

DESCRIPTION

Title of Invention

SEMICONDUCTOR DEVICE, THERMOSETTING RESIN
COMPOSITION USED FOR PRODUCTION THEREOF, AND
5 DICING DIE BONDING INTEGRATED TAPE

Technical Field

[0001] The present disclosure relates to a semiconductor device, a thermosetting resin composition used for manufacturing therefor, and a dicing-die bonding integrated tape.

10 Background Art

[0002] A stacked MCP (Multi Chip Package) obtained by stacking semiconductor elements in multiple stages so as to have a high capacity has become widespread in association with the multi-functionalization of devices such as mobile phones. A film-like adhesive is widely used
15 in the mounting of the semiconductor element. As an example of multistage stacked packages using a film-like adhesive, a wire-embedded type package is mentioned. This package is manufactured through a step of pressure-bonding a film-like adhesive to a semiconductor element having been wire-bonded onto a substrate and
20 thereby embedding the semiconductor element and the wire in the film-like adhesive.

[0003] As one of important properties required in the semiconductor devices such as the stacked MCPs described above, connection reliability is mentioned. In order to improve connection reliability,
25 film-like adhesives in which properties such as heat resistance, moisture resistant, and reflow resistance are taken into consideration have been

developed. For example, Patent Literature 1 discloses an adhesive sheet containing a thermosetting component and a filler and having a thickness of 10 to 250 μm . Patent Literature 2 discloses an adhesive composition which contains a mixture containing an epoxy resin and a phenolic resin and an acrylic copolymer.

[0004] The connection reliability of the semiconductor device also greatly depends on whether or not a semiconductor element can be mounted without voids being generated on an adhesive surface. Therefore, attempts have been made to use a high-flow film-like adhesive so that a semiconductor element can be pressure-bonded without voids being generated, to use a film-like adhesive having a low melt viscosity so that generated voids can be eliminated by a sealing step of a semiconductor element, and the like. For example, Patent Literature 3 discloses an adhesive sheet having a low viscosity and a low tack strength.

Citation List

Patent Literature

[0005] Patent Literature 1: International Publication WO 2005/103180

Patent Literature 2: Japanese Unexamined Patent Publication No. 2002-220576

Patent Literature 3: Japanese Unexamined Patent Publication No. 2009-120830

Summary of Invention

Technical Problem

[0006] Since the adhesive sheets of Patent Literatures 1 and 3 described above embed the wire at the time of pressure-bonding, the adhesive

5 sheets contain a relatively large amount of an epoxy resin for the purpose of high fluidization. For this reason, thermal curing is likely to be advanced by heat generated in the process of manufacturing a semiconductor device. According to this, the adhesive film becomes highly elastic, in other words, the adhesive sheet is less likely to be deformed even under a high-temperature and high-pressure condition at the time of sealing, and thus voids formed at the time of pressure-bonding are not finally eliminated in some cases. On the other hand, since the adhesive composition of Patent Literature 2 described above has a low elastic modulus, voids can be eliminated in the sealing step, but due to a high viscosity, the embeddability of the wire at the time of pressure-bonding is likely to be insufficient.

[0007] In recent years, an increase in operation speed of a wire-embedded semiconductor device becomes important.

15 Conventionally, a controller chip controlling the operation of a semiconductor device has been disposed at the uppermost stage of the stacked semiconductor elements. In order to realize an increase in operation speed, a package technology of a semiconductor device in which a controller chip is disposed at the lowermost stage has been developed. As an aspect of such a package, a package has attracted attention in which a relatively thick film-like adhesive is used when a semiconductor element at the second stage of semiconductor elements stacked in multiple stages is pressure-boned, and a controller chip is embedded inside the film-like adhesive. Film-like adhesives to be used in such use applications require high fluidity that enables a controller chip, a wire connecting a circuit pattern to the controller chip,

and a step difference caused by irregularities on a substrate surface to be embedded. This problem can be solved by using high-flow adhesive sheets like the adhesive sheets of Patent Literatures 1 and 3.

[0008] However, the adhesive sheets described in Patent Literatures 1 and 3 exhibit high fluidity before curing; on the other hand, the resin flowing at the time of embedding the controller chip also contaminates the peripheral circuit in some cases. Further, the adhesive sheet flows by thermal curing after embedding to occur the positional deviation of the chip or the resin thrusts into the inside of the chip like the tide is out from the end surface of the embedded chip to cause phenomenon called "sink" in which the resin disappears from the chip end portion to occur (see FIG. 8). Particularly, in recent years, in order to improve embeddability, a thermal curing treatment is performed under a pressurized condition in many cases. When heat is applied in a state of applying a pressure from the outside in this way, embeddability is improved, but the resin is even more likely to flow, and thereby problems as described above occur in many cases.

[0009] An object of the present disclosure is to provide a semiconductor device having excellent connection reliability. Furthermore, another object of the present disclosure is to provide a thermosetting resin composition useful for manufacturing a semiconductor device having excellent connection reliability and a dicing-die bonding integrated tape including an adhesive layer composed of the thermosetting resin composition.

Solution to Problem

[0010] The present inventors have conducted intensive studies on

selection of a resin of a film-like adhesive and adjustment of physical properties in order to develop a package of an aspect in which a controller chip is embedded in a cured product of a film-like adhesive. As a result, the present inventors have found out that the melt viscosity of the film-like adhesive has a correlation with circuit contamination at the time of embedding and sink occurring in the thermal process at the subsequent step.

[0011] A semiconductor device of the present disclosure includes a substrate, a first semiconductor element disposed on the substrate, a first sealing layer disposed to cover a region in which the first semiconductor element is disposed in the substrate and sealing the first semiconductor element, and a second semiconductor element disposed to cover a surface in the first sealing layer opposite to the side of the substrate and having a larger area than an area of the first semiconductor element, the first sealing layer is composed of a cured product of a thermosetting resin composition, and a melt viscosity at 120°C of the thermosetting resin composition is 2500 to 11500 Pa·s.

[0012] The above-described semiconductor device is an aspect in which the first semiconductor element (for example, a controller chip) is embedded in the cured product of the thermosetting resin composition and the operation speed can be increased. When the first sealing layer is the cured product of the thermosetting resin composition having a melt viscosity at 120°C of 2500 to 11500 Pa·s, voids at an interface with the substrate or the first semiconductor element are sufficiently small and the occurrence of problems of contamination of the substrate and sink is also sufficiently suppressed, and thus excellent connection

reliability between the substrate and the first semiconductor element can be achieved.

[0013] The semiconductor device of the present disclosure may further include a circuit pattern formed on a surface of the substrate and a first wire electrically connecting the first semiconductor element and the circuit pattern to each other. The semiconductor device of the present disclosure may further include a second wire electrically connecting the second semiconductor element and the circuit pattern to each other and a second sealing layer sealing the second semiconductor element and the second wire. The semiconductor device of the present disclosure may further include a third semiconductor element stacked above the second semiconductor element.

