DESCRIPTION

Title of Invention

METHOD FOR MANUFACTURING SEMICONDUCTOR DEVICE HAVING DOLMEN STRUCTURE, METHOD FOR MANUFACTURING SUPPORT PIECE, AND LAMINATE FILM FOR SUPPORT PIECE FORMATION

Technical Field

[0001] The present disclosure relates to a manufacturing method for a semiconductor device having a dolmen structure including a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed around the first chip, on the substrate, and a second chip supported by the plurality of support pieces and disposed to cover the first chip. In addition, the present disclosure relates to a manufacturing method for a support piece and a support piece formation laminate film. Note that, dolmen is a type of stone tomb, and includes a plurality of pillar stones, and a plate-shaped rock placed on the plurality of the pillar stones. In the semiconductor device having a dolmen structure, the support piece corresponds to the "pillar stone", and the second chip corresponds to the "plate-shaped rock".

Background Art

[0002] Recently, in the field of a semiconductor device, high integration, downsizing, and speed-up have been required. As one aspect of the semiconductor device, a structure in which a semiconductor chip is laminated on a controller chip disposed on a substrate has attracted attention. For example, in Patent Literature 1, a semiconductor die assembly including a controller die, and a memory die supported by a

support member on the controller die is disclosed. It can be said that a semiconductor assembly 100 illustrated in FIG. 1A of Patent Literature 1 has a dolmen structure. That is, the semiconductor assembly 100 includes a package substrate 102, a controller die 103 disposed on the surface of the package substrate 102, memory dies 106a and 106b disposed above the controller die 103, and support members 130a and 130b supporting the memory die 106a.

Citation List

Patent Literature

[0003] Patent Literature 1: JP No. 2017-515306

Summary of Invention

Technical Problem

[0004] In Patent Literature 1, it is disclosed that as the support member (a support piece), a semiconductor material such as silicon can be used, and more specifically, a fraction of a semiconductor material that is obtained by dicing a semiconductor wafer can be used (refer to [0012], [0014], and FIG. 2 of Patent Literature 1). In order to manufacture a support piece for a dolmen structure by using a semiconductor chip, as with the manufacturing of the general semiconductor chip, for example, each of the following steps is required:

(1) pasting a back grind tape to a semiconductor wafer;

(2) performing back grinding with respect to the semiconductor wafer;

(3) pasting a film including an adhesive layer and a bonding adhesive layer (a dicing die bonding-integrated film) to a dicing ring and the semiconductor wafer after the back grinding that is disposed in the

dicing ring;

(4) peeling off the back grind tape from the semiconductor wafer;

(5) singulating the semiconductor wafer; and

(6) picking up a support piece including a laminated body of a semiconductor chip and a bonding adhesive piece from the adhesive layer.

[0005] The present disclosure provides a manufacturing method for a semiconductor device in which in a manufacturing process of a semiconductor device having a dolmen structure, a step of preparing a support piece can be simplified, and a semiconductor chip to be laminated can be stably supported. In addition, the present disclosure provides a manufacturing method for a support piece and a support piece formation laminate film.

Solution to Problem

[0006] One aspect of the present disclosure relates to a manufacturing method for a semiconductor device having a dolmen structure including a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed around the first chip, on the substrate, and a second chip supported by the plurality of support pieces and disposed to cover the first chip. The manufacturing method for a semiconductor device includes the following steps:

(A) preparing a laminate film including a base material film, an adhesive layer, and a support piece formation film, in this order;

(B) forming support pieces on a surface of the adhesive layer by singulating the support piece formation film;

(C) picking up the support piece from the adhesive layer;

(D) disposing a first chip on a substrate;

(E) disposing the plurality of support pieces around the first chip, on the substrate;

(F) preparing a bonding adhesive piece-attached chip including a second chip, and a bonding adhesive piece provided on one surface of the second chip; and

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

[0007] According to the manufacturing method for a semiconductor device according to one aspect of the present disclosure, the support piece can be obtained by singulating the support piece formation film. Therefore, the step of preparing the support piece can be simplified, compared to the manufacturing method of the related art in which the fraction of the semiconductor material that is obtained by dicing the semiconductor wafer is used as the support piece. That is, in the related art, the steps of (1) to (6) described above were required, whereas since the support piece formation film does not include a semiconductor wafer, the steps of (1), (2), and (4) relevant to the back grinding of the semiconductor wafer can be omitted. In addition, since the semiconductor wafer that is more expensive than a resin material is not used, the cost can also be reduced.

