

DESCRIPTION

Title of Invention

5 SEMICONDUCTOR DEVICE PRODUCTION METHOD AND
FILM-SHAPED ADHESIVE

Technical Field

[0001] The present invention relates to a semiconductor device production method and a film-shaped adhesive.

Background Art

10 [0002] An adhesive sheet that enables a wire-embedded semiconductor device in which irregularities caused by a substrate wiring in a semiconductor device and wires attached to a semiconductor chip and the like are able to be filled in to be obtained is known (for example, Patent Literatures 1 and 2). The adhesive sheet contains a
15 thermosetting component as a main component so that high fluidity is exhibited during filling in of irregularities.

[0003] In recent years, increasing the speed of operations of such a wire-embedded semiconductor device has been considered to be important. Conventionally, a controller chip that controls operations of
20 a semiconductor device is disposed as the uppermost stage of laminated semiconductor elements, but in order to realize high-speed operations, a package technology for a semiconductor device in which a controller chip is disposed as the lowermost part has been developed. As one form of such a package, among semiconductor elements laminated in
25 multiple stages, a package in which a film-shaped adhesive used when the second semiconductor element is press-bonded is thickened and a

controller chip is embedded in the film-shaped adhesive is being focused on. The film-shaped adhesive used for such an application requires high fluidity so that a controller chip, a wire connected to the controller chip, level differences caused by irregularities on the surface of a substrate, and the like can be embedded.

Citation List

Patent Literature

[0004] [Patent Literature 1] PCT International Publication No. WO2005/103180

[Patent Literature 2] Japanese Unexamined Patent Publication No. 2009-120830

Summary of Invention

Technical Problem

[0005] However, when an adhesive sheet simply having high fluidity before curing like the adhesive sheets described in Patent Literature 1 and 2 is used in order to secure embedding properties, there is a risk of the occurrence of a phenomenon in which a part of an adhesive sheet bleeds out from the end of a press-bonded surface of the semiconductor element during press-bonding. When bleeding occurs, there is a problem of the semiconductor element itself and peripheral circuits being contaminated.

[0006] Therefore, an object of the present invention is to provide a semiconductor device production method through which it is possible to obtain a semiconductor device having excellent connection reliability while minimizing bleeding during press-bonding. Another object of

the present invention is to provide a film-shaped adhesive used in the production method.

Solution to Problem

5 [0007] The present invention provides a semiconductor device production method, including: a first die bonding step in which a first semiconductor element is electrically connected to a substrate with a first wire therebetween; a lamination step in which a film-shaped adhesive having a shear stress relaxation rate of 40 to 85% at 100°C after 0.1 seconds is attached to one surface of a second semiconductor
10 element having a larger area than the first semiconductor element; and a second die bonding step in which the second semiconductor element to which the film-shaped adhesive is attached is disposed so that the film-shaped adhesive covers the first semiconductor element, the film-shaped adhesive is press-bonded and thus the first wire and the first
15 semiconductor element are embedded in the film-shaped adhesive.

[0008] According to the present invention, it is possible to obtain a semiconductor device having excellent connection reliability while minimizing bleeding during press-bonding. More specifically, when a film-shaped adhesive having a shear stress relaxation rate of 40% or
20 more at 100°C after 0.1 seconds is used, it is possible to conform to the shape of a wire, a semiconductor element, and the like, and it is possible to secure embedding properties. In addition, when a film-shaped adhesive having a shear stress relaxation rate of 85% or less is used, the shape of the film can be maintained during press-bonding and it is
25 possible to minimize bleeding.

[0009] In the present invention, the shear stress relaxation rate at 100°C

after 0.1 seconds is obtained by normalizing the shear stress measured after 0.1 seconds after a film-shaped adhesive has been heated up from room temperature to 100°C and then a strain of 10% has been applied to it, by an initial stress. The rate of temperature increase depends on specifications of a measuring device to be used, and can be appropriately set in a range of 10 to 60°C/min. In order to measure the shear stress relaxation rate, a dynamic viscoelasticity measuring device can be used. Here, the shear stress relaxation rate of X% means that a stress of X% is relaxed with the passage of time when the initial stress (stress immediately after the strain is applied) is set as 100%. Therefore, 100-shear stress relaxation rate (%)=shear stress residual rate (%).

[0010] In the present invention, preferably, the film-shaped adhesive has a shear viscosity at 120°C of 5,000 Pa·s or less. Accordingly, favorable embedding properties are easily obtained.

[0011] In the present invention, preferably, the film-shaped adhesive includes an acrylic resin and an epoxy resin. When a thermoplastic component and a thermosetting component are used in combination, favorable embedding properties and thermosetting properties are easily obtained.

[0012] In the present invention, preferably, the film-shaped adhesive includes at least one of an inorganic filler and an organic filler. Accordingly, handling properties of the film-shaped adhesive and the like are improved.

[0013] In addition, the present invention provides a film-shaped adhesive which is used for press-bonding a second semiconductor

element and embedding a first wire and a first semiconductor element and which has a shear stress relaxation rate of 40 to 85% at 100°C after 0.1 seconds in a semiconductor device in which the first semiconductor element is electrically connected to a substrate with the first wire therebetween and the second semiconductor element having a larger area than the first semiconductor element is press-bonded to the first semiconductor element. When the film-shaped adhesive of the present invention is used, it is possible to obtain a semiconductor device having excellent connection reliability while minimizing bleeding during press-bonding.

[0014] In this film-shaped adhesive of the present invention, preferably, a shear viscosity at 120°C is 5,000 Pa·s or less.

[0015] Preferably, this film-shaped adhesive of the present invention includes an acrylic resin and an epoxy resin.

[0016] Preferably, this film-shaped adhesive of the present invention includes at least one of an inorganic filler and an organic filler.

Advantageous Effects of Invention

[0017] According to the present invention, it is possible to provide a semiconductor device production method through which it is possible to obtain a semiconductor device having excellent connection reliability while minimizing bleeding during press-bonding. In addition, according to the present invention, it is possible to provide a film-shaped adhesive used in the production method.