[0014] It is preferable that the thermosetting resin composition constituting the above-described film-like adhesive contains a low-molecular-weight component having a molecular weight of 10 to 1000 (for example, an epoxy resin) and a high-molecular-weight component having a molecular weight of 100000 to 1000000 (for example, acrylic rubber), a content M1 of the low-molecular-weight component is 23 to 35 parts by mass with respect to 100 parts by mass of a mass of resin components contained in the thermosetting resin composition, and a content M2 of the high-molecular-weight component is 25 to 45 parts by mass with respect to 100 parts by mass of the mass of resin components contained in the thermosetting resin composition. By using the thermosetting resin composition having such a composition, the low-molecular-weight component contributes to excellent embeddability; on the other hand, the high-molecular-weight

component contributes to suppression of problems caused by excessive flow. In the thermosetting resin composition, a total amount (M1 + M2) of the low-molecular-weight component and the high-molecular-weight component is preferably 54 to 76 parts by mass with respect to 100 parts by mass of the mass of resin components contained in the thermosetting resin composition.

[0015] Incidentally, the molecular weight (weight average molecular weight) of the resin component contained in the thermosetting resin composition means a value as measured by gel permeation chromatography (GPC) and converted using a calibration curve of standard polystyrene.

[0016] In the case of using a substrate having a circuit pattern on a surface thereof, the semiconductor device of the present disclosure may further include a first wire electrically connecting the first semiconductor element and the circuit pattern to each other, and may further include a second wire electrically connecting the second semiconductor element and the circuit pattern to each other and a second sealing layer sealing the second semiconductor element and the second wire.

[0017] A thermosetting resin composition of the present disclosure is used in a manufacturing process of a semiconductor device, the manufacturing process includes a step of performing a curing treatment in which the thermosetting resin composition is heated and bringing at least one of at least a part of the wire and the semiconductor element into a state of being embedded in the thermosetting resin composition after the curing treatment, and a melt viscosity at 120°C of the

thermosetting resin composition is 2500 to 11500 Pa·s. According to the above-described thermosetting resin composition, the thermosetting resin composition has fluidity that enables a semiconductor element and the like to be embedded and can sufficiently suppress problems caused by contamination of peripheral circuits at the time of embedding and excessive flow of the resin in a thermal process at the subsequent step (the thermal curing treatment of the thermosetting resin composition).

[0018] A dicing-die bonding integrated tape of the present disclosure includes a pressure-sensitive adhesive layer and an adhesive layer composed of the above-described thermosetting resin composition.

Advantageous Effects of Invention

[0019] According to the present disclosure, a semiconductor device having excellent connection reliability is provided, and a thermosetting resin composition used in the manufacturing therefor and a dicing-die bonding integrated tape including an adhesive layer composed of the thermosetting resin composition are provided. This thermosetting resin composition has excellent embeddability that enables at least one of a semiconductor element such as a controller chip and a wire to be embedded and can sufficiently suppress problems caused by contamination of peripheral circuits at the time of embedding and excessive flow of the resin in a thermal process at the subsequent step.

Brief Description of Drawings

[0020] FIG. 1 is a cross-sectional view schematically illustrating an example of a semiconductor device.

FIG. 2 is a cross-sectional view schematically illustrating an example of a laminate including a film-like adhesive and a second

semiconductor element.

FIG. 3 is a cross-sectional view schematically illustrating a process of manufacturing the semiconductor device illustrated in FIG. 1.

FIG. 4 is a cross-sectional view schematically illustrating a process of manufacturing the semiconductor device illustrated in FIG. 1.

FIG. 5 is a cross-sectional view schematically illustrating a process of manufacturing the semiconductor device illustrated in FIG. 1.

FIG. 6 is a cross-sectional view schematically illustrating a process of manufacturing the semiconductor device illustrated in FIG. 1.

FIGS. 7A to 7E are cross-sectional views schematically illustrating a process of manufacturing the laminate including the film-like adhesive and the second semiconductor element.

FIG. 8A is a photograph showing a cross-section of a structure in which the phenomenon called "sink" does not occur, and FIG. 8B is a photograph showing a cross-section of a structure in which "sink" occurs (sink depth: 140 μm).

FIG. 9A is a cross-sectional view schematically illustrating a structure for evaluating presence/absence of the generation of voids, FIG. 9B is a photograph of a structure in which a void is not generated, and FIG. 9C is a photograph of a structure in which a void is generated.

Description of Embodiments

[0021] Hereinafter, embodiments of the present disclosure will be specifically described with reference to the drawings. In the following description, the same or similar portions are denoted with the same reference signs and repeated description is omitted. Furthermore, unless otherwise specified, positional relationships such as top, bottom,

right, and left are assumed to be based on positional relationships illustrated in the drawings. Further, dimension ratios in the drawings are not limited to illustrated ratios. Incidentally, the term "(meth)acrylic" described in the present specification means "acrylic" and its corresponding "methacrylic".

[0022] <Semiconductor device>

FIG. 1 is a cross-sectional view schematically illustrating a semiconductor device of the present embodiment. A semiconductor device 100 illustrated in this drawing includes a substrate 10, a first semiconductor element Wa disposed on a surface of the substrate 10, a first sealing layer 20 sealing the first semiconductor element Wa, a second semiconductor element Wb disposed above the first semiconductor element Wa, and a second sealing layer 40 sealing the second semiconductor element Wb.

[0023] The substrate 10 has circuit patterns 10a and 10b on the surface. From the viewpoint of suppressing the bowing of the semiconductor device 100, the thickness of the substrate 10 is, for example, 90 to 180 μm and may be 90 to 140 μm . Incidentally, the substrate 10 may be an organic substrate and may be a metal substrate such as a lead frame.

[0024] In the present embodiment, the first semiconductor element Wa is a controller chip for driving the semiconductor device 100. The first semiconductor element Wa is attached onto the circuit pattern 10a via an adhesive 15 and connected to the circuit pattern 10b via a first wire 11. The shape of the first semiconductor element Wa in plan view is, for example, a rectangular shape (square or rectangle). The length of one side of the first semiconductor element Wa is, for example, 5 mm or less

and may be 2 to 4 mm or 1 to 4 mm. The thickness of the first semiconductor element Wa is, for example, 10 to 150 μm and may be 20 to 100 μm .

[0025] The second semiconductor element Wb has a larger area than the first semiconductor element Wa. The second semiconductor element Wb is mounted on the substrate 10 via the first sealing layer 20 so that the entire first semiconductor element Wa and a part of the circuit pattern 10b are covered. The shape of the second semiconductor element Wb in plan view is, for example, a rectangular shape (square or rectangle). The length of one side of the second semiconductor element Wb is, for example, 20 mm or less and may be 4 to 20 mm or 4 to 12 mm. The thickness of the second semiconductor element Wb is, for example, 10 to 170 μm and may be 20 to 120 μm . The second semiconductor element Wb is connected to the circuit pattern 10b via a second wire 12 and sealed by the sealing layer 25.

