

DESCRIPTION

Title of Invention

METHOD FOR PRODUCING SEMICONDUCTOR DEVICE AND
FILM-LIKE ADHESIVE

5 Technical Field

[0001] The present invention relates to a method for manufacturing a semiconductor device and a film-like adhesive used therein.

Background Art

10 [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 mobile phones and the like. A film-like adhesive is widely used as an adhesive for die bonding in the mounting of the semiconductor element. As an example of multistage stacked packages using a
15 film-like adhesive, a wire-embedded type package is mentioned. This refers to a package in which a wire connected to a semiconductor element to be pressure-bonded is pressure-bonded by using a high-flow film-like adhesive while covering the wire with the adhesive, and is mounted on memory packages and the like for mobile phones and
20 mobile audio devices.

[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, film-like adhesives in which properties such as heat resistance, moisture
25 resistant, and reflow resistance are taken into consideration have been developed. As such a film-like adhesive, for example, Patent

Literature 1 proposes an adhesive sheet which contains a resin containing a high-molecular-weight component and a thermosetting component containing an epoxy resin as a main component, and a filler and has a thickness of 10 to 250 μm . Furthermore, Patent Literature 2

5 proposes 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.

10 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
15 Literature 3 proposes 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

20 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

25 [0006] Incidentally, in recent years, in the manufacturing of stacked

MCPs, there is a case where a semiconductor element is pressure-bonded to a substrate via an adhesive having a thermosetting property and then a curing treatment of the adhesive is executed by heating under a pressurized atmosphere using a pressure oven or the like. The pressure oven is an apparatus capable of heating and pressurizing the inside atmosphere, and the adhesive is heated in the pressure oven while receiving a pressure from ambient gas. According to this, voids on the adhesive surface of the semiconductor element can be more effectively reduced or eliminated.

[0007] However, since a conventional adhesive film is not assumed to be used in a pressure oven, there is a room for improvement, for example, in terms of occurrence of the positional deviation of a semiconductor element, insufficient embeddability of wires and the like. [0008] The present invention has been made in view of the above-described circumstances, and an object thereof is to provide a method for manufacturing a semiconductor device in which embeddability of wires and the like is excellent and the occurrence of the positional deviation of a semiconductor element can be suppressed even in a case where a curing treatment of an adhesive is executed by heating under a pressurized atmosphere, and an adhesive used therein.

Solution to Problem

[0009] A method for manufacturing a semiconductor device of the present invention includes a first wire bonding step of electrically connecting a first semiconductor element onto a substrate via a first wire, a pressure bonding step of pressure-bonding a second semiconductor element to the substrate via an adhesive having a

thermosetting property, and a heating and pressurizing step of heating the adhesive after the pressure bonding step under a pressurized atmosphere to subject the adhesive to a curing treatment. Through the heating and pressurizing step, at least one of at least a part of the first wire and the first semiconductor element is embedded in the adhesive after the curing treatment. In the method for manufacturing a semiconductor device, a melt viscosity at 120°C of the adhesive before the curing treatment is 1000 to 3000 Pa·s.

[0010] The present inventors have found out that in order to achieve excellent embeddability by a thermosetting adhesive to be heated under a pressurized atmosphere and highly suppress the positional deviation of a semiconductor element to be stacked via this adhesive, it is useful that the adhesive is not too hard and not too soft in the process of being heated under a pressurized atmosphere. Further, the present inventors have repeated evaluation tests under various temperature conditions and with various compositions of the adhesive, and as a result, found out that the melt viscosity at 120°C of the adhesive reflects the fluidity of the adhesive when being heated under a pressurized atmosphere, and in this specific range (1000 to 3000 Pa·s), excellent embeddability can be achieved and the positional deviation of a semiconductor element can be highly suppressed, thereby completing the above-described invention. Therefore, a semiconductor device exhibiting favorable connection reliability can be obtained.

[0011] In the heating and pressurizing step of the above-described method for manufacturing a semiconductor device, the adhesive is preferably heated at 60°C to 175°C for 5 minutes or longer under a

pressurized atmosphere of 0.1 to 1.0 MPa. By performing heating and pressurizing under the above-described conditions, embeddability is more easily obtained.

5 [0012] The above-described method for manufacturing a semiconductor device may further include a step of further stacking a third semiconductor element above the second semiconductor element after the heating and pressurizing step. In this case, the capacity of a semiconductor device to be obtained can be increased.

10 [0013] The above-described method for manufacturing a semiconductor device may further include a second wire bonding step of electrically connecting the substrate and the second semiconductor element to each other via a second wire and a step of sealing the second semiconductor element with a resin. In this case, the reliability of a semiconductor device to be obtained is further enhanced.

15 [0014] Furthermore, an adhesive of the present invention is used in a manufacturing process of a semiconductor device. The manufacturing process includes a step of performing a curing treatment in which the adhesive is heated under a pressurized atmosphere and bringing at least one of at least a part of the wire on the substrate and the semiconductor
20 element into a state of being embedded in the adhesive after the curing treatment. A melt viscosity at 120°C of the adhesive is 1000 to 3000 Pa·s.

[0015] Since the above-described adhesive is not too hard or too soft in the process of being heated under a pressurized atmosphere, the
25 occurrence of the positional deviation of a semiconductor element can be suppressed while exhibiting favorable embeddability in the heating

and pressurizing step in the manufacturing of a semiconductor device.
Therefore, a semiconductor device exhibiting favorable connection
reliability can be obtained.

[0016] An adhesive force of the above-described adhesive after curing
with respect to the substrate applied with respect to solder resist ink is
preferably 1.0 MPa or more. In this case, the connection reliability of
a semiconductor device to be obtained becomes more favorable.

Advantageous Effects of Invention

[0017] According to the present invention, it is possible to provide a
method for manufacturing a semiconductor device in which
embeddability of wires and the like is excellent and the occurrence of
the positional deviation of a semiconductor element can be suppressed
even in a case where a curing treatment of an adhesive is executed by
heating under a pressurized atmosphere, and an adhesive used therein.

Brief Description of Drawings

[0018] FIG. 1 is a cross-sectional view illustrating a method for
manufacturing a semiconductor device of an embodiment of the present
invention.

FIG. 2 is a diagram illustrating a step subsequent to FIG. 1.

FIG. 3 is a diagram illustrating a step subsequent to FIG. 2.

FIG. 4 is a diagram illustrating a step subsequent to FIG. 3.

FIG. 5 is a diagram illustrating a step subsequent to FIG. 4.

FIG. 6 is a diagram illustrating a step subsequent to FIG. 5.

FIG. 7 is a cross-sectional view illustrating an adhesive of an
embodiment of the present invention.

