-formed surface 11a and a side surface are covered with the first cured resin film (r1).

The semiconductor chips 40 have the bump-formed surface 11a and side surface covered with the first cured resin film (r1) and thus have excellent strength. In addition, for the reason described above, the method produces the semiconductor chips 40 in which the peeling of the first cured resin film (r1) as a protective film is prevented.

[0050]

10 Fourth embodiment

In the fourth embodiment, as illustrated in Fig. 1, step (S-BG) is performed in step (S4).

Fig. 8 illustrates a schematic view regarding the fourth embodiment.

[0051]

15 Fourth embodiment: step (S3)

In the fourth embodiment, first, step (S3) is performed, but before that, as illustrated in Fig. 8 (4-a), the first support sheet (Y1) is peeled off from the first laminate ($\alpha 1$). Step (S3) is then performed. Specifically, as illustrated in Fig. 8 (4-b), the first curable resin (x1) is cured to obtain the wafer 10 for producing

20 semiconductor chips with the first cured resin film (r1).

The curing method includes the same method as the curing method described in the first embodiment.

The first support sheet (Y1) is peeled off before performing step (S3), and thus the first support sheet (Y1) is not required to be heat resistant even when the first curable resin (x1) is a thermosetting resin and heat treatment for curing is

25

performed in step (S3). Thus, this improves the degree of freedom of design of the first support sheet (Y1).

In addition, the first curable resin (x1) is cured before grinding the back surface 11b of the wafer 10 for producing semiconductor chips, and this prevents the warpage of the wafer 10 for producing semiconductor chips.

[0052]

Fourth embodiment: step (S4) including step (S-BG)

After performing step (S3), as illustrated in Fig. 8 (4-c), cuts are made along the predetermined segmentation lines in portions of the first cured resin film (r1) of the wafer 10 for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts 13. The depth of the cut is preferably a depth reaching the deepest portion of the groove parts 13 from the viewpoint of facilitating the division of the wafer into individual pieces. This allows the wafer 10 for producing semiconductor chips with the first cured resin film (r1) to be segmented into individual pieces along the cuts in step (S-BG) described later.

Alternatively, although not illustrated, modified regions may be formed along the predetermined segmentation lines in portions of the first cured resin film (r1) of the wafer 10 for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts 13. The modified region can be formed by laser, plasma treatment, or the like. This causes a crack starting from the modified region in step (S-BG) described later and segments the wafer 10 for producing semiconductor chips with the first cured resin film (r1) into individual pieces along the modified region.

Step (S-BG) is then performed. Specifically, as illustrated in Fig. 8 (4-d), the back grinding sheet (b-BG) is attached to the front surface of the first cured resin film (r1) of the wafer 10 for producing semiconductor chips with the first cured resin film (r1). Then, as illustrated in Fig. 8 (4-e), the back surface 11b of the wafer 10 for producing semiconductor chips with the back grinding sheet (b-BG) attached is ground. Finally, as illustrated in Fig. 8 (4-f), the back grinding sheet (b-BG) is peeled off from the wafer 10 for producing semiconductor chips with the first cured resin film (r1).

This can produce semiconductor chips 40 in which at least the bump-formed surface 11a and a side surface are covered with the first cured resin film (r1).

The amount of grinding when the back surface 11b of the wafer 10 for producing semiconductor chips is ground is an amount at which at least the bottoms of the groove parts 13 of the wafer 10 for producing semiconductor chips are exposed, but further grinding may be performed to grind the first cured resin film (r1) embedded in the groove parts 13 together with the wafer 10 for producing semiconductor chips.

The semiconductor chips 40 have the bump-formed surface 11a and side surface covered with the first cured resin film (r1) and thus have excellent strength.

The back grinding sheet (b-BG) is not used in step (S3), and thus the back grinding sheet (b-BG) is not required to be heat resistant even when the first curable resin (x1) is a thermosetting resin and heat treatment for curing is performed in step (S3). Thus, this improves the degree of freedom of design of the back grinding sheet (b-BG).

[0053]

Here, for the first to fourth embodiments, the aspect in which the first support sheet (Y1) or the back grinding sheet (b-BG) is used in step (S-BG) has been described as an example. In an aspect of the present invention, however, a
5 resin layer (Z1) for back grinding may be formed in place of the first support sheet (Y1) or the back grinding sheet (b-BG).

Specifically, after covering the front surface of the first cured resin film (r1) with a resin (z1) having fluidity and also covering a bump exposed from the first cured resin film (r1), the resin (z1) is cured to form the resin layer (Z1) for
10 back grinding, and the grinding process can be performed using the resin layer (Z1) as a substitute for the back grinding sheet.

When the front surface of the first cured resin film (r1) and the bump exposed from the first cured resin film (r1) are covered with the resin (z1), they are covered via a resin film (z2) having flexibility to be able to conform to the
15 unevenness of the bump. This can easily peel off the resin layer (Z1) for back grinding after step (S-BG) when the resin layer (Z1) is no longer necessary.

[0054]

Step (T)

The method for manufacturing a semiconductor chip of an aspect of the
20 present invention preferably further includes step (T) below:

(T) forming a second cured resin film (r2) on the back surface of the wafer for producing semiconductor chips.

[0055]

The manufacturing method according to the embodiment above can produce
25 semiconductor chips 40 in which at least the bump-formed surface 11a and side

surface are covered with the first cured resin film (r1). However, the back surface of the semiconductor chip 40 is uncovered. Thus, from the viewpoint of protecting the back surface of the semiconductor chip 40 and further improving the strength of the semiconductor chip 40, step (T) above is preferably performed.

5 [0056]

Step (T) above in more detail preferably includes steps (T1) to (T2) below in this order:

(T1) attaching the second curable resin (x2) to the back surface of the wafer for producing semiconductor chips; and

10 (T2) curing the second curable resin (x2) to form the second cured resin film (r2).

In addition, in step (T1), a second laminate ($\alpha 2$) having a laminated structure in which the second support sheet (Y2) and the layer (X2) of the second curable resin (x2) are laminated is preferably used. In detail, step (T1) is
15 preferably a process of attaching the second laminate ($\alpha 2$) having a laminated structure in which the second support sheet (Y2) and the layer (X2) of the second curable resin (x2) are laminated to the back surface of the wafer for producing semiconductor chips using the layer (X2) as an attachment surface.

In this case, the timing of peeling off the second support sheet (Y2) from
20 the second laminate ($\alpha 2$) may be between steps (T1) and (T2) or may be after step (T2).

[0057]

Here, when the second laminate ($\alpha 2$) is used in step (T1), the second support sheet (Y2) included in the second laminate ($\alpha 2$) supports the second
25 curable resin (x2) and preferably also has a function as a dicing sheet.

For the manufacturing methods according to the first to third embodiments, the second laminate ($\alpha 2$) is attached to the back surface 11b of the semiconductor wafer 10 with the first cured resin film (r1) in step (S4), and this allows the second support sheet (Y2) to function as a dicing sheet when the semiconductor wafer 10 is segmented into individual pieces by dicing, enabling dicing to be easily performed.

[0058]

Here, when step (S3) is performed after step (S-BG) as in the manufacturing method according to the first embodiment, step (T1) above may be performed before performing step (S3), and then step (S3) and step (T2) may be performed simultaneously. That is, the first curable resin (x1) and the second curable resin (x2) may be collectively cured simultaneously. This can reduce the number of curing treatments.

[0059]

Specifically, in the manufacturing methods according to the first to third embodiments, step (T) includes steps (T1-1) and (T1-2) below in this order:

(T1-1) attaching the second curable resin (x2) to the back surface of the wafer for producing semiconductor chips after step (S-BG) and before step (S4), and

(T1-2) curing the second curable resin (x2) to form the second cured resin film (r2) before or after step (S4),

and in step (S4), when portions of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts, are cut along the predetermined

segmentation lines, the second curable resin (x2) or the second cured resin film (r2) is also preferably cut collectively.

In addition, in the manufacturing method according to the fourth embodiment, step (T) includes steps (T2-1) and (T2-2) below in this order:

5 (T2-1) attaching the second curable resin (x2) to the back surface of the wafer for producing semiconductor chips with the back grinding sheet (b-BG) attached after step (S-BG) and after step (S4), and

 (T2-2) curing the second curable resin (x2) to form the second cured resin film (r2),

10 and furthermore, step (T) preferably includes step (T2-3) below before or after step (T2-2):

 (T2-3) segmenting the second curable resin layer (x2) or the second cured resin film (r2) along the kerf.

[0060]

15 Step (U)

 The method for manufacturing a semiconductor chip of an aspect of the present invention may further include step (U) below:

 (U) removing the first cured resin film (r1) covering a top part of the bump or the first cured resin film (r1) adhering to a portion of the top part of the bump
20 to expose the top part of the bump.

 Examples of the exposure treatment for exposing the top part of the bump includes etching treatments, such as wet etching treatment and dry etching treatment.

 Here, examples of the dry etching treatment include plasma etching
25 treatment.

The exposure treatment may be performed to reduce the thickness of the protective film until the top part of the bump is exposed when the top part of the bump is not exposed on the front surface of the protective film.

[0061]

5 The timing for performing step (U) is not particularly limited as long as step (U) is performed in a state where the first cured resin film (r1) is exposed, and step (U) is performed preferably after step (S3) and before step (S4) and in a state where the first support sheet (Y1) and the back grinding sheet (b-BG) are not attached.

10 [0062]

Next, the first laminate ($\alpha 1$) used in the method for manufacturing a semiconductor chip of an aspect of the present invention will be described. In addition, the back grinding sheet (b-BG) and the second laminate ($\alpha 2$) used in the method for manufacturing a semiconductor chip of an aspect of the present invention will be described.

[0063]

Configuration of first laminate ($\alpha 1$)

An example of the configuration of the first laminate ($\alpha 1$) used in the manufacturing method of an aspect of the present invention is illustrated in Fig. 9.

20 The first laminate ($\alpha 1$) used in the manufacturing method of an aspect of the present invention is provided with the layer (X1) of the first curable resin (x1) on one surface of the first support sheet (Y1) as in the first laminate ($\alpha 1$) illustrated in Fig. 9. The layer (X1) of the first curable resin (x1) is provided on one surface of the first support sheet (Y1), and this stably supports and protects
25 the layer (X1) of the first curable resin (x1) when the layer (X1) of the first

curable resin (x1) is transported as a product package or when the layer (X1) of the first curable resin (x1) is conveyed in the process.

[0064]

In addition, a specific example of the configuration of the first laminate
5 (α1) is illustrated in Figs. 10 to 12.

In the first laminate (α1), as in a first composite sheet (α1a) illustrated in Fig. 10, the first support sheet (Y1) is a substrate 51, and the layer (X1) of the first curable resin (x1) is provided on one surface of the substrate 51.

Furthermore, in the first laminate (α1), as in a first laminate (α1b)
10 illustrated in Fig. 11, the first support sheet (Y1) is a pressure sensitive adhesive (PSA) sheet in which the substrate 51 and a PSA layer 61 are laminated, and the PSA layer 61 of the PSA sheet and the layer (X1) of the first curable resin (x1) may be laminated by bonding.

Moreover, in the first laminate (α1), as in a first laminate (α1c) illustrated
15 in Fig. 12, the first support sheet (Y1) is a PSA sheet in which the substrate 51, an intermediate layer 71, and the PSA layer 61 are laminated in this order, and the PSA layer 61 of the PSA sheet and the layer (X1) of the first curable resin (x1) may be laminated by bonding. The PSA sheet in which the substrate 51, the intermediate layer 71, and the PSA layer 61 are laminated in this order can be
20 suitably used as a back grinding tape. That is, the first laminate (α1c) illustrated in Fig. 12 has a back grinding tape as the first support sheet (Y1) and thus can be suitably used when the layer (X1) of the first curable resin (x1) of the first laminate (α1c) and the bump-formed surface of the wafer for producing semiconductor chips are laminated by bonding, and then the back surface of the

wafer for producing semiconductor chips is ground to reduce the thickness of the wafer.

[0065]

Hereinafter, the first curable resin (x1) and the first support sheet (Y1) used
5 in the first laminate ($\alpha 1$) will be described.

[0066]

First curable resin (x1)

The first curable resin (x1) is a film-shaped resin used to cover the bump-
formed surface of the wafer for producing semiconductor chips as well as to fill
10 the groove parts formed in the wafer for producing semiconductor chips and forms
the first cured resin film (r1) by curing by heating or energy ray irradiation. That
is, the first curable resin (x1) may be a thermosetting resin film (hereinafter also
referred to as the “first thermosetting resin film (x1-1)”) to be cured by heating or
an energy ray-curable resin film (hereinafter also referred to as the “first energy
15 ray-curable resin film (x1-2)”) to be cured by energy ray irradiation.

[0067]

The physical properties of the first curable resin (x1) can be adjusted by
adjusting either the type or amount or both of components contained in the first
curable resin (x1).

20 [0068]

Hereinafter, the first thermosetting resin film (x1-1) and the first energy
ray-curable resin film (x1-2) will be described.