Brief Description of Drawings

[0018] FIG. 1 is a diagram showing a film-shaped adhesive according to an embodiment of the present invention.

FIG. 2 is a diagram showing an adhesive sheet.

FIG. 3 is a diagram showing another adhesive sheet.

FIG. 4 is a diagram showing another adhesive sheet.

FIG. 5 is a diagram showing another adhesive sheet.

5 FIG. 6 is a diagram showing a semiconductor device.

FIG. 7 is a diagram showing a semiconductor device production method according to an embodiment of the present invention.

FIG. 8 is a diagram showing a step subsequent to that of FIG. 7.

FIG. 9 is a diagram showing a step subsequent to that of FIG. 8.

10 FIG. 10 is a diagram showing a step subsequent to that of FIG. 9.

FIG. 11 is a diagram showing a step subsequent to that of FIG. 10.

Description of Embodiments

15 [0019] Preferable embodiments of the present invention will be described below in detail with reference to the drawings. In the following description, the same or corresponding components will be denoted with the same reference numerals and redundant description thereof will be omitted. In addition, positional relationships such as

20 above, below, left, and right are based on the positional relationships shown in the drawings unless otherwise specified. In addition, dimensional ratios in the drawings are not limited to the illustrated ratios. Here, in this specification, the term “(meth)acryl” include “acryl” and a corresponding “methacryl.”

25 [0020] (Film-shaped adhesive)

FIG. 1 is a cross-sectional view schematically showing a

film-shaped adhesive 10 according to the present embodiment. The film-shaped adhesive 10 is thermosetting and is obtained by molding an adhesive composition into a film, which can be in a semi-cured (B stage) state and can be in a completely cured product (C stage) state after a curing treatment.

[0021] The film-shaped adhesive 10 has a shear stress relaxation rate of 40 to 85% at 100°C after 0.1 seconds. In order to more easily obtain a semiconductor device having excellent connection reliability while minimizing bleeding, the shear stress relaxation rate is preferably 50 to 80%, and more preferably 60 to 70%. Here, as will be described below, the shear stress relaxation rate can be adjusted by adjusting the types and amounts of components (a) to (f).

[0022] The film-shaped adhesive 10 preferably has a shear viscosity at 120°C of 5,000 Pa·s or less. In order to more easily obtain favorable embedding properties, the shear viscosity is more preferably 3,000 Pa·s or less. The lower limit of the shear viscosity is not particularly limited, but can be 200 Pa·s in order to curb excessive fluidity. The shear viscosity can be measured using, for example, a dynamic viscoelasticity measuring device.

[0023] Components contained in the film-shaped adhesive 10 are not particularly limited, and examples thereof may include (a) a thermosetting component, (b) a thermoplastic component, (c) an inorganic filler, (d) an organic filler, (e) a curing promoting agent, and (f) other components. Properties of the film-shaped adhesive 10 can be adjusted by adjusting the types and amounts of these components (a) to (f).

[0024] (a) Thermosetting component

Examples of thermosetting components include a thermosetting resin. In particular, in consideration of heat resistance and humidity resistance required when a semiconductor element is mounted, an epoxy resin, a phenolic resin or the like is preferable as the thermosetting component.

[0025] For example, regarding the epoxy resin, generally known epoxy resins such as an aromatic ring-containing epoxy resin, a heterocycle-containing epoxy resin, and an alicyclic epoxy resin can be used. In addition, the epoxy resin may be a multifunctional epoxy resin. Regarding the epoxy resin, specifically, for example, a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, a bisphenol E type epoxy resin, a bifunctional epoxy resin obtained by modifying these bisphenol type epoxy resins, a cresol novolak type epoxy resin, a bisphenol A novolak type epoxy resin, a fluorene-modified epoxy resin, a triphenylmethane type epoxy resin, a biphenyl type epoxy resin, a glycidylamine type epoxy resin, a naphthalene-modified epoxy resin, or the like can be used.

[0026] Examples of epoxy resins include Celloxide series (commercially available from Daicel Corporation), YDF series and YDCN series (commercially available from NSCC Epoxy Manufacturing Co., Ltd.), HP-7000L (commercially available from DIC), and VG-3101L (commercially available from Printec Corporation).

[0027] In addition, examples of phenolic resins include a novolak type phenolic resin, a zylock type phenolic resin, a biphenyl type phenolic

resin, a triphenylmethane type phenolic resin, and a modified phenolic resin in which a hydrogen atom on a phenol ring is substituted with an aryl group. Here, regarding the phenolic resin, in consideration of heat resistance, a phenolic resin which has a water absorption rate of 2 mass% or less after being put into a temperature and humidity testing chamber at 85°C and an RH of 85% for 48 hours and a heating mass reduction rate (rate of temperature increase: 5°C/min, atmosphere: nitrogen) at 350°C measured using a thermogravimetric analyzer (TGA) that is less than 5 mass% is preferable.

[0028] Examples of phenolic resins include HE series (commercially available from Air Water Inc.,) and Resitop series (commercially available from Gun Ei Chemical Industry Co., Ltd.).

[0029] When an epoxy resin and a phenolic resin are used in combination as the thermosetting component (a), the mixing ratio of the epoxy resin and the phenolic resin is preferably 0.70/0.30 to 0.30/0.70 in terms of the equivalent ratio between an epoxy equivalent and a hydroxyl equivalent, and more preferably 0.65/0.35 to 0.35/0.65, still more preferably 0.60/0.40 to 0.40/0.60, and particularly preferably 0.60/0.40 to 0.50/0.50. When the mixing ratio is within the above range, the film-shaped adhesive 10 having excellent curability, fluidity, and the like is easily obtained.

[0030] Here, in order to minimize warping of the semiconductor device after curing, it is preferable to combine thermosetting resins with different curing rates. Specifically, among the epoxy resins and phenolic resins exemplified above, for example, a combination of (a1) a resin having a softening point of 60°C or lower or being a liquid at room

temperature (not particularly limited as long as it has an adhesive action according to curing) and (a2) a resin having a softening point of higher than 60°C (solid at room temperature) is preferably used. In addition, the term “room temperature” here means 5 to 35°C.