FIG. 8 is a cross-sectional view illustrating an example of an

adhesive sheet obtained by using the adhesive of the embodiment of the present invention.

FIG. 9 is a cross-sectional view illustrating another example of the adhesive sheet obtained by using the adhesive of the embodiment of the present invention.

FIG. 10 is a cross-sectional view illustrating still another example of the adhesive sheet obtained by using the adhesive of the embodiment of the present invention.

FIG. 11 is a cross-sectional view illustrating still another example of the adhesive sheet obtained by using the adhesive of the embodiment of the present invention.

Description of Embodiments

[0019] Hereinafter, preferred embodiments of the present invention 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".

[0020] (Method for manufacturing semiconductor device)

A method for manufacturing a semiconductor device of the present embodiment will be described below. First, as illustrated in FIG. 1, a first semiconductor element Wa attached with an adhesive

is pressure-bonded on a circuit pattern 94 on a substrate 14, and a circuit pattern 84 on the substrate 14 and the first semiconductor element Wa are electrically connected to each other by bonding via a first wire 88 (first wire bonding step).

5 [0021] Next, a film-like adhesive-attached semiconductor element illustrated in FIG. 2 is obtained. First, an adhesive sheet in which a film-like adhesive 10 having a thermosetting property is stacked on a base film is prepared. Methods for producing the film-like adhesive 10 and the adhesive sheet will be described below. The adhesive sheet is
10 laminated on one surface of a semiconductor wafer, the base film is peeled off, and thereby the film-like adhesive 10 is pasted to the one surface of the semiconductor wafer. The thickness of the semiconductor wafer is, for example, 50 μm , the size thereof is, for example, 8 inches, and the thickness of the film-like adhesive 10 is, for
15 example, 135 μm . Then, a dicing tape 60 is laminated on the film-like adhesive 10 and then diced into 7.5 mm square, and thereby a film-like adhesive-attached semiconductor element 102 including a second semiconductor element Waa and the film-like adhesive 10 pasted thereon as illustrated in FIG. 2 is obtained (lamination step).

20 [0022] The lamination step is preferably performed at 50°C to 100°C and more preferably performed at 60°C to 80°C. When the temperature of the lamination step is 50°C or higher, favorable adhesiveness with a semiconductor wafer can be obtained. When the temperature of the lamination step is 100°C or lower, excessive flow of
25 the film-like adhesive 10 in the lamination step is suppressed, and thus this can prevent a change in thickness or the like from occurring.

[0023] Examples of a dicing method include a method using a rotary blade (blade dicing), a method of cutting a film-like adhesive or both of a wafer and a film-like adhesive with laser, and a general method such as stretching at normal temperature or under a cooling condition.

5 [0024] Then, the film-like adhesive-attached semiconductor element 102 is pressure-bonded to the substrate 14 to which the first semiconductor element Wa is connected by bonding via the first wire 88 so that the side of the film-like adhesive 10 faces the substrate 15. Specifically, as illustrated in FIG. 3, the film-like adhesive-attached
10 semiconductor element 102 is placed so that the film-like adhesive 10 covers the first semiconductor element Wa, and then as illustrated in FIG. 4, the second semiconductor element Waa is fixed to the substrate 14 by pressure-bonding the second semiconductor element Waa to the substrate 14 along with the film-like adhesive 10 (pressure bonding
15 step). In the pressure bonding step, the film-like adhesive 10 is preferably pressure-bonded for 0.5 to 3.0 seconds under conditions of 80°C to 180°C and 0.01 to 0.50 MPa.

[0025] After the pressure bonding step, the film-like adhesive 10 is heated under a pressurized atmosphere (heating and pressurizing step).

20 As illustrated in FIG. 4, the second semiconductor element Waa has a larger area than the first semiconductor element Wa, and the film-like adhesive 10 embeds not only the first wire 88 on the substrate 14 but also the first semiconductor element Wa. The method for manufacturing a semiconductor device of the present embodiment
25 includes the above-described heating and pressurizing step, and thereby a semiconductor element, which is generally thicker than a wire and is

difficult to be embedded, can also be embedded. The reason for this is that, even if voids on an adhesive surface between the semiconductor element and the substrate remain in the pressure bonding step, through the heating and pressurizing step, the voids can be more certainly eliminated or reduced. Further, the film-like adhesive 10 used in the present embodiment has a melt viscosity at 120°C of 3000 Pa·s or less and preferably 2500 Pa·s or less. According to this, favorable embeddability is obtainable in the above-described pressure bonding step, and if voids remain, the voids are favorably and easily eliminated or reduced in the heating and pressurizing step. On the other hand, the film-like adhesive 10 used in the present embodiment has a melt viscosity at 120°C of 1000 Pa·s or more. According to this, in the heating and pressurizing step, the occurrence of the positional deviation of a semiconductor element can be suppressed.

[0026] In the heating and pressurizing step, heating under a pressurized atmosphere is performed, for example, by putting a semiconductor device during manufacture in a pressure oven. The heating temperature in the pressure oven is, for example, 60°C to 175°C, and is preferably 80°C to 160°C or 100°C to 150°C. The pressure in the pressurized atmosphere is, for example, 0.1 to 1.0 MPa, and is preferably 0.2 to 1.0 MPa, 0.3 to 1.0 MPa, or 0.5 to 1.0 MPa. Heating under a pressurized atmosphere is performed, for example, for 5 minutes or longer. By performing heating and pressurizing under the above-described conditions, embeddability is more easily obtained.

[0027] Next, as illustrated in FIG. 5, after the substrate 14 and the second semiconductor element Waa are electrically connected to each

other via a second wire 98 (second wire bonding step), as illustrated in FIG. 6, the circuit pattern 84, the second wire 98, and the second semiconductor element Waa are sealed with a sealing material 42. Through such a step, a semiconductor device 200 can be manufactured.

5 [0028] In the semiconductor device 200 obtained by the manufacturing method of the present embodiment, the first semiconductor element Wa is connected by wire bonding onto the substrate 14 via the first wire 88, and the second semiconductor element Waa having a larger area than the first semiconductor element Wa is pressure-bonded onto the first
10 semiconductor element Wa via the film-like adhesive 10. Furthermore, in the semiconductor device 200, the first wire 88 and the first semiconductor element Wa are embedded in the film-like adhesive 10. That is, the semiconductor device 200 obtained by the manufacturing method of the present embodiment is a wire and semiconductor
15 element-embedded type semiconductor device. Furthermore, according to the method for manufacturing a semiconductor device of the present embodiment, since embeddability by the film-like adhesive 10 is favorable and there is no positional deviation of a semiconductor element, a semiconductor device having favorable connection reliability
20 can be obtained.