[0008] In addition, a shear viscosity of the support piece formation film at 120°C is 4000 Pa·s or more. In a case where the shear viscosity of the support piece formation film at 120°C is 4000 Pa·s or more, the level of flow deformation of the support piece formation film decreases, and as a result thereof, a semiconductor chip to be laminated can be stably supported. The support piece formation film may include a

thermosetting resin layer.

[0009] The adhesive layer of the laminate film that is prepared in the (A) step may be a pressure-sensitive or ultraviolet-curable adhesive layer. That is, the adhesive layer may or may not be cured by being irradiated with an ultraviolet ray, in other words, may or may not contain a resin having a photoreactive carbon-carbon double bond. Note that, the pressure-sensitive adhesive layer may contain the resin having a photoreactive carbon-carbon double bond. For example, a predetermined region of the adhesive layer may be irradiated with an ultraviolet ray to decrease the adhesiveness of the region, and for example, the resin having a photoreactive carbon-carbon double bond may remain. In a case where the adhesive layer is the ultraviolet-curable adhesive layer, the adhesiveness of the adhesive layer can be decreased by performing a step of irradiating the adhesive layer with an ultraviolet ray, between the (B) step and the (C) step.

[0010] In a case where the support piece formation film includes a thermosetting resin layer, a step of curing the thermosetting resin layer or the bonding adhesive piece by heating the support piece formation film or the support piece may be performed at a suitable timing, and for example, may be performed before the (G) step. In a stage where the bonding adhesive piece-attached chip is disposed to be in contact with the surface of the plurality of support pieces, the deformation of the support piece due to the disposition of the bonding adhesive piece-attached chip can be suppressed by curing in advance the thermosetting resin layer. Note that, since the thermosetting resin layer has adhesiveness with respect to other members (for example, the substrate), a bonding adhesive

layer or the like may not be separately provided on the support piece.

[0011] The thickness of the support piece formation film, for example, may be 5 to 180 μm or 20 to 120 μm. By setting the thickness of the support piece formation film to be in such a range, a dolmen structure having a suitable height with respect to the first chip (for example, a controller chip) can be constructed. The support piece formation film may include a thermosetting resin layer. The thermosetting resin layer, for example, contains an epoxy resin, and it is preferably that the thermosetting resin layer contains an elastomer. Since the thermosetting resin layer configuring the support piece contains the elastomer, a stress in the semiconductor device can be relieved.

[0012] One aspect of the present disclosure relates to a manufacturing method for a support piece used in a manufacturing process of a semiconductor device having a dolmen structure. The manufacturing method for a support piece includes the following steps:

(A) preparing a laminate film including a base material film, an adhesive layer, and a support piece formation film, in this order;

(B) forming support pieces on a surface of the adhesive layer by singulating the support piece formation film; and

(C) picking up the support piece from the adhesive layer.

Note that, a shear viscosity of the support piece formation film at 120°C is 4000 Pa·s or more.

[0013] One aspect of the present disclosure relates to a support piece formation laminate film used in a manufacturing process of a semiconductor device having a dolmen structure including a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed

around the first chip, on the substrate, and a second chip supported by the plurality of support pieces and disposed to cover the first chip, the film including: a base material film; an adhesive layer; and a support piece formation film, in this order, in which a shear viscosity of the support piece formation film at 120°C is 4000 Pa·s or more. The support piece formation film may include a thermosetting resin layer.