5 [0031] The content of the component (a1) is preferably 10 to 50 mass% and more preferably 20 to 40 mass% with respect to the total mass of the component (a). Accordingly, it is easy to achieve both embedding properties and process suitability such as for dicing and pickup.

[0032] The content of the component (a2) is preferably 10 mass% or
10 more and more preferably 15 mass% or more with respect to the total mass of the component (a). Accordingly, it is easy to adjust film-forming properties, fluidity, stress relaxation properties, and the like. Here, the upper limit of the content of the component (a2) is not particularly limited, but can be 90 mass% with respect to the total mass
15 of the component (a).

[0033] Here, when an alicyclic epoxy resin is used as the component (a), the shear stress relaxation rate is easily adjusted to a desired range. When an alicyclic epoxy resin is used, the content thereof can be 30 to 100 mass% with respect to the total mass of the component (a) as a
20 guideline (that is, the entire component (a) may be an alicyclic epoxy resin).

[0034] The weight average molecular weight of the component (a) is preferably 200 to 5,000. Accordingly, the shear stress relaxation rate can be easily adjusted to a desired range.

25 [0035] (b) Thermoplastic component

Regarding the thermoplastic component (b), it is preferable to

use a thermoplastic component having a high proportion of monomers with crosslinkable functional groups and a low molecular weight and a thermoplastic component having a low proportion of monomers with crosslinkable functional groups and a high molecular weight in combination. In particular, the latter thermoplastic component is preferably contained in a certain amount or more.

[0036] The component (b) is preferably an acrylic resin (acrylic resin) which is a thermoplastic resin and more preferably an acrylic resin having a glass transition temperature T_g of -50°C to 50°C such as an epoxy group-containing (meth)acrylic copolymer obtained by polymerizing functional monomers having an epoxy group or a glycidyl group such as glycidyl acrylate, and glycidyl methacrylate as a crosslinkable functional group.

[0037] Regarding such an acrylic resin, an epoxy group-containing (meth)acrylic acid ester copolymer, an epoxy group-containing acrylic rubber or the like can be used, and an epoxy group-containing acrylic rubber is more preferable. The epoxy group-containing acrylic rubber is an acrylic rubber having an epoxy group which includes an acrylic ester as a main component, and is mainly composed of a copolymer of butyl acrylate, acrylonitrile, and the like or a copolymer of ethyl acrylate, acrylonitrile, and the like.

[0038] Here, regarding the crosslinkable functional group of the component (b), in addition to an epoxy group, crosslinkable functional groups such as an alcoholic or phenolic hydroxyl group, and a carboxyl group may be exemplified.

[0039] In the component (b), in order to easily exhibit a high adhesive

strength and easily lower a tensile elastic modulus after heating at 150°C/1 hour, the amount of monomer units having a crosslinkable functional group is preferably 5 to 15 mol% and more preferably 5 to 10 mol% with respect to the total amount of monomer units.

5 [0040] The weight average molecular weight of the component (b) is preferably 200,000 to 1,000,000, and more preferably 500,000 to 1,000,000. Accordingly, the shear stress relaxation rate can be easily adjusted to a desired range. In addition, in particular, when the weight
10 average molecular weight of the component (b) is 500,000 or more, an effect of improving film-forming properties is further improved. When the weight average molecular weight of the component (b) is 1,000,000 or less, since the shear viscosity of the uncured film-shaped adhesive 10 is easily reduced, embedding properties become more
15 favorable. In addition, the machinability of the uncured film-shaped adhesive 10 may be improved and the quality of dicing may become more favorable.

[0041] The weight average molecular weight is a polystyrene conversion value obtained by a gel permeation chromatography method (GPC) using a calibration curve in terms of polystyrene standards.

20 [0042] The glass transition temperature T_g of the entire component (b) is preferably -20°C to 40°C and more preferably -10°C to 30°C. Accordingly, since the film-shaped adhesive 10 is easily cut during dicing, resin waste is less likely to be generated, the adhesive strength and heat resistance of the film-shaped adhesive 10 are easily improved,
25 and high fluidity of the uncured film-shaped adhesive 10 is easily exhibited.

[0043] The glass transition temperature T_g can be measured using a thermal differential scanning calorimeter (for example, “Thermo Plus 2” commercially available from Rigaku Corporation).

5 [0044] The content of the component (b) is preferably 20 to 160 parts by mass and more preferably 50 to 120 parts by mass with respect to 100 parts by mass of the component (a). When the content of the component (b) is the lower limit value or more, reduction in the flexibility of the film-shaped adhesive 10 is easily minimized and after curing, the elasticity becomes lower, and warping of the semiconductor device (package) is easily minimized. On the other hand, when the content of the component (b) is the upper limit value or less, the fluidity of the uncured film-shaped adhesive 10 increases and embedding properties can become more favorable. Here, when the content of the component (b) is within the above range, the shear stress relaxation rate is easily adjusted to a desired range.

15 [0045] (c) Inorganic filler

Regarding the component (c), in order to improve dicing properties of the film-shaped adhesive 10 in the B stage state, improve handling properties of the film-shaped adhesive 10, improve thermal conductivity, adjust the shear viscosity (melt viscosity), impart thixotropic properties, and improve the adhesive strength, a silica filler or the like is preferable.

20 [0046] The component (c) preferably contains two or more types of fillers having different average particle sizes in order to improve dicing properties of the uncured film-shaped adhesive 10, and for the sufficient adhesive strength after curing to be exhibited. The component (c)

preferably includes, for example, (c1) a first filler having an average particle size of 0.2 μm or more in order to improve dicing properties of the uncured film-shaped adhesive 10 and (c2) a second filler having an average particle size of less than 0.2 μm in order for sufficient adhesive strength after curing to be exhibited.

[0047] The average particle size is a value obtained when acetone is used as a solvent for analysis using a laser diffraction type particle size distribution measuring device. It is more preferable to have a large difference between average particle sizes of the first and second fillers to the extent that it is possible to determine that these respective fillers are contained through analysis using a particle size distribution measuring device.

