

DESCRIPTION

Title of Invention

FILM-FORM ADHESIVE, METHOD FOR PRODUCING SAME,
AND SEMICONDUCTOR DEVICE AND METHOD FOR
5 PRODUCING SAME

Technical Field

[0001] The present invention relates to a film-form adhesive, a method for producing the film-form adhesive, a semiconductor device, and a method for producing the semiconductor device.

10 Background Art

[0002] Conventionally, silver pastes have been mainly used for the joining of semiconductor chips and supporting members for mounting semiconductor chips. However, along with size reduction and integration of semiconductor chips in recent years, there have been
15 demands for size reduction and micronization also in the supporting members to be used. On the other hand, in the case of using a silver paste, there may be problems such as the occurrence of inconvenience upon wire bonding, which is attributed to protrusion of the paste or tilting of semiconductor chips; the difficulties in the control of the film
20 thickness; and the void generation.

[0003] Therefore, in recent years, film-form adhesives for joining semiconductor chips and supporting members have been used (see, for example, Patent Literature 1). In a case in which an adhesive sheet including a dicing tape and a film-form adhesive laminated on the
25 dicing tape is used, a film-form adhesive-attached semiconductor chip can be obtained by sticking a film-form adhesive on the rear surface of a

semiconductor wafer and individualizing the semiconductor wafer by dicing. The film-form adhesive-attached semiconductor chip thus obtained can be stuck to a supporting member by means of the film-form adhesive and joined by thermocompression bonding.

5 **Citation List**

Patent Literature

[0004] Patent Literature 1: JP No. 2007-053240

Summary of Invention

Technical Problem

10 [0005] However, as the size of a semiconductor chip decreases, the force exerted per unit area at the time of thermocompression bonding increases, and a phenomenon called bleeding, in which a film-form adhesive protrudes from the semiconductor chip, may occur.

15 [0006] Furthermore, in a case in which a film-form adhesive is used as a film over wire (FOW), which is a wire-embedded type film-form adhesive, or a film over die (FOD), which is a semiconductor chip-embedded type film-form adhesive, high fluidity is required at the time of thermocompression bonding, from the viewpoint of enhancing the embedding properties. Therefore, the frequency of occurrence and
20 the amount of bleeding tend to further increase. Depending on cases, bleeding may occur up to the top face of the semiconductor chip, and as a result, there is a risk that bleeding may lead to electrical defects or wire bonding defects.

25 [0007] The present invention was achieved in view of such circumstances, and it is a main object of the present invention to provide a film-form adhesive that has satisfactory embedding properties at the

time of thermocompression bonding and is capable of suppressing bleeding.

Solution to Problem

5 [0008] The inventors of the present invention conducted a thorough investigation and found that the above-described problems are solved by using a film-form adhesive obtained by laminating an adhesive film, and adjusting the solvent content percentage and the shear viscosity of the film-form adhesive. Thus, the present invention was finally completed.

10 [0009] An aspect of the present invention provides a film-form adhesive, used in a semiconductor device in which a first semiconductor element is connected by wire bonding onto a substrate by means of a first wire, and a second semiconductor element is also compression-bonded onto the first semiconductor element, in order to
15 compression-bond the second semiconductor element and also to embed at least a portion of the first wire, in which the film-form adhesive includes a first adhesive film and a second adhesive film laminated on the first adhesive film, the solvent content percentage of the film-form adhesive is 1.5% by mass or less based on the total amount of the
20 film-form adhesive, and the shear viscosity at 80°C of the film-form adhesive is 5,000 Pa·s or less. According to such a film-form adhesive, it is possible to suppress bleeding while having satisfactory embedding properties at the time of thermocompression bonding.

25 [0010] A thickness of the film-form adhesive may be 3 to 150 μm . A storage modulus at 80°C of the film-form adhesive may be 10 MPa or lower.

- [0011] According to another aspect, the present invention provides a method for producing the above-mentioned film-form adhesive, the method including a step of applying a varnish of a first adhesive composition containing a solvent on a base material, heating and drying the applied varnish of the first adhesive composition at 50°C to 150°C, and producing a first adhesive film having a solvent content percentage of 1.5% by mass or less based on the total amount of the first adhesive film, a step of applying a varnish of a second adhesive composition containing a solvent on a base material, heating and drying the applied varnish of the second adhesive composition at 50°C to 150°C, and producing a second adhesive film having a solvent content percentage of 1.5% by mass or less based on the total amount of the second adhesive film, and a step of pasting the first adhesive film and the second adhesive film together.
- [0012] According to another aspect, the present invention provides a semiconductor device in which a first semiconductor element is connected by wire bonding onto a substrate by means of a first wire, a second semiconductor element is also compression-bonded onto the first semiconductor element by means of the above-mentioned film-form adhesive, and thereby at least a portion of the first wire is embedded in the film-form adhesive. Meanwhile, the semiconductor device may be a wire-embedded type semiconductor device having at least a portion of a first wire embedded in a film-form adhesive, or may be a chip-embedded type semiconductor device having a first wire and a first semiconductor chip embedded in an adhesive film.
- [0013] According to another aspect, the present invention provides a

method for producing a semiconductor device, the method including a wire bonding step of electrically connecting a first semiconductor element onto a substrate by means of a first wire, a lamination step of sticking the above-mentioned film-form adhesive on one side of a second semiconductor element, and a die bonding step of subjecting the second semiconductor element having the film-form adhesive stuck thereto, to compression-bonding by means of the film-form adhesive, and thereby embedding at least a portion of the first wire in the film-form adhesive.

Advantageous Effects of Invention

[0014] According to the present invention, there is provided a film-form adhesive that has satisfactory embedding properties at the time of thermocompression bonding and is capable of suppressing bleeding. Furthermore, according to the present invention, there are provided a method for producing such a film-form adhesive, and a semiconductor device using such a film-form adhesive as well as a method for producing the semiconductor device.

Brief Description of Drawings

[0015] FIG. 1 is a schematic cross-sectional view illustrating a film-form adhesive according to an embodiment.

