

DESCRIPTION

Title of Invention: MULTILAYER FILM FOR FORMING INDIVIDUALIZED PIECES, AND METHOD FOR MANUFACTURING SEMICONDUCTOR DEVICE

5 **Technical Field**

[0001] The present disclosure relates to a laminated film for forming singulated bodies and a method for producing a semiconductor device, and particularly to a semiconductor device having a dolmen structure including a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed on the substrate around the first chip, and a second chip supported by the plurality of support pieces and disposed so as to cover the first chip.

Background Art

[0002] In recent years, in the field of semiconductor devices, high integration, miniaturization, and high-speed operation have been demanded, and as one aspect of semiconductor devices, a structure in which a semiconductor chip is stacked on a controller chip disposed on a substrate has been attracting attention. For example, Patent Literature 1 discloses a semiconductor die assembly including a controller die and a memory die disposed above the controller die and supported by a support member. The semiconductor assembly 100 illustrated in Fig. 1A of Patent Literature 1 can be said to have a dolmen structure. The semiconductor assembly 100 includes a package substrate 102, a controller die 103 disposed on the surface thereof, memory dies 106a and 106b disposed above the controller die 103, and support members 130a and 130b that support the memory die 106a.

5 [0003] Patent Literature 1 discloses that a semiconductor material such as silicon can be used as the support member (support piece), and more specifically, that a fragment of a semiconductor material obtained by dicing a semiconductor wafer can be used. In addition, Patent Literatures 2 and 3 disclose that, as the support member (support piece), a singulated body of a resin film having a multilayer structure with a resin material as a main component can be used in place of a semiconductor material such as silicon.

Citation List

10 Patent Literature

[0004] Patent Literature 1: JP 2017-515306 A

Patent Literature 2: WO 2020/217404 A1

Patent Literature 3: JP 2022-082247 A

Summary of Invention

15 Technical Problem

[0005] A support member (support piece) with a resin material as a main component is formed by preparing a laminated film obtained by laminating a base film, a pressure-sensitive adhesive layer, and the above-described resin film having a multilayer structure in this order, and then dicing the resin film to singulate it. According to studies by the present inventors, it has been found that when a resin film having a conventional multilayer structure is diced and singulated, interfacial delamination may occur between layers of the resin film. Such interfacial delamination tends to occur prominently between layers located at positions away from the pressure-sensitive adhesive layer, and there is a demand for improving the adhesive strength between these

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layers.

[0006] A main object of the present disclosure is to provide a laminated film for forming singulated bodies that includes a film for forming singulated bodies that is singulated into a plurality of pieces by dicing, capable of suppressing the occurrence of interfacial delamination between layers of the film when the film for forming singulated bodies is diced and singulated.

Solution to Problem

[0007] One aspect of the present disclosure relates to a laminated film for forming singulated bodies that includes a film for forming singulated bodies that is singulated into a plurality of pieces by dicing. The laminated film for forming singulated bodies includes a base film, a pressure-sensitive adhesive layer, and a film for forming singulated bodies in this order. The film for forming singulated bodies has a first thermosetting resin layer, a rigid material layer, and a second thermosetting resin layer in this order from the pressure-sensitive adhesive layer. The second thermosetting resin layer contains an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm. The rigid material layer is a layer having higher rigidity than that of the first thermosetting resin layer and the second thermosetting resin layer, and may be, for example, a polyimide layer.

[0008] According to studies by the present inventors, it has been found that when the second thermosetting resin layer contains silica particles having an average primary particle diameter of 30 to 400 nm, the adhesive strength between layers located at positions away from the

pressure-sensitive adhesive layer, that is, the adhesive strength between the second thermosetting resin layer and the rigid material layer, is improved.

5 [0009] The first thermosetting resin layer may contain, similarly to the second thermosetting resin layer, an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm. The composition of the first thermosetting resin layer and the composition of the second thermosetting resin layer may be the same as or different from each other.

10 [0010] The laminated film for forming singulated bodies may be used in a manufacturing process of a semiconductor device. A singulated body formed from the laminated film for forming singulated bodies can be used as a support piece in, for example, a semiconductor device having a dolmen structure including a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed on the substrate around
15 the first chip, and a second chip supported by the plurality of support pieces and disposed so as to cover the first chip. That is, the laminated film for forming singulated bodies can be used as a laminated film for forming support pieces, and the film for forming singulated bodies can be used as a film for forming support pieces. In addition, a singulated body formed from the laminated film for forming singulated bodies can also be used as a reinforcing piece (reinforcing material) for a semiconductor chip, for example, by being attached to a semiconductor chip, in addition to being used as a support piece.

20 [0011] Another aspect of the present disclosure relates to a method for producing a semiconductor device. The semiconductor device has a

dolmen structure including a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed on the substrate around the first chip, and a second chip supported by the plurality of support pieces and disposed so as to cover the first chip. The semiconductor device includes an adhesive piece provided on one surface of the second chip and sandwiched between the second chip and the plurality of support pieces. In one aspect, the first chip may be in contact with the adhesive piece. In this case, the second chip may be disposed so as to be supported by the plurality of support pieces and the first chip. In another aspect, the first chip may be spaced apart from the adhesive piece.

[0012] The method for producing the semiconductor device includes the following steps.

(A) Providing a laminated film for forming support pieces, the laminated film including a base film, a pressure-sensitive adhesive layer, and a film for forming support pieces in this order, the film for forming singulated bodies having a first thermosetting resin layer, a rigid material layer, and a second thermosetting resin layer in this order from the pressure-sensitive adhesive layer, and the second thermosetting resin layer containing an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm

(B) Forming a plurality of support pieces on a surface of the pressure-sensitive adhesive layer by dicing the film for forming support pieces

(C) Picking up the support pieces from the pressure-sensitive adhesive layer

(D) Disposing a first chip on a substrate

(E) Disposing the plurality of support pieces on the substrate around the first chip or around a region where the first chip is to be disposed

(F) Providing a chip with an adhesive piece, the chip including a second chip and an adhesive piece provided on one surface of the second chip

5 (G) Constructing a dolmen structure by disposing the chip with an adhesive piece on surfaces of the plurality of support pieces

[0013] The method for producing a semiconductor device may further include heating the film for forming support pieces or the support pieces before step (G).

10 [0014] The present disclosure provides the laminated film for forming singulated bodies described in [1] to [3] and the method for producing a semiconductor device described in [4] to [7].

[1] A laminated film for forming singulated bodies, including a base film, a pressure-sensitive adhesive layer, and a film for forming singulated
15 bodies in this order, wherein the film for forming singulated bodies has a first thermosetting resin layer, a rigid material layer, and a second thermosetting resin layer in this order from the pressure-sensitive adhesive layer, and the second thermosetting resin layer contains an epoxy resin, a curing agent, an elastomer, and silica particles having an
20 average primary particle diameter of 30 to 400 nm.

[2] The laminated film for forming singulated bodies according to [1], wherein the rigid material layer is a polyimide layer.

[3] The laminated film for forming singulated bodies according to [1] or [2], wherein the first thermosetting resin layer contains an epoxy resin,
25 a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm.

[4] A method for producing a semiconductor device having a dolmen structure including a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed on the substrate around the first chip, and a second chip supported by the plurality of support pieces and disposed so as to cover the first chip, the method including: (A) providing a laminated film for forming support pieces, the laminated film including a base film, a pressure-sensitive adhesive layer, and a film for forming support pieces in this order, the film for forming support pieces having a first thermosetting resin layer, a rigid material layer, and a second thermosetting resin layer in this order from the pressure-sensitive adhesive layer, and the second thermosetting resin layer containing an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm; (B) forming a plurality of support pieces on the surface of the pressure-sensitive adhesive layer by dicing the film for forming support pieces; (C) picking up the support pieces from the pressure-sensitive adhesive layer; (D) disposing a first chip on a substrate; (E) disposing the plurality of support pieces on the substrate around the first chip or around a region where the first chip is to be disposed; (F) providing a chip with an adhesive piece, the chip including a second chip and an adhesive piece provided on one surface of the second chip; and (G) constructing a dolmen structure by disposing the chip with an adhesive piece on the surfaces of the plurality of support pieces.

[5] The method for producing a semiconductor device according to [4], further including heating the film for forming support pieces or the support pieces before step (G).