[0048] The content of the component (c1) is preferably 30 mass% or more with respect to the total mass of the component (c). When the content of the component (c1) is 30 mass% or more, it is easy to minimize deterioration of breakability of the film and deterioration of fluidity of the uncured film-shaped adhesive 10. Here, the upper limit of the content of the component (c1) is not particularly limited, but can be 95 mass% with respect to the total mass of the component (c).

[0049] The content of the component (c2) is preferably 5 mass% or more with respect to the total mass of the component (c). When the content of the component (c2) is 5 mass% or more, the adhesive strength after curing is easily improved. Here, the upper limit of the content of the component (c2) can be 30 mass% with respect to the total mass of the component (c) in order to secure appropriate fluidity.

[0050] The content of the component (c) is preferably 10 to 90 parts by

mass and more preferably 40 to 70 parts by mass with respect to 100 parts by mass of the component (a). When the content of the component (c) is the lower limit value or more, deterioration of dicing properties of the uncured film-shaped adhesive 10 and reduction in the adhesive strength after curing tend to be easily minimized. On the other hand, when the content of the component (c) is the upper limit value or less, reduction in the fluidity of the uncured film-shaped adhesive 10 and increase in the elastic modulus after curing tend to be easily minimized. Here, when the content of the component (c) is within the above range, the shear stress relaxation rate is easily adjusted to a desired range.

[0051] (d) Organic filler

In consideration of improving dicing properties of the film-shaped adhesive 10, improving handling properties of the film-shaped adhesive 10, adjusting the shear viscosity (melt viscosity), and improving the adhesive strength, and stress relaxation properties after curing and the like, the component (d) is preferably a styrene-PMMA modified rubber filler, a silicone-modified rubber filler, or the like. The average particle size of the component (d) is preferably 0.2 μm or less in order to easily exhibit sufficient adhesive strength after curing.

[0052] The content of the component (d) is preferably 0 to 50 parts by mass and more preferably 0 to 30 parts by mass with respect to 100 parts by mass of the component (c). As necessary, when the component (d) contains a predetermined amount, the stress relaxation rate tends to be easily minimized while embedding properties are

improved.

[0053] (e) Curing promoting agent

5 In order to obtain favorable curability, a curing promoting agent (e) is preferably used. In consideration of reactivity, an imidazole compound is preferably used as the component (e). Here, when the reactivity of the component (e) is too high, not only does the shear viscosity easily increase due to heating in a step of producing the film-shaped adhesive 10 but also deterioration over time tends to easily occur. On the other hand, when the reactivity of the component (e) is 10 too low, the curability of the film-shaped adhesive 10 tends to easily decrease. When the film-shaped adhesive 10 that is not sufficiently cured is directly put into a product, sufficient adhesive properties are not obtained, and connection reliability of the semiconductor device may be deteriorated.

15 [0054] When the component (e) is contained, the curability of the film-shaped adhesive 10 is further improved. On the other hand, when the content of the component (e) is too large, not only does the shear viscosity easily increase due to heating in a step of producing the film-shaped adhesive 10 but also deterioration over time tends to easily occur. In this regard, the content of the component (e) is preferably 0 20 to 0.20 parts by mass with respect to 100 parts by mass of the component (a).

[0055] (f) Other components

25 In addition to the above components, in order to improve adhesive properties, appropriate amounts of other components that can be used in this technical field may be additionally added. Examples of

such a component include a coupling agent. Examples of coupling agents include γ -ureidopropyltriethoxysilane, γ -mercaptopropyltrimethoxysilane, 3-phenylaminopropyltrimethoxysilane, and 3-(2-aminoethyl)aminopropyltrimethoxysilane.

[0056] (Film-shaped adhesive)

The film-shaped adhesive 10 can be obtained according to, for example, a step of applying a varnish of an adhesive composition containing the above component to a base film to form a varnish layer, a step of removing a solvent from the varnish layer by heating and drying, and a step of removing the base film.

[0057] The varnish can be prepared by mixing and kneading an adhesive composition containing the above component in an organic solvent. Mixing and kneading can be performed using a dispersing machine such as a general stirrer, a Raikai mixer, a three-roller, and a ball mill. These instruments can be used in an appropriate combination. The varnish can be applied using, for example, a comma coater or a die coater. Varnish heating and drying conditions are not particularly limited as long as an organic solvent used is sufficiently volatilized, and examples of conditions include 60 to 200°C for 0.1 to 90 minutes.

[0058] The organic solvent is not particularly limited as long as the above component can be uniformly dissolved, kneaded or dispersed, and conventionally known organic solvents can be used. Examples of such a solvent include ketone solvents such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and cyclohexanone, and

dimethylformamide, dimethylacetamide, N-methylpyrrolidone, toluene, and xylene. Methyl ethyl ketone, cyclohexanone, or the like is preferably used because the drying rate is high and the price is low.

5 [0059] The base film is not particularly limited, and examples thereof include a polyester film (such as a polyethylene terephthalate film), a polypropylene film (such as an oriented polypropylene (OPP) film), a polyimide film, a polyetherimide film, a polyether naphthalate film, and a methylpentene film.

10 [0060] The thickness of the film-shaped adhesive 10 is preferably 20 to 200 μm so that irregularities of a first wire and a first semiconductor element, and a wiring circuit of a substrate and the like are sufficiently filled. In addition, when the thickness is 20 μm or more, sufficient adhesive strength is easily obtained, and when the thickness is 200 μm or less, it is easy to meet the demand for reducing the size of the
15 semiconductor device. In this regard, the thickness of the film-shaped adhesive 10 is more preferably 30 to 200 μm and still more preferably 40 to 150 μm .

[0061] Examples of a method of obtaining the thick film-shaped adhesive 10 include a method of bonding the film-shaped adhesives 10.

20 [0062] (Adhesive sheet)

As shown in FIG. 2, an adhesive sheet 100 includes the film-shaped adhesive 10 on a base film 20. The adhesive sheet 100 can be obtained without removing the base film 20 in a step of obtaining the film-shaped adhesive 10.