FIG. 2 is a schematic cross-sectional view illustrating an adhesive sheet according to an embodiment.

FIG. 3 is a schematic cross-sectional view illustrating an adhesive sheet according to another embodiment.

FIG. 4 is a schematic cross-sectional view illustrating a semiconductor device according to an embodiment.

FIG. 5 is a schematic cross-sectional view illustrating a series of steps of a method for producing a semiconductor device according to an embodiment.

5 FIG. 6 is a schematic cross-sectional view illustrating a series of steps of a method for producing a semiconductor device according to an embodiment.

FIG. 7 is a schematic cross-sectional view illustrating a series of steps of a method for producing a semiconductor device according to an embodiment.

10 FIG. 8 is a schematic cross-sectional view illustrating a series of steps of a method for producing a semiconductor device according to an embodiment.

15 FIG. 9 is a schematic cross-sectional view illustrating a series of steps of a method for producing a semiconductor device according to an embodiment.

Description of Embodiments

[0016] Hereinafter, embodiments of the present invention will be described with appropriate reference to the drawings. However, the present invention is not intended to be limited to the following
20 embodiments.

[0017] According to the present specification, (meth)acrylic acid means acrylic acid or methacrylic acid corresponding thereto. The same also applies to other similar expressions such as a (meth)acryloyl group.

[0018] [Film-form adhesive]

25 FIG. 1 is a schematic cross-sectional view illustrating a film-form adhesive according to an embodiment. The film-form

adhesive 10 includes a first adhesive film 2 and a second adhesive film 4 laminated on the first adhesive film 2. The first adhesive film 2 and the second adhesive film 4 are both thermosetting films and can be produced by molding a first adhesive composition and a second adhesive composition, which can go through a semi-cured (stage B) state and enter a completely cured product (stage C) state after a curing treatment, into a film form. The film-form adhesive 10 can be produced by laminating the first adhesive film 2 and the second adhesive film 4 thus obtained.

[0019] It is preferable that the first adhesive film 2 and the second adhesive film 4, which constitute the film-form adhesive 10, each contain a thermosetting resin (hereinafter, may be simply referred to as "component (a)"), a high-molecular weight component (hereinafter, may be simply referred to as "component (b)"), and an inorganic filler (hereinafter, may be simply referred to as "component (c)"). The first adhesive film 2 and the second adhesive film 4 may further contain a coupling agent (hereinafter, may be simply referred to as "component (d)") and a curing agent (hereinafter, may be simply referred to as "component (e)"). In the first adhesive film 2 and the second adhesive film 4, the solvent used at the time of forming the first adhesive film 2 and the second adhesive film 4 may remain. The solvent content percentage of the film-form adhesive 10 (first adhesive film 2 and second adhesive film 4) is 1.5% by mass or less based on the total amount of the film-form adhesive. The first adhesive film 2 and the second adhesive film 4 may be identical film or different films; however, it is preferable that they are identical films.

[0020] <(a) Thermosetting resin>

It is preferable, from the viewpoint of adhesiveness, that component (a) includes an epoxy resin (hereinafter, may be simply referred to as "component (a1)") and a phenolic resin (hereinafter, may be simply referred to as "component (a2)") that can serve as a curing agent for an epoxy resin.

[0021] Regarding the component (a1), any compound having an epoxy group in the molecule can be used without any particular limitations. 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 novolac type epoxy resin, a cresol novolac type epoxy resin, a bisphenol A novolac type epoxy resin, a bisphenol F novolac 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 triphenol phenol methane type epoxy resin, a biphenyl type epoxy resin, a xylylene type epoxy resin, a biphenyl aralkyl type epoxy resin, a naphthalene type epoxy resin, a polyfunctional phenol, a diglycidyl ether compound of a polycyclic aromatic compound such as anthracene, and the like. These may be used singly or in combination of two or more kinds thereof. Among these, the component (a1) may be a cresol novolac type epoxy resin, a bisphenol F type epoxy resin, or a bisphenol A type epoxy resin, from the viewpoint of heat resistance.

[0022] 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-form adhesive is maintained.

[0023] 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 a total mass of 100 parts by mass of the component (a), component (b), and component (c). When the content of the component (a1) is 5 parts by mass or more, the embedding properties of the film-form adhesive tend to become more satisfactory. 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.

[0024] Regarding component (a2), any compound having a phenolic hydroxyl group in the molecule can be used without any particular limitations. Examples of the component (a2) include a novolac type phenolic resin obtainable by condensing or co-condensing a phenol such as phenol, cresol, resorcin, catechol, bisphenol A, bisphenol F, phenylphenol, or aminophenol, and/or a naphthol such as α -naphthol, β -naphthol, or dihydroxynaphthalene, with a compound having an aldehyde group, such as formaldehyde, in the presence of an acidic catalyst; a phenol aralkyl resin synthesized from a phenol and/or a naphthol, such as allylated bisphenol A, allylated bisphenol F, allylated naphthalenediol, phenol novolac, or phenol, and dimethoxy-para-xylene or bis(methoxymethyl)biphenyl; a naphthol aralkyl resin, and the like. These may be used singly or in combination of two or more kinds thereof. Among these, the component (a2) may be a phenol aralkyl resin, a naphthol aralkyl resin, or a novolac type phenolic resin, from the viewpoints of hygroscopic properties and heat resistance.

[0025] The hydroxyl group 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 group equivalent of the component (a2) is in such a range, there is a tendency that the adhesive force can be maintained more highly while fluidity of the film-form adhesive is maintained.

[0026] 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.

[0027] 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 a total mass of 100 parts by mass of the component (a), component (b), and component (c). When the content of the component (a2) is 5 parts by mass or more, more satisfactory curability tends to be obtained. When the content of the component (a2) is 50 parts by mass or less, the embedding properties of the film-form adhesive tend to be more satisfactory.