[6] The method for producing a semiconductor device according to [4] or [5], wherein the rigid material layer is a polyimide layer.

[7] The method for producing a semiconductor device according to any one of [4] to [6], wherein the first thermosetting resin layer contains an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm.

Advantageous Effects of Invention

[0015] According to the present disclosure, there is provided a laminated film for forming singulated bodies that includes a film for forming singulated bodies that is singulated into a plurality of pieces by dicing, capable of suppressing the occurrence of delamination between layers of the film when the film for forming singulated bodies is diced and singulated. In addition, according to the present disclosure, there is provided a method for producing a semiconductor device using such a laminated film for forming singulated bodies (laminated film for forming support pieces).

Brief Description of Drawings

[0016] Fig. 1: Fig. 1(a) is a plan view schematically showing an embodiment of a laminated film for forming singulated bodies, and Fig. 1(b) is a cross-sectional view taken along line b-b of Fig. 1(a).

Fig. 2: Fig. 2 is a cross-sectional view schematically showing bonding a pressure-sensitive adhesive layer and a film for forming support pieces together.

Fig. 3: Fig. 3 is a cross-sectional view schematically showing a first embodiment of the semiconductor device of the present disclosure.

Fig. 4: Fig. 4(a) and Fig. 4(b) are plan views schematically

showing examples of the positional relationship between the first chip and the plurality of support pieces.

Fig. 5: Fig. 5(a), (b), (c), and (d) are cross-sectional views schematically showing the process of producing support pieces.

5 Fig. 6: Fig. 6 is a cross-sectional view schematically showing a state in which a plurality of support pieces are disposed on the substrate around the first chip.

Fig. 7: Fig. 7 is a cross-sectional view schematically showing an example of a chip with an adhesive piece.

10 Fig. 8: Fig. 8 is a cross-sectional view schematically showing a dolmen structure formed on a substrate.

Fig. 9: Fig. 9 is a cross-sectional view schematically showing a second embodiment of the semiconductor device of the present disclosure.

15 **Description of Embodiments**

[0017] Hereinafter, embodiments of the present disclosure will be described with appropriate reference to the drawings. However, the present disclosure is not limited to the following embodiments. The constituent elements (including steps, etc.) in the following
20 embodiments are not essential unless otherwise specified. The sizes of the constituent elements in each drawing are conceptual, and the relative relationship of the sizes between the constituent elements is not limited to that shown in each drawing.

[0018] The same applies to the numerical values and their ranges in the
25 present disclosure, and they do not limit the present disclosure. A numerical range indicated using "to" in the present specification

indicates a range including the numerical values described before and after "to" as the minimum and maximum values, respectively. In the numerical ranges described in stages in the present specification, the upper limit value or lower limit value described in one numerical range may be replaced with the upper limit value or lower limit value of another staged numerical range. Further, in the numerical ranges described in the present specification, the upper limit value or lower limit value of the numerical range may be replaced with the values shown in the examples.

[0019] In the present specification, the term "layer" encompasses not only a structure formed over the entire surface when observed as a plan view, but also a structure formed in a part thereof. In addition, in the present specification, the term "step" includes not only an independent step, but also a step in which the intended effect of the step is achieved even when it cannot be clearly distinguished from other steps.

[0020] In the present specification, "(meth)acrylate" refers to acrylate or the corresponding methacrylate. The same applies to other similar expressions such as a "(meth)acryloyl group" and a "(meth)acrylic copolymer."

[0021] Each component and material exemplified in the present specification may be used alone or in combination of two or more, unless otherwise specified.

[0022] [Laminated Film for Forming Singulated Bodies]

Fig. 1(a) is a plan view schematically showing an embodiment of a laminated film for forming singulated bodies, and Fig. 1(b) is a cross-sectional view taken along line b-b of Fig. 1(a). A laminated film for

forming singulated bodies 20 (hereinafter, may be simply referred to as "laminated film 20") includes a base film 1, a pressure-sensitive adhesive layer 2, and a film for forming singulated bodies D (hereinafter, may be simply referred to as "film D") that is singulated into a plurality of pieces by dicing, in this order. The pressure-sensitive adhesive layer 2 is formed in a circular shape by punching or the like (see Fig. 1(a)). The film D is formed in a circular shape by punching or the like and has a smaller diameter than the pressure-sensitive adhesive layer 2 (see Fig. 1(a)).

[0023] Examples of the base film 1 include films of polyesters (polyethylene terephthalate (PET), polybutylene terephthalate, polyethylene naphthalate, and the like), polyolefins (polyethylene, polypropylene, and the like), polycarbonate, polyamide, polyimide, polyamideimide, polyetherimide, polyethersulfide, polyethersulfone, polyetherketone, polyphenylene ether, polyphenylene sulfide, ionomers, and the like. These films may be a single-layer film or a multilayer film composed of two or more types of films. The thickness of the base film 1 may be, for example, 1 to 200 μm , 20 to 150 μm , or 30 to 130 μm .

[0024] The pressure-sensitive adhesive layer 2 is a layer composed of a pressure-sensitive adhesive. As the pressure-sensitive adhesive, a pressure-sensitive adhesive commonly used in the relevant field can be used, and it may be either an ultraviolet-curable pressure-sensitive adhesive or a non-ultraviolet-curable pressure-sensitive adhesive. That is, the pressure-sensitive adhesive layer 2 may be either an ultraviolet-curable pressure-sensitive adhesive layer or a non-ultraviolet-curable pressure-sensitive adhesive layer. An ultraviolet-curable pressure-

sensitive adhesive is a pressure-sensitive adhesive having the property of decreasing in adhesiveness upon ultraviolet irradiation, and a conventionally known pressure-sensitive adhesive can be used. Examples of the ultraviolet-curable pressure-sensitive adhesive include a resin having a photoreactive carbon-carbon double bond and the like. More specifically, examples include acrylic resin-based pressure-sensitive adhesives and the like. Examples of the non-ultraviolet-curable pressure-sensitive adhesive include natural rubber-based, synthetic rubber-based, acrylic resin-based, polyvinyl ether resin-based, urethane resin-based, and silicone resin-based pressure-sensitive adhesives, and the like. The thickness of the pressure-sensitive adhesive layer 2 may be, for example, 1 to 100 μm .

[0025] The film D has a first thermosetting resin layer 5, a rigid material layer 6, and a second thermosetting resin layer 7 in this order from the pressure-sensitive adhesive layer 2. The second thermosetting resin layer 7 contains an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm. When the second thermosetting resin layer 7 contains silica particles having an average primary particle diameter of 30 to 400 nm, the adhesive strength between the second thermosetting resin layer 7 and the rigid material layer 6 tends to be improved. In addition, the first thermosetting resin layer 5 may contain, for example, an epoxy resin, a curing agent, an elastomer, and silica particles. The first thermosetting resin layer 5 may contain, similarly to the second thermosetting resin layer 7, an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm. When the

first thermosetting resin layer 5 contains silica particles having an average primary particle diameter of 30 to 400 nm, the adhesive strength between the first thermosetting resin layer 5 and the rigid material layer 6 also tends to be improved. The composition of the first thermosetting resin layer 5 and the composition of the second thermosetting resin layer 7 may be the same as or different from each other. The composition of the first thermosetting resin layer 5 and the composition of the second thermosetting resin layer 7 may be the same as each other from the viewpoint of efficiency of production of each layer.

[0026] The second thermosetting resin layer 7 (and further, the first thermosetting resin layer 5) can be obtained by molding a thermosetting resin composition containing an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm. The thermosetting resin composition may be one that passes through a semi-cured (B-stage) state and then becomes a cured product (C-stage) state by heat treatment. The thermosetting resin composition may further contain a coupling agent, a curing accelerator, and the like as necessary. The first thermosetting resin layer 5 and the second thermosetting resin layer 7 may be in a semi-cured (B-stage) state and may be capable of becoming a cured product (C-stage) state by subsequent heat treatment.

[0027] The B-stage refers to an intermediate stage in the reaction of certain thermosetting resins in which the material swells when in contact with certain liquids and softens when heated, but does not completely dissolve or melt, and the C-stage refers to the final stage in the reaction of certain thermosetting resins in which the material becomes virtually

insoluble and infusible.