Advantageous Effects of Invention

[0014] According to the present disclosure, a manufacturing method for a semiconductor device is provided in which in a manufacturing process of a semiconductor device having a dolmen structure, a step of preparing a support piece can be simplified, and a semiconductor chip to be laminated can be stably supported. In addition, according to the present disclosure, a manufacturing method for a support piece and a support piece formation laminate film are provided.

Brief Description of Drawings

[0015] FIG. 1 is a sectional view schematically illustrating a first embodiment of a semiconductor device.

FIG. 2(a), FIG. 2(b), and FIG. 2(c) are plan views schematically illustrating an example of a positional relationship between a first chip and a plurality of support pieces.

FIG. 3(a) is a plan view schematically illustrating one embodiment of a support piece formation laminate film, and FIG. 3(b) is a sectional view taken along line b-b of FIG. 3(a).

FIG. 4 is a sectional view schematically illustrating a step of bonding an adhesive layer and a support piece formation film.

FIG. 5(a), FIG. 5(b), FIG. 5(c), and FIG. 5(d) are sectional views

schematically illustrating a preparation procedure of a support piece.

FIG. 6 is a sectional view schematically illustrating a state in which a plurality of support pieces are disposed around a first chip, on a substrate.

FIG. 7 is a sectional view schematically illustrating an example of a bonding adhesive piece-attached chip.

FIG. 8 is a sectional view schematically illustrating a dolmen structure formed on a substrate.

FIG. 9 is a sectional view schematically illustrating a second embodiment of the semiconductor device.

FIG. 10(a) is a top view illustrating an example of a substrate with a support piece that is used in Examples, FIG. 10(b) is a sectional view taken along line b-b of FIG. 10(a), and FIG. 10(c) is a sectional view illustrating an example of a laminated body that is used in Examples.

Description of Embodiments

[0016] Hereinafter, embodiments of the present disclosure will be described in detail, with reference to the drawings. However, the present invention is not limited to the following embodiments. Note that, herein, a "(meth)acrylic acid" indicates an acrylic acid or a methacrylic acid, and "(meth)acrylate" indicates acrylate or methacrylate corresponding thereto. "A or B" may include either A or B, or may include both of A and B.

[0017] Herein, the term of "layer" also includes a structure having a shape formed on the entire surface and a structure having a shape formed on a part of the surface when seen in the plan view. In addition, herein, the term of "step" includes not only an independent step, but also a step

that is not clearly distinguishable from other steps insofar as a desired function of the step is attained. In addition, a numerical range represented by using "to" indicates a range including numerical values described before and after "to" as a minimum value and a maximum value, respectively.

[0018] Herein, in a case where there are a plurality of substances corresponding to each component in a composition, the content of each component in the composition indicates the total amount of the plurality of the substances in the composition, unless otherwise noted. In addition, exemplified materials may be used alone, or two or more types thereof may be used by being combined, unless otherwise noted. In addition, in numerical ranges described in stages herein, an upper limit value or a lower limit value of a numerical range in one stage may be replaced with an upper limit value or a lower limit value of a numerical range in another stage. In addition, in a numerical range described herein, an upper limit value or a lower limit value of the numerical range may be replaced with values described in Examples.

[0019] <First Embodiment>

(Semiconductor Device)

FIG. 1 is a sectional view schematically illustrating a first embodiment of a semiconductor device. A semiconductor device 100 illustrated in FIG. 1 includes a substrate 10, a chip T1 (a first chip) disposed on the surface of the substrate 10, a plurality of support pieces Dc disposed around the chip T1, on the surface of the substrate 10, a chip T2 (a second chip) disposed above the chip T1, a bonding adhesive piece Tc interposed between the chip T2 and the plurality of support pieces Dc,

chips T3 and T4 laminated on the chip T2, a plurality of wires w electrically connecting an electrode (not illustrated) on the surface of the substrate 10 and the chips T1 to T4, respectively, and a sealing material 50 filled in a gap between the chip T1 and the chip T2, or the like.