[0069]

First thermosetting resin film (x1-1)

The first thermosetting resin film (x1-1) contains a polymer component (A) and a thermosetting component (B).

The first thermosetting resin film (x1-1) is formed, for example, from a first thermosetting resin composition (x1-1-1) containing the polymer component (A) and the thermosetting component (B).

The polymer component (A) is a component regarded as being formed by a polymerization reaction of a polymerizable compound. In addition, the thermosetting component (B) is a component that can undergo a curing (polymerization) reaction using heat as a trigger for the reaction. The curing (polymerization) reaction also includes a polycondensation reaction.

In the following description of the present specification, “the content of each component in the total amount of active components of the first thermosetting resin composition (x1-1-1) is synonymous with “the content of each component of the first thermosetting resin film (x1-1) to be formed from the first thermosetting resin composition (x1-1-1)”.

[0070]

Polymer component (A)

The first thermosetting resin film (x1-1) and the first thermosetting resin composition (x1-1-1) contain the polymer component (A).

The polymer component (A) is a polymer compound for imparting film formability and flexibility to the first thermosetting resin film (x1-1). One polymer component (A) may be used alone or two or more in combination. When two or more polymer components (A) are used in combination, their combination and ratios can be freely selected.

[0071]

Examples of the polymer component (A) include acrylic-based resins (resins having a (meth)acryloyl group), poly(vinyl acetal), polyester, urethane-based resins (resins having a urethane bond), acrylic urethane resins, silicone-based resins (resins having a siloxane bond), rubber-based resins (resins having a
5 rubber structure), phenoxy resins, and thermosetting polyimide.

Among these, an acrylic-based resin and poly(vinyl acetal) are preferred.
[0072]

Examples of the acrylic-based resin include known acrylic-based polymers.
The weight average molecular weight (Mw) of the acrylic-based resin is
10 preferably from 10000 to 2000000, more preferably from 300000 to 1500000, and even more preferably from 500000 to 1000000 from the viewpoint of allowing the effects of the present invention to be exhibited more easily.

The acrylic-based resin has a weight average molecular weight of not less than the lower limit described above, and this facilitates improving the shape
15 stability (stability over time during storage) of the first thermosetting resin film (x1-1). In addition, the acrylic-based resin has a weight average molecular weight of not greater than the upper limit described above, and this facilitates the conformity of the first thermosetting resin film (x1-1) to an uneven surface of an adherend and facilitates preventing, for example, the generation of a void or the
20 like between the adherend and the first thermosetting resin film (x1-1). Thus, this facilitates improving not only coverability on the bump-formed surface 11a of the semiconductor wafer 11 but also the embedding property into the groove parts 13.
[0073]

The glass transition temperature (Tg) of the acrylic-based resin is
25 preferably from -60 to 70°C, more preferably from -40 to 50°C, and even more

preferably from -30°C to 30°C from the viewpoint of allowing the effects of the present invention to be exhibited more easily.

The acrylic-based resin has a glass transition temperature (T_g) of not lower than the lower limit described above, and this reduces the adhesive strength
5 between the first cured resin film (r1) and the first support sheet (Y1) and improves the peelability of the first support sheet (Y1). In addition, the acrylic-based resin has a glass transition temperature (T_g) of not higher than the upper limit described above, and this improves the adhesive strength of the first thermosetting resin film (x1-1) and first cured resin film (r1) with an adherend.
10 Thus, this can further facilitate preventing the film peeling of the first cured resin film (r1) as a protective film.

[0074]

Examples of the acrylic-based resin include polymers of one or two or more type(s) of (meth)acrylic esters; and copolymers of two or more types of monomers
15 selected from (meth)acrylic acid, itaconic acid, vinyl acetate, acrylonitrile, styrene, N-methylolacrylamide, and the like.

[0075]

Examples of the (meth)acrylic ester constituting the acrylic-based resin include alkyl (meth)acrylates in which the alkyl group constituting the alkyl ester
20 has a chain structure having from 1 to 18 carbons, such as methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, isopropyl (meth)acrylate, n-butyl (meth)acrylate, isobutyl (meth)acrylate, sec-butyl (meth)acrylate, tert-butyl (meth)acrylate, pentyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, isooctyl (meth)acrylate, n-octyl (meth)acrylate, n-
25 nonyl (meth)acrylate, isononyl (meth)acrylate, decyl (meth)acrylate, undecyl

(meth)acrylate, dodecyl (meth)acrylate (lauryl (meth)acrylate), tridecyl (meth)acrylate, tetradecyl (meth)acrylate (myristyl (meth)acrylate), pentadecyl (meth)acrylate, hexadecyl (meth)acrylate (palmityl (meth)acrylate), heptadecyl (meth)acrylate, and octadecyl (meth)acrylate (stearyl (meth)acrylate);

5 cycloalkyl (meth)acrylates, such as isobornyl (meth)acrylate and dicyclopentanyl (meth)acrylate;

 aralkyl (meth)acrylates, such as benzyl (meth)acrylate;

 cycloalkenyl (meth)acrylates, such as dicyclopentenyl (meth)acrylate;

 cycloalkenyloxyalkyl (meth)acrylates, such as dicyclopentenylloxyethyl

10 (meth)acrylate;

 (meth)acrylate imide;

 glycidyl group-containing (meth)acrylic esters, such as glycidyl

(meth)acrylate;

 hydroxyl group-containing (meth)acrylic esters, such as hydroxymethyl

15 (meth)acrylate, 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 3-hydroxypropyl (meth)acrylate, 2-hydroxybutyl (meth)acrylate, 3-hydroxybutyl (meth)acrylate, and 4-hydroxybutyl (meth)acrylate; and

 substituted amino group-containing (meth)acrylic esters, such as N-methylaminoethyl (meth)acrylate.

20 In the present specification, the “substituted amino group” means a group in which one or two hydrogen atoms of the amino group are replaced by a group(s) other than a hydrogen atom(s).

 Among these, from the viewpoint of allowing the effects of the present invention to be exhibited more easily, the (meth)acrylic ester is preferably a

25 copolymer formed by combining an alkyl (meth)acrylate in which the alkyl group

constituting the alkyl ester has a chain structure having from 1 to 18 carbons, a glycidyl group-containing (meth)acrylate, and a hydroxyl group-containing (meth)acrylate, more preferably a copolymer formed by combining an alkyl (meth)acrylate in which the alkyl group constituting the alkyl ester has a chain structure having from 1 to 4 carbons, a glycidyl group-containing (meth)acrylate, and a hydroxyl group-containing (meth)acrylate, and even more preferably a copolymer formed by combining butyl acrylate, methyl acrylate, glycidyl acrylate, and 2-hydroxyethyl acrylate.

[0076]

The acrylic-based resin may be a resin formed by copolymerization of one or more types of monomers selected from, for example, (meth)acrylic acid, itaconic acid, vinyl acetate, acrylonitrile, and styrene and N-methylolacrylamide in addition to (meth)acrylic esters.

[0077]

The acrylic-based resin may be constituted of one type of monomer alone or two or more types of monomers. When two or more types of monomers constitute the acrylic-based resin, their combination and ratios can be freely selected.

[0078]

The acrylic-based resin may have a functional group, such as a vinyl group, a (meth)acryloyl group, an amino group, a hydroxyl group, a carboxy group, and an isocyanate group, that can be attached to another compound.

The functional group of the acrylic-based resin may be attached to another compound via a crosslinking agent (F) described later or may be directly attached to another compound without the crosslinking agent (F). The acrylic-based resin is

attached to another compound by the functional group, and this tends to improve the reliability of a package obtained using the first thermosetting resin film (x1-1).

[0079]

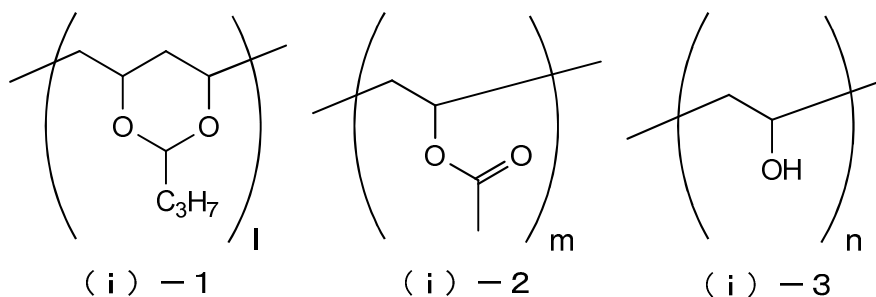
Examples of the poly(vinyl acetal) in the polymer component (A) include known poly(vinyl acetal).

Among others, preferred examples of the poly(vinyl acetal) include poly(vinyl formal) and poly(vinyl butyral), and poly(vinyl butyral) is more preferred.

Examples of poly(vinyl butyral) include those having constitutional units represented by Formulas (i)-1, (i)-2, and (i)-3.

[0080]

[Chem. 1]



where l, m, and n are each independently an integer of 1 or greater.

15 [0081]

The weight average molecular weight (M_w) of the poly(vinyl acetal) is preferably from 5000 to 200000 and more preferably from 8000 to 100000. The poly(vinyl acetal) has a weight average molecular weight of not less than the lower limit described above, and this facilitates improving the shape stability (stability over time during storage) of the first thermosetting resin film (x1-1). In addition, the poly(vinyl acetal) has a weight average molecular weight of not

greater than the upper limit described above, and this facilitates the conformity of the first thermosetting resin film (x1-1) to an uneven surface of an adherend and facilitates preventing, for example, the generation of a void or the like between the adherend and the first thermosetting resin film (x1-1). Thus, this facilitates

5 improving not only the coverability on the bump-formed surface 11a of the semiconductor wafer 11 but also the embedding property into the groove parts 13.

[0082]

The glass transition temperature (T_g) of the poly(vinyl acetal) is preferably from 40 to 80°C and more preferably from 50 to 70°C. The poly(vinyl acetal) has

10 a T_g of not lower than the lower limit described above, and this reduces the adhesive strength between the first cured resin film (r1) and the first support sheet (Y1) and improves the peelability of the first support sheet (Y1). In addition, the poly(vinyl acetal) has a glass transition temperature (T_g) of not higher than the upper limit described above, and this improves the adhesive strength of the first
15 thermosetting resin film (x1-1) and first cured resin film (r1) with an adherend.

Thus, this can further facilitate preventing the film peeling of the first cured resin film (r1) as a protective film.

[0083]

The ratio of three or more monomers constituting the poly(vinyl acetal) can
20 be freely selected.

[0084]

Here, in one aspect of the present invention, for the polymer component (A), a thermoplastic resin (which may be hereinafter abbreviated simply as the “thermoplastic resin”) other than the acrylic-based resin and the poly(vinyl acetal)

25 may be used alone without using both the acrylic-based resin and the poly(vinyl

acetal) or may be used in combination with one or both of the acrylic-based resin and poly(vinyl acetal).

Using the thermoplastic resin improves the peelability of the first cured resin film (r1) from the first support sheet (Y1), facilitates the conformity of the first thermosetting resin film (x1-1) to an uneven surface of an adherend, and may further prevent the generation of a void or the like between the adherend and the first thermosetting resin film (x1-1). Thus, this facilitates improving not only the coverability on the bump-formed surface 11a of the semiconductor wafer 11 but also the embedding property into the groove parts 13.

10 [0085]

A weight average molecular weight of the thermoplastic resin is preferably from 1000 to 100000 and more preferably from 3000 to 80000.

[0086]

A glass transition temperature (T_g) of the thermoplastic resin is preferably from -30 to 150°C and more preferably from -20 to 120°C.

[0087]

Examples of the thermoplastic resin include polyester, polyurethane, phenoxy resins, polybutene, polybutadiene, and polystyrene.

[0088]

20 One thermoplastic resin may be used alone or two or more in combination. When two or more thermoplastic resins are used, their combination and ratios can be freely selected.

[0089]

The content of the polymer component (A) is preferably from 5 to 85 mass% and more preferably from 5 to 80 mass% based on the total amount of the active components of the first thermosetting resin composition (x1-1-1).

[0090]

- 5 The polymer component (A) may also correspond to the thermosetting component (B). In the present invention, when the first thermosetting resin composition (x1-1-1) contains such a component corresponding to both the polymer component (A) and the thermosetting component (B), the first thermosetting resin composition (x1-1-1) is regarded as containing both the
- 10 polymer component (A) and the thermosetting component (B).

[0091]

Thermosetting component (B)

The first thermosetting resin film (x1-1) and the first thermosetting resin composition (x1-1-1) contain the thermosetting component (B).

- 15 The thermosetting component (B) is a component for curing the first thermosetting resin film (x1-1) to form a hard first cured resin film (r1).

One thermosetting component (B) may be used alone or two or more in combination. When two or more thermosetting components (B) are used, their combination and ratios can be freely selected.

- 20 [0092]

Examples of the thermosetting component (B) include epoxy-based thermosetting resins, thermosetting polyimides, polyurethanes, unsaturated polyesters, and silicone resins. Among these, an epoxy-based thermosetting resin is preferred.