[0026] The first sealing layer 20 is composed of a film-like adhesive 20P (see FIG. 2). Incidentally, as illustrated in FIG. 2, the film-like adhesive 20P and the second semiconductor element Wb have substantially the same size. A laminate 30 illustrated in FIG. 2 is composed of the film-like adhesive 20P and the second semiconductor element Wb and is also referred to as an adhesive-attached semiconductor chip. The laminate 30 is prepared through a dicing step and a pickup step as described below (see FIG. 7).

[0027] <Method for manufacturing a semiconductor device>

The method for manufacturing the semiconductor device 100 will be described. First, a structure 50 illustrated in FIG. 3 is prepared.

That is, the first semiconductor element Wa is disposed on the surface of the substrate 10 via the adhesive 15. Thereafter, the first semiconductor element Wa and the circuit pattern 10b are electrically connected via the first wire 11.

5 [0028] Next, as illustrated in FIGS. 3 and 4, the film-like adhesive 20P of the laminate 30 separately prepared is pressed against the substrate 10. According to this, the first semiconductor element Wa and the first wire 11 are embedded in the film-like adhesive 20P. The thickness of the film-like adhesive 20P may be appropriately set depending on the
10 thickness of the first semiconductor element Wa and the like, and for example, may be in a range of 20 to 200 μm and may be 30 to 200 μm or 40 to 150 μm . When the thickness of the film-like adhesive 20P is set in the above-described range, a space (distance G in FIG. 5) between the first semiconductor element Wa and the second semiconductor
15 element Wb can be sufficiently secured. The distance G is, for example, 50 μm or more and may be 50 to 75 μm or 50 to 80 μm .

[0029] The pressure-bonding of the film-like adhesive 20P to the substrate 10 is preferably executed, for example, under conditions of 80°C to 180°C and 0.01 to 0.50 MPa for 0.5 to 3.0 seconds.

20 [0030] Next, the film-like adhesive 20P is cured by heating. This curing treatment is preferably executed, for example, under conditions of 60°C to 175°C and 0.01 to 1.0 MPa for 5 minutes or longer. According to this, the first semiconductor element Wa is sealed with a cured product (first sealing layer 20) of the film-like adhesive 20P (see
25 FIG. 6). The curing treatment of the film-like adhesive 20P may be executed under a pressurized atmosphere from the viewpoint of

reducing voids. After the second semiconductor element Wb and the circuit pattern 10b are electrically connected via the second wire 12, the second semiconductor element Wb is sealed by the second sealing layer 40, and thereby the semiconductor device 100 is completed (see FIG. 1).

5 [0031] <Method for preparing adhesive-attached semiconductor chip>

An example of the method for manufacturing the laminate 30 (adhesive-attached semiconductor chip) illustrated in FIG. 2 will be described with reference to FIGS. 7A to 7E. First, a dicing-die bonding integrated tape 8 (hereinafter, referred to as the "tape 8" in
10 some cases) is disposed in a predetermined apparatus (not illustrated). The tape 8 is provided with a base layer 1, a pressure-sensitive adhesive layer 2, and an adhesive layer 20A in this order. The base layer 1 is, for example, a polyethylene terephthalate film (PET film). The semiconductor wafer W is, for example, a thin semiconductor wafer
15 having a thickness of 10 to 100 μm . The semiconductor wafer W may be single-crystal silicon and a compound semiconductor such as various ceramics and gallium arsenide.

[0032] As illustrated in FIGS. 7A and 7B, the tape 8 is pasted so that the adhesive layer 20A is in contact with one surface of a semiconductor
20 wafer W. This step is executed under a temperature condition of preferably 50°C to 100°C and more preferably 60°C to 80°C. When the temperature is 50°C or higher, favorable adhesiveness between the semiconductor wafer W and the adhesive layer 20A can be obtained, and when the temperature is 100°C or lower, excessive flow of the
25 adhesive layer 20A in this step is suppressed.

[0033] As illustrated in FIG. 7C, the semiconductor wafer W, the

pressure-sensitive adhesive layer 2, and the adhesive layer 20A are diced. According to this, the semiconductor wafer W is individuated to become a semiconductor element Wb. The adhesive layer 20A is also individuated to become the film-like adhesive 20P. As the dicing method, a method using a rotary blade or laser is mentioned. Incidentally, the thickness may be decreased by grinding the semiconductor wafer W prior to the dicing of the semiconductor wafer W.

[0034] Next, in a case where the pressure-sensitive adhesive layer 2 is, for example, a UV curable type, as illustrated in FIG. 7D, the pressure-sensitive adhesive layer 2 is cured by irradiating the pressure-sensitive adhesive layer 2 with ultraviolet rays, and thereby the pressure-sensitive adhesive force between the pressure-sensitive adhesive layer 2 and the film-like adhesive 20P is decreased. After irradiation of ultraviolet rays, as illustrated in FIG. 7E, while the semiconductor elements Wa are separated from each other by expanding the base layer 1 at normal temperature or under cooling conditions, the film-like adhesive 20P of the laminate 30 is peeled off from the pressure-sensitive adhesive layer 2 by being thrust up by a needle 42, and the laminate 30 is sucked by a suction collet 44 so as to be picked up. The laminate 30 obtained in this way is provided in the manufacturing of the structure 50 illustrated in FIG. 3.

[0035] <Thermosetting resin composition>

The thermosetting resin composition constituting the film-like adhesive 20P will be described. Incidentally, the film-like adhesive 20P is obtained by individuating the adhesive layer 20A, and both the

film-like adhesive and the adhesive layer are composed of a thermosetting resin composition. This thermosetting resin composition may be, for example, in a completely cured product (C-stage) state through a semi-cured (B-stage) state by the curing treatment at the subsequent step.

[0036] The thermosetting resin composition preferably contains the following components:

(a) a thermosetting resin (hereinafter, simply referred to as the "component (a)" in some cases);

(b) a high-molecular-weight component (hereinafter, simply referred to as the "component (b)" in some cases); and

(c) an inorganic filler (hereinafter, simply referred to as the "component (c)" in some cases).

Incidentally, in the present embodiment, in a case where the (a) thermosetting resin contains an epoxy resin, the epoxy resin (hereinafter, simply referred to as the "component (a1)" in some cases) corresponds to the "low-molecular-weight component". In this case, the (a) thermosetting resin preferably contains a phenolic resin that may be a curing agent of the epoxy resin (hereinafter, simply referred to as the "component (a2)" in some cases).

[0037] The thermosetting resin composition may further contain the following components:

(d) a coupling agent (hereinafter, simply referred to as the "component (d)" in some cases); and

(e) a curing accelerator (simply referred to as the "component (e)" in some cases).

[0038] The thermosetting resin composition preferably contains both a low-molecular-weight component having a molecular weight of 10 to 1000 (the component (a1)) and a high-molecular-weight component having a molecular weight of 100000 to 1000000 (the component (b)).