[0028] (Epoxy Resin)

An epoxy resin is a component that has the property of forming three-dimensional bonds between molecules and curing upon heating or the like, and is a component that exhibits an adhesive action after curing. The epoxy resin can be used without particular limitation as long as it has an epoxy group in the molecule. The epoxy resin may have two or more epoxy groups in the molecule.

[0029] Examples of the epoxy resin include bisphenol-type epoxy resins such as a bisphenol A-type epoxy resin, a bisphenol F-type epoxy resin, and a bisphenol S-type epoxy resin; and novolac-type epoxy resins such as a phenol novolac-type epoxy resin and a cresol novolac-type epoxy resin. In addition, as the epoxy resin, generally known ones such as a stilbene-type epoxy resin, a triazine skeleton-containing epoxy resin, a fluorene skeleton-containing epoxy resin, a triphenolmethane-type epoxy resin, a biphenyl-type epoxy resin, a xylylene-type epoxy resin, a biphenylaralkyl-type epoxy resin, a naphthalene-type epoxy resin, a dicyclopentadiene-type epoxy resin, and diglycidyl ether compounds of polyfunctional phenols and polycyclic aromatics such as anthracene can be used.

[0030] The content of the epoxy resin may be 1 to 40% by mass based on the total amount of the thermosetting resin composition (the first thermosetting resin layer 5 or the second thermosetting resin layer 7). The content of the epoxy resin may be 2% by mass or more, 3% by mass or more, or 5% by mass or more, and may be 35% by mass or less, 30% by mass or less, or 25% by mass or less, based on the total amount of the

thermosetting resin composition (the first thermosetting resin layer 5 or the second thermosetting resin layer 7).

[0031] (Curing Agent)

5 Examples of the curing agent include a phenolic resin, an ester compound, an aromatic amine, an aliphatic amine, and an acid anhydride. Among these, the curing agent may be a phenolic resin from the viewpoint of achieving high adhesive strength. The phenolic resin can be used without particular limitation as long as it has a phenolic hydroxyl group in the molecule. Examples of the phenolic resin include
10 novolac-type phenolic resins obtained by condensation or co-condensation of phenols such as phenol, cresol, resorcinol, catechol, bisphenol A, bisphenol F, phenylphenol, and aminophenol, and/or naphthols such as α -naphthol, β -naphthol, and dihydroxynaphthalene, with a compound having an aldehyde group such as formaldehyde under
15 an acidic catalyst; and phenol aralkyl resins, naphthol aralkyl resins, biphenylaralkyl-type phenolic resins, and phenylaralkyl-type phenolic resins synthesized from phenols such as allylated bisphenol A, allylated bisphenol F, allylated naphthalenediol, phenol novolac, and phenol, and/or naphthols, and dimethoxy-para-xylene or
20 bis(methoxymethyl)biphenyl.

[0032] The content of the curing agent may be 1 to 40% by mass based on the total amount of the thermosetting resin composition (the first thermosetting resin layer 5 or the second thermosetting resin layer 7). The content of the curing agent may be 2% by mass or more, 3% by mass
25 or more, or 5% by mass or more, and may be 30% by mass or less, 25% by mass or less, or 20% by mass or less, based on the total amount of the

thermosetting resin composition (the first thermosetting resin layer 5 or the second thermosetting resin layer 7).

[0033] (Elastomer)

5 Examples of the elastomer include an acrylic resin, a polyester resin, a polyamide resin, a polyimide resin, a silicone resin, polybutadiene, acrylonitrile, epoxy-modified polybutadiene, maleic anhydride-modified polybutadiene, phenol-modified polybutadiene, and carboxy-modified acrylonitrile.

10 [0034] The elastomer may be an acrylic resin from the viewpoint of achieving high adhesive strength. The acrylic resin may be an acrylic resin such as an epoxy group-containing (meth)acrylic copolymer obtained by polymerizing a functional monomer having an epoxy group or a glycidyl group as a crosslinkable functional group, such as glycidyl acrylate or glycidyl methacrylate. Among these, the acrylic resin may
15 be an epoxy group-containing (meth)acrylic acid ester copolymer or an epoxy group-containing acrylic rubber, and is preferably an epoxy group-containing acrylic rubber. The epoxy group-containing acrylic rubber is a rubber having an epoxy group, with an acrylic acid ester as a main component, and mainly includes copolymers such as a copolymer
20 of butyl acrylate and acrylonitrile, and a copolymer of ethyl acrylate and acrylonitrile. The acrylic resin may have not only an epoxy group but also a crosslinkable functional group such as an alcoholic or phenolic hydroxyl group and a carboxyl group.

[0035] Examples of commercially available products of the elastomer
25 include SG-P3, SG-70L, SG-708-6, WS-023 EK30, and SG-280 EK23 (all manufactured by Nagase ChemteX Corporation) and the like.

- [0036] The glass transition temperature (T_g) of the elastomer may be -50 to 50 °C or -30 to 20 °C from the viewpoint of achieving high adhesive strength. The T_g of the elastomer refers to a value measured using a DSC (differential scanning calorimeter) (e.g., trade name: Thermo Plus 2, manufactured by Rigaku Corporation). The weight-average molecular weight (M_w) of the elastomer may be 50,000 to 1,600,000, 100,000 to 1,400,000, or 300,000 to 1,200,000 from the viewpoint of achieving high adhesive strength. The M_w of the elastomer refers to a value measured by gel permeation chromatography (GPC) and converted using a calibration curve based on standard polystyrene.
- [0037] The content of the elastomer may be 30 to 90% by mass based on the total amount of the thermosetting resin composition (the first thermosetting resin layer 5 or the second thermosetting resin layer 7). Based on the total amount of the thermosetting resin composition (the first thermosetting resin layer 5 or the second thermosetting resin layer 7), the content of the elastomer may be 35% by mass or more, 40% by mass or more, or 45% by mass or more, and may be 85% by mass or less, 80% by mass or less, or 78% by mass or less.
- [0038] (Silica Particles)
- The silica particles may include primary particles (particles that do not constitute secondary particles) that form a single particle integrally as judged from the apparent geometric form, and secondary particles formed by aggregation of a plurality of primary particles.
- [0039] The average primary particle diameter (average particle diameter of primary particles) of the silica particles is 30 to 400 nm from the viewpoint of suppressing the occurrence of delamination between layers

of the film for forming singulated bodies (particularly, between the second thermosetting resin layer 7 and the rigid material layer 6), and may be 35 nm or more, 40 nm or more, 45 nm or more, or 50 nm or more, and may be 380 nm or less, 350 nm or less, 320 nm or less, or 300 nm or less. The average primary particle diameter of the silica particles can be measured by the following method. First, a thermosetting resin layer (film-shaped molded article) composed of a thermosetting resin composition is produced. Next, the thermosetting resin layer (film-shaped molded article) is cut, and the cut surface (film cross-section) is observed using a scanning electron microscope, and an image of the cut surface (film cross-section) is taken. Then, the major axes of 50 primary particles of the silica particles are measured from the captured image, and the average value thereof is taken as the average primary particle diameter.

[0040] The surface of the silica particles may be chemically modified. Examples of materials for chemically modifying the surface of the silica particles include a silane coupling agent and the like. Examples of the types of functional groups of the silane coupling agent include a vinyl group, an acryloyl group, an epoxy group, a mercapto group, an amino group, a diamino group, an alkoxy group, and an ethoxy group.

[0041] The chemically modified silica particles may be those produced by a known method, or commercially available products may be used without modification.

[0042] The content of the silica particles may be 1 to 50% by mass based on the total amount of the thermosetting resin composition (the first thermosetting resin layer 5 or the second thermosetting resin layer 7).

The content of the silica particles may be 3% by mass or more, 5% by mass or more, or 8% by mass or more, and may be 45% by mass or less, 40% by mass or less, or 35% by mass or less, based on the total amount of the thermosetting resin composition (the first thermosetting resin layer 5 or the second thermosetting resin layer 7).

[0043] (Coupling Agent)

The coupling agent may be a silane coupling agent. Examples of the silane coupling agent include γ -glycidoxypropyltrimethoxysilane, γ -ureidopropyltriethoxysilane, γ -mercaptopropyltrimethoxysilane, 3-phenylaminopropyltrimethoxysilane, and 3-(2-aminoethyl)aminopropyltrimethoxysilane. The coupling agent may contain 3-phenylaminopropyltrimethoxysilane from the viewpoint of adhesive strength.