- 25 [0093]

The epoxy-based thermosetting resin is composed of an epoxy resin (B1) and a thermal curing agent (B2).

One epoxy-based thermosetting resin may be used alone or two or more in combination. When two or more epoxy-based thermosetting resins are used, their combination and ratios can be freely selected.

[0094]

- Epoxy resin (B1)

Examples of the epoxy resin (B1) include known epoxy resins, for example, including multifunctional epoxy resins, biphenyl compounds, bisphenol A diglycidyl ethers and their hydrogenated products, ortho-cresol novolak epoxy resins, dicyclopentadiene-type epoxy resins, biphenyl-type epoxy resins, bisphenol A-type epoxy resins, bisphenol F-type epoxy resins, phenylene backbone-type epoxy resins, and bifunctional or higher functional epoxy compounds.

Among these, a multifunctional epoxy resin, a dicyclopentadiene-type epoxy resin, and a bisphenol F-type epoxy resin are preferably used from the viewpoint of allowing the effects of the present invention to be exhibited more easily. Also, in the polyfunctional epoxy resin, a multifunctional aromatic epoxy resin is preferred.

[0095]

An epoxy resin having an unsaturated hydrocarbon group may be used as the epoxy resin (B1). The epoxy resin having an unsaturated hydrocarbon group has higher compatibility with the acrylic-based resin than an epoxy resin having no unsaturated hydrocarbon group. Thus, using the epoxy resin having an unsaturated hydrocarbon group improves the reliability of a package obtained using the first thermosetting resin film (x1-1).

[0096]

Examples of the epoxy resin having an unsaturated hydrocarbon group include compounds in which one or some epoxy groups of a multifunctional epoxy resin are converted to a group(s) having an unsaturated hydrocarbon group. Such a
5 compound is formed, for example, by addition reaction of (meth)acrylic acid or its derivative to an epoxy group. In addition, examples of the epoxy resin having an unsaturated hydrocarbon group include compounds in which a group having an unsaturated hydrocarbon group is directly attached to an aromatic ring or the like constituting the epoxy resin.

10 The unsaturated hydrocarbon group is an unsaturated group with polymerizability, and specific examples include an ethenyl group (vinyl group), a 2-propenyl group (allyl group), a (meth)acryloyl group, and a (meth)acrylamide group. Among these, an acryloyl group is preferred.

[0097]

15 The number average molecular weight of the epoxy resin (B1) is not particularly limited but is preferably from 300 to 30000, more preferably from 400 to 10000, and even more preferably from 500 to 3000 from the viewpoint of curing properties of the first thermosetting resin film (x1-1) and the strength and heat resistance of the first cured resin film (r1) after curing.

20 An epoxy equivalent weight of the epoxy resin (B1) is preferably from 100 to 1000 g/eq and more preferably from 300 to 800 g/eq.

[0098]

One epoxy resin (B1) may be used alone or two or more in combination. When two or more epoxy resins (B1) are used in combination, their combination
25 and ratios can be freely selected.

[0099]

- Thermal curing agent (B2)

The thermal curing agent (B2) functions as a curing agent for the epoxy resin (B1).

- 5 Examples of the thermal curing agent (B2) include compounds having two or more functional groups that can react with an epoxy group per molecule.
- Examples of the functional group include a phenolic hydroxyl group, an alcoholic hydroxyl group, an amino group, a carboxy group, and an anhydride group formed by dehydration of an acid group, and the functional group is preferably a phenolic
- 10 hydroxyl group, an amino group, or an anhydride group formed by dehydration of an acid group, and more preferably a phenolic hydroxyl group or an amino group.

[0100]

- Among the thermal curing agents (B2), examples of a phenol-based curing agent having a phenolic hydroxyl group include multifunctional phenolic resins,
- 15 biphenol, novolak-type phenolic resins, dicyclopentadiene-based phenolic resins, and aralkyl phenolic resins.

Among the thermal curing agents (B2), examples of an amine-based curing agent having an amino group include a dicyandiamide (which may be hereinafter abbreviated as “DICY”).

- 20 Among these, from the viewpoint of allowing the effects of the present invention to be exhibited more easily, a phenol-based curing agent having a phenolic hydroxyl group is preferred, and a novolac-type phenolic resin is more preferred.

[0101]

- 25 The thermal curing agent (B2) may have an unsaturated hydrocarbon group.

Examples of the thermal curing agent (B2) having an unsaturated hydrocarbon group include compounds in which one or some hydroxyl groups of a phenolic resin are replaced by a group(s) having an unsaturated hydrocarbon group, or compounds in which a group having an unsaturated hydrocarbon group is directly attached to an aromatic ring of a phenolic resin. The unsaturated hydrocarbon group in the thermal curing agent (B2) is the same as the unsaturated hydrocarbon group in the epoxy resin having an unsaturated hydrocarbon group described above.

[0102]

10 When a phenol-based curing agent is used as the thermal curing agent (B2), the thermal curing agent (B2) preferably has a high softening point or glass transition temperature from the viewpoint of facilitating improving the peelability of the first cured resin film (r1) from the first support sheet (Y1).

[0103]

15 A number average molecular weight of a resin component, such as, for example, a multifunctional phenolic resin, a novolak-type phenolic resin, a dicyclopentadiene-based phenolic resin, and an aralkyl phenolic resin, among the thermal curing agents (B2) is preferably from 300 to 30000, more preferably from 400 to 10000, and even more preferably from 500 to 3000.

20 The molecular weight of the non-resin component, such as, for example, bisphenol or dicyandiamide, among the thermal curing agents (B2) is not particularly limited but is, for example, preferably from 60 to 500.

[0104]

One thermal curing agent (B2) may be used alone or two or more in combination. When two or more thermal curing agents (B2) are used, their combination and ratios can be freely selected.

[0105]

5 In the first thermosetting resin composition (x1-1-1), the content of the thermal curing agent (B2) is preferably from 0.1 to 500 parts by mass and more preferably from 1 to 200 parts by mass per 100 parts by mass of the content of the epoxy resin (B1). The thermal curing agent (B2) is contained in an amount not lower than the lower limit described above, and this further facilitates the curing
10 of the first thermosetting resin film (x1-1). In addition, the thermal curing agent (B2) is contained in an amount not higher than the upper limit described above, and this reduces the moisture absorption rate of the first thermosetting resin film (x1-1) and further improves the reliability of a package obtained using the first thermosetting resin film (x1-1).

15 [0106]

 In the first thermosetting resin composition (x1-1-1), the content of the thermosetting component (B) (total content of the epoxy resin (B1) and the thermal curing agent (B2)) is preferably from 50 to 1000 parts by mass, more preferably from 100 to 900 parts by mass, and even more preferably from 150 to
20 800 parts by mass per 100 parts by mass of the content of the polymer component (A). The thermosetting component (B) is contained in such a range, and this reduces the adhesive strength between the first cured resin film (r1) and the first support sheet (Y1) and improves the peelability of the first support sheet (Y1).

[0107]

25 Curing accelerator (C)

The first thermosetting resin film (x1-1) and the first thermosetting resin composition (x1-1-1) may contain a curing accelerator (C).

The curing accelerator (C) is a component for adjusting the curing rate of the first thermosetting resin composition (x1-1-1).

5 Preferred examples of the curing accelerator (C) include tertiary amines, such as triethylenediamine, benzyldimethylamine, triethanolamine, dimethylaminoethanol, and tris(dimethylaminomethyl)phenol; imidazoles (imidazoles in which one or more hydrogen atoms are replaced by groups other than hydrogen atoms), such as 2-methylimidazole, 2-phenylimidazole, 2-phenyl-4-
10 methylimidazole, 2-phenyl-4,5-dihydroxymethylimidazole, and 2-phenyl-4-methyl-5-hydroxymethylimidazole; organic phosphines (phosphines in which one or more hydrogen atoms are replaced by organic groups), such as tributylphosphine, diphenylphosphine, and triphenylphosphine; and tetraphenylboron salts, such as tetraphenylphosphonium tetraphenylborate and
15 triphenylphosphine tetraphenylborate.

Among these, from the viewpoint of allowing the effects of the present invention to be exhibited more easily, the curing accelerator (C) is preferably an imidazole and more preferably 2-phenyl-4,5-dihydroxymethylimidazole.

[0108]

20 One curing accelerator (C) may be used alone or two or more in combination. When two or more curing accelerators (C) are used, their combination and ratios can be freely selected.

[0109]

In the first thermosetting resin composition (x1-1-1), the content of the
25 curing accelerator (C) when the curing accelerator (C) is used is preferably from

0.01 to 10 parts by mass and more preferably from 0.1 to 5 parts by mass per 100 parts by mass of the content of the thermosetting component (B). The content of the curing accelerator (C) is not lower than the lower limit described above, and this facilitates obtaining the effect of using the curing accelerator (C) more remarkably. In addition, the curing accelerator (C) is contained in an amount not higher than the upper limit described above, and for example, this increases an effect of preventing the curing accelerator (C) with high polarity from moving in the first thermosetting resin film (x1-1) to the adhesive interface side with an adherend and segregating there under high temperature and high humidity conditions, thus further improving the reliability of a package obtained using the first thermosetting resin film (x1-1).

[0110]

Filler (D)

The first thermosetting resin film (x1-1) and the first thermosetting resin composition (x1-1-1) may contain a filler (D).

Containing the filler (D) allows the thermal expansion coefficient of the first cured resin film (r1) obtained by curing the first thermosetting resin film (x1-1) to be easily adjusted to an appropriate range and further improves the reliability of a package obtained using the first thermosetting resin film (x1-1). In addition, the first thermosetting resin film (x1-1) contains the filler (D), and this also can reduce the moisture absorption rate of the first cured resin film (r1) and improve the heat dissipation.

[0111]

The filler (D) may be either an organic filler or an inorganic filler but is preferably an inorganic filler. Preferred examples of the inorganic filler include

powders of silica, alumina, talc, calcium carbonate, titanium white, red iron oxide, silicon carbide, or boron nitride; spheronized beads of these inorganic fillers; surface-modified products of these inorganic fillers; single crystal fibers of these inorganic fillers; and glass fibers. Among these, the inorganic filler is preferably
5 silica or alumina from the viewpoint of allowing the effects of the present invention to be exhibited more easily.

[0112]

One filler (D) may be used alone or two or more in combination.

When two or more fillers (D) are used, their combination and ratios can be
10 freely selected.

[0113]

The content of the filler (D) when the filler (D) is used is preferably from 5 to 80 mass% and more preferably from 7 to 60 mass% based on the total amount of the active components of the first thermosetting resin composition (x1-1-1).

15 The filler (D) is contained in such a range, and this further facilitates the adjustment of the thermal expansion coefficient described above.

[0114]

The average particle size of the filler (D) is preferably from 5 nm to 1000 nm, more preferably from 5 nm to 500 nm, and even more preferably from 10 nm
20 to 300 nm. The average particle size described above is determined by measuring the outer diameter of one particle in several places and determining the average value.

[0115]

Coupling agent (E)

The first thermosetting resin film (x1-1) and the first thermosetting resin composition (x1-1-1) may contain a coupling agent (E).

Using a coupling agent having a functional group that can react with an inorganic compound or organic compound as the coupling agent (E) facilitates
5 improving adhesiveness and adhesion of the first thermosetting resin film (x1-1) and first cured resin film (r1) to an adherend. Thus, this can further facilitate preventing the film peeling of the first cured resin film (r1) as a protective film. In addition, using the coupling agent (E) does not impair the heat resistance of the first cured resin film (r1) obtained by curing the first thermosetting resin film (x1-
10 1) and facilitates improving the water resistance of the first cured resin film (r1).
[0116]

The coupling agent (E) is preferably a compound having a functional group that can react with a functional group contained in the polymer component (A) and the thermosetting component (B) and more preferably a silane coupling agent.

15 Examples of a preferred silane coupling agent include 3-glycidyloxypropyltrimethoxysilane, 3-glycidyloxypropylmethyldiethoxysilane, 3-glycidyloxypropyltriethoxysilane, 3-glycidyloxymethyldiethoxysilane, 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane, 3-methacryloyloxypropyltrimethoxysilane, 3-aminopropyltrimethoxysilane, 3-(2-aminoethylamino)propyltrimethoxysilane, 3-(2-aminoethylamino)propylmethyldiethoxysilane, 3-(phenylamino)propyltrimethoxysilane, 3-anilinopropyltrimethoxysilane, 3-ureidopropyltriethoxysilane, 3-mercaptopropyltrimethoxysilane, 3-mercaptopropylmethyldimethoxysilane, bis(3-triethoxysilylpropyl)tetrasulfane,

20

methyltrimethoxysilane, methyltriethoxysilane, vinyltrimethoxysilane, vinyltriacetoxysilane, and imidazole silane.

[0117]

One coupling agent (E) may be used alone or two or more in combination.

- 5 When two or more coupling agents (E) are used, their combination and ratios can be freely selected.