25 [0063] As shown in FIG. 3, an adhesive sheet 110 further includes a cover film 30 on the surface opposite to the base film 20 of the adhesive

sheet 100. Examples of the cover film 30 include a PET film, a PE film, and an OPP film.

[0064] The film-shaped adhesive 10 may be laminated on a dicing tape. When a dicing/die bonding integrated adhesive sheet obtained in this manner is used, a step of performing lamination on the semiconductor wafer can be performed at one time, and work efficiency can be improved.

[0065] Examples of dicing tapes 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. As necessary, a surface treatment such as a primer treatment, a UV treatment, a corona discharge treatment, a polishing treatment, and an etching treatment may be performed on the dicing tape.

[0066] The dicing tape is preferably sticky. Examples of such a dicing tape include those obtained by imparting stickiness to the plastic film and those obtained by providing a sticky layer on one surface of the plastic film.

[0067] Examples of such a dicing/die bonding integrated adhesive sheet include an adhesive sheet 120 shown in FIG. 4 and an adhesive sheet 130 shown in FIG. 5. As shown in FIG. 4, the adhesive sheet 120 has a structure including a dicing tape 60 in which a sticky layer 50 is provided on a base film 40 that can secure elongation when a tensile tension is applied as a support base and the film-shaped adhesive 10 provided on the sticky layer 50 of the dicing tape 60. As shown in FIG. 5, the adhesive sheet 130 has a structure in which the base film 20

is additionally provided on the surface of the film-shaped adhesive 10 in the adhesive sheet 120.

[0068] Examples of the base film 40 include the above plastic film described in the dicing tape. In addition, the sticky layer 50 can be formed using, for example, a resin composition containing a liquid component and a thermoplastic component and having appropriate tack strength. Examples of a method of obtaining the dicing tape 60 include a method of applying the resin composition to the base film 40 and drying it to form the sticky layer 50, and a method of bonding the sticky layer 50 first formed on another film such as a PET film with the base film 40.

[0069] Examples of a method of laminating the film-shaped adhesive 10 on the dicing tape 60 include a method of directly applying a varnish of the above adhesive composition to the dicing tape 60 and drying it, a method of screen printing a varnish on the dicing tape 60, and a method of preparing the film-shaped adhesive 10 in advance, and laminating it on the dicing tape 60 by pressing and hot roll lamination. Lamination by hot roll lamination is preferable because continuous production is possible and efficiency is high.

[0070] The thickness of the dicing tape 60 is not particularly limited, but can be appropriately determined based on the knowledge of those skilled in the art depending on the thickness of the film-shaped adhesive 10, applications of the dicing/die bonding integrated adhesive sheet, and the like. Here, when the thickness of the dicing tape 60 is 60 μm or more, deterioration of handling properties, tearing due to expansion, and the like tend to be easily minimized. On the other hand, when the

thickness of the dicing tape is 180 μm or less, it is easy to achieve both economic efficiency and favorable handling properties.

[0071] (Semiconductor device)

FIG. 6 is a cross-sectional view showing a semiconductor device. As shown in FIG. 6, a semiconductor device 200 is a semiconductor device in which a second semiconductor element Waa is laminated on a first semiconductor element Wa. Specifically, the first semiconductor element Wa on the first stage is electrically connected to a substrate 14 with a first wire 88 therebetween, the second semiconductor element Waa on the second stage whose area is larger than the area of the first semiconductor element Wa is press-bonded to the first semiconductor element Wa with the film-shaped adhesive 10 therebetween, and the first wire 88 and the first semiconductor element Wa are embedded in the film-shaped adhesive 10 to obtain a wire-embedded semiconductor device. In addition, in the semiconductor device 200, additionally, the substrate 14 is electrically connected to the second semiconductor element Waa with a second wire 98 therebetween, and the second semiconductor element Waa is sealed with a sealing material 42.

[0072] The thickness of the first semiconductor element Wa is 10 to 170 μm , and the thickness of the second semiconductor element Waa is 20 to 400 μm . The first semiconductor element Wa embedded into the film-shaped adhesive 10 is a controller chip for driving the semiconductor device 200.

[0073] The substrate 14 is formed of an organic substrate 90 in which circuit patterns 84 and 94 are each formed at two places on the surface

thereof. The first semiconductor element Wa is press-bonded to the circuit pattern 94 with an adhesive 41 therebetween, and the second semiconductor element Waa is press-bonded to the substrate 14 with the film-shaped adhesive 10 therebetween so that it covers the circuit pattern 94 onto which no first semiconductor element Wa is press-bonded, the first semiconductor element Wa, and a part of the circuit pattern 84. Irregularities caused by the circuit patterns 84 and 94 on the substrate 14 are filled with the film-shaped adhesive 10. Then, the second semiconductor element Waa, the circuit pattern 84, and the second wire 98 are sealed with the resin sealing material 42.

[0074] (Semiconductor device production method)

A semiconductor device is produced by a semiconductor device production method including a first die bonding step in which a first semiconductor element is electrically connected to a substrate with a first wire therebetween, a lamination step in which a film-shaped adhesive having a shear stress relaxation rate of 40 to 85% at 100°C after 0.1 seconds is attached to one surface of a second semiconductor element having a larger area than the first semiconductor element, and a second die bonding step in which the second semiconductor element to which the film-shaped adhesive is attached is disposed so that the film-shaped adhesive covers the first semiconductor element, the film-shaped adhesive is press-bonded, and thus the first wire and the first semiconductor element are embedded in the film-shaped adhesive. Hereinafter, procedures of producing the semiconductor device 200 will be exemplified in detail.

[0075] First, as shown in FIG. 7, the first semiconductor element Waa

with the adhesive 41 is press-bonded to the circuit pattern 94 on the substrate 14, and the circuit pattern 84 on the substrate 14 is electrically connected to the first semiconductor element Wa with the first wire 88 therebetween (first die bonding step).