[0028] The ratio of the epoxy equivalent of the component (a1) and the hydroxyl group equivalent of the component (a2) (epoxy equivalent of component (a1) / hydroxyl group equivalent of 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 this equivalent ratio is 0.30/0.70 or higher, more sufficient curability tends to be obtained. When this equivalent ratio is 0.70/0.30 or lower, the viscosity can be prevented from becoming excessively high, and more sufficient fluidity can be obtained.

[0029] <(b) High-molecular weight component>

Component (b) is preferably a compound having a glass

transition temperature (Tg) of 50°C or lower.

[0030] 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, modification products of these, and the like.

[0031] From the viewpoint of fluidity, the component (b) may include an acrylic resin. Here, the acrylic resin means a polymer including a constituent unit derived from a (meth)acrylic acid ester. It is preferable that the acrylic resin is a polymer including a constituent unit derived from a (meth)acrylic acid ester having a crosslinkable functional group such as an epoxy group, an alcoholic or phenolic hydroxyl group, or a carboxyl group, as a constituent unit. Furthermore, the acrylic resin may be an acrylic rubber such as a copolymer of a (meth)acrylic acid ester and acrylonitrile.

[0032] The glass transition temperature (Tg) of the acrylic resin may be -50°C to 50°C or -30°C to 30°C. When the Tg of the acrylic resin is -50°C or higher, there is a tendency that the flexibility of the adhesive composition can be prevented from becoming excessively high. Thereby, it is easier to cut the film-form adhesive at the time of wafer dicing, and it is possible to prevent the occurrence of burrs. When the 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. Thereby, at the time of sticking the film-form adhesive to a wafer, voids tend to be easily embedded sufficiently. Furthermore, it is possible to prevent chipping at the time of dicing, which is caused by a decrease in the adhesiveness of the wafer. Here, the glass transition

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

5 [0033] The weight average molecular weight (Mw) of the acrylic resin may be 100,000 to 3,000,000 or 500,000 to 2,000,000. When the Mw of the acrylic resin is in such a range, the film-forming properties and the strength, flexibility, tackiness, and the like in a film form can be appropriately controlled, the reflow characteristics are also excellent, and the embedding properties can be enhanced. Here, the Mw means a
10 value measured by gel permeation chromatography (GPC) and converted using a calibration curve based on polystyrene standards.

[0034] 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
15 Nagase ChemteX Corporation).

[0035] 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 a total mass of 100 parts by mass of the component (a), component (b), and component (c). When the content of the component (b) is 5 parts by
20 mass or more, the control of fluidity at the time of molding and the handleability at high temperature can be made more satisfactory. When the content of the component (b) is 70 parts by mass or less, the embedding properties can be made more satisfactory.

[0036] <(c) Inorganic filler>
25 Examples of component (c) include, for example, aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium

carbonate, calcium silicate, magnesium silicate, calcium oxide, magnesium oxide, aluminum oxide, aluminum nitride, aluminum borate whiskers, boron nitride, silica, and the like. These may be used singly or in combination of two or more kinds thereof. Among these, the component (c) may be silica, from the viewpoint of the compatibility with resins.

[0037] 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 enhancing the adhesiveness. Here, the average particle size means a value that is determined by converting from the BET specific surface area.

[0038] 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 a total mass of 100 parts by mass of the component (a), component (b), and component (c). When the content of the component (c) is 5 parts by mass or more, the fluidity of the film-form adhesive tends to be further enhanced. When the content of the component (c) is 50 parts by mass or less, the dicing characteristics of the film-form adhesive tend to become more satisfactory.

[0039] <(d) Coupling agent>

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

[0040] The content of the component (d) may be 0.01 to 5 parts by

mass with respect to a total mass of 100 parts by mass of the component (a), component (b), and component (c).

[0041] <(e) Curing accelerator>

5 Component (e) is not particularly limited, and agents that are generally used can be used. Examples of the component (e) include an imidazole and derivatives thereof, an organic phosphorus-based compound, a secondary amine, a tertiary amine, a quaternary ammonium salt, and the like. These may be used singly or in combination of two or more kinds thereof. Among these, from the
10 viewpoint of reactivity, the component (e) may be an imidazole or a derivative thereof.

[0042] Examples of the imidazole include 2-methylimidazole, 1-benzyl-2-methylimidazole, 1-cyanoethyl-2-phenylimidazole, 1-cyanoethyl-2-methylimidazole, and the like. These may be used
15 singly or in combination of two or more kinds thereof.

[0043] The content of the component (e) may be 0.01 to 1 part by mass with respect to a total mass of 100 parts by mass of the component (a), component (b), and component (c).

[0044] <Solvent>

20 In the first adhesive film 2 and the second adhesive film 4, the solvent used at the time of forming the first adhesive film 2 and the second adhesive film 4 that will be described below may remain. The solvent is not limited as long as it can uniformly dissolve, knead, or disperse various components, and conventionally known solvents can be
25 used. Examples of such a solvent include ketone-based solvents such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and

cyclohexanone; dimethylformamide, dimethylacetamide, N-methylpyrrolidone, toluene, xylene, and the like. From the viewpoint that the drying speed is fast, and the price is cheap, it is preferable to use methyl ethyl ketone, cyclohexanone, or the like.

5 [0045] The solvent content percentage of the film-form adhesive 10 (first adhesive film 2 and second adhesive film 4) is 1.5% by mass or less based on the total amount of the film-form adhesive. The solvent content percentage may also be 1.2% by mass or less, 0.9% by mass or less, or 0.6% by mass or less. When the solvent content percentage is 10 1.5% by mass or less, there is a tendency that bleeding can be suppressed. The lower limit value of the solvent content percentage is not particularly limited; however, the solvent content percentage may be, for example, 0.01% by mass or more.

[0046] The adhesive film is such that when the thickness is made 15 thinner, it is easier to heat and dry the solvent, and the solvent content percentage tends to be reduced. Therefore, in a film including a first adhesive film 2 and a second adhesive film 4 as in the case of the film-form adhesive 10, the solvent content percentage is easily reduced without increasing the conditions for heating and drying, compared to a 20 film having the same thickness and composed of a single layer. Furthermore, the solvent content percentage of the film-form adhesive 10 can be adjusted by, for example, changing the conditions for heating and drying a varnish of the adhesive composition.