[0118]

- In the first thermosetting resin composition (x1-1-1), the content of the coupling agent (E) when the coupling agent (E) is used is preferably from 0.03 to 20 parts by mass, more preferably from 0.05 to 10 parts by mass, and even more preferably from 0.1 to 5 parts by mass per 100 parts by mass of the total content of the polymer component (A) and the thermosetting component (B). The coupling agent (E) is contained in an amount not lower than the lower limit described above, and this produces the effects of using the coupling agent (E) more remarkably, including improvement of the dispersibility of the filler (D) into the resin and improvement of the adhesiveness of the first thermosetting resin film (x1-1) to an adherend. In addition, the content of the coupling agent (E) is not higher than the upper limit described above, and this further prevents the generation of outgas.

20 [0119]

Crosslinking agent (F)

- When the polymer component (A) having a functional group, such as a vinyl group, a (meth)acryloyl group, an amino group, a hydroxyl group, a carboxy group, or an isocyanate group, that can be attached to another compound is used, the first thermosetting resin film (x1-1) and the first thermosetting resin

composition (x1-1-1) may contain a crosslinking agent (F) for attaching the functional group to another compound to crosslink.

The crosslinking using the crosslinking agent (F) can adjust the initial adhesive strength and cohesive strength of the first thermosetting resin film (x1-1).

[0120]

Examples of the crosslinking agent (F) include organic polyvalent isocyanate compounds, organic polyvalent imine compounds, metal chelate-based crosslinking agents (crosslinking agents having a metal chelate structure), and aziridine-based crosslinking agents (crosslinking agents having an aziridinyl group).

[0121]

Examples of the organic polyvalent isocyanate compound include aromatic polyvalent isocyanate compounds, aliphatic polyvalent isocyanate compounds, and alicyclic polyvalent isocyanate compounds (hereinafter, these compounds may be abbreviated collectively as “the aromatic polyvalent isocyanate compound or the like”); trimers, isocyanurates, and adducts of the aromatic polyvalent isocyanate compound or the like; and terminal isocyanate urethane prepolymers formed by reacting the aromatic polyvalent isocyanate compound or the like and a polyol compound. The “adduct” means a reaction product of the aromatic polyvalent isocyanate compound, aliphatic polyvalent isocyanate compound, or alicyclic isocyanate compound with a low-molecular active hydrogen-containing compound, such as ethylene glycol, propylene glycol, neopentyl glycol, trimethylolpropane, or castor oil, and examples include xylylene diisocyanate adduct of trimethylolpropane.

[0122]

Examples of the organic polyvalent isocyanate compound more specifically include 2,4-tolylene diisocyanate; 2,6-tolylene diisocyanate; 1,3-xylylene diisocyanate; 1,4-xylylene diisocyanate; diphenylmethane-4,4'-diisocyanate; 5 diphenylmethane-2,4'-diisocyanate; 3-methyldiphenylmethane diisocyanate; hexamethylene diisocyanate; isophorone diisocyanate; dicyclohexylmethane-4,4'-diisocyanate; dicyclohexylmethane-2,4'-diisocyanate; compounds in which any one or two or more type(s) of tolylene diisocyanate, hexamethylene diisocyanate, and xylylene diisocyanate are added to all or some of the hydroxyl groups of a 10 polyol, such as trimethylolpropane; and lysine diisocyanate.

[0123]

Examples of the organic polyvalent imine compound include N,N'-diphenylmethane-4,4'-bis(1-aziridinecarboxamide), trimethylolpropane-tri- β -aziridinyl propionate, tetramethylolmethane-tri- β -aziridinyl propionate, and N,N'- 15 toluene-2,4-bis(1-aziridinecarboxamide)triethylenemelamine.

[0124]

When the organic polyvalent isocyanate compound is used as the crosslinking agent (F), a hydroxyl group-containing polymer is preferably used as the polymer component (A). When the crosslinking agent (F) has an isocyanate 20 group and the polymer component (A) has a hydroxyl group, a crosslinking structure can be easily introduced into the first thermosetting resin film (x1-1) by reaction of the crosslinking agent (F) and the polymer component (A).

[0125]

One crosslinking agent (F) may be used alone or two or more in combination. When two or more crosslinking agents (F) are used, their combination and ratios can be freely selected.

[0126]

- 5 In the first thermosetting resin composition (x1-1-1), the content of the crosslinking agent (F) when the crosslinking agent (F) is used is preferably from 0.01 to 20 parts by mass, more preferably from 0.1 to 10 parts by mass, and even more preferably from 0.5 to 5 parts by mass per 100 parts by mass of the content of the polymer component (A). The crosslinking agent (F) is contained in an
- 10 amount not lower than the lower limit described above, and this produces the effect of using the crosslinking agent (F) more remarkably. In addition, the content of the crosslinking agent (F) is not higher than the upper limit described above, and this prevents overuse of the crosslinking agent (F).

[0127]

- 15 Energy ray-curable resin (G)

 The first thermosetting resin film (x1-1) and the first thermosetting resin composition (x1-1-1) may contain an energy ray-curable resin (G).

 The first thermosetting resin film (x1-1) contains the energy ray-curable resin (G), and thus the properties can be changed by energy ray irradiation.

- 20 [0128]

 The energy ray-curable resin (G) is formed by polymerizing (curing) an energy ray-curable compound. Examples of the energy ray-curable compound include a compound having at least one polymerizable double bond in the molecule, and an acrylate-based compound having a (meth)acryloyl group is

25 preferred.

[0129]

Examples of the acrylate-based compound include chain aliphatic backbone-containing (meth)acrylates, such as trimethylolpropane tri(meth)acrylate, tetramethylolmethane tetra(meth)acrylate, pentaerythritol tri(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol monohydroxy penta(meth)acrylate, dipentaerythritol hexa(meth)acrylate, 1,4-butylene glycol di(meth)acrylate, and 1,6-hexanediol di(meth)acrylate; cycloaliphatic backbone-containing (meth)acrylates, such as dicyclopentanyl di(meth)acrylate; poly(alkylene glycol)(meth)acrylates, such as polyethylene glycol di(meth)acrylate; oligoester (meth)acrylates; urethane (meth)acrylate oligomers; epoxy-modified (meth)acrylates; polyether (meth)acrylates other than the poly(alkylene glycol) (meth)acrylates; and itaconic acid oligomers.

[0130]

A weight average molecular weight of the energy ray-curable compound is preferably from 100 to 30000 and more preferably from 300 to 10000.

[0131]

One energy ray-curable compound used for polymerization may be used alone or two or more in combination. When two or more energy ray-curable compounds are used for polymerization, their combination and ratios can be freely selected.

[0132]

The content of the energy ray-curable resin (G) when the energy ray-curable resin (G) is used is preferably from 1 to 95 mass%, more preferably from 5 to 90 mass%, and even more preferably from 10 to 85 mass% based on the total

amount of the active components of the first thermosetting resin composition (x1-1-1).

[0133]

Photopolymerization initiator (H)

5 When the first thermosetting resin film (x1-1) and the first thermosetting resin composition (x1-1-1) contain the energy ray-curable resin (G), the first thermosetting resin film (x1-1) and the first thermosetting resin composition (x1-1-1) may contain a photopolymerization initiator (H) to allow efficient polymerization reaction of the energy ray-curable resin (G).

10 [0134]

Examples of the photopolymerization initiator (H) include benzophenone, acetophenone, benzoin, benzoin methyl ether, benzoin ethyl ether, benzoin isopropyl ether, benzoin isobutyl ether, benzoin benzoic acid, methyl benzoin benzoate, benzoin dimethyl ketal, 2,4-diethylthioxanthone, 1-hydroxycyclohexyl phenyl ketone, benzyldiphenyl sulfide, tetramethylthiuram monosulfide, azobisisobutyronitrile, benzyl, dibenzyl, diacetyl, 1,2-diphenylmethane, 2-hydroxy-2-methyl-1-[4-(1-methylvinyl)phenyl]propanone, 2,4,6-trimethylbenzoyldiphenylphosphine oxide, and 2-chloroanthraquinone.

[0135]

20 One photopolymerization initiator (H) may be used alone or two or more in combination. When two or more photopolymerization initiators (H) are used, their combination and ratios can be freely selected.

[0136]

25 In the first thermosetting resin composition (x1-1-1), the content of the photopolymerization initiator (H) is preferably from 0.1 to 20 parts by mass, more

preferably from 1 to 10 parts by mass, and even more preferably from 2 to 5 parts by mass per 100 parts by mass of the content of the energy ray-curable resin (G).

[0137]

Versatile additive (I)

5 The first thermosetting resin film (x1-1) and the first thermosetting resin composition (x1-1-1) may contain a versatile additive (I) within a range that does not impair the effects of the present invention. The versatile additive (I) is a known additive, can be freely selected according to the purpose, and is not particularly limited.

10 Preferred examples of the versatile additive (I) include rheology control agents, surfactants, silicone oils, plasticizers, antistatic agents, antioxidants, and gettering agent.

[0138]

 One versatile additive (I) may be used alone or two or more in
15 combination. When two or more versatile additives (I) are used, their combination and ratios can be freely selected.

 A content of the versatile additive (I) is not particularly limited and is appropriately selected according to the purpose.

[0139]

20 The first thermosetting resin composition (x1-1-1) and the first thermosetting resin film (x1-1) may contain an additional component not corresponding to any of the polymer component (A), thermosetting component (B), curing accelerator (C), filler (D), coupling agent (E), crosslinking agent (F), energy ray-curable resin (G), photopolymerization initiator (H), and additive (I)

described above within a range that does not impair the effects of the present invention.

The first thermosetting resin composition (x1-1-1) and the first thermosetting resin film (x1-1) may contain only one additional component, or
5 two or more additional components. When two or more additional components are contained, their combination and ratio can be freely selected.

The content of the additional component of the first thermosetting resin composition (x1-1-1) and the first thermosetting resin film (x1-1) is not particularly limited and is appropriately selected according to the purpose.

10 [0140]

Solvent

The first thermosetting resin composition (x1-1-1) preferably further contains a solvent.

The first thermosetting resin composition (x1-1-1) containing a solvent has
15 good handling properties.

The solvent is not particularly limited, but preferred examples include hydrocarbons, such as toluene and xylene; alcohols, such as methanol, ethanol, 2-propanol, isobutyl alcohol (2-methylpropan-1-ol), and 1-butanol; esters, such as ethyl acetate; ketones, such as acetone and methyl ethyl ketone; ethers, such as
20 tetrahydrofuran; and amides, such as dimethylformamide and N-methylpyrrolidone (compounds having an amide bond).

One solvent may be used alone or two or more in combination. When two or more solvents are used, their combination and ratios can be freely selected.

The solvent is preferably methyl ethyl ketone or the like from the viewpoint that the components contained in the first thermosetting resin composition (x1-1-1) can be more uniformly mixed.

[0141]

5 Method of preparing first thermosetting resin composition (x1-1-1)

The first thermosetting resin composition (x1-1-1) is prepared by blending the components for constituting the composition.

The order of adding the components when the components are blended is not particularly limited, and two or more components may be added

10 simultaneously. When a solvent is used, the solvent may be used by mixing with any of the components to be blended other than this solvent to predilute this component to be blended, or the solvent may be used by mixing with these components to be blended without prediluting any of the components to be blended other than the solvent.

15 The method of mixing the components when the components are blended is not particularly limited and is appropriately selected from known methods, such as a method of mixing by rotating a stirrer, a stirring blade, or the like; a method of mixing using a mixer; and a method of mixing by applying an ultrasonic wave.

The temperature and time when the components are added and mixed are
20 not particularly limited as long as each component to be blended is not degraded. The temperature and time are appropriately adjusted, but the temperature is preferably from 15 to 30°C.

[0142]

First energy ray-curable resin film (x1-2)

The first energy ray-curable resin film (x1-2) contains an energy ray-curable component (a).

The first energy ray-curable resin film (x1-2) is formed, for example, from a first energy ray-curable resin composition (x1-2-1) containing the energy ray-curable component (a).

The energy ray-curable component (a) is preferably uncured, preferably has pressure sensitive adhesion, and more preferably is uncured and has pressure sensitive adhesion.

In the following description of the present specification, “the content of each component based on the total amount of the active components of the first energy ray-curable resin composition (x1-2-1)” is synonymous with “the content of each component of the first energy ray-curable resin film (x1-2) formed from the first energy ray-curable resin composition (x1-2-1)”.

[0143]

Energy ray-curable component (a)

The energy ray-curable component (a) is a component cured by energy ray irradiation and is also a component for imparting film formability and flexibility to the first energy ray-curable resin film (x1-2).

Examples of the energy ray-curable component (a) include a polymer (a1) with a weight average molecular weight of 80000 to 2000000 having an energy ray-curable group, and a compound (a2) with a molecular weight of 100 to 80000 having an energy ray-curable group. The polymer (a1) may be at least partially crosslinked with a crosslinking agent or may be not crosslinked.