[0029] Furthermore, in the semiconductor device 200, the substrate 14 and the second semiconductor element Waa are further electrically connected to each other via the second wire 98 and the second semiconductor element Waa is sealed with the sealing material 42.
25 According to this, the reliability of a semiconductor device to be obtained is further enhanced.

[0030] The thickness of the first semiconductor element Wa is, for example, 10 to 170 μm and the thickness of the second semiconductor element Waa is, for example, 20 to 400 μm . The thickness of the film-like adhesive 10 is, for example, 20 to 200 μm , and is preferably 30 to 200 μm and more preferably 40 to 150 μm . The first semiconductor element Wa embedded inside the film-like adhesive 10 is a controller chip for driving the semiconductor device 200.

[0031] The substrate 14 is configured by an organic substrate 90 in which two of each of the circuit patterns 84 and 94 are formed on the surface. The first semiconductor element Wa is pressure-bonded onto the circuit pattern 94 via the adhesive 41, and the second semiconductor element Waa is pressure-bonded to the substrate 14 via the film-like adhesive 10 so that the circuit pattern 94 to which the first semiconductor element Wa is not pressure-bonded, the first semiconductor element Wa, and a part of the circuit pattern 84 are covered. The film-like adhesive 10 is embedded in the unevenness of the irregularities caused by the circuit patterns 84 and 94 on the substrate 14. Then, the second semiconductor element Waa, the circuit pattern 84, and the second wire 98 are sealed with the sealing material 42 made of a resin.

[0032] (Film-like adhesive)

Next, the adhesive of the present embodiment will be described using a film-like adhesive as an example. The film-like adhesive is used in the above-described method for manufacturing a semiconductor device. FIG. 7 is a cross-sectional view schematically illustrating the film-like adhesive 10. The film-like adhesive 10 is a thermal cure type

and can be prepared by molding an adhesive composition, which may be in a state of a completely cured product (C-stage) through a semi-cured (B-stage) state after the curing treatment, into a film shape.

[0033] The film-like adhesive 10 has a melt viscosity at 120°C of 3000

5 Pa·s or less. According to this, favorable embeddability is obtainable at the time of pressure-bonding a semiconductor element and voids can be favorably eliminated or reduced in a pressure oven. On the other hand, the film-like adhesive 10 has a melt viscosity at 120°C of 1000 Pa·s or more. According to this, the occurrence of the positional
10 deviation of a semiconductor element in the pressurizing and heating step can be suppressed. The upper limit value of the melt viscosity may be 2800 Pa·s, 2500 Pa·s, or 2200 Pa·s. The lower limit value of the melt viscosity may be 1200 Pa·s, 1500 Pa·s, or 2000 Pa·s.

[0034] Incidentally, the melt viscosity means a measurement value
15 measured using ARES (TA Instruments) while applying 5% strain to the film-like adhesive 10 and increasing the temperature at a temperature increasing rate of 5°C/min.

[0035] Furthermore, the adhesive force of the film-like adhesive 10 after curing with respect to the substrate applied with solder resist ink
20 (for example, trade name: AUS308, manufactured by TAIYO INK MFG. CO., LTD.) is preferably 1.0 MPa or more. In this case, the connection reliability of a semiconductor device to be obtained becomes more favorable.

[0036] The film-like adhesive 10 can contain, for example, (a) a
25 thermosetting component, (b) a high-molecular-weight component, (c) a filler, and as necessary, (d) a curing accelerator and (e) a coupling agent.

The range of the above-described melt viscosity can be realized, for example, by adjusting the types, contents, and the like of the (a) thermosetting component, the (b) high-molecular-weight component, and the (c) filler.

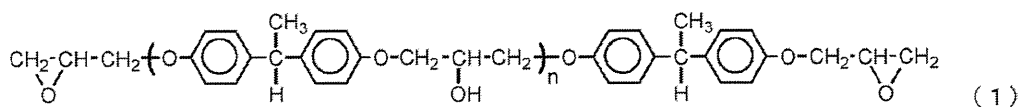
5 [0037] The film-like adhesive 10 can contain 20 to 60% by mass of the (a) thermosetting component on the basis of the total amount of the film-like adhesive 10.

[0038] The (a) thermosetting component can be a thermosetting resin and can be an epoxy resin, a phenolic resin, or the like having heat resistance and moisture resistant required in the case of mounting a semiconductor element.

10 [0039] Examples of the epoxy resin of the component (a) include an aromatic ring-containing epoxy resin, an aliphatic ring-containing epoxy resin, a heterocyclic ring-containing epoxy resin, and an aliphatic linear epoxy resin. The epoxy resin of the component (a) is preferably an aromatic ring-containing epoxy resin. Furthermore, the epoxy resin of the component (a) may be a polyfunctional epoxy resin and may be a bifunctional epoxy resin.

20 [0040] Examples of the aromatic ring-containing epoxy resin include an epoxy resin represented by general formula (1) below. In formula (1), n represents an integer of 0 to 5.

[Chemical formula 1]



25 [0041] As the aromatic ring-containing epoxy resin of the component (a) other than the resin of general formula (1), a bisphenol A type epoxy

resin, a bisphenol F type epoxy resin, a bisphenol E type epoxy resin, bifunctional epoxy resins obtained by modifying these epoxy resins, and the like can be used.

5 [0042] Further, an epoxy resin other than the epoxy resins mentioned above may be used in combination as the (a) thermosetting component. For example, a novolak type epoxy resin such as a phenol novolak type epoxy resin or a cresol novolak type epoxy resin, a glycidyl amine type epoxy resin, or the like can be used.

10 [0043] As the phenolic resin of the component (a), an aliphatic ring-containing phenolic resin, a heterocyclic ring-containing phenolic resin, an aliphatic linear phenolic resin, and the like can be used.

[0044] Specific examples of the phenolic resin include PHENOLITE KA and TD series manufacture by DIC Corporation, and MILEX XLC-series and XL series (for example, MILEX XLC-LL) manufactured by Mitsui Chemicals, Inc. From the viewpoint of heat resistance, the phenolic resin can be a phenolic resin having a water absorption percentage of 2% by mass or less after being put for 48 hours in a thermo-hygrostat at 85°C and 85% RH and a heating mass decrease rate (temperature increasing rate: 5°C/min, atmosphere: nitrogen) of less than 5% by mass at 350°C as measured with a thermogravimetric analyzer (TGA).

25 [0045] The (a) thermosetting component can contain (a1) at least one of an epoxy resin which has a softening point equal to or lower than room temperature or is a liquid at room temperature and a phenolic resin which has a softening point equal to or lower than room temperature or is a liquid at room temperature (hereinafter, referred to as the

component (a1)) and (a2) at least one of an epoxy resin which has a softening point equal to or higher than room temperature and a phenolic resin which has a softening point equal to or higher than room temperature (hereinafter, referred to as the component (a2)).