[0044] (Curing Accelerator)

Examples of the curing accelerator include imidazoles and derivatives thereof, organic phosphorus-based compounds, secondary amines, tertiary amines, and quaternary ammonium salts. Among these, the curing accelerator may be imidazoles and derivatives thereof from the viewpoint of reactivity.

[0045] Examples of the imidazoles include 2-methylimidazole, 1-benzyl-2-methylimidazole, 1-cyanoethyl-2-phenylimidazole, and 1-cyanoethyl-2-methylimidazole.

[0046] The thermosetting resin composition may further contain other components. Examples of other components include pigments, ion scavengers, and antioxidants.

[0047] The total content of the coupling agent, the curing accelerator,

and other components may be 0.005 to 10% by mass based on the total amount of the thermosetting resin composition (the first thermosetting resin layer 5 or the second thermosetting resin layer 7).

5 [0048] The thickness of the first thermosetting resin layer 5 may be, for example, 3 to 150 μm or 10 to 100 μm . The thickness of the second thermosetting resin layer 7 may be, for example, 3 to 150 μm or 10 to 100 μm . The thickness of the first thermosetting resin layer 5 and the thickness of the second thermosetting resin layer 7 may be the same as or different from each other, but may be the same as each other.

10 [0049] The rigid material layer 6 may be, for example, a resin layer or a metal layer having higher rigidity than that of the first thermosetting resin layer 5 and the second thermosetting resin layer 7. Here, rigidity can be based on various mechanical properties, and can be based on, for example, tensile modulus. The tensile modulus can be measured, for example, in accordance with K7161-1:2014.

15 [0050] The resin layer as the rigid material layer 6 is made of a material different from that of the first thermosetting resin layer 5 and the second thermosetting resin layer 7, and may be, for example, a polyimide layer. When the rigid material layer 6 is a resin layer (polyimide layer), there is a tendency for excellent pickupability even without performing heat curing treatment of the first thermosetting resin layer 5 and the second thermosetting resin layer 7 after singulation by dicing. The metal layer as the rigid material layer 6 may be, for example, a copper layer or an aluminum layer. When the rigid material layer 6 is a metal layer, in addition to excellent pickupability, there is a tendency for excellent visibility in the pickup step due to the optical contrast between the resin

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material and the metal material.

[0051] The thickness of the rigid material layer 6 may be, for example, 5 to 200 μm or 10 to 150 μm .

5 [0052] The thickness of the film D (the total thickness of all layers constituting the film D) may be, for example, 5 to 250 μm or 10 to 200 μm .

10 [0053] The laminated film 20 may be used in a manufacturing process of a semiconductor device. A singulated body formed from the laminated film 20 can be used as a support piece in, for example, a semiconductor device having a dolmen structure including a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed on the substrate around the first chip, and a second chip supported by the plurality of support pieces and disposed so as to cover the first chip.

15 [0054] In addition, a singulated body formed from the laminated film 20 can also be used as a reinforcing piece (reinforcing material) for a semiconductor chip, for example, by being attached to a semiconductor chip. A singulated body formed from the laminated film 20 can be produced by a method including steps (A) to (C) in the method for producing a semiconductor device described below.

20 [0055] [Method for Producing Laminated Film for Forming Singulated Bodies]

25 The laminated film 20 can be produced, for example, by bonding a dicing film having the base film 1 and the pressure-sensitive adhesive layer 2 on a surface of the base film 1 and a laminated film having a cover film 3 and the film D on the surface of the cover film 3 (see Fig. 2). The dicing film can be obtained by a method including applying a pressure-

sensitive adhesive onto the surface of the base film 1 to form the pressure-sensitive adhesive layer 2, and processing the pressure-sensitive adhesive layer 2 into a predetermined shape (e.g., circular) by punching or the like. The laminated film can be obtained by a method including applying (coating) a thermosetting resin composition onto the surface of the cover film 3 (e.g., a PET film or a polyethylene film) to form the second thermosetting resin layer 7, forming the rigid material layer 6 (e.g., a polyimide layer) on the surface of the second thermosetting resin layer 7, applying (coating) a thermosetting resin composition onto the surface of the rigid material layer 6 to form the first thermosetting resin layer 5, and processing the formed film D into a predetermined shape (e.g., circular) by punching or the like. The laminated film can also be obtained by bonding one surface of the rigid material layer 6 to the first thermosetting resin layer 5, and then bonding the other surface of the rigid material layer 6 to the second thermosetting resin layer 7 provided on the cover film 3. When using the laminated film 20, the cover film 3 is peeled off at an appropriate timing.

[0056] In forming the second thermosetting resin layer 7, a varnish of the thermosetting resin composition (thermosetting resin varnish) may be used. When using a thermosetting resin varnish, the second thermosetting resin layer 7 can be obtained by mixing or kneading each component of the thermosetting resin composition in a solvent to prepare a thermosetting resin varnish, applying the obtained thermosetting resin varnish, and removing the solvent by heating and drying.

[0057] Mixing or kneading can be carried out using a disperser such as an ordinary stirrer, an automated mortar, a three-roll mill, or a ball mill,

and these can be used in appropriate combination.

5 [0058] The solvent used for preparing the thermosetting resin varnish is not limited as long as it can uniformly dissolve, knead, or disperse each component, and conventionally known solvents can be used. Examples of such solvents include ketone-based solvents such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and cyclohexanone, dimethylformamide, dimethylacetamide, N-methylpyrrolidone, toluene, and xylene.

10 [0059] As methods for applying the thermosetting resin varnish onto the cover film or the rigid material layer, known methods can be used, and for example, a knife coating method, a roll coating method, a spray coating method, a gravure coating method, a bar coating method, and a curtain coating method can be used. The heating and drying is not particularly limited as long as the conditions are such that the solvent used is sufficiently volatilized, but can be carried out in the range of 50 to 150 °C for 1 to 30 minutes. The heating and drying may be carried out stepwise at different heating temperatures and for different heating times.

20 [0060] The first thermosetting resin layer 5 can be obtained, similarly to the second thermosetting resin layer 7, by mixing or kneading each component of the thermosetting resin composition in a solvent to prepare a thermosetting resin varnish, applying the obtained thermosetting resin varnish, and removing the solvent by heating and drying.

25 [0061] [Semiconductor Device and Method for Producing the Same]
<First Embodiment>

Fig. 3 is a cross-sectional view schematically showing a first

embodiment of the semiconductor device of the present disclosure. The semiconductor device 100 shown in Fig. 3 includes a substrate 10, a chip T1 (first chip) disposed on the surface of the substrate 10, a plurality of support pieces DXc disposed on the surface of the substrate 10 around the chip T1, a chip T2 (second chip) disposed above the chip T1, an adhesive piece Tc sandwiched between the chip T2 and the plurality of support pieces DXc, chips T3 and T4 stacked on the chip T2, a plurality of wires w electrically connecting electrodes (not shown) on the surface of the substrate 10 to the chips T1 to T4, respectively, and an encapsulant 50 filled in the gap between the chip T1 and the chip T2 and the like. The support piece DXc may be a cured product of a singulated body obtained by singulating the film D.

[0062] In the present embodiment, a dolmen structure is formed on the substrate 10 by the plurality of support pieces DXc, the chip T2, and the adhesive piece Tc located between the support pieces DXc and the chip T2. The chip T1 is in contact with the adhesive piece Tc. That is, the adhesive piece Tc is in contact with the upper surface of the chip T1 and the upper surface of the support pieces DXc. For example, by appropriately setting the thickness of the film DX, the position of the upper surface of the chip T1 and the position of the upper surface of the support pieces DXc can be made to coincide. At this time, a part of the wire w electrically connecting the electrode (not shown) on the surface of the substrate 10 to the chip T1 is embedded in the adhesive piece Tc.