[0020] In this embodiment, the plurality of support pieces Dc, the chip T2, and the bonding adhesive piece Tc positioned between the support piece Dc and the chip T2 configure a dolmen structure on the substrate 10. The chip T1 is separated from the bonding adhesive piece Tc. By suitably setting the thickness of the support piece Dc, a space for the wire w connecting an upper surface of the chip T1 and the substrate 10 can be ensured.

[0021] The substrate 10 may be an organic substrate, or may be a metal substrate such as a lead frame. The thickness of substrate 10, for example, is 90 to 300 μm, and may be 90 to 210 μm, from the viewpoint of suppressing the warpage of the semiconductor device 100.

[0022] The chip T1, for example, is a controller chip, and is adhered to the substrate 10 by the bonding adhesive piece Tc and is electrically connected to the substrate 10 by the wire w. The shape of the chip T1 in the planar view, for example, is a quadrangular shape (a square shape or a rectangular shape). The length of one side of the chip T1, for example, is 5 mm or less, and may be 2 to 5 mm or 1 to 5 mm. The thickness of the chip T1, for example, is 10 to 150 μm, and may be 20 to 100 μm.

[0023] The chip T2, for example, is a memory chip, and is adhered onto the support piece Dc via the bonding adhesive piece Tc. The chip T2 has a size larger than that of the chip T1, in the planar view. The shape

of the chip T2 in the planar view, for example, is a quadrangular shape (a square shape or a rectangular shape). The length of one side of the chip T2, for example, is 20 mm or less, and may be 4 to 20 mm or 4 to 12 mm. The thickness of the chip T2, for example, is 10 to 170 μm, and may be 20 to 120 μm. Note that, the chips T3 and T4, for example, are a memory chip, and are adhered onto the chip T2 via the bonding adhesive piece Tc. The length of one side of the chips T3 and T4 may be identical to that of the chip T2, and the thickness of the chips T3 and T4 may also be identical to that of the chip T2.

[0024] The support piece Dc serves in the role of a spacer for forming a space around the chip T1. The support piece Dc contains a cured product of a support piece formation film (a cured product of a thermosetting resin composition). A shear viscosity of the support piece formation film at 120°C, as described below, is 4000 Pa·s or more. Note that, as illustrated in FIG. 2(a), two support pieces Dc (Shape: a rectangular shape) may be disposed in separated positions on both sides of the chip T1, as illustrated in FIG. 2(b), one support piece Dc (Shape: a square shape, a total of 4) may be disposed in each position corresponding to the corner of the chip T1, or as illustrated in FIG. 2(c), one support piece Dc (Shape: a rectangular shape, a total of 4) may be disposed in each position corresponding to the side of the chip T1. The length of one side of the support piece Dc in the planar view, for example, is 20 mm or less, and may be 1 to 20 mm or 1 to 12 mm. The thickness (the height) of the support piece Dc, for example, is 10 to 180 μm, and may be 20 to 120 μm.

[0025] (Preparation Method for Support Piece)

An example of a manufacturing method for a support piece will be described. A manufacturing method according to this embodiment includes the following (A) to (C) steps:

(A) preparing a support piece formation laminate film 20 (hereinafter, may be referred to as a "laminate film 20") including a base material film 1, an adhesive layer 2, and a support piece formation film D, in this order (refer to FIG. 3 and FIG. 4);

(B) forming support pieces Da on the surface of the adhesive layer 2 by singulating the support piece formation film D (refer to FIG. 5(b)); and

(C) picking up the support piece Da from the adhesive layer 2 (refer to FIG. 5(d)).

[0026] Note that, the support piece Dc illustrated in FIG. 1 is in a state after the bonding adhesive piece (the thermosetting resin composition) in the support piece Dc is cured. On the other hand, the support piece Da is in a state before the bonding adhesive piece (the thermosetting resin composition) in the support piece Da is completely cured (for example, refer to FIG. 5(b)).

[0027] The (A) to (C) steps are a process for manufacturing the plurality of support pieces Da. Hereinafter, the (A) to (C) steps will be described with reference to FIGS. 3 to 5.