[0144]

Polymer (a1)

Examples of the polymer (a1) with a weight average molecular weight of 80000 to 2000000 having an energy ray-curable group include an acrylic-based resin (a1-1) formed by polymerization of an acrylic-based polymer (a11) having a functional group that can react with a group contained in another compound and
5 an energy ray-curable compound (a12) having a group that can react with the functional group described above and an energy ray-curable group, such as an energy ray-curable double bond.

[0145]

Examples of the functional group that can react with a group contained in
10 another compound include a hydroxyl group, a carboxy group, an amino group, a substituted amino group (a group in which one or two hydrogen atoms of the amino group are replaced by a group(s) other than a hydrogen atom(s)), and an epoxy group. However, in terms of preventing corrosion of a circuit of a semiconductor wafer, semiconductor chip, or the like, the functional group is
15 preferably a group other than a carboxy group. Among these, the functional group is preferably a hydroxyl group.

[0146]

- Acrylic-based polymer (a11) having functional group

Examples of the acrylic-based polymer (a11) having a functional group
20 include a polymer formed by copolymerization of an acrylic-based monomer having a functional group and an acrylic-based monomer having no functional group. The acrylic-based polymer (a11) having a functional group may be a polymer formed by further copolymerization of monomers (non-acrylic-based monomers) other than acrylic-based monomers in addition to the acrylic-based

monomers described above. In addition, the acrylic-based polymer (a11) may be a random copolymer or a block copolymer.

[0147]

Examples of the acrylic-based monomer having a functional group include

5 hydroxyl group-containing monomers, carboxy group-containing monomers, amino group-containing monomers, substituted amino group-containing monomers, and epoxy group-containing monomers.

[0148]

Examples of the hydroxyl group-containing monomer include

10 hydroxyalkyl(meth)acrylates, such as hydroxymethyl(meth)acrylate, 2-hydroxyethyl(meth)acrylate, 2-hydroxypropyl(meth)acrylate, 3-hydroxypropyl(meth)acrylate, 2-hydroxybutyl(meth)acrylate, 3-hydroxybutyl(meth)acrylate, and 4-hydroxybutyl(meth)acrylate; and non-

15 (meth)acrylic-based unsaturated alcohols (unsaturated alcohols having no (meth)acryloyl backbone), such as vinyl alcohol and allyl alcohol.

[0149]

Examples of the carboxy group-containing monomer include ethylenically unsaturated monocarboxylic acids (monocarboxylic acids having an ethylenically unsaturated bond), such as (meth)acrylic acid and crotonic acid; ethylenically

20 unsaturated dicarboxylic acids (dicarboxylic acids having an ethylenically unsaturated bond), such as fumaric acid, itaconic acid, maleic acid, and citraconic acid; anhydrides of the ethylenically unsaturated dicarboxylic acids; and carboxyalkyl(meth)acrylates, such as 2-carboxyethyl methacrylate.

[0150]

The acrylic-based monomer having a functional group is preferably a hydroxyl group-containing monomer or a carboxy group-containing monomer and more preferably a hydroxyl group-containing monomer.

[0151]

- 5 One type of acrylic-based monomer having a functional group and constituting the acrylic-based polymer (a11) may be used alone or two or more types in combination. When two or more types of acrylic-based monomers constitute the acrylic-based polymer (a11), their combination and ratios can be freely selected.

10 [0152]

Examples of the acrylic-based monomer having no functional group include alkyl (meth)acrylates in which the alkyl group constituting the alkyl ester has a chain structure having from 1 to 18 carbons, such as methyl(meth)acrylate, ethyl(meth)acrylate, n-propyl(meth)acrylate, isopropyl(meth)acrylate, n-
15 butyl(meth)acrylate, isobutyl(meth)acrylate, sec-butyl(meth)acrylate, tert-butyl(meth)acrylate, pentyl(meth)acrylate, hexyl(meth)acrylate, heptyl(meth)acrylate, 2-ethylhexyl(meth)acrylate, isooctyl(meth)acrylate, n-octyl(meth)acrylate, n-nonyl(meth)acrylate, isononyl(meth)acrylate, decyl(meth)acrylate, undecyl(meth)acrylate, dodecyl(meth)acrylate (lauryl
20 (meth)acrylate), tridecyl(meth)acrylate, tetradecyl(meth)acrylate (myristyl(meth)acrylate), pentadecyl(meth)acrylate, hexadecyl(meth)acrylate (palmityl(meth)acrylate), heptadecyl(meth)acrylate, and octadecyl(meth)acrylate (stearyl(meth)acrylate).

[0153]

Examples of the acrylic-based monomer having no functional group also include alkoxyalkyl group-containing (meth)acrylates, such as methoxymethyl(meth)acrylate, methoxyethyl(meth)acrylate, ethoxymethyl(meth)acrylate, and ethoxyethyl(meth)acrylate; (meth)acrylates having an aromatic group, including aryl(meth)acrylates, such as phenyl(meth)acrylate; non-crosslinkable (meth)acrylamides and their derivatives; and (meth)acrylic esters having a non-crosslinkable tertiary amino group, such as N,N-dimethylaminoethyl(meth)acrylate and N,N-dimethylaminopropyl(meth)acrylate.

10 [0154]

One type of acrylic-based monomer having no functional group and constituting the acrylic-based polymer (a11) may be used alone or two or more types in combination. When two or more types of acrylic-based monomers having no functional group constitute the acrylic-based polymer (a11), their combination and ratios can be freely selected.

[0155]

Examples of the non-acrylic-based monomer include olefins, such as ethylene and norbornene; vinyl acetate; and styrene.

[0156]

20 One type of non-acrylic-based monomer constituting the acrylic-based polymer (a11) may be used alone or two or more types in combination. When two or more types of non-acrylic-based monomers constitute the acrylic-based polymer (a11), their combination and ratios can be freely selected.

[0157]

In the acrylic-based polymer (a11), a ratio of an amount (content) of the constitutional unit derived from the acrylic-based monomer having a functional group to the total mass of the constitutional units constituting the acrylic-based polymer (a11) is preferably from 0.1 to 50 mass%, more preferably from 1 to 40 mass%, and even more preferably from 3 to 30 mass%. The constitutional unit is contained in the ratio in such a range, and this allows the energy ray-curable group to be contained in an amount enabling the degree of curing of the first cured resin film (r1) to be easily adjusted to a preferred range in the acrylic-based resin (a1-1) obtained by copolymerization of the acrylic-based polymer (a11) and the energy ray-curable compound (a12).

[0158]

One type of acrylic-based polymer (a11) constituting the acrylic-based resin (a1-1) may be used alone or two or more types in combination. When two or more types of acrylic-based polymers (a11) constitute the acrylic-based resin (a1-1), their combination and ratios can be freely selected.

[0159]

The content of the acrylic-based resin (a1-1) is preferably from 1 to 60 mass%, more preferably from 3 to 50 mass%, and even more preferably from 5 to 40 mass% based on the total amount of the active components of the first energy ray-curable resin composition (x1-2-1).

[0160]

- Energy ray-curable compound (a12)

The energy ray-curable compound (a12) preferably has one type or two or more types selected from the group consisting of an isocyanate group, an epoxy group, and a carboxy group as a group that can react with a functional group

contained in the acrylic-based polymer (a11) and more preferably has an isocyanate group as the group described above.

When the energy ray-curable compound (a12) has, for example, an isocyanate group as the group described above, this isocyanate group readily
5 reacts with a hydroxyl group of the acrylic-based polymer (a11) having this hydroxyl group as the functional group described above.

[0161]

The energy ray-curable compound (a12) has preferably from 1 to 5 and more preferably 1 or 2 energy ray-curable groups in one molecule.

10 [0162]

Examples of the energy ray-curable compound (a12) include 2-methacryloyloxyethyl isocyanate, meta-isopropenyl- α,α -dimethylbenzyl isocyanate, methacryloyl isocyanate, allyl isocyanate, and 1,1-(bisacryloyloxymethyl)ethyl isocyanate; acryloyl monoisocyanate compounds
15 formed by a reaction of a diisocyanate compound or a polyisocyanate compound with hydroxyethyl(meth)acrylate; and acryloyl monoisocyanate compounds formed by a reaction of a diisocyanate compound or a polyisocyanate compound with a polyol compound, and hydroxyethyl(meth)acrylate. Among these, the energy ray-curable compound (a12) is preferably 2-methacryloyloxyethyl
20 isocyanate.

[0163]

One energy ray-curable compound (a12) constituting the acrylic-based resin (a1-1) may be used alone or two or more in combination. When two or more energy ray-curable compounds (a12) constitute the acrylic-based resin (a1-1), their
25 combination and ratios can be freely selected.

[0164]

In the acrylic-based resin (a1-1), a ratio of the content of the energy ray-curable group derived from the energy ray-curable compound (a12) to the content of the functional group derived from the acrylic-based polymer (a11) is preferably from 20 to 120 mol%, more preferably from 35 to 100 mol%, and even more preferably from 50 to 100 mol%. The energy ray-curable group is contained in the ratio in such a range, and this allows the first cured resin film (r1) after curing to have greater adhesive strength. Thus, this can further facilitate preventing the film peeling of the first cured resin film (r1) as a protective film. In a case where the energy ray-curable compound (a12) is a monofunctional compound (having one group described above in one molecule), an upper limit of the ratio of the content is 100 mol%, but in a case where the energy ray-curable compound (a12) is a multifunctional compound (having two or more groups described above in one molecule), an upper limit of the ratio of the content may exceed 100 mol%.

[0165]

A weight average molecular weight (Mw) of the polymer (a1) is preferably from 100000 to 2000000 and more preferably from 300000 to 1500000.

[0166]

When the polymer (a1) is at least partially crosslinked with a crosslinking agent, the polymer (a1) may be a polymer in which a monomer not corresponding to any of the monomers described above as those constituting the acrylic-based polymer (a11) and having a group reacting with the crosslinking agent is polymerized and crosslinked at the group reacting with the crosslinking agent, or may be a polymer in which the monomer is crosslinked at the group derived from

the energy ray-curable compound (a12) and reacting with the functional group described above.

[0167]

One polymer (a1) may be used alone or two or more in combination. When
5 two or more polymers (a1) are used, their combination and ratios can be freely selected.

[0168]

Compound (a2)

Examples of the energy ray-curable group contained in the compound (a2)
10 with a weight average molecular weight of 100 to 80000 having an energy ray-curable group include a group containing an energy ray-curable double bond, and preferred examples include a (meth)acryloyl group or a vinyl group.

[0169]

The compound (a2) is not particularly limited as long as the compound
15 satisfies the conditions described above, but examples include low-molecular weight compounds having an energy ray-curable group, an epoxy resin having an energy ray-curable group, and a phenolic resin having an energy ray-curable group.

[0170]

20 Among the compounds (a2), examples of the low-molecular weight compound having an energy ray-curable group include multifunctional monomers or oligomers, and an acrylate-based compound having a (meth)acryloyl group is preferred. Examples of the acrylate-based compound include bifunctional (meth)acrylates, such as 2-hydroxy-3-(meth)acryloyloxypropyl methacrylate,
25 polyethylene glycol di(meth)acrylate, propoxylated ethoxylated bisphenol A

di(meth)acrylate, 2,2-bis[4-((meth)acryloxypolyethoxy)phenyl]propane,
 ethoxylated bisphenol A di(meth)acrylate, 2,2-bis[4-((meth)acryloxy
 diethoxy)phenyl]propane, 9,9-bis[4-(2-(meth)acryloyloxy ethoxy)phenyl]fluorene,
 2,2-bis[4-((meth)acryloxy polypropoxy)phenyl]propane, tricyclodecane
 5 dimethanol di(meth)acrylate, 1,10-decanediol di(meth)acrylate, 1,6-hexanediol
 di(meth)acrylate, 1,9-nonanediol di(meth)acrylate, dipropylene glycol
 di(meth)acrylate, tripropylene glycol di(meth)acrylate, polypropylene glycol
 di(meth)acrylate, poly(tetramethylene glycol) di(meth)acrylate, ethylene glycol
 di(meth)acrylate, diethylene glycol di(meth)acrylate, triethylene glycol
 10 di(meth)acrylate, 2,2-bis[4-((meth)acryloxyethoxy)phenyl]propane, neopentyl
 glycol di(meth)acrylate, ethoxylated polypropylene glycol di(meth)acrylate, and
 2-hydroxy-1,3-di(meth)acryloxypropane; polyfunctional (meth)acrylates, such as
 tris(2-(meth)acryloxyethyl)isocyanurate, ϵ -caprolactone-modified tris-(2-
 (meth)acryloxyethyl)isocyanurate, ethoxylated glycerin tri(meth)acrylate,
 15 pentaerythritol tri(meth)acrylate, trimethylolpropane tri(meth)acrylate,
 ditrimethylolpropane tetra(meth)acrylate, ethoxylated pentaerythritol
 tetra(meth)acrylate, pentaerythritol tetra(meth)acrylate, dipentaerythritol
 poly(meth)acrylate, and dipentaerythritol hexa(meth)acrylate; and polyfunctional
 (meth)acrylate oligomers, such as urethane (meth)acrylate oligomers.