5 [0076] Next, the adhesive sheet 100 is laminated on one surfaces of a semiconductor wafer (for example, 8-inch size), the base film 20 is peeled off, and the film-shaped adhesive 10 is attached to one surface of the semiconductor wafer. Then, the dicing tape 60 is bonded to the film-shaped adhesive 10, and then diced into a predetermined size (for
10 example, 7.5 square mm), and the dicing tape 60 is peeled off. Thereby, as shown in FIG. 8, the second semiconductor element Waa to which the film-shaped adhesive 10 is attached is obtained (lamination step).

[0077] The lamination step is preferably performed at 50 to 100°C, and
15 more preferably performed at 60 to 80°C. When the temperature in the lamination step is 50°C or higher, favorable adhesion to the semiconductor wafer can be obtained. When the temperature in the lamination step is 100°C or lower, since the film-shaped adhesive 10 in the lamination step is prevented from excessively flowing, for example,
20 it is possible to prevent the thickness from changing.

[0078] Examples of a dicing method include a method of performing blade dicing using a rotary blade, a method of cutting the film-shaped adhesive 10 or both the wafer and the film-shaped adhesive 10 with a laser, and a general-purpose method such as extension at room
25 temperature or under cooling conditions.

[0079] Then, the second semiconductor element Waa to which the

film-shaped adhesive 10 is attached is press-bonded to the substrate 14 to which the first semiconductor element Wa is connected via the wire 88. Specifically, as shown in FIG. 9, the second semiconductor element Waa to which the film-shaped adhesive 10 is attached is disposed so that the film-shaped adhesive 10 covers the first semiconductor element Wa, and as shown in FIG. 10, the second semiconductor element Waa is then press-bonded to the substrate 14, and thereby the second semiconductor element Waa is fixed to the substrate 14 (second die bonding step). In the second die bonding step, preferably, the film-shaped adhesive 10 is press-bonded under conditions of 80 to 180°C and 0.01 to 0.50 MPa for 0.5 to 3.0 seconds. [0080] In order to remove voids that can occur in the second die bonding step, after the second die bonding step, the film-shaped adhesive 10 may be subjected to a step of pressurizing and heating under conditions of 60 to 175°C and 0.3 to 0.7 MPa for 5 minutes or longer. Accordingly, it is possible to produce a semiconductor device more easily while stabilizing a yield. [0081] Next, as shown in FIG. 11, the substrate 14 is electrically connected to the second semiconductor element Waa with the second wire 98, and the circuit pattern 84, the second wire 98, and the entire second semiconductor element Waa are then sealed with the sealing material 42 under conditions of 170 to 180°C and 5 to 8 MPa (sealing step). The semiconductor device 200 can be produced through such a step. [0082] As described above, the semiconductor device 200 is produced using a film-shaped adhesive which is used for press-bonding a second

semiconductor element and embedding a first wire and a first semiconductor element and which has a shear elastic modulus at 100°C of 40 to 85% after 0.1 second in a semiconductor device in which the first semiconductor element is electrically connected to a substrate with the first wire therebetween and the second semiconductor element having a larger area than the first semiconductor element is press-bonded to the first semiconductor element. When a film-shaped adhesive having a shear stress relaxation rate of 40% or more at 100°C after 0.1 seconds is used, it is possible to conform to the shape of a wire, a semiconductor element, and the like, and it is possible to secure embedding properties. In addition, when a film-shaped adhesive having a shear stress relaxation rate of 85% or less is used, the shape of the film can be maintained during press-bonding and it is possible to minimize bleeding.

[0083] While preferable embodiments of the present invention have been described above, the present invention is not necessarily limited to the above embodiments. For example, appropriate modifications can be made as follows without departing from the spirit and scope of the invention.

[0084] In the semiconductor device 200, the substrate 14 is the organic substrate 90 in which the circuit patterns 84 and 94 are each formed at two places on the surface thereof, but the substrate 14 is not limited thereto, and a metal substrate such as a lead frame may be used.

[0085] The semiconductor device 200 has a configuration in which the second semiconductor element Waa is laminated on the first semiconductor element Wa and the semiconductor elements are

laminated in two stages, but the configuration of the semiconductor device is not limited thereto. A third semiconductor element may be additionally laminated on the second semiconductor element Waa, or a plurality of semiconductor elements may be additionally laminated on the second semiconductor element Waa. When the number of semiconductor elements laminated increases, it is possible to increase the capacity of the obtained semiconductor device.

[0086] In the semiconductor device production method according to the present embodiment, in the lamination step, the adhesive sheet 100 shown in FIG. 2 is laminated on one surface of the semiconductor wafer, the base film 20 is peeled off, and thus the film-shaped adhesive 10 is attached. However, the adhesive sheet used during lamination is not limited thereto. The dicing/die bonding integrated adhesive sheets 120 and 130 shown in FIGS. 4 and 5 can be used in place of the adhesive sheet 100. In this case, it is not necessary to separately attach the dicing tape 60 when the semiconductor wafer is diced.

[0087] In the lamination step, rather than the semiconductor wafer, semiconductor elements obtained by separating a semiconductor wafer into pieces may be laminated on the adhesive sheet 100. In this case, the dicing step can be omitted.

[Examples]

[0088] The present invention will be described below in detail with reference to examples. However, the present invention is not limited to the following examples.

[0089] (Examples and Comparative Examples)

According to Table 1 and Table 2 (unit: parts by mass), an epoxy

resin and a phenolic resin, which are a thermosetting resin, and an inorganic filler were weighed out to obtain a composition, and cyclohexanone was additionally added thereto and the mixture was stirred and mixed. An acrylic rubber, which is a thermoplastic resin, was added thereto and the mixture was stirred, and a coupling agent and a curing promoting agent were then additionally added thereto, and the mixture was stirred until respective components became uniform to obtain a varnish. Here, product names of respective components in the tables are as follows.