[0028] [(A) Step]

The (A) step is a step of preparing the laminate film 20. The laminate film 20 includes the base material film 1, the adhesive layer 2, and the support piece formation film D. The base material film 1, for example, is a polyethylene terephthalate film (a PET film). The

adhesive layer 2 is formed into a circular shape by punching or the like (refer to FIG. 3(a)). The adhesive layer 2 may contain a pressure-sensitive adhesive, or may contain an ultraviolet-curable adhesive. In a case where the adhesive layer 2 contains the ultraviolet-curable adhesive, the adhesive layer 2 has properties of decreasing adhesiveness by being irradiated with an ultraviolet ray. The support piece formation film D is formed into a circular shape by punching or the like, and has a diameter smaller than that of the adhesive layer 2 (refer to FIG. 3(a)). The support piece formation film D may include a thermosetting resin layer 5 containing a thermosetting resin composition.

[0029] The thermosetting resin composition configuring the thermosetting resin layer 5 in the support piece formation film D can be in a semi-cured (a B-stage) state, and then, in a completely cured product (a C-stage) state by the subsequent curing treatment. The thermosetting resin composition may contain an epoxy resin, a curing agent, and an elastomer (for example, an acrylic resin), and as necessary, may further contain an inorganic filler, a curing accelerator, and the like, from the viewpoint of easily adjusting the shear viscosity in a predetermined range. The details of the thermosetting resin composition configuring the thermosetting resin layer 5 in the support piece formation film D will be described below.

[0030] The thickness of the support piece formation film D, for example, may be 5 to 180 μm or 20 to 120 μm. By setting the thickness of the support piece formation film to be in such a range, a dolmen structure having a suitable height with respect to the first chip (for example, the controller chip) can be constructed.

[0031] The shear viscosity of the support piece formation film D at 120°C is 4000 Pa·s or more. The shear viscosity of the support piece formation film D at 120°C may be 4500 Pa·s or more, may be 5000 Pa·s or more, may be 7000 Pa·s or more, may be 10000 Pa·s or more, may be 15000 Pa·s or more, may be 18000 Pa·s or more, may be 20000 Pa·s or more, or may be 23000 Pa·s or more. In a case where the shear viscosity of the support piece formation film D at 120°C is 4000 Pa·s or more, the level of flow deformation of the support piece formation film decreases, and as a result thereof, support stability of a semiconductor chip can be improved. An upper limit of the shear viscosity of the support piece formation film D at 120°C is not particularly limited, and may be 100000 Pa·s or less, may be 70000 Pa·s or less, or may be 50000 Pa·s or less. The shear viscosity of the support piece formation film D at 120°C, for example, can be adjusted by suitably adjusting the type, the content, or the like of components contained in the thermosetting resin composition described below.

[0032] The laminate film 20, for example, can be prepared by bonding a first laminate film including the base material film 1 and the adhesive layer 2 on the surface of the base material film 1, and a second laminate film including a cover film 3 and the support piece formation film D on the surface of the cover film 3 (refer to FIG. 4). The first laminate film is obtained through a step of forming the adhesive layer on the surface of the base material film 1 by coating, and a step of processing the adhesive layer into a predetermined shape (for example, a circular shape) by punching or the like. The second laminate film is obtained through a step of forming the support piece formation film on the surface of the

cover film 3 (for example, a PET film or a polyethylene film) by coating, and a step of processing the support piece formation film into a predetermined shape (for example, a circular shape) by punching or the like. When the laminate film 20 is used, the cover film 3 is peeled off at a suitable timing.

[0033] [(B) Step]

The (B) step is a step of forming support pieces Da on the surface of the adhesive layer 2 by singulating the support piece formation film D. As illustrated in FIG. 5(a), a dicing ring DR is pasted to the laminate film 20. That is, the dicing ring DR is pasted to the adhesive layer 2 of the laminate film 20 such that the support piece formation film D is disposed inside the dicing ring DR. The support piece formation film D is singulated by dicing (refer to FIG. 5(b)). Therefore, the plurality of support pieces Da are obtained from the support piece formation film D.