[0047] The first adhesive film 2 and the second adhesive film 4 may 25 further contain other components. Examples of the other components include an ion trapping agent, a rheology control agent, and the like.

The content of the other components may be 0.01 to 20 parts by mass with respect to a total amount of 100 parts by mass of the component (a), component (b), and component (c).

5 [0048] The shear viscosity at 80°C of the film-form adhesive 10 (first adhesive film 2 and second adhesive film 4) is 5,000 Pa·s or less. The shear viscosity at 80°C may be 3,500 Pa·s or less, 2,500 Pa·s or less, or 1,500 Pa·s or less. When the shear viscosity at 80°C is 5,000 Pa·s or less, fluidity increases, and the embedding properties tend to be enhanced. The lower limit value of the shear viscosity at 80°C is not particularly limited; however, the shear viscosity may be, for example, 10 Pa·s or higher. Meanwhile, the shear viscosity at 80°C can be measured, for example, according to the method described in the Examples.

15 [0049] The shear viscosity at 80°C of the film-form adhesive 10 tends to depend on, for example, the contents of the above-mentioned component (b) and component (c), and the shear viscosity can be adjusted by changing these.

20 [0050] The storage modulus at 80°C of the film-form adhesive 10 (first adhesive film 2 and second adhesive film 4) may be 10 MPa or lower. The storage modulus at 80°C may be 5 MPa or lower, 1 MPa or lower, or 0.5 MPa or lower. When the storage modulus at 80°C is 10 MPa or lower, the embedding properties tend to be superior. The lower limit value of the storage modulus at 80°C is not particularly limited; however, for example, the storage modulus may be 0.02 MPa or higher.

25 [0051] The storage modulus at 80°C of the film-form adhesive 10 can be adjusted by, for example, changing the functional group equivalent of

the component (a).

[0052] The thickness of the first adhesive film 2 and the thickness of the second adhesive film 4 may be identical with or different from each other; however, it is preferable that the thicknesses are identical with each other. The thickness of the first adhesive film 2 and the thickness of the second adhesive film 4 may be 2 to 140 μm , respectively. The thickness of the first adhesive film 2 and the thickness of the second adhesive film 4 may be 5 to 110 μm , 10 to 90 μm , or 20 to 60 μm , respectively. When these thicknesses are respectively 2 μm or more, the embedding properties tend to become more satisfactory. When these thicknesses are respectively 140 μm or less, there is a tendency that the solvent content percentage can be lowered.

[0053] The thickness of the film-form adhesive 10 (total thickness of the first adhesive film 2 and the second adhesive film 4) may be 3 to 150 μm in order to enable sufficient filling of the first wire and the first semiconductor element, and the surface unevenness of the wiring circuit of the substrate, and the like. The thickness of the film-form adhesive 10 may be 20 to 140 μm or 40 to 130 μm . When the thickness of the film-form adhesive 10 is 3 μm or more, the embedding properties tend to be superior. When the thickness of the film-form adhesive 10 is 150 μm or less, there is a tendency that bleeding can be further suppressed.

[0054] The film-form adhesive 10 may have an adhesive film further laminated on the first adhesive film 2 and the second adhesive film 4. That is, the film-form adhesive 10 may include three or more layers of adhesive films. The adhesive film other than the first adhesive film 2 and the second adhesive film 4 may be an adhesive film identical to the

first adhesive film 2 and the second adhesive film 4.

[0055] [Method for producing film-form adhesive]

5 The method for producing a film-form adhesive includes a step of applying a varnish of a first adhesive composition containing a solvent on a base material, heating and drying the applied varnish of the first adhesive composition at 50°C to 150°C, and producing a first adhesive film having a solvent content percentage of 1.5% by mass or less based on the total amount of the first adhesive film, a step of
10 applying a varnish of a second adhesive composition containing a solvent on a base material, heating and drying the applied varnish of the second adhesive composition at 50°C to 150°C, and producing a second adhesive film having a solvent content percentage of 1.5% by mass or less based on the total amount of the second adhesive film, and a step of pasting together the first adhesive film and the second adhesive film.

15 [0056] The varnish of the first adhesive composition and the varnish of the second adhesive composition can be prepared by, for example, mixing and kneading components (a) to (e) and if necessary, component (d) and component (e) in a solvent.

[0057] Mixing and kneading can be carried out by using conventional
20 dispersing machines such as a stirrer, a grinding machine, a three-roll mill, and a ball mill, and appropriately combining these.

[0058] The solvent for producing the varnish of the first adhesive composition and the varnish of the second adhesive composition is not limited, as long as the solvent is capable of uniformly dissolving,
25 kneading, or dispersing the above-described various components, and conventionally known solvents can be used. Examples of such a

solvent include ketone-based solvents such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and cyclohexanone; dimethylformamide, dimethylacetamide, N-methylpyrrolidone, toluene, xylene, and the like. From the viewpoint that the drying speed is fast, and the price is cheap, it is preferable to use methyl ethyl ketone, cyclohexanone, or the like.

[0059] The base material film is not particularly limited, and examples 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, a methylpentene film, and the like.

[0060] Regarding the method of applying a varnish of a first adhesive composition and a varnish of a second adhesive composition on a base material film, any known method can be used, and examples include a knife coating method, a roll coating method, a spray coating method, a gravure coating method, a bar coating method, a curtain coating method, and the like. The conditions for heating and drying are not particularly limited as long as the conditions are conditions in which the solvent used is sufficiently volatilized; however, for example, heating and drying can be carried out by heating for 1 to 30 minutes at 50°C to 150°C. Heating and drying may also be carried out by raising the temperature stepwise to a temperature in the range of 50°C to 150°C. By adjusting the heating temperature to 50°C or higher, there is a tendency that it is easier to adjust the solvent content percentage of the first adhesive film 2 and the second adhesive film 4 (film-form adhesive 10) to 1.5% by mass or less based on the total amount of the film-form adhesive. On the other hand, when the heating temperature is adjusted

to 150°C or lower, there is a tendency that the progress of curing of the adhesive composition can be suppressed.