[0063] As shown in Fig. 3, the adhesive piece Tc between the chip T1 and the chip T2 covers a region R of the chip T2 facing the chip T1, and continuously extends from the region R toward the peripheral side of the

chip T2. That is, a single adhesive piece Tc covers the region R of the chip T2, and is interposed between the chip T2 and the plurality of support pieces, adhering them together. Note that Fig. 3 illustrates an aspect in which the adhesive piece Tc is provided so as to cover one entire surface (lower surface) of the chip T2. However, since the adhesive piece Tc may shrink during the manufacturing process of the semiconductor device 100, it is sufficient that the adhesive piece Tc substantially covers the one entire surface (lower surface) of the chip T2, and for example, there may be a portion on a part of the periphery of the chip T2 that is not covered by the adhesive piece Tc. The lower surface of the chip T2 in Fig. 3 corresponds to the back surface of the chip. In recent years, the back surface of chips often has irregularities formed thereon. By substantially covering the entire back surface of the chip T2 with the adhesive piece Tc, the occurrence of cracks or fractures in the chip T2 can be suppressed.

[0064] The substrate 10 may be an organic substrate or a metal substrate such as a lead frame. From the viewpoint of suppressing warpage of the semiconductor device 100, the thickness of the substrate 10 is, for example, 90 to 300 μm , and may be 90 to 210 μm .

[0065] The chip T1 is, for example, a controller chip, and is adhered to the substrate 10 by an adhesive piece T1c and electrically connected to the substrate 10 by a wire w. The shape of the chip T1 in plan view is, for example, rectangular (square or rectangular). The length of one side of the chip T1 is, for example, 5 mm or less, and may be 2 to 5 mm or 1 to 5 mm. The thickness of the chip T1 is, for example, 10 to 150 μm , and may be 20 to 100 μm .

[0066] The chip T2 is, for example, a memory chip, and is adhered onto the support pieces DXc and the chip T1 via the adhesive piece Tc. In plan view, the chip T2 has a larger size than the chip T1. The shape of the chip T2 in plan view is, for example, rectangular (square or rectangular). The length of one side of the chip T2 is, for example, 20 mm or less, and may be 4 to 20 mm or 4 to 12 mm. The thickness of the chip T2 is, for example, 10 to 170 μm , and may be 20 to 120 μm . The chips T3 and T4 are also, for example, memory chips, and are adhered onto the chip T2 via an adhesive piece Tc. The length of one side of the chips T3 and T4 may be the same as that of the chip T2, and the thickness of the chips T3 and T4 may also be the same as that of the chip T2.

[0067] The support piece DXc serves as a spacer that forms a space around the chip T1. The support piece DXc includes, in order from the substrate 10, a first adhesive piece 5c composed of a cured product of the thermosetting resin composition constituting the first thermosetting resin layer 5, a rigid material piece 6p, and a second adhesive piece 7c composed of a cured product of the thermosetting resin composition constituting the second thermosetting resin layer 7 (a layer obtained by curing the second thermosetting resin layer 7). As shown in Fig. 4(a), two support pieces DXc (shape: rectangular) may be disposed at positions away from each other on both sides of the chip T1, or as shown in Fig. 4(b), one support piece DXc (shape: square, four in total) may be disposed at each position corresponding to the corners of the chip T1. The length of one side of the support piece DXc in plan view is, for example, 20 mm or less, and may be 1 to 20 mm or 1 to 12 mm. The thickness (height) of the support piece DXc is, for example, 10 to 180

μm, and may be 20 to 120 μm.

[0068] Next, the method for producing the semiconductor device 100 will be described. The production method of the present embodiment includes the following steps (A) to (G). The production method of the present embodiment may further include the following step (H).

(A) Preparing a laminated film for forming support pieces 20X (hereinafter, may be simply referred to as "laminated film 20X") including a base film 1, a pressure-sensitive adhesive layer 2, and a film for forming support pieces DX (hereinafter, may be simply referred to as "film DX") that is singulated into a plurality of pieces by dicing, in this order, wherein the film DX has a first thermosetting resin layer 5, a rigid material layer 6, and a second thermosetting resin layer 7 in this order from the pressure-sensitive adhesive layer 2, and the second thermosetting resin layer 7 contains an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm

(B) Forming a plurality of support pieces DXa on the surface of the pressure-sensitive adhesive layer 2 by dicing the film DX (see Fig. 5(b))

(C) Picking up the support pieces DXa from the pressure-sensitive adhesive layer 2 (see Fig. 5(d))

(D) Disposing the chip T1 on the substrate 10

(E) Disposing a plurality of support pieces DXa on the substrate 10 around the chip T1 or around a region where the chip T1 is to be disposed (see Fig. 6)

(F) Preparing a chip with an adhesive piece T2a including the chip T2 and an adhesive piece Ta provided on one surface of the chip T2 (see

Fig. 7)

(G) Constructing a dolmen structure by disposing the chip with the adhesive piece T2a on the surfaces of the plurality of support pieces DXc (see Fig. 8)

5 (H) Sealing the gap between the chip T1 and the chip T2 and the like with an encapsulant 50 (see Fig. 3)

[0069] (Step (A))

Step (A) is preparing the laminated film 20X. The above-described laminated film 20 can be used as the laminated film 20X. At this time,
10 the film D becomes the film DX. When using the laminated film 20X, the cover film 3 is peeled off at an appropriate timing.

[0070] (Steps (B) and (C))

Step (B) is forming a plurality of support pieces DXa on the surface of the pressure-sensitive adhesive layer 2 by dicing the film DX, and step
15 (C) is picking up the support pieces DXa from the pressure-sensitive adhesive layer 2. As shown in Fig. 5(a), a dicing ring DR is attached to the laminate obtained by peeling the cover film 3 from the laminated film 20X. That is, the dicing ring DR is attached to the pressure-sensitive adhesive layer 2 of the laminated film 20X so that the film DX is
20 disposed inside the dicing ring DR. In this state, the film DX is singulated by dicing (see Fig. 5(b)). The dicing may be, for example, blade dicing or laser dicing. As a result, a large number of support pieces DXa can be obtained from the film DX. The support piece DXa includes a first adhesive piece 5p, a rigid material piece 6p, and a second adhesive
25 piece 7p. Thereafter, when the pressure-sensitive adhesive layer 2 is an ultraviolet-curable pressure-sensitive adhesive layer, the pressure-

sensitive adhesive layer 2 is irradiated with ultraviolet rays to reduce the adhesive force between the pressure-sensitive adhesive layer 2 and the support pieces DXa. As shown in Fig. 5(c), the pressure-sensitive adhesive layer 2 is expanded to separate the support pieces DXa from each other. As shown in Fig. 5(d), the support pieces DXa are pushed up by a push-up jig 42 to peel the support pieces DXa from the pressure-sensitive adhesive layer 2, and the support pieces DXa are picked up by suction with a suction collet 44. The film DX before dicing or the support pieces DXa before pickup may be heated to advance the curing reaction of the first thermosetting resin layer 5 and the second thermosetting resin layer 7. When the support pieces DXa are appropriately cured at the time of pickup, there is a tendency for excellent pickupability. The cuts for singulation are preferably formed up to the outer edge of the film DX.

15 [0071] (Step (D))

Step (D) is disposing the chip T1 on the substrate 10. For example, first, the chip T1 is disposed at a predetermined position on the substrate 10 via an adhesive piece T1c. Thereafter, the chip T1 is electrically connected to the substrate 10 by a wire w. Step (D) may be a step carried out before step (E) or a step carried out after step (E), and may be carried out before step (A), between steps (A) and (B), between steps (B) and (C), or between steps (C) and (E).

[0072] (Step (E))

Step (E) is disposing a plurality of support pieces DXa on the substrate 10 around the chip T1 or around a region where the chip T1 is to be disposed (see Fig. 6). Through step (E), the structure 30 shown in Fig.

6 is produced. The structure 30 includes the substrate 10, the chip T1 disposed on the surface thereof, and the plurality of support pieces DXa. The disposition of the support pieces DXa can be carried out by pressure bonding. The pressure bonding can be carried out, for example, under conditions of 80 to 180 °C and 0.01 to 0.50 MPa for 0.5 to 3.0 seconds. The support pieces DXa may be completely cured to become support pieces DXc at the time of step (E), or may not be completely cured at this point. The support pieces DXa are preferably completely cured to become support pieces DXc before the start of step (G).

[0073] (Step (F))

Step (F) is preparing a chip with an adhesive piece T2a including the chip T2 and an adhesive piece Ta provided on one surface of the chip T2 (see Fig. 7). The chip with the adhesive piece T2a includes the chip T2 and an adhesive piece Ta provided on one surface thereof. The chip with the adhesive piece T2a can be obtained, for example, by using a semiconductor wafer and a dicing/die-bonding integrated film, and going through a dicing step and a pickup step.