20 [0171]

Among the compounds (a2), for the epoxy resin having an energy ray-
 curable group and the phenolic resin having an energy ray-curable group, for
 example, those described in paragraph [0043] and the like in “JP 2013-194102 A”
 can be used.

25 [0172]

A weight average molecular weight (Mw) of the compound (a2) is preferably from 100 to 30000 and more preferably from 300 to 10000.

[0173]

One compound (a2) may be used alone or two or more in combination.

- 5 When two or more compounds (a2) are used, their combination and ratios can be freely selected.

[0174]

Polymer (b) having no energy ray-curable group

- 10 When the first energy ray-curable resin composition (x1-2-1) and the first energy ray-curable resin film (x1-2) contain the compound (a2) as the energy ray-curable component (a), the first energy ray-curable resin composition (x1-2-1) and the first energy ray-curable resin film (x1-2) preferably further contain a polymer (b) having no energy ray-curable group as well.

- 15 The polymer (b) having no energy ray-curable group may be at least partially crosslinked with a crosslinking agent or may be not crosslinked.

[0175]

- 20 Examples of the polymer (b) having no energy ray-curable group include acrylic-based polymers, phenoxy resins, urethane resins, polyesters, rubber-based resins, and acrylic urethane resins. Among these, the polymer (b) is preferably an acrylic-based polymer (which may be hereinafter abbreviated as the “acrylic-based polymer (b-1)”).

[0176]

- 25 The acrylic-based polymer (b-1) may be a known acrylic-based polymer and for example, may be a homopolymer of one type of acrylic-based monomer or may be a copolymer of two or more types of acrylic-based monomers. In addition,

the acrylic-based polymer (b-1) may be a copolymer of one type or two or more types of acrylic-based monomers and one type or two or more types of monomers (non-acrylic-based monomers) other than acrylic-based monomers.

[0177]

- 5 Examples of the acrylic-based monomer constituting the acrylic-based polymer (b-1) include alkyl(meth)acrylates, (meth)acrylic esters having a cyclic backbone, glycidyl group-containing (meth)acrylic esters, hydroxyl group-containing (meth)acrylic esters, and substituted amino group-containing (meth)acrylic esters.

10 [0178]

Examples of the alkyl (meth)acrylates include alkyl (meth)acrylates in which the alkyl group constituting the alkyl ester has a chain structure having from 1 to 18 carbons, such as methyl(meth)acrylate, ethyl(meth)acrylate, n-propyl(meth)acrylate, isopropyl(meth)acrylate, n-butyl(meth)acrylate,

- 15 isobutyl(meth)acrylate, sec-butyl(meth)acrylate, tert-butyl(meth)acrylate, pentyl(meth)acrylate, hexyl(meth)acrylate, heptyl(meth)acrylate, 2-ethylhexyl(meth)acrylate, isooctyl(meth)acrylate, n-octyl(meth)acrylate, n-nonyl(meth)acrylate, isononyl(meth)acrylate, decyl(meth)acrylate, undecyl(meth)acrylate, dodecyl(meth)acrylate (lauryl(meth)acrylate),
20 tridecyl(meth)acrylate, tetradecyl(meth)acrylate (myristyl(meth)acrylate), pentadecyl(meth)acrylate, hexadecyl(meth)acrylate (palmityl(meth)acrylate), heptadecyl(meth)acrylate, and octadecyl(meth)acrylate (stearyl(meth)acrylate).

[0179]

- Examples of the (meth)acrylic ester having a cyclic backbone include
25 cycloalkyl(meth)acrylates, such as isobornyl(meth)acrylate and

dicyclopentanyl(meth)acrylate; aralkyl(meth)acrylates, such as benzyl(meth)acrylate; cycloalkenyl(meth)acrylates, such as dicyclopentenyl(meth)acrylate; and cycloalkenyloxyalkyl(meth)acrylates, such as dicyclopentenyoxyethyl(meth)acrylate.

5 [0180]

Examples of the glycidyl group-containing (meth)acrylic ester include glycidyl(meth)acrylate. Examples of the hydroxyl group-containing (meth)acrylate include hydroxymethyl(meth)acrylate, 2-hydroxyethyl(meth)acrylate, 2-hydroxypropyl(meth)acrylate, 3-hydroxypropyl(meth)acrylate, 2-
10 hydroxybutyl(meth)acrylate, 3-hydroxybutyl(meth)acrylate, and 4-hydroxybutyl(meth)acrylate.

Examples of the substituted amino group-containing (meth)acrylic ester include N-methylaminoethyl (meth)acrylate.

[0181]

15 Examples of the non-acrylic-based monomer constituting the acrylic-based polymer (b-1) include olefins, such as ethylene and norbornene; vinyl acetate; and styrene.

[0182]

Examples of the polymer (b) at least partially crosslinked with a
20 crosslinking agent and having no energy ray-curable group include those in which a reactive functional group in the polymer (b) is reacted with the crosslinking agent.

The reactive functional group is appropriately selected according to the type of crosslinking agent or the like and is not particularly limited. For example,
25 when the crosslinking agent is a polyisocyanate compound, examples of the

reactive functional group include a hydroxyl group, a carboxy group, and an amino group, and among these, a hydroxyl group, which has high reactivity with an isocyanate group, is preferred.

In addition, in a case where the crosslinking agent is an epoxy-based compound, examples of the reactive functional group include a carboxy group, an amino group, and an amide group, and among these, a carboxy group, which has high reactivity with an epoxy group, is preferred.

However, in terms of preventing corrosion of a circuit of a semiconductor wafer or semiconductor chip, the reactive functional group is preferably a group other than a carboxy group.

[0183]

Examples of the polymer (b) having a reactive functional group and having no energy ray-curable group include those formed by polymerization of a monomer having at least a reactive functional group. In the case of the acrylic-based polymer (b-1), a monomer having a reactive functional group is used as one or both of the acrylic-based monomer and the non-acrylic-based monomer exemplified as the monomer constituting the acrylic-based polymer (b-1).

Examples of the polymer (b) having a hydroxyl group as a reactive functional group include those formed, for example, by polymerization of a hydroxyl group-containing (meth)acrylic ester, and in addition to these, examples include those formed by polymerization of a monomer in which one or two or more hydrogen atoms are replaced by the reactive functional group(s) in the acrylic-based monomer or non-acrylic-based monomer previously exemplified.

[0184]

In the polymer (b) having a reactive functional group, a ratio of the amount (content) of the constitutional unit derived from the monomer having a reactive functional group to the total mass of the constitutional units constituting this polymer (b) is preferably from 1 to 20 mass% and more preferably from 2 to 10 mass%. The ratio is in such a range, and this allows the degree of crosslinking to be in a more preferred range in the polymer (b).

[0185]

The weight average molecular weight (Mw) of the polymer (b) having no energy ray-curable group is preferably from 10000 to 2000000 and more preferably from 100000 to 1500000 from the viewpoint of allowing the first energy ray-curable resin composition (x1-2-1) to have better film formability.

[0186]

One type of polymer (b) having no energy ray-curable group may be used alone or two or more types in combination. When two or more types of polymers (b) having no energy ray-curable group are used, their combination and ratios can be freely selected.

[0187]

Examples of the first energy ray-curable resin composition (x1-2-1) include those having either the polymer (a1) or the compound (a2) or both.

In addition, when the first energy ray-curable resin composition (x1-2-1) contains the compound (a2), the first energy ray-curable resin composition (x1-2-1) preferably further contains the polymer (b) having no energy ray-curable group as well, and in this case, the first energy ray-curable resin composition (x1-2-1) preferably further contains the polymer (a1) as well.

Furthermore, the first energy ray-curable resin composition (x1-2-1) may contain no compound (a2) and contain both the polymer (a1) and the polymer (b) having no energy ray-curable group.

[0188]

- 5 When the first energy ray-curable resin composition (x1-2-1) contains the polymer (a1), the compound (a2), and the polymer (b) having no energy ray-curable group, the content of the compound (a2) is preferably from 10 to 400 parts by mass and more preferably from 30 to 350 parts by mass per 100 parts by mass of the total content of the polymer (a1) and the polymer (b) having no energy ray-
10 curable group.

[0189]

- The total content of the energy ray-curable component (a) and the polymer (b) having no energy ray-curable group is preferably from 5 to 90 mass%, more preferably from 10 to 80 mass%, and even more preferably from 20 to 70 mass%
15 based on the total amount of the active components of the first energy ray-curable resin composition (x1-2-1). The energy ray-curable component is contained in such a range, and this allows the first energy ray-curable resin film (x1-2) to have better energy ray curability.

[0190]

- 20 The first energy ray-curable resin composition (x1-2-1) may contain one or two or more selected from the group consisting of thermosetting components, curing accelerators, photopolymerization initiators, fillers, coupling agents, crosslinking agents, and versatile additives according to the purpose in addition to the energy ray-curable component.

For example, using the first energy ray-curable resin composition (x1-2-1) containing an energy ray-curable component and a thermosetting component improves the adhesive strength of the first energy ray-curable resin film (x1-2) to be formed to an adherend by heating, and this in turn also improves the strength of the first cured resin film (r1) formed from this first energy ray-curable resin film (x1-2).

[0191]

Examples of the thermosetting component, photopolymerization initiator, filler, coupling agent, crosslinking agent, and versatile additive in the first energy ray-curable resin composition (x1-2-1) include the same as those for the thermosetting component (B), curing accelerator (C), photopolymerization initiator (H), filler (D), coupling agent (E), crosslinking agent (F), and versatile additive (I) in the first thermosetting resin composition (x1-1-1), respectively.

[0192]

In the first energy ray-curable resin composition (x1-2-1), one each of the thermosetting components, photopolymerization initiators, fillers, coupling agents, crosslinking agents, and versatile additives may be used alone or two or more of them each in combination. When two or more of them each are used, their combination and ratios can be freely selected.

The content of the thermosetting component, photopolymerization initiator, filler, coupling agent, crosslinking agent, and versatile additive in the first energy ray-curable resin composition (x1-2-1) is appropriately adjusted according to the purpose and is not particularly limited.

[0193]

Diluting the first energy ray-curable resin composition (x1-2-1) improves its handling properties, and thus the first energy ray-curable resin composition (x1-2-1) preferably further contains a solvent.

5 Examples of the solvent contained in the first energy ray-curable resin composition (x1-2-1) include the same solvents as those exemplified for the first energy ray-curable resin composition (x1-1-1).

For the solvent contained in the first energy ray-curable resin composition (x1-2-1), one solvent may be used alone or two or more in combination. When two or more solvents are used, their combination and ratios can be freely selected.

10 [0194]

Another component

The first energy ray-curable resin composition (x1-2-1) and the first energy ray-curable resin film (x1-2) may contain an additional component not corresponding to any of the components described above within a range that does
15 not impair the effects of the present invention.

The first energy ray-curable resin composition (x1-2-1) and the first energy ray-curable resin film (x1-2) may contain only one additional component, or two or more additional components. When two or more additional components are contained, their combination and ratio can be freely selected.

20 The content of the additional component of the first energy ray-curable resin composition (x1-2-1) and the first energy ray-curable resin film (x1-2) is not particularly limited and is appropriately selected according to the purpose.

[0195]

Method for manufacturing first energy ray-curable resin composition (x1-2-1)

The first energy ray-curable resin composition (x1-2-1) is formed by blending the components for constituting this. The order of adding the components when the components are blended is not particularly limited, and two or more components may be added simultaneously.

5 When a solvent is used, the solvent may be used by mixing with any of the components to be blended other than this solvent to predilute this component to be blended, or the solvent may be used by mixing with these components to be blended without prediluting any of the components to be blended other than the solvent. The method of mixing the components when the components are blended
10 is not particularly limited and is appropriately selected from known methods, such as a method of mixing by rotating a stirrer, a stirring blade, or the like; a method of mixing using a mixer; and a method of mixing by applying an ultrasonic wave.

The temperature and time when the components are added and mixed are not particularly limited as long as each component to be blended is not degraded.

15 The temperature and time are appropriately adjusted, but the temperature is preferably from 15 to 30°C.

[0196]

First support sheet (Y1)

20 The first support sheet (Y1) functions as a support for supporting the first curable resin (x1).

The first support sheet (Y1) may be composed of only the substrate 51 as illustrated in Fig. 10 or may be a laminate of the substrate 51 and the PSA layer 61 as illustrated in Fig. 11, or may be a laminate in which the substrate 51, the intermediate layer 71, and the PSA layer 61 are laminated in this order as
25 illustrated in Fig. 12. The laminate in which the substrate 51, the intermediate

layer 71, and the PSA layer 61 are laminated in this order is suitable for use as a back grinding sheet (b-BG).

[0197]

Hereinafter, the substrate included in the first support sheet (Y1), the PSA
5 layer and intermediate layer that may be included in the first support sheet (Y1) will be described.

[0198]

Substrate

The substrate is in the form of a sheet or film, and examples of its
10 constitutional material include various resins below.