5 [0061] The film-form adhesive 10 can be produced by pasting together the first adhesive film 2 and the second adhesive film 4 using a roll laminator, a vacuum laminator, or the like under predetermined conditions (for example, room temperature (20°C) or a heated state).

10 [0062] The film-form adhesive 10 can also be produced by first applying a varnish of a first adhesive composition on a base material film, removing the solvent by heating and drying the solvent to produce a first adhesive film 2, subsequently applying a varnish of a second adhesive composition on the first adhesive film 2, removing the solvent by heating and drying the solvent, and thereby forming a second adhesive film.

[0063] [Adhesive sheet]

15 FIG. 2 is a schematic cross-sectional view illustrating an adhesive sheet according to an embodiment. The adhesive sheet 100 includes a base material film 20 and a film-form adhesive 10 composed of a first adhesive film 2 and a second adhesive film 4, provided on the base material film 20.

20 [0064] The base material film 20 may be a dicing tape. Such an adhesive sheet can be used as a dicing-die bonding integrated type adhesive sheet. In this case, since the lamination step on a semiconductor wafer is carried out once, the operation can be made more efficient.

25 [0065] 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, and the like. Furthermore, if necessary, the dicing tape may be subjected to a surface treatment such as primer application, a UV treatment, a corona discharge treatment, a polishing treatment, or an etching treatment. It is preferable that the dicing tape has tacky adhesiveness. Such a dicing tape may be a product obtained by imparting tacky adhesiveness to the above-mentioned plastic film, or may be a product in which a tacky adhesive layer is provided on one surface of the above-mentioned plastic film.

[0066] Regarding the adhesive sheet 100, first, a first adhesive film 2 is produced by preparing a varnish of a first adhesive composition, applying this on a base material film, and removing the solvent by heating and drying the solvent. Next, separately a second adhesive film 4 is produced from a varnish of a second adhesive composition, this is laminated on the first adhesive film 2, and thereby the adhesive sheet can be produced.

[0067] FIG. 3 is a schematic cross-sectional view illustrating an adhesive sheet according to another embodiment. An adhesive sheet 110 further includes a protective film 30 laminated on the surface of the film-form adhesive 10 on the opposite side of the base material film 20 (surface on the second adhesive film 4 side). The protective film 30 may be a film similar to the above-mentioned base material film 20. The thickness of the protective film may be, for example, 60 to 200 μm or 70 to 170 μm .

[0068] [Semiconductor device]

FIG. 4 is a schematic cross-sectional view illustrating a

semiconductor device according to an embodiment. The semiconductor device 200 is a semiconductor device in which a first semiconductor element Wa of a first stage is connected by wire bonding onto a substrate 14 by means of a first wire 88, a second semiconductor element Waa is also compression-bonded onto the first semiconductor element Wa by means of a film-form adhesive 10, and thereby at least a portion of the first wire 88 is embedded in the film-form adhesive 10. The semiconductor device may be a wire-embedded type semiconductor device in which at least a portion of the first wire 88 is embedded, or may be a semiconductor device in which the first wire 88 and the first semiconductor element Wa are embedded. Furthermore, in the semiconductor device 200, the substrate 14 and the second semiconductor element Waa are further electrically connected by means of a second wire 98, and also, the second semiconductor element Waa is sealed by a sealing material 42.

[0069] The thickness of the first semiconductor element Wa may be 10 to 170 μm , and the thickness of the second semiconductor element Waa may be 20 to 400 μm . The first semiconductor element Wa embedded inside the film-form adhesive 10 is a controller chip for driving the semiconductor device 200.

[0070] The substrate 14 is formed from an organic substrate 90 having circuit patterns 84 and 94 respectively formed at two sites each on the surface. The first semiconductor element Wa is compression-bonded onto a circuit pattern 94 by means of an adhesive 41. The second semiconductor element Waa is compression-bonded onto the substrate 14 by means of the film-form adhesive 10 such that a circuit pattern 94

onto which the first semiconductor element Wa is not compression-bonded, the first semiconductor element Wa, and a portion of the circuit pattern 84 are covered. At the level difference of the surface unevenness attributed to the circuit patterns 84 and 94 on the substrate 14, the film-form adhesive 10 is embedded. Further, the second semiconductor element Waa, the circuit pattern 84, and the second wire 98 are sealed by a sealing material 42 made of a resin.

[0071] [Method for producing semiconductor device]

The method for producing a semiconductor device according to the present embodiment includes a first wire bonding step of electrically connecting a first semiconductor element onto a substrate by means of a first wire, a lamination step of sticking the above-mentioned film-form adhesive on one side of a second semiconductor element, and a die bonding step of subjecting the second semiconductor element to which the film-form adhesive is stuck, to compression-bonding by means of a film-form adhesive, and thereby embedding at least a portion of the first wire in the film-form adhesive.

[0072] FIGS. 5 to 9 are schematic cross-sectional views illustrating a series of steps of the method for producing a semiconductor device according to an embodiment. The semiconductor device 200 according to the present embodiment is a semiconductor device in which a first wire 88 and a first semiconductor element Wa are embedded, and the semiconductor device 200 is produced by the following procedure. First, as shown in FIG. 5, the first semiconductor element Wa having an adhesive 41 is compression-bonded onto a circuit pattern 94 on a substrate 14, and the circuit pattern 84 on the substrate

14 and the first semiconductor element Wa are electrically connected by bonding by means of the first wire 88 (first wire bonding step).

5 [0073] Next, the adhesive sheet 100 is laminated on one side of a semiconductor wafer (for example, thickness: 50 μm , size: 8 inches), the base material film 20 is peeled off, and thereby the film-form adhesive 10 (for example, thickness: 135 μm) is stuck on one side of the semiconductor wafer. Then, a dicing tape is pasted together with the film-form adhesive 10, subsequently the assembly is diced into a predetermined size (for example, 7.5 mm on each side), and thereby, as shown in FIG. 6, a second semiconductor element Waa having the film-form adhesive 10 stuck thereto is obtained (lamination step).