5 Incidentally, in the present specification, the room temperature indicates 23°C.

[0046] The epoxy resins of the component (a1) and the component (a2) can be selected from the above-described epoxy resins depending on the softening point and the state at room temperature. Furthermore, the
10 phenolic resins of the component (a1) and the component (a2) can be selected from the above-described phenolic resins depending on the softening point and the state at room temperature.

[0047] The melt viscosity at 120°C of the film-like adhesive 10 being 1000 to 3000 Pa·s can also be realized, for example, by adjusting the
15 contents of the component (a1) and the component (a2).

[0048] In a case where the film-like adhesive 10 contains both the epoxy resin and the phenolic resin as the (a) thermosetting component, the epoxy resin and the phenolic resin are blended so that the ratio of the number of epoxy groups to the number of hydroxyl groups is preferably
20 0.70/0.30 to 0.30/0.70, more preferably 0.65/0.35 to 0.35/0.65, further preferably 0.60/0.40 to 0.40/0.60, and particularly preferably 0.60/0.40 to 0.50/0.50. The number of epoxy groups in the film-like adhesive 10 is a value obtained by dividing the used epoxy resin by epoxy equivalent, and the number of hydroxyl groups can be obtained as a
25 value obtained by dividing the used phenolic resin by hydroxyl equivalent. By blending the epoxy resin and the phenolic resin to have

the above-described range, the prepared film-like adhesive is likely to have curability, an increase in viscosity of the film-like adhesive in an uncured state is suppressed, and fluidity is easily improved.

[0049] Furthermore, in order to adjust the adhesive force after curing with respect to the substrate applied with solder resist ink to 1.0 MPa or more, for example, the adhesive force can be adjusted by decreasing the content of the component (a2), increasing the content of the (c) filler, or increasing the (d) curing accelerator.

[0050] The film-like adhesive 10 can contain 10 to 40% by mass of the (b) high-molecular-weight component on the basis of the total amount of the film-like adhesive 10. When the content of the (b) high-molecular-weight component is 40% by mass or less, fusibility at the time of die attaching tends to be improved and embeddability tends to be improved. On the other hand, when the content of the (b) high-molecular-weight component is 10% by mass or more, film formability is easily obtained.

[0051] The (b) high-molecular-weight component can be an acrylic resin and may be an acrylic resin such as an epoxy group-containing (meth)acrylic copolymer having a glass transition temperature (T_g) of -50°C to 50°C which is obtained by polymerizing functional monomers having an epoxy group such as glycidyl acrylate or glycidyl methacrylate or a glycidyl group as a cross-linkable functional group.

[0052] As such a resin, an epoxy group-containing (meth)acrylic acid ester copolymer, an epoxy group-containing acrylic rubber, and the like can be used, and the component (b) may be an epoxy group-containing acrylic rubber. The epoxy group-containing acrylic rubber is a rubber

having an epoxy group which has an acrylic acid ester as a main component and is mainly composed of, for example, a copolymer of butyl acrylate, acrylonitrile, and the like and a copolymer of ethyl acrylate, acrylonitrile, and the like.

5 [0053] The weight average molecular weight of the (b) high-molecular-weight component can be 300000 or more and may be 500000 or more. Furthermore, the weight average molecular weight of the (b) high-molecular-weight component can be 1000000 or less and may be 800000 or less. When the weight average molecular weight of
10 the (b) high-molecular-weight component is 300000 or more, film formability tends to be improved. When the weight average molecular weight of the (b) high-molecular-weight component is 1000000 or less, the shear viscosity of an uncured film-like adhesive can be decreased, and thereby embeddability becomes more favorable. Furthermore, the
15 cuttability of an uncured film-like adhesive may be improved and the quality of dicing may become favorable in some cases.

[0054] The glass transition temperature (T_g) of the (b) high-molecular-weight component can be -50°C to 50°C . When the glass transition temperature (T_g) of the (b) high-molecular-weight
20 component is 50°C or lower, the flexibility of the film-like adhesive becomes favorable. On the other hand, when the glass transition temperature (T_g) is -50°C or higher, the flexibility of the film-like adhesive is not too high, and thereby the film-like adhesive
25 cut at the time of dicing a semiconductor wafer. Therefore, deterioration in dicing property caused by occurrence of burrs is suppressed.

[0055] The glass transition temperature (T_g) of the (b) high-molecular-weight component may be -20°C to 40°C and may be -10°C to 30°C . In this case, the film-like adhesive is easily cut at the time of dicing so that resin scraps hardly occur, adhesive force and heat resistance can be enhanced, and high fluidity of an uncured film-like adhesive can be exhibited.

[0056] Since the (b) high-molecular-weight component exhibits high adhesive force, the (b) high-molecular-weight component can have 1 to 15% of the structure unit having a cross-linkable functional group on the basis of the total number of structure units. The structure unit having a cross-linkable functional group can also refer to the number of functional monomers in the total number of material monomers (the number of moles) used at the time of synthesis of the (b) high-molecular-weight component. As the functional monomer, glycidyl acrylate, glycidyl methacrylate, or the like is mentioned, and the cross-linkable functional group of the (b) high-molecular-weight component is derived from a functional group of a functional monomer. In a case where the functional monomer is glycidyl acrylate or glycidyl methacrylate, the cross-linkable functional group is an epoxy group.

[0057] Incidentally, as the cross-linkable functional group of the (b) high-molecular-weight component, a cross-linkable functional group such as an alcoholic or phenolic hydroxyl group or a carboxyl group is mentioned as well as an epoxy group.

[0058] The weight average molecular weight is a value in terms of polystyrene using a calibration curve of standard polystyrene by gel permeation chromatography (GPC). The glass transition temperature

(Tg) is a value measured using DSC (differential scanning calorimeter) (for example, "Thermo Plus 2" manufactured by Rigaku Corporation).

[0059] The (b) high-molecular-weight component used in the present invention can also be obtained as a commercially available product.

5 For example, trade name "Acrylic rubber HTR-860P-3CSP" manufactured by Nagase ChemteX Corporation, and the like are mentioned.

[0060] From the viewpoint of suppressing the fluidity and the breakage of an uncured film-like adhesive and the tensile elastic modulus and the
10 adhesive force of a film-like adhesive after curing, the film-like adhesive 10 can contain 20 to 50% by mass of the (c) filler on the basis of the total amount of the film-like adhesive 10. When the content of the (c) filler is 20% by mass or more, the dicing property of an uncured film-like adhesive tends to be improved and adhesive force after curing
15 tends to be improved. On the other hand, when the content of the (c) filler is 50% by mass or less, the fluidity of an uncured film-like adhesive tends to be improved and embeddability at the time of die attaching tends to be improved.