[0074] (Step (G))

Step (G) is disposing the chip with the adhesive piece T2a such that the adhesive piece Ta is in contact with the upper surfaces of the plurality of support pieces DXc and the upper surface of the chip T1 (see Fig. 8). Specifically, the chip T2 is pressure-bonded onto the upper surfaces of the support pieces DXc and the upper surface of the chip T1 via the adhesive piece Ta. The pressure bonding can be carried out, for example, under conditions of 80 to 180 °C and 0.01 to 0.50 MPa for 0.5 to 3.0 seconds. Next, the adhesive piece Ta is cured by heating. The curing

treatment can be carried out, for example, under conditions of 60 to 175 °C and 0.01 to 1.0 MPa for 5 minutes or more. As a result, the adhesive piece Ta is cured to become the adhesive piece Tc. Through this step, a dolmen structure is constructed on the substrate 10 (see Fig. 8).

[0075] After step (G) and before step (H), the chip T3 is disposed on the chip T2 via an adhesive piece, and further, the chip T4 is disposed on the chip T3 via an adhesive piece. The adhesive piece may be a thermosetting resin composition similar to the above-described adhesive piece Ta, and becomes the adhesive piece Tc by heat curing (see Fig. 3). On the other hand, the chips T2, T3, and T4 are each electrically connected to the substrate 10 by wires w. The number of chips stacked above the chip T1 is not limited to three in the present embodiment, and can be set as appropriate.

[0076] (Step (H))

Step (H) is sealing the gap between the chip T1 and the chip T2, and the like with the encapsulant 50 (see Fig. 3). Through step (H), the semiconductor device 100 shown in Fig. 3 can be obtained.

[0077] <Second Embodiment>

Fig. 9 is a cross-sectional view schematically showing a second embodiment of the semiconductor device of the present disclosure. While the semiconductor device 100 of the first embodiment is an aspect in which the chip T1 is in contact with the adhesive piece Tc, the semiconductor device 200 of the present embodiment is an aspect in which the chip T1 is spaced apart from the adhesive piece Tc (see Fig. 9). For example, by appropriately setting the thickness of the support

pieces DXc, a space for the wire w connecting the upper surface of the chip T1 and the substrate 10 can be secured. By having the chip T1 spaced apart from the adhesive piece Tc, it is possible to prevent a short circuit of the wire w due to the upper portion of the wire w connected to the chip T1 coming into contact with the chip T2. In addition, since there is no need to embed a wire in the adhesive piece Tc in contact with the chip T2, there is an advantage that the adhesive piece Tc can be made thinner.

[0078] The embodiments of the present disclosure have been described in detail above, but the present disclosure is not limited to the above-described embodiments. For example, in the above-described embodiments, the case where the pressure-sensitive adhesive layer 2 is an ultraviolet-curable pressure-sensitive adhesive layer has been exemplified, but the pressure-sensitive adhesive layer 2 may be a non-ultraviolet-curable pressure-sensitive adhesive layer.

[Examples]

[0079] Hereinafter, the present disclosure will be described by way of examples, but the present disclosure is not limited to these examples.

[0080] [Preparation of Thermosetting Resin Varnish]

<Preparation of Varnish A>

Varnish A for producing the first thermosetting resin layer and the second thermosetting resin layer was prepared using the following materials. The numerical values of parts by mass of the following materials mean parts by mass of solid content. The same applies to the numerical values of parts by mass of Varnishes B to G.

(Epoxy Resin)

- N-500P-10 (trade name, manufactured by DIC Corporation, o-cresol novolac-type epoxy resin, epoxy equivalent: 204 g/eq, softening point: 75 to 85 °C): 7.1 parts by mass
(Curing Agent)
- 5 · MEH-7800M (trade name, manufactured by Meiwa Kasei Co., Ltd. (currently UBE Corporation), phenylaralkyl-type phenolic resin, hydroxyl equivalent: 174 g/eq, softening point: 80 °C): 3.2 parts by mass
- GPH-103 (trade name, manufactured by Nippon Kayaku Co., Ltd., biphenylaralkyl-type phenolic resin, hydroxyl equivalent: 220 to 240
10 g/eq, softening point: 99 to 106 °C): 4.2 parts by mass
(Elastomer)
- Solvent-changed product of SG-P3 (SG-P3 is a trade name (manufactured by Nagase ChemteX Corporation) and is an epoxy group-containing acrylic resin (glass transition temperature: 12 °C).): 75.6 parts
15 by mass
(Silica Particles)
- YA050C-HHG (trade name, manufactured by Admatechs Co., Ltd., vinylsilane surface-treated silica filler): 8.3 parts by mass
(Coupling Agent)
- 20 · A-189 (trade name, manufactured by Momentive Performance Materials Japan LLC, γ -mercaptopropyltrimethoxysilane): 0.4 parts by mass
- Y9669 (trade name, manufactured by Momentive Performance Materials Japan LLC, 3-phenylaminopropyltrimethoxysilane): 1.2 parts
25 by mass
(Curing Accelerator)

- 2PZ-CN (trade name, manufactured by Shikoku Chemicals Corporation, 1-cyanoethyl-2-phenylimidazole): 0.01 parts by mass (Solvent)
 - Cyclohexanone
- 5 [0081] <Preparation of Varnish B>
- Varnish B for producing the first thermosetting resin layer and the second thermosetting resin layer was prepared using the following materials.
- (Epoxy Resin)
- N-500P-10: 7.1 parts by mass
- 10 (Curing Agent)
- MEH-7800M: 3.2 parts by mass
 - GPH-103: 4.2 parts by mass
- (Elastomer)
- Solvent-changed product of SG-P3: 67.8 parts by mass
- 15 (Silica Particles)
- YA050C-HHG: 16.0 parts by mass
- (Coupling Agent)
- A-189: 0.4 parts by mass
 - Y9669: 1.2 parts by mass
- 20 (Curing Accelerator)
- 2PZ-CN: 0.01 parts by mass
- [0082] <Preparation of Varnish C>
- Varnish C for producing the first thermosetting resin layer and the second thermosetting resin layer was prepared using the following materials.
- 25 (Epoxy Resin)

- N-500P-10: 7.1 parts by mass
- (Curing Agent)
- MEH-7800M: 3.2 parts by mass
- GPH-103: 4.2 parts by mass
- 5 (Elastomer)
- Solvent-changed product of SG-P3: 51.8 parts by mass
- (Silica Particles)
- YA050C-HHG: 32.1 parts by mass
- (Coupling Agent)
- 10 · A-189: 0.4 parts by mass
- Y9669: 1.2 parts by mass
- (Curing Accelerator)
- 2PZ-CN: 0.01 parts by mass
- (Solvent)
- 15 · Cyclohexanone
- [0083] <Preparation of Varnish D>
- Varnish D for producing the first thermosetting resin layer and the second thermosetting resin layer was prepared using the following materials.
- 20 (Epoxy Resin)
- N-500P-10: 11.0 parts by mass
- EXA-830CRP (trade name, manufactured by DIC Corporation, bisphenol F-type liquid epoxy resin, epoxy equivalent: 155 to 163 g/eq): 13.0 parts by mass
- 25 (Curing Agent)

- MEH-7800M: 18.7 parts by mass
(Elastomer)
- Solvent-changed product of SG-P3: 48.8 parts by mass
(Silica Particles)
- 5 · K180SE-EH1 (trade name, manufactured by Admatechs Co., Ltd.): 8.3 parts by mass
(Coupling Agent)
- A-189: 0.1 parts by mass
- A-1160 (trade name, manufactured by Momentive Performance Materials Japan LLC, γ -ureidopropyltriethoxysilane): 0.2 parts by mass
(Curing Accelerator)
- 10 · 2PZ-CN: 0.06 parts by mass
(Solvent)
- Cyclohexanone
- 15 [0084] <Preparation of Varnish E>
Varnish E for producing the first thermosetting resin layer and the second thermosetting resin layer was prepared using the following materials.
(Epoxy Resin)
- N-500P-10: 11.0 parts by mass
- 20 · EXA-830CRP: 13.0 parts by mass
(Curing Agent)
- MEH-7800M: 18.7 parts by mass
(Elastomer)
- Solvent-changed product of SG-P3: 48.8 parts by mass
(Silica Particles)
- 25