10 [0074] The temperature conditions for the lamination step may be 50°C to 100°C or 60°C to 80°C. When the temperature of the lamination step is 50°C or higher, satisfactory adhesiveness to the semiconductor wafer can be obtained. When the temperature of the lamination step is 15 100°C or lower, since the film-form adhesive 10 excessively flowing during the lamination step is suppressed, the occurrence of a change in the thickness and the like can be prevented.

20 [0075] Regarding the dicing method, for example, blade dicing of using a rotating blade, a method of cutting the film-form adhesive or both the wafer and the film-form adhesive using a laser, and the like may be mentioned.

25 [0076] Then, the second semiconductor element Waa having the film-form adhesive 10 stuck thereto is compression-bonded onto the substrate 14, onto which the first semiconductor element Wa is connected by bonding by means of the first wire 88. Specifically, as

shown in FIG. 7, the second semiconductor element Waa having the film-form adhesive 10 stuck thereto is placed such that the first wire 88 and the first semiconductor element Wa are covered by the film-form adhesive 10, and subsequently, as shown in FIG. 8, the second semiconductor element Waa is compression-bonded onto the substrate 14. Thereby, the second semiconductor element Waa is fixed to the substrate 14 (die bonding step). In the die bonding step, it is preferable that the film-form adhesive 10 is compression-bonded for 0.5 to 3.0 seconds under the conditions of 80°C to 180°C and 0.01 to 0.50 MPa. After the die bonding step, the film-form adhesive 10 is pressed and heated for 5 minutes or longer under the conditions of 60°C to 175°C and 0.3 to 0.7 MPa.

[0077] Next, as shown in FIG. 9, the substrate 14 and the second semiconductor element Waa are electrically connected by means of a second wire 98 (second wire bonding step), and then the circuit pattern 84, the second wire 98, and the second semiconductor element Waa are sealed with a sealing material 42. By going through such steps, the semiconductor device 200 can be produced.

[0078] A semiconductor device as another embodiment may also be a wire-embedded type semiconductor device in which at least a portion of the first wire 88 is embedded.

Examples

[0079] Hereinafter, the present invention will be more specifically described by way of Examples. However, the present invention is not intended to be limited to these Examples.

[0080] <Preparation of varnish of adhesive composition>

(Synthesis Examples 1 to 3)

Cyclohexanone was added to a composition composed of (a) an epoxy resin and a phenolic resin as thermosetting resins, and (c) an inorganic filler at the product names and composition ratios (unit: parts by mass) shown in Table 1, and the mixture was stirred and mixed. To this, (b) an acrylic rubber as a high-molecular weight component as shown in Table 1 was added, and the mixture was stirred. Furthermore, (d) a coupling agent and (e) a curing accelerator shown in Table 1 were added thereto, the mixture was stirred until the various components became uniform, and thus varnishes of adhesive compositions of Synthesis Examples 1 to 3 were prepared.

[0081] Meanwhile, the notations of the various components in Table 1 mean the following.

[0082] (Epoxy resin)

YDCN-700-10 (trade name, manufactured by Nippon Steel & Sumikin Chemical Co., Ltd., o-cresol novolac type epoxy resin, epoxy equivalent: 209 g/eq)

EXA-830CRP (trade name, manufactured by DIC Corporation, bisphenol F type epoxy resin, epoxy equivalent: 159 g/eq)

JER YL-980 (trade name, manufactured by Mitsubishi Chemical Corporation, bisphenol A type epoxy resin, epoxy equivalent: 185 g/eq)

[0083] (Phenolic resin)

HE-100C-30 (trade name, manufactured by AIR WATER INC., phenolic aralkyl resin, hydroxyl group equivalent: 175 g/eq, softening point 77°C)

MEH-7800H (trade name, manufactured by Meiwa Plastic

Industries, Ltd., phenolic aralkyl resin, hydroxyl group equivalent: 178 g/eq, softening point 87°C)

[0084] (High-molecular weight component)

5 HTR-860P-3CSP (trade name, manufactured by Nagase ChemteX Corporation, acrylic rubber, weight average molecular weight: 800,000, Tg: 12°C)

SG-70L (trade name, manufactured by Nagase ChemteX Corporation, acrylic rubber, weight average molecular weight: 900,000, Tg: -13°C)

10 [0085] (Inorganic filler)

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

15 SE2050-MC (trade name, manufactured by Admatechs Company Limited, silica filler dispersion liquid, average particle size: 0.50 μm)

[0086] (Coupling agent)

A-1160 (trade name, manufactured by Momentive Performance Materials Japan LLC, γ-ureidopropyltriethoxysilane)

20 A-189 (trade name, manufactured by Momentive Performance Materials Japan LLC, γ-mercaptopropyltrimethoxysilane)

[0087] (Curing accelerator)

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

25 TPP-K (trade name, manufactured by HOKKO CHEMICAL INDUSTRY CO., LTD., tetraphenylphosphonium tetraphenyl borate)

[0088] Table 1

Item	Name	Synthesis Example 1	Synthesis Example 2	Synthesis Example 3
Epoxy resin	YDCN-700-10	15	10	30
	EXA-830	10	10	-
	JER YL-980	-	-	25
Phenolic resin	HE-100C-30	25	20	-
	MEH-7800H	-	-	20
High-molecular weight component	HTR-860P-3CSP	20	20	-
	SG-70L	-	-	10
Inorganic filler	SC2050-HLG	30	40	-
	SE2050-MC	-	-	25
Coupling agent	A-1160	0.4	0.4	0.4
	A-189	0.4	0.4	0.4
Curing accelerator	2PZ-CN	0.1	0.1	-
	TPP-K	-	-	0.1

[0089] <Production of adhesive sheet>

(Example 1)