5 By using these components in combination, the low-molecular-weight component contributes to excellent embeddability; on the other hand, the high-molecular-weight component contributes to suppression of problems caused by excessive flow.

[0039] A content M1 of the low-molecular-weight component is preferably 23 to 35 parts by mass and more preferably 25 to 35 parts by mass with respect to 100 parts by mass of the mass of resin components contained in the thermosetting resin composition. When the content M1 of the low-molecular-weight component is 23 parts by mass or more, excellent embeddability is easily achieved; on the other hand, 10
15 when the content M1 is 35 parts by mass or less, excellent pickup property is easily achieved. Incidentally, the softening point of the low-molecular-weight component is preferably 50°C or lower and may be, for example, 10°C to 30°C.

[0040] A content M2 of the high-molecular-weight component is preferably 25 to 45 parts by mass and more preferably 30 to 40 parts by mass with respect to 100 parts by mass of the mass of resin components contained in the thermosetting resin composition. When the content M2 of the high-molecular-weight component is 25 parts by mass or more, problems caused by excessive flow (such as contamination of the 20
25 substrate, sink, and bowing) are easily suppressed; on the other hand, when the content M2 is 45 parts by mass or less, excellent

embeddability is easily achieved. Incidentally, the softening point of the high-molecular-weight component is preferably higher than 50°C and 100°C or lower.

[0041] The total amount ($M1 + M2$) of the low-molecular-weight component and the high-molecular-weight component is preferably 54 to 76 parts by mass and more preferably 55 to 75 parts by mass with respect to 100 parts by mass of the mass of resin components contained in the thermosetting resin composition. When this total amount is 54 parts by mass or more, the effect obtained by using these components in combination tends to be sufficiently exhibited; on the other hand, when this total amount is 76 parts by mass or less, the effect of easily achieving excellent pickup property is exhibited. Incidentally, as a component that is a resin component contained in the thermosetting resin composition and is a component other than the low-molecular-weight component and the high-molecular-weight component, mainly, a thermosetting resin having a molecular weight of 1001 to 99000, and the like are exemplified.

[0042] The melt viscosity at 120°C of the thermosetting resin composition is 2500 to 11500 Pa·s from the viewpoint of connection reliability. When this melt viscosity is 2500 Pa·s or more, the occurrence of problems of contamination of the substrate 10 and sink at the time of a pressure-bonding treatment and the like can be sufficiently suppressed. For example, if there is a region (sink) in which a cured product of the thermosetting resin composition does not exist between the second semiconductor element Wb and the substrate 10, a sealing material for the second sealing layer 40 penetrates this region, and

according to this, a problem is likely to arise in that the second semiconductor element Wb is easily peeled off. When the melt viscosity at 120°C of the thermosetting resin composition is 11500 Pa·s or less, voids at the interface with the substrate 10 or the first semiconductor element Wa can be sufficiently decreased. This melt viscosity is preferably 5000 to 11000 Pa·s, more preferably 5000 to 10000 Pa·s, and further preferably 5000 to 9000 Pa·s. Incidentally, the melt viscosity means a measurement value measured using ARES (TA Instruments) while applying 5% strain to the thermosetting resin composition molded in a film shape and increasing the temperature at a temperature increasing rate of 5°C/min.

[0043] The melt viscosity at 100°C of the thermosetting resin composition is preferably 3500 to 13500 Pa·s from the viewpoint of connection reliability. When this melt viscosity is 3500 Pa·s or more, the occurrence of problems of contamination of the substrate 10 and sink at the time of a pressure-bonding treatment and the like can be sufficiently suppressed. On the other hand, when this melt viscosity is 13500 Pa·s or less, voids at the interface with the substrate 10 or the first semiconductor element Wa can be sufficiently decreased. This melt viscosity is preferably 5500 to 10500 Pa·s. In order to adjust the melt viscosities at 100°C and 120°C of the thermosetting resin composition within the above-described range, the amounts of the (a) thermosetting resin, the (b) high-molecular-weight component, and the (c) inorganic filler may be appropriately adjusted.

[0044] FIG. 9A illustrates a structure which includes the substrate 10 that is transparent, the first semiconductor element Wa disposed thereon,

the first sealing layer 20 (the cured product of the film-like adhesive 20P), and the second semiconductor element Wb disposed thereon. FIGS. 9B and 9C are photographs captured from the rear surface side (the direction of arrow in FIG. 9A) of the transparent substrate 10. In the structure shown in FIG. 9B, the embeddability of the film-like adhesive is sufficient, and a void is not generated. On the other hand, in the structure shown in FIG. 9C, the embeddability of the film-like adhesive is insufficient, and a void V is generated.

[0045] The storage elastic modulus at 180°C of the cured product (C-stage) of the thermosetting resin composition is preferably 10 MPa or more and more preferably 25 MPa or more, and may be 50 MPa or more or 100 MPa or more, from the viewpoint of connection reliability. Incidentally, the upper limit value of this storage elastic modulus is, for example, 600 MPa and may be 500 MPa. The storage elastic modulus at 180°C of the cured product of the thermosetting resin composition can be measured by using, as a sample, a product obtained by curing the film-like adhesive under a temperature condition of 175°C and using a dynamic viscoelasticity apparatus.

[0046] <(a) Thermosetting resin>

The component (a1) can be used without particular limitation as long as it has an epoxy group in the molecule. Examples of the component (a1) include a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, a bisphenol S type epoxy resin, a phenol novolak type epoxy resin, a cresol novolak type epoxy resin, a bisphenol A novolak type epoxy resin, a bisphenol F novolak type epoxy resin, a dicyclopentadiene skeleton-containing epoxy resin, a stilbene type

epoxy resin, a triazine skeleton-containing epoxy resin, a fluorene skeleton-containing epoxy resin, a triphenolphenolmethane type epoxy resin, a biphenyl type epoxy resin, a xylylene type epoxy resin, a biphenyl aralkyl type epoxy resin, a naphthalene type epoxy resin, and a diglycidyl ether compound of a polyfunctional phenol or a polycyclic aromatic compound such as anthracene. These may be used alone or in combination of two or more kinds thereof. Of these, the component (a1) may be a cresol novolak type epoxy resin, a bisphenol F type epoxy resin, or a bisphenol A type epoxy resin from the viewpoint of heat resistance.

[0047] The epoxy equivalent of the component (a1) may be 90 to 300 g/eq, 110 to 290 g/eq, or 130 to 280 g/eq. When the epoxy equivalent of the component (a1) is in such a range, there is a tendency that fluidity can be secured while the bulk strength of the film-like adhesive is maintained.

[0048] The content of the component (a1) may be 5 to 50 parts by mass, 10 to 40 parts by mass, or 20 to 30 parts by mass with respect to 100 parts by mass of the total mass of the component (a), the component (b), and the component (c). When the content of the component (a1) is 5 parts by mass or more, the embeddability of the film-like adhesive tends to become more favorable. When the content of the component (a1) is 50 parts by mass or less, there is a tendency that the occurrence of bleeding can be further suppressed.