- 3SE-EH1 (trade name, manufactured by Admatechs Co., Ltd.): 8.3 parts by mass
- (Coupling Agent)
- A-189: 0.1 parts by mass
- 5 · A-1160: 0.2 parts by mass
- (Curing Accelerator)
- 2PZ-CN: 0.06 parts by mass
- (Solvent)
- Cyclohexanone
- 10 [0085] <Preparation of Varnish F>
- Varnish F for producing the first thermosetting resin layer and the second thermosetting resin layer was prepared using the following materials.
- (Epoxy Resin)
- N-500P-10: 9.7 parts by mass
- 15 (Curing Agent)
- MEH-7800M: 10.6 parts by mass
- (Elastomer)
- Solvent-changed product of SG-P3: 69.8 parts by mass
- (Silica Particles)
- 20 · R972 (trade name, manufactured by Admatechs Co., Ltd., dimethyldichlorosilane surface-treated silica filler): 8.3 parts by mass
- (Coupling Agent)
- A-189: 0.4 parts by mass
- A-1160: 1.3 parts by mass
- 25 (Curing Accelerator)

- 2PZ-CN: 0.02 parts by mass
- (Solvent)
- Cyclohexanone
- [0086] <Preparation of Varnish G>
- 5 Varnish G for producing the first thermosetting resin layer and the second thermosetting resin layer was prepared using the following materials.
- (Epoxy Resin)
- N-500P-10: 11.0 parts by mass
- 10 · EXA-830CRP: 13.0 parts by mass
- (Curing Agent)
- MEH-7800M: 18.7 parts by mass
- (Elastomer)
- Solvent-changed product of SG-P3: 48.8 parts by mass
- 15 (Silica Particles)
- SC2050-HLG (trade name, manufactured by Admatechs Co., Ltd.): 8.3 parts by mass
- (Coupling Agent)
- A-189: 0.1 parts by mass
- 20 · A-1160: 0.2 parts by mass
- (Curing Accelerator)
- 2PZ-CN: 0.06 parts by mass
- (Solvent)
- Cyclohexanone
- 25 [0087] (Example 1)

[Production of Laminated Film for Forming Singulated Bodies
(Laminated Film for Forming Support Pieces)]

(Production of Film for Forming Singulated Bodies (Film for Forming
Support Pieces))

5 As described above, cyclohexanone was used as a solvent, and the solid
content ratio of Varnish A was adjusted to 15% by mass. Varnish A was
filtered through a 100-mesh filter and vacuum-defoamed. A
polyethylene terephthalate (PET) film (thickness: 38 μm) subjected to a
release treatment was prepared as a film (cover film) onto which Varnish
10 A was to be applied. The vacuum-defoamed Varnish A was applied onto
the release-treated surface of the PET film. The applied Varnish A was
heated and dried in two stages: at 90 °C for 5 minutes, and then at 140 °C
for 5 minutes. In this way, a thermosetting resin layer (first
thermosetting resin layer and second thermosetting resin layer) in a B-
15 stage state (semi-cured state) was formed on the surface of the cover
film, and a first laminate including the cover film and the thermosetting
resin layer was obtained. Next, the thermosetting resin layer of the first
laminate was attached onto one surface of a polyimide film (thickness:
25 μm , tensile modulus: 46.4 MPa) as a rigid material layer on a hot plate
20 at 60 °C, thereby obtaining a second laminate including the cover film,
the thermosetting resin layer (second thermosetting resin layer), and the
polyimide film. Next, the thermosetting resin layer of the first laminate
was attached onto the surface of the polyimide film opposite to the
thermosetting resin layer (second thermosetting resin layer) on a hot
25 plate at 60 °C, thereby producing a film for forming singulated bodies
having a three-layer structure (first thermosetting resin layer, polyimide

film, and second thermosetting resin layer).

[0088] A laminated film (dicing film) having an ultraviolet-curable pressure-sensitive adhesive layer was produced by the following procedure. First, a copolymer was obtained by solution radical polymerization using 83 parts by mass of 2-ethylhexyl acrylate, 15 parts by mass of 2-hydroxyethyl acrylate, and 2 parts by mass of methacrylic acid as raw materials, and ethyl acetate as a solvent. To this acrylic copolymer, 12 parts by mass of 2-methacryloyloxyethyl isocyanate was reacted to synthesize an ultraviolet-irradiation-type acrylic copolymer having a carbon-carbon double bond. In this reaction, 0.05 parts of hydroquinone monomethyl ether was used as a polymerization inhibitor. The weight-average molecular weight of the synthesized acrylic copolymer was measured by GPC and found to be 300,000 to 700,000. The obtained acrylic copolymer, 2.0 parts in terms of solid content of a polyisocyanate compound (manufactured by Nippon Polyurethane Co., Ltd., trade name: Coronate L) as a curing agent, and 0.5 parts of 1-hydroxycyclohexyl phenyl ketone as a photopolymerization initiator were mixed to prepare an ultraviolet-irradiation-type pressure-sensitive adhesive solution. This ultraviolet-irradiation-type pressure-sensitive adhesive solution was applied onto a polyethylene terephthalate release film (thickness: 38 μm) and dried so that the thickness after drying would be 10 μm . Thereafter, a polyolefin film (thickness: 90 μm) with one surface subjected to a corona discharge treatment was bonded to the pressure-sensitive adhesive layer. The obtained laminated film was aged in a constant temperature bath at 40 °C for 72 hours to produce a dicing film.

[0089] The film for forming singulated bodies having a three-layer structure was bonded to the pressure-sensitive adhesive layer of the above-described dicing film using a rubber roll on a hot plate at 60 °C, with the surface of the film for forming singulated bodies having the first thermosetting resin layer facing the pressure-sensitive adhesive layer. As a result, a laminated film for forming singulated bodies of Example 1, which is a laminate of the film for forming singulated bodies and the dicing film, was obtained. The thickness of the first thermosetting resin layer and the thickness of the second thermosetting resin layer were each 25 μm .

[0090] [Measurement of Average Primary Particle Diameter of Silica Particles]

The average primary particle diameter of the silica particles was measured using the first laminate obtained above. The thermosetting resin layer of the first laminate was cut, and the cut surface (film cross-section) was observed using a scanning electron microscope, and an image of the cut surface (film cross-section) was taken. The major axes of 50 primary particles of the silica particles were measured from the captured image, and the average value thereof was obtained. The average primary particle diameter of the silica particles contained in the thermosetting resin layer was 50 nm. The results are summarized in Table 1.

[0091] [Measurement of Peel Strength of Thermosetting Resin Layer with Respect to Polyimide Film]

The 90° peel strength of the thermosetting resin layer (second thermosetting resin layer) with respect to the polyimide film was

measured using the second laminate obtained above. The 90° peel strength was measured by the following method. First, a piece of 25 mm in width × 100 mm in length was cut from the second laminate, and this was used as a measurement sample. Next, the 90° peel strength was measured by peeling off the thermosetting resin layer (second thermosetting resin layer) under conditions of a measurement temperature of 25 °C, a peel angle of 90°, and a peel speed of 50 mm/min, with the polyimide film side fixed to a metal support plate. As a result, the 90° peel strength was sufficiently strong, and no delamination was confirmed under the above measurement conditions. The results are summarized in Table 1.

[0092] (Example 2)

A laminated film for forming singulated bodies of Example 2 was obtained in the same manner as in Example 1, except that Varnish A was changed to Varnish B. The average primary particle diameter of the silica particles contained in the thermosetting resin layer was measured in the same manner as in Example 1, and the average primary particle diameter of the silica particles was 50 nm. The peel strength of the thermosetting resin layer (second thermosetting resin layer) with respect to the polyimide film was measured in the same manner as in Example 1, and the 90° peel strength was sufficiently strong, and no delamination was confirmed under the above measurement conditions. The results are summarized in Table 1.

[0093] (Example 3)

A laminated film for forming singulated bodies of Example 3 was obtained in the same manner as in Example 1, except that Varnish A was

changed to Varnish C. The average primary particle diameter of the silica particles contained in the thermosetting resin layer was measured in the same manner as in Example 1, and the average primary particle diameter of the silica particles was 50 nm. The peel strength of the thermosetting resin layer (second thermosetting resin layer) with respect to the polyimide film was measured in the same manner as in Example 1, and the 90° peel strength was sufficiently strong, and no delamination was confirmed under the above measurement conditions. The results are summarized in Table 1.