Examples of the resin constituting the substrate include polyethylenes, such as low-density polyethylenes (LDPEs), linear low-density polyethylenes (LLDPEs), and high-density polyethylenes (HDPEs); polyolefins other than polyethylenes, such as polypropylenes, polybutenes, polybutadienes,
15 polymethylpentenes, and norbornene resins; ethylene-based copolymers (copolymers formed using ethylene as a monomer), such as ethylene-vinyl acetate copolymers, ethylene-(meth)acrylic acid copolymers, ethylene-(meth)acrylic ester copolymers, and ethylene-norbornene copolymers; vinyl chloride-based resins (resins formed by using vinyl chloride as a monomer), such as poly(vinyl
20 chloride) and vinyl chloride copolymers; polystyrenes; polycycloolefins; polyesters, such as poly(ethylene terephthalate), poly(ethylene naphthalate), poly(butylene terephthalate), poly(butylene isophthalate), poly(ethylene-2,6-naphthalene dicarboxylate), and wholly aromatic polyesters in which all the constitutional units have an aromatic cyclic group; copolymers of two or more
25 types of polyesters described above; poly(meth)acrylic esters; polyurethanes;

poly(urethane acrylate); polyimides; polyamides; polycarbonates; fluororesins; polyacetals; modified poly(phenylene oxide); poly(phenylene sulfide); polysulfones; and poly(ether ketone).

In addition, examples of the resin constituting the substrate also include
5 polymer alloys, such as a mixture of the polyester described above and a resin other than the polyester. The polymer alloy of the polyester and a resin other than the polyester preferably contains a relatively small amount of the resin other than the polyester.

Furthermore, examples of the resin constituting the substrate also include
10 crosslinked resins in which one or two or more of the resins exemplified so far are crosslinked; and modified resins, such as ionomers formed using one or two or more of the resins exemplified so far.

[0199]

One resin constituting the substrate may be used alone or two or more in
15 combination. When two or more resins constitute the substrate, their combination and ratios can be freely selected.

[0200]

The substrate may be composed of only one layer (a single layer) or may be composed of two or more layers (multiple layers). When the substrate is composed
20 of multiple layers, these multiple layers may be identical to or different from each other, and the combination of these multiple layers is not particularly limited.

[0201]

A thickness of the substrate is preferably from 5 μm to 1000 μm , more preferably from 10 μm to 500 μm , even more preferably from 15 μm to 300 μm ,
25 and still more preferably from 20 μm to 150 μm .

Here, the “thickness of the substrate” means the thickness of the entire substrate; for example, the thickness of the substrate composed of multiple layers means the total thickness of all layers composing the substrate.

[0202]

- 5 The substrate is preferably highly precise in its thickness, that is, variation in thickness is preferably small in any portion of the substrate. Examples of such a material highly precise in thickness among the constitutional materials described above include polyethylene, polyolefins other than the polyethylene, poly(ethylene terephthalate), and ethylene-vinyl acetate copolymers.

10 [0203]

The substrate may contain a known additive of various types, such as a filler, colorant, antistatic agent, antioxidant, organic lubricant, catalyst, or softener (plasticizer), in addition to the primary constitutional materials, such as the resin.

[0204]

- 15 The substrate may be transparent or opaque or may be colored according to the purpose, or alternatively another layer may be vapor-deposited on the substrate. In addition, when the first curable resin (x1) is the first energy ray-curable resin film (x1-2), and when the PSA layer is an energy ray-curable PSA layer, the substrate preferably transmits an energy ray.

20 [0205]

The substrate can be manufactured by a known method. For example, a substrate containing a resin can be manufactured by molding a resin composition containing the resin.

[0206]

- 25 Pressure sensitive adhesive layer

The pressure sensitive adhesive (PSA) layer is in the form of a sheet or film and contains a PSA.

Examples of the PSA include pressure sensitive adhesive resins, such as acrylic-based resins (PSAs made of a resin having a (meth)acryloyl group), urethane resins (PSAs made of a resin having a urethane bond), rubber-based resins (PSAs made of a resin having a rubber structure), silicone-based resins (PSAs made of a resin having a siloxane bond), epoxy resins (PSAs made of a resin having an epoxy group), polyvinyl ethers, and polycarbonates. Among these, an acrylic-based resin is preferred.

10 [0207]

In the present invention, the “pressure sensitive adhesive resin” is a concept that includes both a resin having pressure sensitive adhesion and a resin having adhesiveness and includes, for example, not only a resin having pressure sensitive adhesion per se but also a resin that exhibits pressure sensitive adhesion by combined use with an additional component, such as an additive, and a resin that exhibits adhesiveness by the presence of a trigger, such as heat or water.

15

[0208]

The PSA layer may be composed of only one layer (a single layer) or may be composed of two or more layers (multiple layers). When the PSA layer is composed of multiple layers, these multiple layers may be identical to or different from each other, and the combination of these multiple layers is not particularly limited.

20

[0209]

The thickness of the PSA layer is preferably from 1 μm to 1000 μm , more preferably from 5 μm to 500 μm , and even more preferably from 10 μm to 100

25

μm. Here, the “thickness of the PSA layer” means the thickness of the entire PSA layer; for example, the thickness of the PSA layer composed of multiple layers means the total thickness of all layers composing the PSA layer.

[0210]

- 5 The PSA layer may be formed using an energy ray-curable PSA or may be formed using a non-energy ray-curable PSA. The physical properties of the PSA layer formed using an energy ray-curable PSA before and after curing can be easily adjusted.

[0211]

- 10 Intermediate layer

 The intermediate layer is in the form of a sheet or film, and the constitutional material is appropriately selected according to the purpose and is not particularly limited. For example, the shape of the bump present on the semiconductor surface may be reflected on the protective film covering the

- 15 semiconductor surface, and this may cause deformation of the first cured resin film (r1). When the purpose is to prevent such deformation of the first cured resin film (r1), examples of a preferred constitutional material of the intermediate layer include urethane (meth)acrylates from the viewpoints of high conformability to unevenness and further improving the bondability of the intermediate layer.

- 20 [0212]

 The intermediate layer may be composed of only one layer (a single layer) or may be composed of two or more layers (multiple layers). When the intermediate layer is composed of multiple layers, these multiple layers may be identical to or different from each other, and the combination of these multiple

- 25 layers is not particularly limited.

[0213]

A thickness of the intermediate layer can be appropriately adjusted according to the height of the bump of the semiconductor surface to be protected but is preferably from 50 μm to 600 μm , more preferably from 70 μm to 500 μm ,
5 and even more preferably from 80 μm to 400 μm from the viewpoint that the effect of bumps with relatively great height can also be easily absorbed. Here, the “thickness of the intermediate layer” means the thickness of the entire intermediate layer; for example, the thickness of the intermediate layer composed of multiple layers means the total thickness of all layers composing the
10 intermediate layer.

[0214]

Next, a method for manufacturing the first laminate ($\alpha 1$) will be described.

[0215]

Method for manufacturing first laminate ($\alpha 1$)

15 The first laminate ($\alpha 1$) can be manufactured by sequentially laminating the layers described above to make the corresponding positional relationship.

For example, when the PSA layer or intermediate layer is laminated on the substrate in manufacturing the first support sheet (Y1), the PSA layer or intermediate layer can be laminated by coating the substrate with a PSA
20 composition or a composition for forming an intermediate layer, and drying as necessary or irradiating with an energy ray.

Examples of the coating method include a spin coating method, spray coating method, bar coating method, knife coating method, roll coating method, roll knife coating method, blade coating method, die coating method, and gravure
25 coating method.

[0216]

On the other hand, for example, when the first curable resin (x1) is further laminated on the PSA layer already laminated on the substrate, the first thermosetting resin composition (x1-1-1) or the first energy ray-curable resin composition (x1-2-1) is applied onto the PSA layer, and the first curable resin (x1) can be directly formed.

Likewise, when the PSA layer is further laminated on the intermediate layer already laminated on the substrate, a PSA composition is applied onto the intermediate layer, and the PSA layer can be directly formed.

10 [0217]

When a continuous two-layer laminated structure is thus formed using any of the compositions, a composition is further applied onto the layer formed from the composition described above, and a layer can be newly formed. However, the continuous two-layer laminated structure is formed preferably by the following procedure: of the two layers in the laminated structure, the layer to be laminated later is formed in advance on another release film using the composition; and an exposed surface of this formed layer, the exposed surface opposite from the side in contact with the release film, is bonded to an exposed surface of another layer already formed. In this case, the composition is preferably applied to a release-treated surface of the release film. The release film is removed as necessary after formation of the laminated structure.

[0218]

Second laminate ($\alpha 2$)

The second laminate ($\alpha 2$) is not particularly limited as long as it has a configuration capable of forming a protective film on the back surface of the

25

semiconductor wafer, and for example, the same configuration as that of the first laminate ($\alpha 1$) can be employed.

Thus, the second curable resin (x2) contained in the second laminate ($\alpha 2$) may be composed of the same material and have the same configuration as that of the first curable resin (x1) described above.

[0219]

Colorant (J)

Here, the second curable resin (x2) and a composition for forming the second curable resin, which is for forming the second curable resin (x2), preferably contain a colorant (J) from the viewpoint of improving the visibility of print formed by laser marking and from the viewpoint of improving the designability of the semiconductor chip by obscuring a grinding trace on the back surface of the semiconductor chip.

Examples of the colorant (J) include known colorants, such as inorganic pigments, organic pigments, and organic dyes.

Examples of the organic pigment and the organic dye include aminium-based dyes, cyanine-based dyes, merocyanine-based dyes, croconium-based dyes, squalium-based dyes, azulenium-based dyes, polymethine-based dyes, naphthoquinone-based dyes, pyrylium-based dyes, phthalocyanine-based dyes, naphthalocyanine-based dyes, naphtholactam-based dyes, azo-based dyes, fused azo-based dyes, indigo-based dyes, perinone-based dyes, perylene-based dyes, dioxazine-based dyes, quinacridone-based dyes, isoindolinone-based dyes, quinophthalone-based dyes, pyrrole-based dyes, thioindigo-based dyes, metal complex-based dyes (metal complex dyes), dithiol metal complex-based dyes, indolephenol-based dyes, triallylmethane-based dyes, anthraquinone-based dyes,

naphthol-based dyes, azomethine-based dyes, benzimidazolone-based dyes, pyranthrone-based dyes, and threne-based dyes.

Examples of the inorganic pigment include carbon blacks, cobalt-based pigments, iron-based pigments, chromium-based pigments, titanium-based pigments, vanadium-based pigments, zirconium-based pigments, molybdenum-based pigments, ruthenium-based pigments, platinum-based pigments, indium tin oxide (ITO)-based pigments, and antimony tin oxide (ATO)-based pigments.
[0220]

The second curable resin (x2) and the second composition for forming the second curable resin, which is for forming the second curable resin (x2), may contain only one colorant (J), or two or more colorants (J). When two or more colorants (J) are contained, their combination and ratios can be freely selected.

When the colorant (J) is used, the content of the colorant (J) of the second curable resin film (x2) is appropriately adjusted according to the purpose. For example, as described above, print may be applied by laser irradiation onto the second cured resin film (r2), which is a cured product formed by curing the second curable resin (x2). In such a case, the print visibility can be adjusted by adjusting the content of the colorant (J) of the second curable resin (x2) and adjusting the light transmissivity of the protective film. In addition, the adjustment of the content of the colorant (J) can improve the designability of the protective film and obscure the grinding trace on the back surface of the semiconductor wafer. In view of these points, the ratio of the content of the colorant (J) to the total content of all components other than the solvent (also referred to as the total mass of the solid content of the composition for forming the second curable resin) in the composition for forming the second curable resin, which is for forming the second

curable resin (x2), (i.e., the content of the colorant (J) of the second curable resin (x2)) is preferably from 0.1 to 10 mass%, more preferably from 0.1 to 7.5 mass%, and particularly preferably from 0.1 to 5 mass%. The colorant (J) is contained in an amount not lower than the lower limit described above, and this produces the effect of using the colorant (J) more remarkably. In addition, the colorant (J) is contained in an amount not higher than the upper limit described above, and this prevents excessive decrease in the light transmissivity of the second curable resin (x2).

[0221]

The first curable resin (x1) and the composition for forming the first curable resin may also contain the colorant (J). However, from the viewpoint of ensuring the visibility of the predetermined segmentation lines of the wafer for producing semiconductor chips, the content of the colorant (J) is preferably an amount within a range ensuring the level of transparency to achieve the visibility of the predetermined segmentation lines.

[0222]

In addition, the second support sheet (Y2) included in the second laminate ($\alpha 2$) may have the same configuration as that of the first support sheet (Y1) described above. Specifically, the second support sheet (Y2) like the first support sheet (Y1) may be composed of only the substrate 51 as illustrated in Fig. 10 or may be a PSA sheet in which the substrate 51 and the PSA layer 61 are laminated as illustrated in Fig. 11, or may be a PSA sheet in which the substrate 51, the intermediate layer 71, and the PSA layer 61 are laminated as illustrated in Fig. 12.

The substrate, intermediate layer, and PSA layer included in the second support sheet (Y2) may have the same configuration and be composed of the same

material as the substrate, intermediate layer, and PSA layer included in the first support sheet (Y1).