[0049] The component (a2) can be used without particular limitation as long as it has a phenolic hydroxyl group in the molecule. Examples of the component (a2) include novolak type phenolic resins obtained by

condensation or co-condensation of phenols such as phenol, cresol, resorcin, catechol, bisphenol A, bisphenol F, phenylphenol, and aminophenol and/or naphthols such as α -naphthol, β -naphthol, and dihydroxynaphthalene with a compound having an aldehyde group such as formaldehyde in the presence of an acidic catalyst; and phenol aralkyl resins and naphthol aralkyl resins synthesized from phenols such as allylated bisphenol A, allylated bisphenol F, allylated naphthalene diol, phenol novolak, and phenol and/or naphthols with dimethoxyparaxylene or bis(methoxymethyl)biphenyl. These may be used alone or in combination of two or more kinds thereof. Of these, the component (a2) may be a phenol aralkyl resin, a naphthol aralkyl resin, or a novlack type phenolic resin from the viewpoints of hygroscopicity and heat resistance.

[0050] The hydroxyl equivalent of the component (a2) may be 80 to 250 g/eq, 90 to 200 g/eq, or 100 to 180 g/eq. When the hydroxyl equivalent of the component (a2) is in such a range, there is a tendency that adhesive force can be more highly maintained while the fluidity of the film-like adhesive is secured.

[0051] The softening point of the component (a2) may be 50°C to 140°C, 55°C to 120°C, or 60°C to 100°C.

[0052] The content of the component (a2) may be 5 to 50 parts by mass, 10 to 40 parts by mass, or 20 to 30 parts by mass with respect to 100 parts by mass of the total mass of the component (a), the component (b), and the component (c). When the content of the component (a2) is 5 parts by mass or more, more favorable curability tends to be obtainable. When the content of the component (a2) is 50 parts by

mass or less, the embeddability of the film-like adhesive tends to become more favorable.

[0053] The ratio of the epoxy equivalent of the component (a1) and the hydroxyl equivalent of the component (a2) (the epoxy equivalent of the component (a1)/the hydroxyl equivalent of the component (a2)) may be 0.30/0.70 to 0.70/0.30, 0.35/0.65 to 0.65/0.35, 0.40/0.60 to 0.60/0.40, or 0.45/0.55 to 0.55/0.45 from the viewpoint of curability. When the equivalent ratio is 0.30/0.70 or more, more sufficient curability tends to be obtainable. When the equivalent ratio is 0.70/0.30 or less, an excessive increase in viscosity can be prevented and more sufficient fluidity can be obtained.

[0054] <(b) High-molecular-weight component>

The glass transition temperature (T_g) of the component (b) is preferably 50°C or lower.

[0055] Examples of the component (b) include an acrylic resin, a polyester resin, a polyamide resin, a polyimide resin, a silicone resin, a butadiene resin, an acrylonitrile resin, and modified products thereof.

[0056] The component (b) may contain an acrylic resin from the viewpoint of fluidity. Herein, the acrylic resin means a polymer containing a structural unit derived from a (meth)acrylic acid ester. The acrylic resin is preferably a monomer containing a structure unit derived from (meth)acrylic acid ester having a cross-linkable functional group such as an epoxy group, an alcoholic or phenolic hydroxyl group, or a carboxyl group. Furthermore, the acrylic resin may be acrylic rubber such as a copolymer of (meth)acrylic acid ester and acrylonitrile.

[0057] The glass transition temperature (T_g) of the acrylic resin may be

-50°C to 50°C or -30°C to 30°C. When Tg of the acrylic resin is -50°C or higher, there is a tendency that it can be prevented that the flexibility of the adhesive composition becomes too high. According to this, the film-like adhesive is easily cut at the time of wafer dicing and the occurrence of burr can be prevented. When Tg of the acrylic resin is 50°C or lower, there is a tendency that a decrease in the flexibility of the adhesive composition can be suppressed. According to this, there is a tendency that voids are easily embedded when the film-like adhesive is pasted to a wafer. Furthermore, chipping at the time of dicing caused by a decrease in adhesiveness of the wafer can be prevented. Herein, the glass transition temperature (Tg) means a value measured using DSC (differential scanning calorimeter) (for example, "Thermo Plus 2" manufactured by Rigaku Corporation).

[0058] The weight average molecular weight (Mw) of the acrylic resin may be 100000 to 3000000 or 500000 to 2000000. When the Mw of the acrylic resin is in such a range, film forming properties, a strength in a film shape, flexibility, tackiness, and the like can properly controlled, reflow properly is excellent, and embeddability can be improved. Herein, the Mw means a value as measured by gel permeation chromatography (GPC) and converted using a calibration curve of standard polystyrene.

[0059] Examples of commercially available products of the acrylic resin include SG-70L, SG-708-6, WS-023 EK30, SG-280 EK23, HTR-860P-3CSP, and HTR-860P-3CSP-3DB (all manufactured by Nagase ChemteX Corporation).

[0060] The content of the component (b) may be 5 to 70 parts by mass,

10 to 50 parts by mass, or 15 to 30 parts by mass with respect to 100 parts by mass of the total mass of the component (a), the component (b), and the component (c). When the content of the component (b) is 5 parts by mass or more, control of fluidity during molding and handleability at a high temperature can be made further favorable. When the content of the component (b) is 70 parts by mass or less, embeddability can be made further favorable.

[0061] <(c) Inorganic filler>

Examples of the component (c) include aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate, magnesium silicate, calcium oxide, magnesium oxide, aluminum oxide, aluminum nitride, aluminum borate whisker, boron nitride, and silica. These may be used alone or in combination of two or more kinds thereof. Of these, the component (c) may be silica from the viewpoint of compatibility with a resin.

[0062] The average particle size of the component (c) may be 0.005 to 1 μm or 0.05 to 0.5 μm from the viewpoint of improving adhesiveness. Herein, the average particle size means a value obtained by conversion from a BET specific surface area.

[0063] The content of the component (c) may be 5 to 50 parts by mass, 15 to 45 parts by mass, or 25 to 40 parts by mass with respect to 100 parts by mass of the total mass of the component (a), the component (b), and the component (c). When the content of the component (c) is 5 parts by mass or more, the fluidity of the film-like adhesive tends to be further improved. When the content of the component (c) is 50 parts by mass or less, the dicing property of the film-like adhesive tends to

become more favorable.

[0064] <(d) Coupling agent>

The component (d) may be a silane coupling agent. Examples of the silane coupling agent include γ -ureidopropyltriethoxysilane, γ -mercaptopropyltrimethoxysilane, 3-phenylaminopropyltrimethoxysilane, and 3-(2-aminoethyl)aminopropyltrimethoxysilane. These may be used alone or in combination of two or more kinds thereof.

[0065] The content of the component (d) may be 0.01 to 5 parts by mass with respect to 100 parts by mass of the total mass of the component (a), the component (b), and the component (c).