10 [0094] (Comparative Example 1)

A laminated film for forming singulated bodies of Comparative Example 1 was obtained in the same manner as in Example 1, except that Varnish A was changed to Varnish F. The average primary particle diameter of the silica particles contained in the thermosetting resin layer was measured in the same manner as in Example 1, and the average primary particle diameter of the silica particles was 16 nm. The peel strength of the thermosetting resin layer (second thermosetting resin layer) with respect to the polyimide film was measured in the same manner as in Example 1, and the 90° peel strength was 1.5 N/25 mm. The results are summarized in Table 1.

20 [0095] [Table 1]

		Comp. Exam. 1	Exam. 1	Exam. 2	Exam. 3
Type of varnish		Varnish F	Varnish A	Varnish B	Varnish C
Epoxy resin	N-500P-10	9.7	7.1	7.1	7.1
Curing agent	MEH-7800M	10.6	3.2	3.2	3.2
	GPH-103	-	4.2	4.2	4.2
Elastomer	Solvent-changed product of SG-P3	69.8	75.6	67.8	51.8
Silica particles	YA050C-HHG	-	8.3	16.0	32.1
	R972	8.3	-	-	-
Coupling agent	A-189	0.4	0.4	0.4	0.4
	A-1160	1.3	-	-	-
	Y9669	-	1.2	1.2	1.2
Curing accelerator	2PZ-CN	0.02	0.01	0.01	0.01
Average primary particle diameter of silica particles (nm)		16	50	50	50
90° peel strength (N/25 mm)		1.5	No delamination	No delamination	No delamination

[0096] (Example 4)

A laminated film for forming singulated bodies of Example 4 was obtained in the same manner as in Example 1, except that Varnish A was changed to Varnish D. The average primary particle diameter of the silica particles contained in the thermosetting resin layer was measured in the same manner as in Example 1, and the average primary particle diameter of the silica particles was 180 nm. The peel strength of the thermosetting resin layer (second thermosetting resin layer) with respect to the polyimide film was measured in the same manner as in Example 1, and the 90° peel strength was sufficiently strong, and no delamination was confirmed under the above measurement conditions. The results are summarized in Table 2.

[0097] (Example 5)

A laminated film for forming singulated bodies of Example 5 was

obtained in the same manner as in Example 1, except that Varnish A was changed to Varnish E. The average primary particle diameter of the silica particles contained in the thermosetting resin layer was measured in the same manner as in Example 1, and the average primary particle diameter of the silica particles was 300 nm. The peel strength of the thermosetting resin layer (second thermosetting resin layer) with respect to the polyimide film was measured in the same manner as in Example 1, and the 90° peel strength was sufficiently strong, and no delamination was confirmed under the above measurement conditions. The results are summarized in Table 2.

[0098] (Comparative Example 2)

A laminated film for forming singulated bodies of Comparative Example 2 was obtained in the same manner as in Example 1, except that Varnish A was changed to Varnish G. The average primary particle diameter of the silica particles contained in the thermosetting resin layer was measured in the same manner as in Example 1, and the average primary particle diameter of the silica particles was 500 nm. The peel strength of the thermosetting resin layer (second thermosetting resin layer) with respect to the polyimide film was measured in the same manner as in Example 1, and the 90° peel strength was 6.3 N/25 mm. The results are summarized in Table 2.

[0099] [Table 2]

		Exam. 4	Exam. 5	Comp. Exam. 2
Type of varnish		Varnish D	Varnish E	Varnish G
Epoxy resin	N-500P-10	11.0	11.0	11.0
	EXA-830CRP	13.0	13.0	13.0
Curing agent	MEH-7800M	18.7	18.7	18.7
Elastomer	Solvent-changed product of SG-P3	48.8	48.8	48.8
Silica particles	K180SE-EH1	8.3	-	-
	3SE-EH1	-	8.3	-
	SC2050-HLG	-	-	8.3
Coupling agent	A-189	0.1	0.1	0.1
	A-1160	0.2	0.2	0.2
Curing accelerator	2PZ-CN	0.06	0.06	0.06
Average primary particle diameter of silica particles (nm)		180	300	500
90° peel strength (N/25 mm)		No delamination	No delamination	6.3

[0100] As shown in Table 1 and Table 2, it was found that the thermosetting resin layer containing silica particles having an average primary particle diameter of 30 to 400 nm was higher in terms of the 90° peel strength of the thermosetting resin layer (second thermosetting resin layer) with respect to the polyimide film, compared to the thermosetting resin layer containing silica particles having an average primary particle diameter outside the predetermined range. From these results, it was suggested that the laminated film for forming singulated bodies including the film for forming singulated bodies of the present disclosure has sufficiently strong peel strength between the thermosetting resin layer and the rigid material layer, and is capable of suppressing the occurrence of interfacial delamination between layers of the film when the film for forming singulated bodies is diced and singulated.

Reference Signs List

[0101] 1: base film; 2: pressure-sensitive adhesive layer; 3: cover film;

5: first thermosetting resin layer; 5p: first adhesive piece; 5c: first
 adhesive piece (cured product); 6: rigid material layer; 6p: rigid material
 piece; 7: second thermosetting resin layer; 7p: second adhesive piece;
 7c: second adhesive piece (cured product); 10: substrate; 20: laminated
 5 film for forming singulated bodies (laminated film); 20X: laminated film
 for forming support pieces (laminated film); 50: encapsulant; 100, 200:
 semiconductor device; D: film for forming singulated bodies (film); DX:
 film for forming support pieces (film); DXa: support piece; DXc:
 support piece (cured product); R: region; T1, T2, T3, T4: chip; T2a: chip
 10 with adhesive piece; Ta: adhesive piece; Tc: adhesive piece (cured
 product).

CLAIMS

[Claim 1] A laminated film for forming singulated bodies, comprising:

a base film;

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a pressure-sensitive adhesive layer; and

a film for forming singulated bodies,

in this order,

wherein the film for forming singulated bodies has a first thermosetting resin layer, a rigid material layer, and a second thermosetting resin layer in this order from the pressure-sensitive adhesive layer, and

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the second thermosetting resin layer comprises an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm.

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[Claim 2] The laminated film for forming singulated bodies according to claim 1, wherein the rigid material layer is a polyimide layer.

[Claim 3] The laminated film for forming singulated bodies according to claim 1 or 2, wherein the first thermosetting resin layer comprises an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm.

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[Claim 4] A method for producing a semiconductor device having a dolmen structure comprising a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed on the substrate around the first chip, and a second chip supported by the plurality of support pieces and disposed so as to cover the first chip, the method comprising:

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5 (A) providing a laminated film for forming support pieces, the laminated film comprising a base film, a pressure-sensitive adhesive layer, and a film for forming support pieces in this order, the film for forming support pieces having a first thermosetting resin layer, a rigid material layer, and a second thermosetting resin layer in this order from the pressure-sensitive adhesive layer, and the second thermosetting resin layer comprising an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm;

10 (B) forming a plurality of support pieces on a surface of the pressure-sensitive adhesive layer by dicing the film for forming support pieces;

(C) picking up the support pieces from the pressure-sensitive adhesive layer;

(D) disposing a first chip on a substrate;

15 (E) disposing the plurality of support pieces on the substrate around the first chip or around a region where the first chip is to be disposed;

20 (F) providing a chip with an adhesive piece, the chip comprising a second chip and an adhesive piece provided on one surface of the second chip; and

(G) constructing a dolmen structure by disposing the chip with an adhesive piece on surfaces of the plurality of support pieces.

[Claim 5] The method for producing a semiconductor device according to claim 4, further comprising heating the film for forming support pieces or the support pieces before step (G).

[Claim 6] The method for producing a semiconductor device

according to claim 4 or 5, wherein the rigid material layer is a polyimide layer.

[Claim 7] The method for producing a semiconductor device according to claim 4 or 5, wherein the first thermosetting resin layer
5 comprises an epoxy resin, a curing agent, an elastomer, and silica particles having an average primary particle diameter of 30 to 400 nm.