[0061] The average particle size of the (c) filler can be 0.1 μm or more
20 and may be 0.1 to 5.0 μm from the viewpoint of the fluidity of the film-like adhesive 10. Herein, the "average particle size" refers to a value obtained in the case of performing analysis using acetone as a solvent by a laser diffraction type particle size distribution measurement apparatus.

25 [0062] The (c) filler can be an inorganic filler and may be a silica filler, from the viewpoints of improving of the dicing property of the film-like

adhesive in the B-stage state, improving of the handleability of the film-like adhesive, improving thermal conductivity, adjusting the melt viscosity, imparting thixotropic properties, improving adhesive force, and the like.

5 [0063] Furthermore, the film-like adhesive 10 may contain the (d) curing accelerator for the purpose of obtaining favorable curability. The content of the (d) curing accelerator in a case where the film-like adhesive 10 contains the (d) curing accelerator can be 0.01 to 0.2% by mass on the basis of the total amount of the film-like adhesive 10.

10 [0064] Incidentally, from the viewpoint of reactivity, the (d) curing accelerator is preferably an imidazole-based compound. A curing accelerator in which reactivity is too high tends to not only increase the shear viscosity of the film-like adhesive by heating in the manufacturing process but also cause significant degradation over time. On the other
15 hand, with a curing accelerator in which reactivity is too low, the film-like adhesive is difficult to be completely cured in thermal history in the manufacturing process of a semiconductor device, the film-like adhesive in an uncured state is mounted in a product, and thus there is possibility in that sufficient adhesiveness is not obtainable and the
20 connection reliability of a semiconductor device is deteriorated.

[0065] The adhesive composition of the present embodiment can contain the (e) coupling agent from the viewpoint of improving adhesiveness, in addition to the above-described components (a) to (d). Examples of the coupling agent include γ -ureidopropyltriethoxysilane,
25 γ -mercaptopropyltrimethoxysilane,
3-phenylaminopropyltrimethoxysilane, and

3-(2-aminoethyl)aminopropyltrimethoxysilane.

[0066] (Film-like adhesive and adhesive sheet)

Regarding the film-like adhesive 10, the varnish of the adhesive composition mentioned above is applied onto a base film and the dried adhesive composition can be used as an adhesive sheet. Specifically, first, the components (a) to (c) and, as necessary, other additive components such as the (d) curing accelerator or the (e) coupling agent described above are mixed in an organic solvent and kneaded to prepare a varnish.

[0067] The mixing and kneading described above can be performed by appropriately combining dispersers such as stirrers, Raikai machines, three-roll mills, and ball mills. The drying described above can be performed by typically performing heating at 60°C to 200°C for 0.1 to 90 minutes although the condition is not particularly limited as long as it is a condition that the used solvent vaporizes sufficiently.

[0068] The organic 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.

[0069] 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.

[0070] Next, the obtained varnish is applied onto the base film and thereby a varnish layer is formed. Next, the solvent is removed from the varnish layer by heating and drying to obtain an adhesive sheet. Thereafter, the base film is removed from the adhesive sheet and thereby the film-like adhesive 10 is obtained.

[0071] As one of methods for producing the film-like adhesive 10 that is thick, a method for producing the film-like adhesive 10 that is thick by laminating the film-like adhesive 10 obtained in advance and the film-like adhesive 10 (adhesive sheet) formed on the base film is mentioned.

[0072] The film thickness of the film-like adhesive 10 is preferably 20 to 200 μm because the first semiconductor element, a wire for semiconductor element connection, and irregularities of a wire circuit or the like of the substrate can be sufficiently filled. When the film thickness is 20 μm or more, a decrease in adhesive force tends to be suppressed, and when the film thickness is 200 μm or less, there is an economic advantage and it is possible to meet the demand of decreasing a semiconductor device in size. In the present embodiment, since the semiconductor element is embedded by the film-like adhesive 10, the film thickness of the film-like adhesive 10 is more preferably 50 to 200 μm , further preferably 80 to 200 μm , and particularly preferably 100 to 200 μm .

[0073] As illustrated in FIG. 8, the film-like adhesive 10 can be used as

an adhesive sheet 100 in which the film-like adhesive 10 is stacked on a base film 20 while the base film applied with the varnish is not removed.

[0074] Furthermore, as illustrated in FIG. 9, the film-like adhesive 10 can also be used as an adhesive sheet 110 in which a cover film 30 is provided on a surface opposite to the surface on which the base film 20 is provided. Examples of the cover film 30 include a PET film, a PE film, and an OPP film.

[0075] Furthermore, the film-like adhesive can also be used as a dicing die bonding integrated adhesive sheet in which the film-like adhesive 10 is stacked on a dicing tape. In this case, since the lamination step to a semiconductor wafer is sufficient to be performed once, the efficiency of the operation can be achieved.

[0076] Examples of the dicing tape 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 dicing tape.

[0077] Further, the dicing tape can have tackiness and may be a tape obtained by imparting tackiness to the aforementioned plastic film. Furthermore, a pressure-sensitive adhesive layer may be provided on one surface of the aforementioned plastic film.

[0078] As such a dicing die bonding integrated adhesive sheet, an adhesive sheet 120 illustrated in FIG. 10, an adhesive sheet 130

illustrated in FIG. 11, and the like are mentioned. As illustrated in FIG. 10, the adhesive sheet 120 has a structure in which the dicing tape 60 on which a pressure-sensitive adhesive layer 50 is provided on a base film 40 that can ensure elongation when pulling tension is applied, is used as a support base and the film-like adhesive 10 is provided on the pressure-sensitive adhesive layer 50 of the dicing tape 60. As illustrated in FIG. 11, in the adhesive sheet 130, the base film 20 is provided on the surface of the film-like adhesive 10 in the adhesive sheet 120.

[0079] As the base film 40, the aforementioned plastic films described in the section of the dicing tape are mentioned. Furthermore, as the pressure-sensitive adhesive layer 50, for example, a resin composition containing a liquid component and a high-molecular-weight component and having a proper tack strength is mentioned. The dicing tape can be formed by applying and drying the pressure-sensitive adhesive layer 50 onto the base film 40 or laminating a pressure-sensitive adhesive layer, which is applied and dried onto a base film such as a PET film, on the base film 40. The tack strength is set to a desired value, for example, by adjusting the ratio of the liquid component and Tg of the high-molecular-weight component.

[0080] In the case of using the dicing die bonding integrated adhesive sheet such as the adhesive sheet 120 and the adhesive sheet 130 in the manufacturing of a semiconductor device, it is necessary to have pressure-sensitive adhesive force so that a semiconductor element does not fly off at the time of dicing and to easily peel off the semiconductor element from the dicing tape at the time of picking up at the subsequent

step.