[0090] (Epoxy resin)

Celloxide 2021P: (product name, commercially available from Daicel Corporation,

3',4'-epoxycyclohexylmethyl

3,4-epoxycyclohexanecarboxylate: epoxy equivalent of 126, liquid at room temperature, molecular weight of 236)

YDF-8170C: (product name, commercially available from NSCC Epoxy Manufacturing Co., Ltd., bisphenol F type epoxy resin: epoxy equivalent of 159, liquid at room temperature, weight average molecular weight of about 310)

YDCN-700-10: (product name, commercially available from NSCC Epoxy Manufacturing Co., Ltd., cresol novolak type epoxy resin: epoxy equivalent of 210, softening point of 75 to 85°C)

HP-7000L: (product name, commercially available from DIC, dicyclopentadiene modified epoxy resin: epoxy equivalent of 242 to 252, softening point: 50 to 60°C)

VG-3101L: (product name, commercially available from Printec Corporation, multifunctional epoxy resin: epoxy equivalent of 210,

- softening point of 39 to 46°C)
- [0091] (Phenolic resin)
- HE-100C-30: (product name, commercially available from Air Water Inc., phenolic resin: hydroxyl equivalent of 175, softening point of 79°C, water absorption rate of 1 mass%, heating mass reduction rate of 4 mass%)
- Resitop PSM-4326: (product name, commercially available from Gun Ei Chemical Industry Co., Ltd., phenolic resin: hydroxyl equivalent of 105, softening point of 118 to 122°C, water absorption rate of 1 mass%)
- [0092] (Inorganic filler)
- SC2050-HLG: (product name, commercially available from Admatechs, silica filler dispersion solution: average particle size of 0.50 µm)
- AEROSIL R972: (product name, commercially available from Nippon Aerosil Co., Ltd., silica: average particle size of 0.016 µm)
- [0093] (Acrylic rubber)
- HTR-860P-3CSP: (sample name: commercially available from Nagase ChemteX Corporation, acrylic rubber: weight average molecular weight of 800,000, glycidyl functional group monomer proportion of 3 mol%, Tg of 12°C)
- HTR-860P-3CSP Mw: 50: (sample name: commercially available from Nagase ChemteX Corporation, acrylic rubber: weight average molecular weight of 500,000, glycidyl functional group monomer proportion of 3 mol%, Tg of 12°C)
- HTR-860P-30B-CHN: (sample name, commercially available from Nagase ChemteX Corporation, acrylic rubber: weight average molecular weight of 230,000, glycidyl functional group monomer

proportion of 8 mass%, Tg of -7°C)

[0094] (Coupling agent)

A-189: (product name, commercially available from Momentive Performance Materials Japan LLC, γ -mercaptopropyltrimethoxysilane)

5 A-1160: (product name, commercially available from Momentive Performance Materials Japan LLC, γ -ureidopropyltriethoxysilane)

[0095] (Curing promoting agent)

Curezol 2PZ-CN: (product name, commercially available from Shikoku Chemical Corporation, 1-cyanoethyl-2-phenylimidazole)

10 [0096]

[Table 1]

		Example					
		1	2	3	4	5	6
Epoxy resin	Celloxide 2021P	-	-	10.2	7	7	-
	YDF-8170C	14.2	13	-	-	-	10
	YDCN-700-10	16.2	11	16.9	-	-	-
	HP-7000L	-	-	-	22.1	-	19.1
	VG-3101L	-	-	-	-	22.1	-
Phenolic resin	HE-100C-30	23.2	18.7	24.3	20.6	20.6	20.6
	Resitop PSM-4326	-	-	-	-	-	-
Inorganic filler	SC2050-HLG	29.3	39	30.7	31.8	31.8	31.8
	AEROSIL R972	-	-	-	-	-	-
Acrylic rubber	HTR-860P-3CSP	16.7	18	17.5	18.1	18.1	18.1
	HTR-860P-3CSP Mw:50	-	-	-	-	-	-
	HTR-860P-30B-CHN	-	-	-	-	-	-
Coupling agent	A-189	0.1	0.1	0.1	0.1	0.1	0.1
	A-1160	0.2	0.2	0.2	0.2	0.2	0.2
Curing promoting agent	Curezol 2PZ-CN	0.1	0.1 or less	0.1 or less	0.1 or less	0.1 or less	0.1 or less

(unit: parts by mass)

[0097]

[Table 2]

		Comparative Example			
		1	2	3	4
Epoxy resin	Celloxide 2021P	-	-	-	-
	YDF-8170C	14.2	14.2	-	19
	YDCN-700-10	16.2	16.2	13.2	8.9
	HP-7000L	-	-	-	-
	VG-3101L	-	-	-	-
Phenolic resin	HE-100C-30	23.2	23.2	11	-
	Resitop PSM-4326	-	-	-	11.3
Inorganic filler	SC2050-HLG	29.3	39	-	39
	AEROSIL R972	-	-	7.8	
Acrylic rubber	HTR-860P-3CSP	8.4	-	66.4	21.5
	HTR-860P-3CSP Mw:50	-	16.7	-	-
	HTR-860P-30B-CHN	8.4	-	-	-
Coupling agent	A-189	0.1	0.1	0.4	0.1
	A-1160	0.2	0.2	1.2	0.2
Curing promoting agent	Curezol 2PZ-CN	0.1	0.1 or less	0.1 or less	0.1 or less

(unit: parts by mass)

[0098] Next, the obtained varnish was filtered through a 100-mesh filter, and vacuum-degassed. The varnish after vacuum degassing was applied to a polyethylene terephthalate (PET) film (with a thickness of 38 μm) on which a mold release treatment was performed, which was a base film. The applied varnish was heated and dried in two steps: at 90°C for 5 minutes, and then at 140°C for 5 minutes. Thereby, an adhesive sheet including a film-shaped adhesive with a thickness of 60 μm in a B stage state on the PET film was obtained.

[0099] <Evaluation of various physical properties>

The obtained film-shaped adhesives were evaluated as follows.

The evaluate results are shown in Table 3 and Table 4.

[0100] [Measurement of shear stress relaxation rate]

A plurality of film-shaped adhesives from which the base film was peeled off and removed were bonded and cut into a 10 square mm in the thickness direction. Thereby, a 10 square mm film-shaped adhesive evaluation sample with a thickness of 360 μm was obtained.