[0066] <(e) Curing accelerator>

The component (e) is not particularly limited, and those generally used can be used. Examples of the component (e) include imidazoles and derivatives thereof, an organic phosphorus-based compound, secondary amines, tertiary amines, and a quaternary ammonium salt. These may be used alone or in combination of two or more kinds thereof. Of these, the component (e) may be imidazoles and derivatives thereof from the viewpoint of reactivity.

[0067] Examples of the imidazoles include 2-methylimidazole, 1-benzyl-2-methylimidazole, 1-cyanoethyl-2-phenylimidazole, and 1-cyanoethyl-2-methylimidazole. These may be used alone or in combination of two or more kinds thereof.

[0068] The content of the component (e) may be 0.01 to 1 part by mass with respect to 100 parts by mass of the total mass of the component (a), the component (b), and the component (c).

[0069] [Dicing-die bonding integrated tape and manufacturing method therefor]

The dicing-die bonding integrated tape 8 illustrated in FIG. 7A and a manufacturing method therefor will be described. The method for manufacturing the tape 8 includes a step of applying a varnish of an adhesive composition containing a solvent onto a base film (not illustrated) and a step of heating and drying the applied varnish at 50°C to 150°C to thereby form the adhesive layer 20A.

[0070] The varnish of the adhesive composition can be prepared, for example, by mixing or kneading the components (a) to (c), and as necessary, the component (d) and the component (e) in a solvent. The mixing or kneading can be performed by appropriately combining dispersers such as stirrers, Raikai machines, three-roll mills, and ball mills.

[0071] The solvent for preparing the varnish is not limited as long as it can uniformly dissolve, knead, or disperse the above-described components, and a conventionally known organic solvent can be used. Examples of such a solvent include a ketone-based solvent such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and cyclohexanone, dimethylformamide, dimethyl acetamide, N-methylpyrrolidone, toluene, and xylene. From the viewpoints of a high drying speed and low price, methyl ethyl ketone, cyclohexanone, and the like are preferably used.

[0072] The above-described base film is not particularly limited, and examples thereof include a polyester film, a polypropylene film (OPP film or the like), a polyethylene terephthalate film, a polyimide film, a

polyetherimide film, a polyether naphthalate film, and a methyl pentene film.

[0073] As the method of applying the varnish to the base film, known methods can be used, and examples thereof include a knife coating method, a roll coating method, a spray coating method, a gravure coating method, a bar coating method, and a curtain coating method. The heating and drying condition is not particularly limited as long as it is a condition that the used solvent vaporizes sufficiently, and for example, heating and drying can be performed by heating at 50°C to 150°C for 1 to 30 minutes. The heating and drying may be performed while the temperature is gradually increased in a temperature range of 50°C to 150°C. The solvent contained in the varnish is vaporized by heating and drying, and thereby a laminated film of the base film and the adhesive layer 20A can be obtained.

[0074] The laminated film obtained as described above and the dicing tape (the laminate of the base layer 1 and the pressure-sensitive adhesive layer 2) are laminated and thereby the tape 8 can be obtained. Examples of the base layer 1 include plastic films such as a polytetrafluoroethylene film, a polyethylene terephthalate film, a polyethylene film, a polypropylene film, a polymethylpentene film, and a polyimide film. Furthermore, as necessary, a surface treatment such as a primer application, a UV treatment, a corona discharge treatment, a polishing treatment, and an etching treatment may be performed on the base layer 1. The pressure-sensitive adhesive layer 2 may be a UV curable type and may be a pressure-sensitive type. The tape 8 may further include a protective film (not illustrated) covering the

pressure-sensitive adhesive layer 2.

[0075] Hereinbefore, embodiments of the present disclosure have been described in detail, but the present invention is not limited to the above embodiments. For example, in the above-described embodiment, the package having an aspect of stacking two semiconductor elements Wa and Wb has been exemplified, but the third semiconductor element may be stacked above the second semiconductor element Wb, and one or a plurality of semiconductor elements may be further stacked thereabove.

Examples

[0076] Hereinafter, the present disclosure will be more specifically described by means of Examples. However, the present invention is not limited to the following Examples.

[0077] (Examples 1 to 6 and Comparative Examples 1 and 2)

Varnishes (six types in total) containing components shown in Tables 1 and 2 were prepared as follows. That is, cyclohexanone was added to a composition containing an epoxy resin and a phenolic resin as thermosetting resins and an inorganic filler and then stirred. Acrylic rubber as the high-molecular-weight component was added thereto and stirred, and then the coupling agent and the curing accelerator were further added and sufficiently stirred until the respective components became homogeneous, thereby obtaining a varnish.

[0078] Components described in Tables 1 and 2 are as follows.

(Epoxy resin)

· YDF-8170C (trade name): manufactured by TOHTO Chemical Industry Co., Ltd., bisphenol F type epoxy resin, epoxy equivalent: 159, liquid in room temperature, softening point: 10°C to 30°C, molecular

weight: 100 to 1000 (low-molecular-weight component)

· YDCN-700-10 (trade name): manufactured by TOHTO Chemical Industry Co., Ltd., cresol novolak type epoxy resin, epoxy equivalent: 210, softening point: 75°C to 85°C), molecular weight: more than 1000

(Phenolic resin)

· MILEX XLC-LL (trade name): manufactured by Mitsui Chemicals, Inc., phenolic resin, hydroxyl equivalent: 175, softening point: 77°C, molecular weight: more than 1000

(Acrylic rubber)

· HTR-860P-3CSP: manufactured by Nagase ChemteX Corporation, weight average molecular weight: 800000 (high-molecular-weight component)

(Inorganic filler)

· SC2050-HLG (trade name): manufactured by Admatechs Company Limited, silica filler dispersion, average particle size: 0.50 μm

(Curing accelerator)

· CUREZOL 2PZ-CN (trade name): manufactured SHIKOKU CHEMICALS CORPORATION, 1-cyanoethyl-2-phenylimidazole

[0079] The varnish containing the above-described components was filtered with a 100-mesh filter and vacuum-defoamed. The varnish after being vacuum-defoamed was applied onto a polyethylene terephthalate (PET) film (thickness: 38 μm) subjected to a mold release treatment. The applied varnish was heated and dried at two stages of 90°C for 5 minutes and subsequently 140°C for 5 minutes. In this way, an adhesive sheet provided with a film-like adhesive (thickness: 60

μm) in the B-stage on a PET film as the base film was obtained.

[0080] (Measurement of melt viscosity of film-like adhesive)

The melt viscosities at 100°C and 120°C of the film-like adhesive were measured by the following method. That is, five film-like adhesives having a thickness of 60 μm were stacked to have a thickness of 300 μm, and this resultant product was punched in a size of 10 mm × 10 mm, thereby obtaining a measurement sample. A circular aluminum plate jig having a diameter of 8 mm was set to a dynamic viscoelasticity apparatus ARES (manufactured by TA Instruments), and the above-described sample was set thereto. Thereafter, measurement was performed while applying 5% strain at 35°C and increasing the temperature to 130°C at a temperature increasing rate of 5°C/min, and values of the melt viscosity at 100°C and 120°C were recorded. The results are shown in Tables 1 and 2.