A varnish of the adhesive composition of Synthesis Example 1 was filtered through a 100-mesh filter and was subjected to vacuum degassing. As a base material film, a polyethylene terephthalate (PET) film having a thickness of 38 μm that had been subjected to a mold release treatment was prepared, and the varnish of the adhesive composition after vacuum degassing was applied on the PET film. The varnish thus applied was dried by heating in two stages for 5 minutes at 90°C and subsequently for 5 minutes at 140°C. In this way, an adhesive sheet including a film-form adhesive, which had a thickness of 60 μm and was in a stage B state, on a PET film was obtained. Next, two sheets of the adhesive sheet were prepared and were disposed such that the adhesive films were in contact with each other, and the adhesive sheets were laminated on a hot plate at 70°C. Thus, an adhesive sheet including a film-form adhesive having a thickness of 120 μm , the film-form adhesive being formed from two layers of adhesive films, was produced.

[0090] (Example 2)

An adhesive sheet including a film-form adhesive having a thickness of 120 μm and formed from two layers of adhesive films was produced in the same manner as in Example 1, except that the varnish of the adhesive composition of Synthesis Example 1 was changed to the varnish of the adhesive composition of Synthesis Example 2.

[0091] (Example 3)

An adhesive sheet including a film-form adhesive having a

thickness of 120 μm and formed from two layers of adhesive films was produced in the same manner as in Example 1, except that the varnish of the adhesive composition of Synthesis Example 1 was changed to a varnish of the adhesive composition of Synthesis Example 3.

5 [0092] (Comparative Example 1)

The varnish of the adhesive composition of Synthesis Example 1 was filtered through a 100-mesh filter and was subjected to vacuum degassing. As a base material film, a polyethylene terephthalate (PET) film having a thickness of 38 μm that had been subjected to a mold
10 release treatment was prepared, and the varnish of the adhesive composition after vacuum degassing was applied on the PET film. The varnish thus applied was dried by heating in two stages for 10 minutes at 90°C and subsequently for 10 minutes at 150°C. In this way, an adhesive sheet including a single-layered film-form adhesive,
15 which had a thickness of 120 μm and was in a stage B state, on a PET film was produced.

[0093] (Comparative Example 2)

An adhesive sheet including a single-layered film-form adhesive, which had a thickness of 120 μm and was in a stage B state,
20 on a PET film was produced in the same manner as in Comparative Example 1, except that the drying by heating in two stages for 10 minutes at 90°C and for 10 minutes at 150°C, was changed to drying by heating in two stages for 20 minutes at 120°C and for 20 minutes at 160°C.

25 [0094] (Comparative Example 3)

An adhesive sheet including a single-layered film-form

adhesive, which had a thickness of 120 μm and was in a stage B state, on a PET film was produced in the same manner as in Comparative Example 2, except that the varnish of the adhesive composition of Synthesis Example 1 was changed to a varnish of the adhesive composition of Synthesis Example 2.

[0095] (Comparative Example 4)

An adhesive sheet including a single-layered film-form adhesive, which had a thickness of 120 μm and was in a stage B state, on a PET film was produced in the same manner as in Comparative Example 2, except that the varnish of the adhesive composition of Synthesis Example 1 was changed to a varnish of the adhesive composition of Synthesis Example 3.

[0096] <Evaluation of various physical properties>

For the film-form adhesives of the adhesive sheets of Examples 1 to 3 and Comparative Examples 1 to 4, measurement of the solvent content percentage, the shear viscosity at 80°C, the storage modulus at 80°C, the embedding properties after curing in a pressurized oven at 175°C, and the amount of bleeding was carried out.

[0097] (Solvent content percentage)

The base material film was removed by peeling off the film from each of the above-described adhesive sheets. 1 g of the film-form adhesive was added to 30 g of a 1,4-dioxane solution including 1% by mass of 2-(2-ethoxyethoxy)ethanol, and the mixture was stirred for 6 hours in a shaker. The solution after stirring was measured by gas chromatography (carrier gas: helium, column temperature: 140°C), and the solvent content percentage (% by mass) of

the film-form adhesive was estimated from the respective peak areas of the solvent and 2-(2-ethoxyethoxy)ethanol. The results are presented in Table 2.

[0098] (Shear viscosity at 80°C)

5 The base material film was removed by peeling off the film from each of the above-described adhesive sheets, and a square-shaped laminate that measured 10 mm on each side was obtained by punching the adhesive sheet in the thickness direction into a size of 10 mm on each side. A circular aluminum plate jig having a diameter of 8 mm
10 was set up in a dynamic viscoelasticity apparatus, ARES (manufactured by Rheometric Scientific, Inc.), and the square laminate of the punched film-form adhesive was mounted here. Subsequently, the temperature was raised to 80°C at a rate of temperature increase of 5°C/min while a strain of 5% was applied at 35°C, and the shear viscosity (Pa·s) at 80°C
15 was measured. The results are presented in Table 2.

[0099] (Storage modulus at 80°C)

 The base material film was removed by peeling off the film from each of the above-described adhesive sheets, and the adhesive sheet was cut into a size of 4 cm in length and 4 mm in width. The
20 sample was mounted in a dynamic viscoelasticity apparatus (product name: RHEOGEL-E4000, manufactured by UBM), a tensile load was applied thereto, the temperature was raised to 80°C at a rate of temperature increase of 3°C/min and a frequency of 10 Hz, and the storage modulus at 80°C was measured. The results are presented in
25 Table 2.