[0081] Such properties can be obtained by adjusting the tack strength of the pressure-sensitive adhesive layer as described above or changing the tack strength by light response or the like, but if the tackiness of the film-like adhesive is too high, there is a case where picking up becomes difficult. Therefore, it is preferable to appropriately adjust the tack strength of the film-like adhesive 10. As a method thereof, for example, there is mentioned a method using tendencies that the pressure-sensitive adhesive strength and the tack strength are also increased when the flow of the film-like adhesive 10 at room temperature (25°C) is increased and the pressure-sensitive adhesive strength and the tack strength are also decreased when the flow is decreased.

[0082] As a method of increasing the flow, for example, a method of increasing the content of a compound functioning as a plasticizer, and the like are mentioned. As a method of decreasing the flow, for example, a method of decreasing the content of a compound functioning as a plasticizer, and the like are mentioned. Examples of the plasticizer include a monofunctional acrylic monomer, a monofunctional epoxy resin, a liquid epoxy resin, and an acrylic resin.

[0083] As a method of stacking the film-like adhesive 10 on the dicing tape 60, in addition to a method of applying and drying the varnish of the adhesive composition mentioned above onto the whole surface or a method of partially coating the varnish of the adhesive composition mentioned above by printing, a method of stacking the film-like adhesive 10 prepared in advance onto the dicing tape 60 by press or hot

roll lamination is mentioned. In the present embodiment, a method using hot roll lamination is preferred from the viewpoints that continuous manufacturing can be performed and favorable efficiency is obtained.

5 [0084] The film thickness of the dicing tape 60 is not particularly limited and can be determined appropriately on the basis of knowledge of those skilled in the art depending on the film thickness of the film-like adhesive 10 or the use application of the dicing die bonding integrated adhesive sheet. When the thickness of the dicing tape 60 is
10 60 μm or more, handleability becomes favorable and the tearing of the dicing tape 60 by expansion in a step of peeling off individuated semiconductor elements by dicing from the dicing tape 60 can be suppressed. On the other hand, from the viewpoints of favorable economic efficiency and handleability, the thickness of the dicing tape
15 60 is preferably 180 μm or less. From the above points, the film thickness of the dicing tape 60 is preferably 60 to 180 μm .

[0085] Hereinabove, preferred embodiments of the method for manufacturing a semiconductor device and the adhesive used therein of the present invention have been described, but the present invention is
20 not necessarily limited to the aforementioned embodiments and may be adequately modified within a scope not departing from the gist thereof.

[0086] In the above-described embodiments, the film-like adhesive has been described and the method for manufacturing a semiconductor device using the film-like adhesive has been described, but the film-like
25 adhesive is not necessarily a film shape and it is only necessary to be an adhesive. That is, the film-like adhesive may be an adhesive of a

liquid, paste, or the like.

[0087] The semiconductor device 200 of FIG. 6 is a wire and semiconductor-embedded type semiconductor device in which the first wire 88 and the first semiconductor element Wa are embedded in the film-like adhesive 10, but the first semiconductor element Wa may not be necessarily embedded. That is, the semiconductor device 200 may be a wire-embedded type semiconductor device in which the first wire 88 is embedded in the film-like adhesive 10. Furthermore, the entire first wire may not be embedded and it is only necessary that at least a part thereof is embedded.

[0088] In a case where the first semiconductor element Wa is not embedded in the film-like adhesive 10, from the viewpoints that adhesiveness is high and the semiconductor device 200 can be formed to be thin, the film thickness of the film-like adhesive 10 can be 30 to 200 μm and may be 40 to 150 μm , 40 to 100 μm , or 40 to 80 μm .

[0089] In the semiconductor device 200, the substrate 14 is the organic substrate 90 in which two of each of the circuit patterns 84 and 94 are formed on the surface, but the substrate 14 is not limited thereto and a metal substrate such as a lead frame may be used.

[0090] The semiconductor device 200 has a configuration in which the second semiconductor element Waa is stacked on the first semiconductor element Wa and the semiconductor elements are stacked on two stages, but the configuration of the semiconductor device is not limited thereto. A third semiconductor element may be further stacked above the second semiconductor element Waa, and a plurality of semiconductor elements may be further stacked above the second

semiconductor element Waa. As the number of semiconductor elements to be stacked increases, the capacity of a semiconductor device to be obtained can be increased.

[0091] In the method for manufacturing a semiconductor device of the above-described embodiment, the film-like adhesive-attached semiconductor element 102 in which the film-like adhesive 10 is pasted onto the second semiconductor element Waa is prepared before the pressure bonding step, but a film-like adhesive-attached semiconductor element as described above may not be prepared as long as the second semiconductor element Waa is pressure-bonded to the substrate 14 via the film-like adhesive 10.

[0092] Furthermore, in the method for manufacturing a semiconductor device of the above-described embodiment, the adhesive sheet 100 illustrated in FIG. 8 is laminated on one surface of a semiconductor wafer in the lamination step, the base film 20 is peeled off, and thereby the film-like adhesive 10 is pasted, but an adhesive sheet to be used at the time of lamination is not limited thereto. Instead of the adhesive sheet 100, the dicing die bonding integrated adhesive sheets 120 and 130 illustrated in FIGS. 10 and 11 can be used. In this case, it is not necessary to separately paste the dicing tape 60 at the time of dicing a semiconductor wafer.

[0093] Furthermore, in the lamination step, semiconductor elements obtained by individuating a semiconductor wafer may be laminated on the adhesive sheet 100 instead of the semiconductor wafer. In this case, the dicing step can be omitted.

Examples

[0094] Hereinafter, the present invention will be more specifically described by means of Examples. However, the present invention is not limited to the following Examples.

[0095] <Preparation of film-like adhesive sheet>

5 (Examples 1 to 4 and Comparative Examples 1 to 3)

Cyclohexanone was added to a composition composed of an epoxy resin and a phenolic resin as the (a) thermosetting resin of product names and composition ratios (unit: parts by mass) shown in Table 1 and an inorganic filler as the (c) filler and mixed under stirring.
10 Acrylic rubber as the (b) high-molecular-weight component shown in Table 1 was added thereto and stirred, and the (e) coupling agent and the (d) curing accelerator similarly shown in Table 1 were further added and stirred until the respective components became homogeneous, thereby obtaining a varnish.

15 [0096] Incidentally, symbols of respective components in Table 1 mean as follows.