[0081] (Measurement of elastic modulus of cured product of film-like adhesive)

The elastic modulus at 180°C of a cured product (a product obtained by curing under a temperature condition of 175°C) of the film-like adhesive was measured. A dynamic viscoelasticity apparatus (product name: Rheogel-E4000, manufactured by UBM) was used in the measurement, a tensile load was applied to the sample, and the elastic modulus at 180°C was measured at a frequency of 10 Hz with the temperature being increased to 300°C at a temperature increasing rate of 3°C/min. The results are shown in Tables 1 and 2.

[0082] [Table 1]

		Example 1	Example 2	Example 3	Example 4	Example 5
Resin component [parts by mass]	Epoxy resin	17	17	16	15	19
	YDF-8170C (low-molecular-weight component)					
	YDCN-700-10	10	5	6	13	2
	Phenolic resin	12	11	13	15	12
	Acrylic rubber	22	25	15	20	25
	HTR-860P-3CSP (high-molecular-weight component)					
Inorganic filler [parts by mass]	SC2050-HLG	39	42	50	37	42
Curing accelerator [parts by mass]	2PZ-CN	0.05	0.04	0.1	0.05	0.04
Total amount (parts by mass) of resin components		61	58	50	63	58
Ratio [mass%] of low-molecular-weight component in resin components		27.9	29.3	32.0	23.8	32.8
Ratio [mass%] of high-molecular-weight component in resin components		36.1	43.1	30.0	31.7	43.1
Total amount [mass%] of low-molecular-weight component and high-molecular-weight component		63.9	72.4	62.0	55.6	75.9
Melt viscosity [Pa·s]	100°C	4000	11000	7000	8000	13000
	200°C	3000	9000	5000	6000	11000
Elastic modulus [MPa] of cured product of film-like adhesive		30	30	500	30	30

[0083] [Table 2]

		Comparative Example 1	Comparative Example 2	Comparative Example 3
Resin component [parts by mass]	Epoxy resin	YDF-8170C (low-molecular-weight component)	22	13
	Phenolic resin	YDCN-700-10	-	11
		XLC-LL	11	19
	Acrylic rubber	HTR-860P-3CSP (high-molecular-weight component)	36	18
Inorganic filler [parts by mass]		SC2050-HLG	31	39
Curing accelerator [parts by mass]		2PZ-CN	0.04	0.09
Total amount (parts by mass) of resin components			69	61
Ratio [mass%] of low-molecular-weight component in resin components			31.9	21.3
Ratio [mass%] of high-molecular-weight component in resin components			52.2	29.5
Total amount [mass%] of low-molecular-weight component and high-molecular-weight component			84.1	50.8
Melt viscosity [Pa·s]		100°C	14000	3000
		200°C	12000	1500
Elastic modulus [MPa] of cured product of film-like adhesive			10	30
				20

[0084] <Evaluation of film-like adhesive>

The following items were evaluated for the film-like adhesive.

[0085] [Embeddability]

The embeddability of the film-like adhesive was evaluated by the following method.

(Preparation of laminate including first semiconductor element and film-like adhesive)

A dicing-die bonding integrated film HR-9004-10 (manufactured by Hitachi Chemical Company, Ltd., thickness of the adhesive layer: 10 μm , thickness of the pressure-sensitive adhesive layer: 110 μm) was pasted to a semiconductor wafer (diameter: 8 inches, thickness: 50 μm). By dicing this, a first laminate including the first semiconductor element (controller chip, size: 3.0 mm $\times$ 3.0 mm) and the film-like adhesive was obtained.

(Preparation of laminate including second semiconductor element and film-like adhesive)

A dicing-die bonding integrated film including each film-like adhesive (thickness: 120 μm) of Examples and Comparative Examples and a pressure-sensitive adhesive film for dicing was prepared. This film was pasted to a semiconductor wafer (diameter: 8 inches, thickness: 30 μm). By dicing this, a second laminate including the second semiconductor element (size: 7.5 mm $\times$ 7.5 mm) and the film-like adhesive was obtained.

(Bonding of first and second semiconductor elements)

A substrate (surface asperity: up to 6 μm) for pressure-bonding the first and second semiconductor elements was prepared. The first

semiconductor element was pressure-bonded to this substrate via a film-like adhesive under conditions of 120°C, 0.20 MPa, and 2 seconds and then heated at 120°C for 2 hours, and thereby the film-like adhesive was cured.

5 Next, the second semiconductor element was pressure-bonded so as to cover the first semiconductor element under conditions of 120°C, 0.20 MPa, and 2 seconds via the film-like adhesive as the evaluation target. In this case, positioning was performed so that the center positions of the first semiconductor element and the second
10 semiconductor element which had been firstly pressure-bonded coincided with each other in plan view.

The structure obtained as described above was put in a pressure oven, the temperature was increased from 35°C to 140°C at a temperature increasing rate of 3°C/min, and the structure was heated at
15 140°C for 30 minutes. The structure after the heating treatment was analyzed with an ultrasonic imaging device SAT (manufactured by Hitachi Power Solutions Co., Ltd., Product No. FS200II, probe: 25 MHz), and embeddability was checked. The evaluation was performed by the following criteria. The results are shown in Tables 3
20 and 4.

A: The area ratio of voids in a predetermined cross-section is less than 5%.

B: The area ratio of voids in a predetermined cross-section is 5% or more.

25 [0086] [Presence/Absence of package contamination and occurrence of sink]

Presence/absence of contamination and presence/absence of the occurrence of sink were checked by observing the upper portion and the side surface of the structure provided to the evaluation of embeddability with a microscope. For the sample in which sink occurred, the depth of sink (point of origin: the end portion of the second semiconductor element) was measured. The results are shown in Tables 3 and 4.

[0087] [Measurement of bonding strength]

The die shear strength (bonding strength) of the cured product of the film-like adhesive was measured by the following method. First, each film-like adhesive (thickness: 120 μm) of Examples and Comparative Examples was pasted to a semiconductor wafer (thickness: 400 μm) at 70°C. By dicing this, a laminate including the semiconductor element (size: 5 mm $\times$ 5 mm) and the film-like adhesive was obtained. On the other hand, a substrate in which solder resist ink (AUS308) was applied to the surface was prepared. The semiconductor element was pressure-bonded to this surface via the film-like adhesive under conditions of 120°C, 0.1 MPa, and 5 seconds. Thereafter, this was subjected to the heating treatment at 110°C for 1 hour and then was further heated at 170°C for 3 hours, and thereby the film-like adhesive was cured to obtain a measurement sample. This sample was left to stand under conditions of 85°C and 60 RH% for 168 hours. Thereafter, the sample was left to stand for 30 minutes under conditions of 25°C and 50% RH, and the die shear strength was then measured at 250°C and regarded as the bonding strength. Multipurpose Bondtester Series 4000 manufactured by Nordson Dage was used in the measurement of the die shear strength. The results are

shown in Tables 3 and 4.