[0100] (Embedding properties after curing in pressurized oven at

175°C)

The film-form adhesive of the above-described adhesive sheets was stuck to a semiconductor wafer (8 inches) having a thickness of 50 μm at 70°C. Next, those were diced into a size of 7.5 mm on each side, and thereby semiconductor elements were obtained. Furthermore, a film-form adhesive, HR-9004T-10 (manufactured by Hitachi Chemical Company, Ltd., thickness 20 μm), was stuck to a semiconductor wafer (8 inches) having a thickness of 50 μm at 70°C. Next, those were diced into a size of 3.0 mm on each side, and thereby chips were obtained. The individualized HR-9004T-10-attached chips were compression-bonded to a substrate for evaluation having a surface unevenness of 6 μm at the maximum under the conditions of 130°C, 0.20 MPa, and 2 seconds, and were heated for 2 hours at 120°C to be semi-cured. Next, the film-form adhesive-attached, 7.5-mm semiconductor elements were compression-bonded to the samples obtained as such, under the conditions of 120°C, 0.20 MPa, and 2 seconds. At this time, alignment was implemented such that the HR-9004T-10-attached chip that had been previously compression-bonded would come to the center. The samples thus obtained were introduced into a pressurized oven, the temperature was raised to 175°C at a rate of temperature increase of 3°C/min at 35°C, and the chips were heated for 30 minutes at 175°C. In the samples obtained in this manner, the presence or absence of voids was observed with an ultrasonic imaging apparatus, SAT (manufactured by Hitachi Construction Machinery Co., Ltd., product No. FS200II, probe: 25 MHz). In a case in which voids were observed, the area of voids per

unit area was calculated, and these analysis results were evaluated as the embedding properties. The evaluation criteria are as follows. The results are presented in Table 2.

A: Voids were not observed.

5 B: Voids were observed; however, the proportion thereof was less than 5% by area.

C: Voids were observed, and the proportion thereof was 5% by area or more.

[0101] (Measurement of amount of bleeding)

10 For samples that were rated as "A" and "B" in the evaluation of the embedding properties after curing in a pressurized oven at 175°C, the amount of bleeding was measured. The samples were produced by a procedure similar to that for the samples produced for the embedding properties after curing in a pressurized oven at 175°C. The amounts of
15 protrusion of the film-form adhesive were respectively measured at the centers of the four edges of each of the obtained samples, and the average value was designated as the amount of bleeding. The results are presented in Table 2.

[0102] Table 2

	Exam. 1	Exam. 2	Exam. 3	Comp. Exam. 1	Comp. Exam. 2	Comp. Exam. 3	Comp. Exam. 4
Solvent content percentage (mass%)	0.4	0.5	0.5	6.5	0.7	0.8	0.8
Shear viscosity at 80°C (Pa·s)	1,400	3,000	1,200	640	6,000	8,600	8,200
Storage modulus at 80°C (MPa)	0.1	0.2	0.07	0.01	500	650	620
Embedding properties (after curing at 170°C)	A	B	A	A	C	C	C
Amount of bleeding (μm)	150	70	250	400	-	-	-

[0103] From Table 1, it was found that in the adhesive sheets of Examples 1 to 3 formed from two layers of adhesive films, the embedding properties were satisfactory, and bleeding was suppressed. On the other hand, in the adhesive sheet of Comparative Example 1 that used a single-layered adhesive film having a solvent content percentage of more than 1.5% by mass, the embedding properties were satisfactory; however, bleeding could not be suppressed. Furthermore, in the adhesive sheet that used a single-layered adhesive film having a shear viscosity at 80°C of higher than 5,000 Pa·s, the embedding properties were not sufficient. From these results, it was verified that the film-form adhesive of the present invention has satisfactory embedding properties at the time of thermocompression bonding and is capable of suppressing bleeding.

Reference Signs List

[0104] 2: first adhesive film, 4: second adhesive film, 10: film-form adhesive, 14: substrate, 20: base material film, 30: protective film, 41: adhesive, 42: sealing material, 84, 94: circuit pattern, 88: first wire, 90: organic substrate, 98: second wire, 100, 110: adhesive sheet, 200: semiconductor device, Wa: first semiconductor element, Waa: second semiconductor element.

CLAIMS

1. A film-form adhesive, used in a semiconductor device in which a first semiconductor element is connected by wire bonding onto a substrate by means of a first wire, and a second semiconductor element is also compression-bonded onto the first semiconductor element, in order to compression-bond the second semiconductor element and also to embed at least a portion of the first wire,

wherein the film-form adhesive comprises a first adhesive film and a second adhesive film laminated on the first adhesive film,

- the solvent content percentage of the film-form adhesive is 1.5% by mass or less based on the total amount of the film-form adhesive, and the shear viscosity at 80°C of the film-form adhesive is 5,000 Pa·s or less.

2. The film-form adhesive according to claim 1, wherein a thickness of the film-form adhesive is 3 to 150 μm .

3. The film-form adhesive according to claim 1 or 2, wherein a storage modulus at 80°C of the film-form adhesive is 10 MPa or lower.

4. A method for producing the film-form adhesive according to any one of claims 1 to 3, the method comprising:

- applying a varnish of a first adhesive composition containing a solvent on a base material, heating and drying the applied varnish of the first adhesive composition at 50°C to 150°C, and producing a first adhesive film having a solvent content percentage of 1.5% by mass or less based on the total amount of the first adhesive film;

- applying a varnish of a second adhesive composition containing a solvent on a base material, heating and drying the applied varnish of

the second adhesive composition at 50°C to 150°C, and producing a second adhesive film having a solvent content percentage of 1.5% by mass or less based on the total amount of the second adhesive film; and

5 pasting the first adhesive film and the second adhesive film together.

5. A semiconductor device, wherein a first semiconductor element is connected by wire bonding onto a substrate by means of a first wire, a second semiconductor element is also compression-bonded onto the first semiconductor element by means of the film-form adhesive according to any one of claims 1 to 3, and thereby at least a portion of the first wire is embedded in the film-form adhesive.

6. A method for producing a semiconductor device, the method comprising:

15 a wire bonding step of electrically connecting a first semiconductor element onto a substrate by means of a first wire;

 a lamination step of sticking the film-form adhesive according to any one of claims 1 to 3 on one side of a second semiconductor element; and

20 a die bonding step of subjecting the second semiconductor element having the film-form adhesive stuck thereto, to compression-bonding by means of the film-form adhesive, and thereby embedding at least a portion of the first wire in the film-form adhesive.