[0097] (Epoxy resin)

YDF-8170C: (trade name, manufactured by TOHTO Chemical Industry Co., Ltd., bisphenol F type epoxy resin, epoxy equivalent: 159,
20 liquid in room temperature)

VG-3101L: (trade name, manufactured by Printec Corporation, polyfunctional epoxy resin, epoxy equivalent: 210, softening point: 39°C to 46°C)

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

- HP-7200: (trade name, manufactured by DIC Corporation, dicyclopentadiene-containing epoxy resin, epoxy equivalent: 247, softening point: 55°C to 65°C)
[0098] (Phenolic resin)
- 5 PSM-4326: (trade name, manufactured by Gun Ei Chemical Industry Co., Ltd., hydroxyl equivalent: 105, softening point: 118°C to 122°C)
- MILEX XLC-LL: (trade name, manufactured by Mitsui Chemicals, Inc., phenolic resin, hydroxyl equivalent: 175, softening point: 77°C, water absorption percentage: 1% by mass, heating mass decrease rate: 4% by mass)
10 [0099] (Acrylic rubber)
- Acrylic rubber HTR-860P-3CSP: (trade name, manufactured by Nagase ChemteX Corporation, weight average molecular weight: 800000, ratio of structure unit having a glycidyl functional group: 3%, Tg: -7°C)
15
- Acrylic rubber HTR-860P-30B-CHN: (trade name, manufactured by Nagase ChemteX Corporation, weight average molecular weight: 230000, ratio of structure unit having a glycidyl functional group: 8%, Tg: -7°C)
20 [0100] (Inorganic filler)
- SC2050-HLG: (trade name, manufactured by Admatechs Company Limited, silica filler dispersion, average particle size: 0.50 μm)
- 25 AEROSIL R972: (trade name, manufactured by Nippon Aerosil Co., Ltd., silica, average particle size: 0.016 μm)

[0101] (Curing accelerator)

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

[0102] (Coupling agent)

5 A-1160: (trade name, manufactured by GE Toshiba Co., Ltd.,
γ-ureidopropyltriethoxysilane)

 A-189: (trade name, manufactured by GE Toshiba Co., Ltd.,
γ-mercaptopropyltrimethoxysilane)

[0103] [Table 1]

		Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2	Comparative Example 3	
(a) Thermosetting component	Epoxy resin	YDF-8170C	8	12	13	13	15	9	13
		VG-3101L	-	5	-	-	-	-	-
		YDCN-700-10	-	6	11	11	17	16	11
	Phenolic resin	HP-7200	21	-	-	-	-	-	-
		PSM-4326	-	-	-	4	-	-	-
(b) High-molecular-weight component	Acrylic rubber	XLC-LL	21	19	19	15	23	22	19
		HTR-860P-3CSP	18	19	18	18	16	16	9
		HTR-860P-30B-CHN	-	-	-	-	-	-	9
(c) Filler	Inorganic filler	SC2050-HLG	32	39	39	39	29	28	39
R972		-	-	-	-	-	9	-	
(d) Curing accelerator		2PZ-CN	0.06	0.07	0.06	0.06	0.07	0.07	0.06
A-1160		0.18	0.15	0.18	0.18	0.18	0.18	0.18	
A-189		0.09	0.10	0.09	0.09	0.09	0.09	0.09	
(e) Coupling agent									

[0104] Next, the obtained varnish was filtered with a 100-mesh filter and vacuum-defoamed. The varnish after being vacuum-defoamed was applied onto a polyethylene terephthalate (PET) film having a thickness of 38 μm and subjected to a mold release treatment, as the
5 base film. 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 having a thickness of 60 μm in the B-stage on a PET film as the base film was obtained. This adhesive sheet was laminated at 60°C and thereby an
10 adhesive sheet provided with a film-like adhesive having a thickness of 120 μm was obtained.

[0105] <Evaluation of various physical properties>

The melt viscosity, the embeddability and the positional deviation of a semiconductor element after heating and pressurizing by
15 a pressure oven, the bonding strength, and the reflow resistance of the film-like adhesive of the adhesive sheet thus obtained were evaluated according to the following methods.

[0106] [Melt viscosity]

The melt viscosity of the film-like adhesive was evaluated by
20 measuring the shear viscosity by the following method. A plurality of the above-described adhesive sheets were prepared and laminated at 60°C, and the film-like adhesive was stacked onto the base film to have a thickness of about 300 μm . The base film was peeled off and removed from the stacked film-like adhesive, this product was punched
25 into 10 mm square in a thickness direction, and thereby a square laminate having a size of 10 mm square and a thickness of 300 μm was

obtained. A circular aluminum plate jig having a diameter of 8 mm was set to a dynamic viscoelasticity measuring apparatus ARES (manufactured by TA Instruments), and the punched laminate of the film-like adhesive was further set thereto. Thereafter, measurement was performed while applying 5% strain at 35°C and increasing the temperature to 150°C at a temperature increasing rate of 5°C/min, and values of the melt viscosity at 120°C were recorded. The measurement results are shown in Table 2.

[0107] [Embeddability after heating and pressurizing by pressure oven]

The embeddability of the film-like adhesive after heating and pressurizing by a pressure oven was evaluated by the following method. The film-like adhesive (thickness: 120 μm) of the adhesive sheet obtained above was pasted onto a semiconductor wafer (8 inches) having a thickness of 50 μm at 70°C. Next, these were diced into 7.5 mm square to obtain a film-like adhesive-attached semiconductor element (second semiconductor element). Furthermore, a dicing die bonding integrated film (trade name: HR-9004-10, manufactured by Hitachi Chemical Company, Ltd., thickness: 10 μm) was pasted to a semiconductor wafer having a thickness of 50 μm (8 inches) at 70°C. Next, these were diced into 3.0 mm square to obtain a chip. The individuated HR-9004-10-attached chip (first semiconductor element) was pressure-bonded to an evaluation substrate having a surface asperity up to 6 μm under conditions of 130°C, 0.20 MPa, and 2 seconds, and semi-cured by heating at 120°C for 2 hours.

[0108] Next, the above-described film-like adhesive-attached semiconductor element was disposed on the first semiconductor element

obtained in this way, and this was pressure-bonded under conditions of 120°C, 0.20 MPa, and 2 seconds. In this case, positioning was performed so that the HR-9004-10-attached chip firstly pressure-bonded was disposed at the center of the above-described film-like adhesive-attached semiconductor element. The obtained sample was put in a pressure oven, the pressure in the pressure oven was set to 0.7 MPa, the temperature was increased from 35°C to 140°C at a temperature increasing rate of 3°C/min, and the sample was heated at 140°C for 30 minutes. The evaluation sample obtained in this way was analyzed with an ultrasonic imaging device SAT (manufactured by Hitachi Construction Machinery Co., Ltd., Product No. FS200II, probe: 25 MHz), and embeddability was checked. The evaluation criteria of embeddability are as follows. The evaluation results are shown in Table 2.