Examples

5 [0223]

The present invention will be specifically described with reference to examples below, but the present invention is not limited to the following examples.

[0224]

10 1. Preparation of wafer for producing semiconductor chips

For the wafer for producing semiconductor chips, a 12-inch silicon wafer (wafer thickness 775 μm) in which predetermined segmentation lines were half-cut was used. The width (width of the groove part) of the half-cut part of the silicon wafer is 200 μm , and the depth of the groove is 200 μm .

15 [0225]

2. Attachment of first curable resin (x1)

A first laminate ($\alpha 1$) in which a back grinding tape ("E-8510HR" available from Lintec Corporation) as the first support sheet (Y1) and a layer (X1) of the first curable resin (x1) with a thickness of 90 μm were laminated was attached to
20 the front surface side (half-cut-formed surface) of the wafer for producing semiconductor chips using the first curable resin (x1) side as the attachment surface while the first laminate ($\alpha 1$) was pressed under the following conditions.

- Attachment apparatus: full-automatic laminator (trade name "RAD-3510" available from Lintec Corporation)

25 • Roller pressure: 0.5 MPa

- Roller height: -400 μm
- Attachment rate: 5 mm/sec
- Attachment temperature: 90°C

[0226]

5 The shear modulus of elasticity G' of the layer (X1) was 1000 Pa.

 The shear modulus of elasticity G' was measured by the following method.

 For the first curable resin (x1), 10 sheets of first curable resin (x1) with a thickness of 100 μm were laminated, and a layer (X1) of the first curable resin (x1) with a thickness of 1 mm was prepared. This first curable resin (x1) was then
 10 cut into a disk shape with a diameter of 8 mm, and a test piece of the layer (X1) of the first curable resin (x1) was obtained. The position for placing the test piece in a shear viscometer, or a dynamic viscoelasticity measuring device, (ARES available from TA Instruments) was kept warm at 90°C in advance, and the test piece was placed in this placing position. A measuring jig was pressed against the
 15 upper surface of the test piece, and the test piece was placed by fixing to the placing position. A 400% strain was generated in the test piece under conditions of a temperature of 90°C and a measurement frequency of 1 Hz, and the shear modulus of elasticity G' of the test piece was measured.

[0227]

20 The first curable resin (x1) was manufactured using the first thermosetting resin composition (x1-1-1).

 Raw materials used in manufacturing the first thermosetting resin composition (x1-1-1) are shown below.

- Polymer component

Polymer component (A)-1: an acrylic-based resin (weight average molecular weight 800000, glass transition temperature -28°C) formed by copolymerization of butyl acrylate (hereinafter abbreviated as “BA”) (55 parts by mass), methyl acrylate (hereinafter abbreviated as “MA”) (10 parts by mass),
5 glycidyl methacrylate (hereinafter abbreviated as “GMA”) (20 parts by mass), and 2-hydroxyethyl acrylate (hereinafter abbreviated as “HEA”) (15 parts by mass).

- Epoxy resins

Epoxy resin (B1)-1: a liquid bisphenol F-type epoxy resin (“YL983U” available from Mitsubishi Chemical Corporation); a weight average molecular
10 weight of 340

Epoxy resin (B1)-2: a multifunctional aromatic epoxy resin (“EPPN-502H” available from Nippon Kayaku Co., Ltd.); a weight average molecular weight of 1000

Epoxy resin (B1)-3: a dicyclopentadiene-type epoxy resin (“EPICLON HP-
15 7200” available from DIC Corporation); a weight average molecular weight of 600

- Thermal curing agent

Thermal curing agent (B2)-1: a novolac-type phenolic resin (“BRG-556” available from Showa Denko K.K.)

- Curing accelerator

20 Curing accelerator (C)-1: 2-phenyl-4,5-dihydroxymethylimidazole (“CUREZOL 2PHZ-PW” available from Shikoku Chemicals Corporation)

- Filler

Filler (D)-1: spherical silica modified with an epoxy group (“ADMANANO YA050C-MKK” available from Admatechs Company Limited); 0.05 μm (average

particle size); 19 mass% (content in the first thermosetting resin composition (x1-1-1))

[0228]

A first thermosetting resin composition (x1-1-1) with a solid concentration
5 of 55 mass% was prepared by dissolving or dispersing 100 parts by mass of the
polymer component (A)-1, 135 parts by mass of the epoxy resin (B1)-1, 90 parts
by mass of the epoxy resin (B1)-2, 150 parts by mass of the epoxy resin (B1)-3,
180 parts by mass of the thermal curing agent (B2)-1, 1 part by mass of the curing
accelerator (C)-1, and 160 parts by mass of the filler (D)-1 in methyl ethyl ketone
10 and stirring at 23°C.

[0229]

A release-treated surface of a release film ("SP-PET381031" available from
Lintec Corporation, thickness 38 μm) made of a poly(ethylene terephthalate) film
whose one surface is release-treated with silicone was coated with the first
15 thermosetting resin composition (x1-1-1) obtained above, heated and dried at
100°C for 2 minutes, and a first thermosetting resin film (x1-1) with a thickness of
90 μm having thermosetting properties was prepared as the first curable resin (x1).

An exposed surface of the first curable resin (x1) was then bonded to an
exposed surface of a PSA layer of the back grinding tape, and a first laminate ($\alpha 1$)
20 in which the back grinding tape, the first curable resin (x1), and a release film
were laminated in this order in the thickness direction of these was obtained.

When this first laminate ($\alpha 1$) was attached to the wafer for producing
semiconductor chips, the release film was peeled off from the first laminate ($\alpha 1$)
to expose the first curable resin (x1), and the resulting first laminate ($\alpha 1$) with the
25 exposed first curable resin (x1) was used.

[0230]

3. Evaluation

The first curable resin (x1)-attached wafer for producing semiconductor chips was heated at 160°C for 1 hour to cure into the first cured resin film (r1), then the back surface was background by 625 μm to make the thickness of the wafer for producing semiconductor chips 150 μm, and then the back surface and a ground cross section were observed. The ground cross section was observed with an optical microscope (“VHX-1000” available from Keyence Corporation).

[0231]

4. Results

Fig. 13 illustrates the observation result of the back surface, and Fig. 14 illustrates the observation result of the ground cross section. Both results confirmed a good embedding property of the first cured resin film (r1) into the groove parts 13. In addition, the observation result of the ground cross section confirmed good coverability of the first cured resin film (r1) on the front surface of the wafer. These results confirmed that the manufacturing method of the present invention can produce a semiconductor chip in which the bump-formed surface and the side surface are well covered with the first cured resin film (r1).

[Reference Signs List]

[0232]

10: Wafer for producing semiconductor chips

11: Wafer

11a: Bump-formed surface

11b: Back surface

12: Bump

	13: Groove part
	40: Semiconductor chip
	x1: First curable resin
	r1: First cured resin film
5	X1: Layer
	Y1: First support sheet
	α 1: First laminate
	x2: Second curable resin
	r2: Second cured resin film
10	X2: Layer
	Y2: Second support sheet
	α 2: Second laminate
	51: Substrate
	61: Pressure sensitive adhesive layer
15	71: Intermediate layer

[CLAIMS]

[Claim 1]

A method for manufacturing a semiconductor chip, the method comprising steps (S1) to (S4) in this order:

5 (S1) preparing a wafer for producing semiconductor chips, wherein groove parts as predetermined segmentation lines are formed in a bump-formed surface of a semiconductor wafer having the bump-formed surface comprising bumps, the groove parts not reaching a back surface of the semiconductor wafer;

(S2) attaching a first curable resin (x1) by pressing to the bump-formed
10 surface of the wafer for producing semiconductor chips to cover the bump-formed surface of the wafer for producing semiconductor chips with the first curable resin (x1) and to embed the first curable resin (x1) into the groove parts formed in the wafer for producing semiconductor chips;

(S3) curing the first curable resin (x1) to obtain a wafer for producing
15 semiconductor chips with a first cured resin film (r1);

(S4) segmenting the wafer for producing semiconductor chips with the first cured resin film (r1) along the predetermined segmentation lines into individual pieces to obtain semiconductor chips in which at least the bump-formed surface and a side surface are covered with the first cured resin film (r1); and

20 the method further comprising step (S-BG) after the step (S2) and before the step (S3), after the step (S3) and before the step (S4), or in the step (S4):

(S-BG) grinding the back surface of the wafer for producing semiconductor chips.

[Claim 2]

The method for manufacturing a semiconductor chip according to claim 1,
wherein the step (S2) is performed by attaching by pressing a first laminate ($\alpha 1$)
having a laminated structure in which a first support sheet (Y1) and a layer (X1)
of the first curable resin (x1) are laminated to the bump-formed surface of the
5 wafer for producing semiconductor chips using the layer (X1) as an attachment
surface.

[Claim 3]

The method for manufacturing a semiconductor chip according to claim 2,
the method comprising the step (S-BG) after the step (S2) and before the step
10 (S3), wherein

the step (S-BG) is performed by grinding the back surface of the wafer for
producing semiconductor chips with the first laminate ($\alpha 1$) attached and then
peeling off the first support sheet (Y1) from the first laminate ($\alpha 1$), and

the step (S4) is performed by cutting portions of the first cured resin film
15 (r1) of the wafer for producing semiconductor chips with the first cured resin film
(r1), the portions being formed in the groove parts, along the predetermined
segmentation lines.

[Claim 4]

The method for manufacturing a semiconductor chip according to claim 2,
20 the method comprising the step (S-BG) after the step (S3) and before the step
(S4), wherein

the step (S3) is performed without peeling off the first support sheet (Y1)
from the first laminate ($\alpha 1$),

the step (S-BG) is performed by grinding the back surface of the wafer for producing semiconductor chips with the first laminate ($\alpha 1$) attached, and then peeling off the first support sheet (Y1) from the first laminate ($\alpha 1$), and

the step (S4) is performed by cutting portions of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts, along the predetermined segmentation lines.

[Claim 5]

The method for manufacturing a semiconductor chip according to claim 2, the method comprising the step (S-BG) after the step (S3) and before the step (S4), wherein

the first support sheet (Y1) is peeled off from the first laminate ($\alpha 1$) after the step (S2) and before the step (S3),

the step (S-BG) is performed by attaching a back grinding sheet (b-BG) to a front surface of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), grinding the back surface of the wafer for producing semiconductor chips with the back grinding sheet (b-BG) attached, and then peeling off the back grinding sheet (b-BG) from the wafer for producing semiconductor chips with the first cured resin film (r1), and

the step (S4) is performed by cutting portions of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts, along the predetermined segmentation lines.

[Claim 6]

The method for manufacturing a semiconductor chip according to claim 2, the method comprising the step (S-BG) in the step (S4), wherein

the first support sheet (Y1) is peeled off from the first laminate ($\alpha 1$) after the step (S2) and before the step (S3), and

5 the step (S4) is performed by making cuts in portions of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), the portions being formed in the groove parts, along the predetermined segmentation lines, or forming modified regions along the predetermined segmentation lines, and then performing the step (S-BG) by
10 attaching a back grinding sheet (b-BG) to a front surface of the first cured resin film (r1) of the wafer for producing semiconductor chips with the first cured resin film (r1), and grinding the back surface of the wafer for producing semiconductor chips with the back grinding sheet (b-BG) attached.

[Claim 7]

15 The method for manufacturing a semiconductor chip according to any one of claims 1 to 6, further comprising step (T):

(T) forming a second cured resin film (r2) on the back surface of the wafer for producing semiconductor chips.

[Claim 8]

20 The method for manufacturing a semiconductor chip according to any one of claims 1 to 7, further comprising step (U):

(U) removing the first cured resin film (r1) covering a top part of the bump or the first cured resin film (r1) adhering to a portion of the top part of the bump to expose the top part of the bump.

25 [Claim 9]

The method for manufacturing a semiconductor chip according to claim 8, wherein the step (U) is performed by plasma etching treatment.

[Claim 10]

5 The method for manufacturing a semiconductor chip according to any one of claims 1 to 9, wherein a shear modulus of elasticity G' is from 5.0×10 Pa to 1.0×10^6 Pa when a strain dispersion measurement is performed to measure a shear modulus of elasticity G' of a test piece of the layer (X1) by causing a 400% strain on the test piece of the layer (X1) under conditions of a temperature of 90°C and a frequency of 1 Hz.

10 [Claim 11]

The method for manufacturing a semiconductor chip according to any one of claims 1 to 10, wherein a thickness of the layer (X1) is 10 μm or greater and 200 μm or less.

[Claim 12]

15 The method for manufacturing a semiconductor chip according to any one of claims 1 to 11, wherein a width of the groove part is from 10 μm to 2000 μm .

[Claim 13]

The method for manufacturing a semiconductor chip according to any one of claims 1 to 12, wherein a depth of the groove part is from 30 μm to 700 μm .

20 [Claim 14]

The method for manufacturing a semiconductor chip according to any one of claims 1 to 13, wherein the first cured resin film (r1) is transparent.