5 A circular aluminum plate jig with a diameter of 8 mm was set in a dynamic viscoelastic device ARES (commercially available from TA), and the evaluation sample was inserted into the jig. Then, the evaluation sample was heated from room temperature (30°C) to 100°C at a rate of temperature increase of 60°C/min at maximum and a strain
10 of 10% was then applied, and the shear stress after 0.1 seconds was recorded. The stress was normalized by the initial stress and the stress relaxation rate was calculated.

[0101] [Measurement of shear viscosity]

As in measurement of the shear stress relaxation rate, when a
15 strain of 5% was applied to the evaluation sample at a frequency of 1 Hz and heating was performed from room temperature (30°C) to 140°C at a rate of temperature increase of 5°C/min, the shear viscosity was measured. Then, the measured value at 120°C was recorded.

[0102] [Evaluation of embedding properties after press-bonding]

20 Two film-shaped adhesives of the adhesive sheets were bonded together to have a thickness of 120 μm , and the result was attached to a semiconductor wafer (8 inches) with a thickness of 100 μm at 70°C. Next, this was diced into a size of 7.5 square mm to obtain a semiconductor element with an adhesive sheet.

25 On the other hand, a dicing/die bonding integrated film (commercially available from Hitachi Chemical Company, HR-9004-10

(with a thickness of 10 μm)) was attached to a semiconductor wafer (8 inches) with a thickness of 50 μm at 70°C. Next, this was diced into a size of 3.0 square mm to obtain the above chip with an integrated film. The chip with an integrated film was press-bonded to an evaluation substrate having a maximum surface roughness of 6 μm under conditions of 120°C and 0.20 MPa for 2 seconds, and then heated at 120°C for 2 hours, and the integrated film was semi-cured. Thereby, a substrate with a chip was obtained.

A semiconductor element with an adhesive sheet was press-bonded to the obtained substrate with a chip under conditions of 120°C and 0.20 MPa for 1.5 seconds. In this case, a chip that was press-bonded in advance was aligned so that it was at the center of the semiconductor element with an adhesive sheet.

A structure that was naturally cooled to room temperature after heating was analyzed using an ultrasonic C-SCAN image diagnostic device (commercially available from Insight Co., Ltd., part number IS350, probe: 75 MHz), and embedding properties after press-bonding were checked. The embedding properties after press-bonding were evaluated according to the following criteria.

◎: A proportion of a void area with respect to the press-bonded film area was less than 3%.

○: A proportion of a void area with respect to the press-bonded film area was 3% or more and less than 5%.

△: A proportion of a void area with respect to the press-bonded film area was 5% or more and less than 8%.

×: A proportion of a void area with respect to the press-bonded film area

was 8% or more.

[0103] [Evaluation of amount of bleeding]

5 The structure obtained in the evaluation of embedding properties after press-bonding was observed directly above using an optical microscope. Then, using the edge of the semiconductor element as a starting point, a distance from the edge of the semiconductor element to the edge of the film-shaped adhesive extruded by press-bonding was measured. Measurement was performed using image analysis software bundled in the microscope, and the maximum value of the measured distance was used as the amount of bleeding. Here, no evaluation was performed in examples in which embedding properties after press-bonding were × and △.

[0104]

[Table 3]

	Example					
	1	2	3	4	5	6
Shear stress relaxation rate (%)	77	70	71	66	75	62
Shear viscosity (Pa·s)	300	2,500	600	1,500	800	2,000
Embedding properties after press-bonding	○	○	◎	◎	○	◎
Amount of bleeding (μm)	91.5	60	85.5	60.7	85.3	63.6

15 [0105]

[Table 4]

	Comparative Example			
	1	2	3	4

Shear stress relaxation rate (%)	88	87	15	35
Shear viscosity (Pa·s)	100 or less	100 or less	30,000	10,000
Embedding properties after press-bonding	◎	◎	×	△
Amount of bleeding (μm)	109.8	115.8	-	-

Reference Signs List

[0106] 10 Film-shaped adhesive

14 Substrate

42 Resin (sealing material)

5

88 First wire

98 Second wire

200 Semiconductor device

Wa First semiconductor element

Waa Second semiconductor element

CLAIMS

[Claim 1]

A semiconductor device production method, comprising:

5 a first die bonding step in which a first semiconductor element is electrically connected to a substrate with a first wire therebetween;

a lamination step in which a film-shaped adhesive having a shear stress relaxation rate of 40 to 85% at 100°C after 0.1 seconds is attached to one surface of a second semiconductor element having a larger area than the first semiconductor element; and

10 a second die bonding step in which the second semiconductor element to which the film-shaped adhesive is attached is disposed so that the film-shaped adhesive covers the first semiconductor element, the film-shaped adhesive is press-bonded and thus the first wire and the first semiconductor element are embedded in the film-shaped adhesive.

15 [Claim 2]

The production method according to claim 1,

wherein the film-shaped adhesive has a shear viscosity at 120°C of 5,000 Pa·s or less.

[Claim 3]

20 The production method according to claim 1 or 2,

wherein the film-shaped adhesive includes an acrylic resin and an epoxy resin.

[Claim 4]

The production method according to any one of claims 1 to 3,

25 wherein the film-shaped adhesive includes at least one of an inorganic filler and an organic filler.

[Claim 5]

A film-shaped adhesive which is used for press-bonding a second semiconductor element and embedding a first wire and a first semiconductor element and which has a shear stress relaxation rate of 40 to 85% at 100°C after 0.1 seconds in a semiconductor device in which the first semiconductor element is electrically connected to a substrate with the first wire therebetween and the second semiconductor element having a larger area than the first semiconductor element is press-bonded to the first semiconductor element.

[Claim 6]

The film-shaped adhesive according to claim 5,
wherein a shear viscosity at 120°C is 5,000 Pa·s or less.

[Claim 7]

The film-shaped adhesive according to claim 5 or 6, comprising an acrylic resin and an epoxy resin.

[Claim 8]

The film-shaped adhesive according to any one of claims 5 to 7, comprising
at least one of an inorganic filler and an organic filler.