[0088] [Evaluation of reflow resistance]

The reflow resistance of the film-like adhesive was evaluated by the following method. First, the same structure as the structure provided to the evaluation of embeddability was prepared. The second semiconductor element of the structure was sealed with a sealing material for molding (manufactured by Hitachi Chemical Company, Ltd., trade name "CEL-9750ZHF10) and thereby a package for evaluation was obtained. Incidentally, conditions of resin sealing were set to 175°C/6.7 MPa/90 seconds and conditions of curing were set to 175°C for 5 hours.

Twenty-four packages described above were prepared and these packages were exposed to an environment defined in JEDEC (level 3, 30°C, 60 RH%, 192 hours) and caused to absorb moisture. Subsequently, the packages after absorbing moisture were passed through an IR reflow furnace (260°C, maximum temperature: 265°C) three times. The evaluation was performed by the following criteria. The results are shown in Tables 3 and 4.

A: The breakage or the thickness change of the package, peeling-off at the interface between the film-like adhesive and the semiconductor element, or the like is not observed in any of 24 packages.

B: The breakage or the thickness change of the package, peeling-off at the interface between the film-like adhesive and the semiconductor element, or the like is observed in at least one package of 24 packages.

[0089] [Table 3]

	Example 1	Example 2	Example 3	Example 4	Example 5
Embeddability	A	A	A	A	A
Presence/Absence of package contamination	Absent	Absent	Absent	Absent	Absent
Presence/Absence of occurrence of sink	Absent	Absent	Absent	Absent	Absent
Depth of sink [μm]	-	-	-	-	-
Bonding strength [MPa]	2.5	2.0	2.5	2.5	2.0
Reflow resistance	A	A	A	A	A

[0090] [Table 4]

	Comparative Example 1	Comparative Example 2	Comparative Example 3
Embeddability	B	A	A
Presence/Absence of package contamination	Absent	Absent	Present
Presence/Absence of occurrence of sink	Absent	Present	Present
Depth of sink [μm]	-	100	140
Bonding strength [MPa]	1.5	2.5	3.0
Reflow resistance	A	A	A

[0091] As clearly understood from the results shown in Tables 3 and 4, it was confirmed that the film-like adhesives of Examples 1 to 5 are excellent in embeddability and can suppress package contamination and the occurrence of sink after the treatment by the pressure oven, as compared to the film-like adhesives of Comparative Examples 1 to 3.

Industrial Applicability

[0092] According to the present disclosure, there are provided a thermosetting resin composition, which has fluidity that enables at least one of a semiconductor element such as a controller chip and a wire to be embedded and can sufficiently suppress problems caused by contamination of peripheral circuits at the time of embedding and excessive flow of the resin in a thermal process at the subsequent step, and a semiconductor device to be manufactured by using the thermosetting resin composition and a method for manufacturing the semiconductor device.

Reference Signs List

[0093] 2: pressure-sensitive adhesive layer, 8: dicing-die bonding integrated tape, 10: substrate, 11: first wire, 12: second wire, 10a, 10b: circuit pattern, 20: first sealing layer (cured product of film-like adhesive), 20A: adhesive layer, 20P: film-like adhesive, 40: second sealing layer, 100: semiconductor device, Wa: first semiconductor element, Wb: second semiconductor element.

CLAIMS

[Claim 1] A semiconductor device comprising:

a substrate;

a first semiconductor element disposed on the substrate;

5 a first sealing layer disposed to cover a region in which the first semiconductor element is disposed in the substrate and sealing the first semiconductor element; and

a second semiconductor element disposed to cover a surface in the first sealing layer opposite to the side of the substrate and having a larger area than an area of the first semiconductor element, wherein

10 the first sealing layer is composed of a cured product of a thermosetting resin composition and a melt viscosity of the thermosetting resin composition is 5000 to 11500 Pa·s at 120°C.

[Claim 2] The semiconductor device according to claim 1, wherein

15 the thermosetting resin composition contains a low-molecular-weight component having a molecular weight of 10 to 1000 and a high-molecular-weight component having a molecular weight of 100000 to 1000000,

a content M1 of the low-molecular-weight component is 23 to

20 35 parts by mass with respect to 100 parts by mass of a mass of resin components contained in the thermosetting resin composition, and

a content M2 of the high-molecular-weight component is 25 to 45 parts by mass with respect to 100 parts by mass of the mass of resin components contained in the thermosetting resin composition.

25 [Claim 3] The semiconductor device according to claim 2, wherein a total amount of the low-molecular-weight component and the

high-molecular-weight component is 54 to 76 parts by mass with respect to 100 parts by mass of the mass of resin components contained in the thermosetting resin composition.

5 [Claim 4] The semiconductor device according to any one of claims 1 to 3, further comprising:

a circuit pattern formed on a surface of the substrate; and

a first wire electrically connecting the first semiconductor element and the circuit pattern to each other.

10 [Claim 5] The semiconductor device according to claim 4, further comprising:

a second wire electrically connecting the second semiconductor element and the circuit pattern to each other; and

a second sealing layer sealing the second semiconductor element and the second wire.

15 [Claim 6] The semiconductor device according to any one of claims 1 to 5, further comprising a third semiconductor element stacked above the second semiconductor element.

[Claim 7] A thermosetting resin composition being used in a manufacturing process of a semiconductor device,

20 the manufacturing process including a step of performing a curing treatment in which the thermosetting resin composition is heated and bringing at least one of at least a part of a wire and a semiconductor element into a state of being embedded in the thermosetting resin composition after the curing treatment, wherein

25 a melt viscosity of the thermosetting resin composition is 5000 to 11500 Pa·s at 120°C.

[Claim 8] The thermosetting resin composition according to claim 7, comprising:

a low-molecular-weight component having a molecular weight of 10 to 1000; and

5 a high-molecular-weight component having a molecular weight of 100000 to 1000000, wherein

a content M1 of the low-molecular-weight component is 23 to 35 parts by mass with respect to 100 parts by mass of a mass of resin components contained in the thermosetting resin composition, and

10 a content M2 of the high-molecular-weight component is 25 to 45 parts by mass with respect to 100 parts by mass of the mass of resin components contained in the thermosetting resin composition.

[Claim 9] The thermosetting resin composition according to claim 8, wherein a total amount of the low-molecular-weight component and
15 the high-molecular-weight component is 54 to 76 parts by mass with respect to 100 parts by mass of the mass of resin components contained in the thermosetting resin composition.

[Claim 10] A dicing-die bonding integrated tape comprising:

a pressure-sensitive adhesive layer; and

20 an adhesive layer composed of the thermosetting resin composition according to any one of claims 7 to 9.