[0034] [(C) Step]

The (C) step is a step of picking up the support piece Da from the adhesive layer 2. As illustrated in FIG. 5(c), the support pieces Da are separated from each other by expanding the base material film 1. Next, as illustrated in FIG. 5(d), the support piece Da is thrust up by a thrust-up jig 42 such that the support piece Da is peeled off from the adhesive layer 2 and the support piece Da is picked up by being sucked with a suction collet 44.

[0035] (Manufacturing Method for Semiconductor Device)

A manufacturing method for the semiconductor device 100 will be described. A manufacturing method according to this embodiment includes the (A) to (C) steps, and further includes the following (D) to

(H) steps:

(D) disposing the first chip T1 on the substrate 10;

(E) disposing the plurality of support pieces Da (the support pieces Da including at least a metal piece 6p) that are obtained by the manufacturing method described above around the first chip T1, on the substrate 10 (refer to FIG. 6);

(F) preparing a bonding adhesive piece-attached chip T2a including a second chip T2, and a bonding adhesive piece Ta provided on one surface of the second chip T2 (refer to FIG. 7);

(G) constructing a dolmen structure by disposing the bonding adhesive piece-attached chip T2a on the surfaces of the plurality of support pieces Dc (refer to FIG. 8); and

(H) sealing the gap between the chip T1 and the chip T2, or the like, with the sealing material 50 (refer to FIG. 1).

[0036] The (D) to (H) steps are a process for constructing the dolmen structure on the substrate 10 by using the plurality of support pieces Da. Hereinafter, the (D) to (H) steps will be described with reference to FIGS. 6 to 8.

[0037] [(D) Step]

The (D) step is a step of disposing the first chip T1 on the substrate 10. For example, first, the chip T1 is disposed in a predetermined position on the substrate 10 via a bonding adhesive layer T1c. After that, the chip T1 is electrically connected to the substrate 10 by the wire w.

[0038] [(E) Step]

The (E) step is a step of disposing the plurality of support pieces Da around the first chip T1, on the substrate 10. Through this step, a

structural body 30 illustrated in FIG. 6 is prepared. The structural body 30 includes the substrate 10, and the chip T1 and the plurality of support pieces Da disposed on the surface of the substrate 10. The support piece Da may be disposed by a compression treatment. It is preferable that the compression treatment, for example, is performed in a condition of 80 to 180°C and 0.01 to 0.50 MPa, for 0.5 to 3.0 seconds. Note that, the support piece Da may become the support piece Dc by a bonding adhesive piece 5p in the support piece Da being completely cured at a time point of the (E) step, or the bonding adhesive piece 5p may not be completely cured at the time point. It is preferable that the bonding adhesive piece 5p in the support piece Da becomes a bonding adhesive piece 5c by being completely cured at a time point before the (G) step starts.

[0039] [(F) Step]

The (F) step is a step of preparing the bonding adhesive piece-attached chip T2a illustrated in FIG. 7. The bonding adhesive piece-attached chip T2a includes the chip T2, and the bonding adhesive piece Ta provided on one surface of the chip T2. The bonding adhesive piece-attached chip T2a, for example, can be obtained by using a semiconductor wafer and a dicing die bonding-integrated film through a dicing step and a pickup step.

[0040] [(G) Step]

The (G) step is a step of disposing the bonding adhesive piece-attached chip T2a above the chip T1 such that the bonding adhesive piece Ta is in contact with the upper surfaces of the plurality of support pieces Dc. Specifically, the chip T2 is compressed against the upper surface of

the support piece Dc via the bonding adhesive piece Ta. It is preferable that such a compression treatment, for example, is performed in a condition of 80 to 180°C and 0.01 to 0.50 MPa, for 0.5 to 3.0 seconds. Next, the bonding adhesive piece Ta is cured by heating. It is preferable that such a curing treatment, for example, is performed in a condition of 60 to 175°C and 0.01 to 1.0 MPa, for 5 minutes or more. Accordingly, the bonding adhesive piece Ta is cured to be the bonding adhesive piece Tc. Through this step, the dolmen structure is constructed on the substrate 10 (refer to FIG. 8).