A: The ratio of voids is less than 5%.

B: The ratio of voids is 5% or more.

[0109] [Positional deviation of semiconductor element after heating and pressurizing by pressure oven]

When the same evaluation sample as that in the embeddability evaluation after heating and pressurizing by a pressure oven was prepared, images of the whole chip before and after heating and pressurizing by the pressure oven were acquired, and the positional deviation before and after heating and pressurizing by the pressure oven was measured by microscopic analysis. The evaluation criteria are as follows. The evaluation results are shown in Table 2.

A: The positional deviation after heating and pressurizing by the

pressure oven is less than 10 μm .

B: The positional deviation after heating and pressurizing by the pressure oven is 10 μm or more.

[0110] [Bonding strength]

5 The die shear strength (bonding strength) of the film-like adhesive was measured by the following method. First, the film-like adhesive (thickness: 120 μm) of the adhesive sheet obtained above was pasted onto a semiconductor wafer having a thickness of 400 μm at 70°C. Next, these were diced into 5.0 mm square to obtain a film-like
10 adhesive-attached semiconductor element. The side of the film-like adhesive of the individuated film-like adhesive-attached semiconductor element was thermocompression-bonded onto the substrate applied with solder resist ink (trade name: AUS308, manufactured by TAIYO INK MFG. CO., LTD.) under conditions of 120°C, 0.1 MPa, and 5 seconds
15 and thereby a sample was obtained. Thereafter, the adhesive of the sample thus obtained was cured by heating at 120°C for 2 hours and at 170°C for 3 hours. Further, the sample after the adhesive was cured was left to stand for 168 hours under conditions of 85°C and 60% RH. Thereafter, the sample was left to stand for 30 minutes under conditions
20 of 25°C and 50% RH, and the die shear strength was measured at 250°C and regarded as the bonding strength. The measurement results are shown in Table 2.

[0111] [Reflow resistance]

25 The reflow resistance of the film-like adhesive was evaluated by the following method. An evaluation sample was prepared in the same manner as the evaluation sample obtained in the evaluation of the

embeddability after heating and pressurizing by the pressure oven. The obtained evaluation sample was resin-sealed by using a sealing material for molding (manufactured by Hitachi Chemical Company, Ltd., trade name: CEL-9750ZHF10) under conditions of 175°C, 6.7 MPa, and 90 seconds, the sealing material was cured under conditions of 175°C and 5 hours, and thereby a package was obtained.

[0112] 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 criteria are as follows. The evaluation results are shown in Table 2.

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 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 one or more packages.

[0113] [Table 2]

	Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2	Comparative Example 3
Melt viscosity (120°C)	1600	1200	1700	2200	500	5000	300
Embeddability after heating and pressurizing by pressure oven	A	A	A	A	A	B	A
Positional deviation of semiconductor element after heating and pressurizing by pressure oven	A	A	A	A	B	A	B
Bonding strength	2.2	2.1	2.5	3.0	2.8	3.1	2.4
Reflow resistance	A	A	A	A	A	B	A

5 [0114] As clearly understood from the results shown in Table 2, it was confirmed that the adhesive sheets of Examples 1 to 4 are excellent in embeddability as compared to the adhesive sheets of Comparative Examples 1 to 3, have no positional deviation of a semiconductor element, and are also excellent in reflow resistance.

Reference Signs List

[0115] 10: film-like adhesive, 14: substrate, 42: resin (sealing material), 88: first wire, 98: second wire, 200: semiconductor device, Wa: first semiconductor element, Waa: second semiconductor element.

10

CLAIMS

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

5 a first wire bonding step of electrically connecting a first semiconductor element onto a substrate via a first wire;

a pressure bonding step of pressure-bonding a second semiconductor element to the substrate via an adhesive such that the first semiconductor is embedded in the adhesive, the adhesive having a thermosetting property; and

10 a heating and pressurizing step of heating the adhesive after the pressure bonding step under a pressurized atmosphere to subject the adhesive to a curing treatment,

wherein a melt viscosity of the adhesive before the curing treatment is 1000 to 3000 Pa·s at 120°C and the first semiconductor element is embedded in the adhesive after the curing treatment through the heating and pressurizing step.

[Claim 2] A method for manufacturing a semiconductor device, the method comprising:

20 a first wire bonding step of electrically connecting a first semiconductor element to a substrate via a first wire;

a pressure bonding step of pressure-bonding a second semiconductor element to the substrate via a film-like adhesive having a thermosetting property and a thickness of 100 to 200 μm; and

25 a heating and pressurizing step of heating the adhesive after the pressure bonding step under a pressurized atmosphere to subject the adhesive to a curing treatment,

wherein a melt viscosity of the adhesive before the curing

treatment is 1000 to 3000 Pa·s at 120°C, and at least one of at least a part of the first wire and the first semiconductor element is embedded in the adhesive after the curing treatment through the heating and pressurizing step.

5 [Claim 3] The method for manufacturing a semiconductor device according to claim 1 or 2, wherein in the heating and pressurizing step, the adhesive is heated at 60°C to 175°C for 5 minutes or longer under a pressurized atmosphere of 0.1 to 1.0 MPa.

[Claim 4] The method for manufacturing a semiconductor device
10 according to any one of claims 1 to 3, further comprising a step of further stacking a third semiconductor element above the second semiconductor element after the heating and pressurizing step.

[Claim 5] The method for manufacturing a semiconductor device according to any one of claims 1 to 4, further comprising:

15 a second wire bonding step of electrically connecting the substrate and the second semiconductor element to each other via a second wire; and

a step of sealing the second semiconductor element with a resin.

[Claim 6] A film-like adhesive being used in a manufacturing
20 process of a semiconductor device,

the manufacturing process including a step of performing a curing treatment in which the adhesive is heated under a pressurized atmosphere to embed a semiconductor element on a substrate in the adhesive after the curing treatment,

25 wherein a melt viscosity of the film-like adhesive is 1000 to 3000 Pa·s at 120°C.

[Claim 7] A film-like adhesive for use in a manufacturing process of a semiconductor device,

the manufacturing process including a step of performing a curing treatment in which the adhesive is heated under a pressurized atmosphere to embed at least one of at least a part of a first wire and a first semiconductor element in the adhesive after the curing treatment, wherein the at least a part of the first wire and the first semiconductor element are on the substrate,

wherein a thickness of the film-like adhesive is 100 to 200 μm and a melt viscosity of the film-like adhesive is 1000 to 3000 Pa·s at 120°C.

[Claim 8] The film-like adhesive according to claim 6 or 7, wherein the film-like adhesive has an adhesive force after curing of 1.0 MPa or more with respect to the substrate coated with solder resist ink.