[0041] The chip T3 is disposed on the chip T2 via a bonding adhesive piece, and the chip T4 is disposed on the chip T3 via a bonding adhesive piece, before the (H) step and after the (G) step. The bonding adhesive piece may contain the same thermosetting resin composition as that of the bonding adhesive piece Ta described above, and becomes the bonding adhesive piece Tc by heating and curing (refer to FIG. 1). On the other hand, each of the chips T2, T3, and T4 is electrically connected to the substrate 10 by the wire w. Note that, the number of chips to be laminated above the chip T1 is not limited to 3 described in this embodiment, and may be suitably set.

[0042] [(H) Step]

The (H) step is a step of sealing the gap between the chip T1 and the chip T2, or the like, with the sealing material 50. Through this step, the semiconductor device 100 illustrated in FIG. 1 is completed.

[0043] (Thermosetting Resin Composition)

As described above, the thermosetting resin composition configuring the thermosetting resin layer 5 in the support piece formation

film D may contain the epoxy resin, the curing agent, and the elastomer, and as necessary, may further contain the inorganic filler, the curing accelerator, and the like, from the viewpoint of easily adjusting the shear viscosity in a predetermined range. According to the studies of the present inventors, it is preferable that the support piece Da and the support piece Dc after curing have the following properties:

· Property 1: when the support piece Da is thermally compressed in a predetermined position of the substrate 10, a position shift is less likely to occur;

· Property 2: in the semiconductor device 100, the bonding adhesive piece 5c exhibits stress relieving properties (the thermosetting resin composition contains the elastomer (a rubber component));

· Property 3: adhesion strength between the bonding adhesive piece-attached chip and the bonding adhesive piece Tc is sufficiently high (die shear strength (shear strength) of the bonding adhesive piece 5c (that is, a cured product of a film including a thermosetting resin layer) with respect to the bonding adhesive piece Tc, for example, is 2.0 to 7.0 MPa or 3.0 to 6.0 MPa);

· Property 4: a contraction rate associated with curing is sufficiently small;

· Property 5: the visibility of the support piece Da by a camera is excellent in the pickup step (the thermosetting resin composition, for example, contains a colorant); and

· Property 6: the bonding adhesive piece 5c has sufficient mechanical strength.

[0044] [Epoxy Resin]

The epoxy resin is not particularly limited insofar as having an adhesion function by curing. A difunctional epoxy resin such as a bisphenol A type epoxy resin, a bisphenol F type epoxy resin, and a bisphenol S type epoxy resin, a novolac type epoxy resin such as a phenol novolac type epoxy resin and a cresol novolac type epoxy resin, and the like can be used. In addition, generally known epoxy resins such as a polyfunctional epoxy resin, a glycidyl amine type epoxy resin, a heterocyclic ring-containing epoxy resin, and an alicyclic epoxy resin can be applied. One type of the epoxy resins may be used alone, or two or more types thereof may be used together.

[0045] [Curing Agent]

Examples of the curing agent include a phenolic resin, an ester compound, aromatic amine, aliphatic amine, an acid anhydride, and the like. Among them, the phenolic resin is preferable from the viewpoint of attaining high die shear strength (shear strength). Examples of a commercially available product of the phenolic resin include LF-4871 (Product Name, a BPA novolac type phenolic resin), manufactured by DIC Corporation, HE-100C-30 (Product Name, a phenyl aralkyl type phenolic resin), manufactured by AIR WATER INC., PHENOLITE KA and TD series, manufactured by DIC Corporation, Milex XLC-series and XL series (for example, Milex XLC-LL), manufactured by Mitsui Chemicals, Inc., HE series (for example, HE100C-30), manufactured by AIR WATER INC., MEHC-7800 series (for example, MEHC-7800-4S), manufactured by MEIWA PLASTIC INDUSTRIES, LTD., JDPP series, manufactured by JFE Chemical Corporation, PSM series (for example, PSM-4326), manufactured by Gunei Chemical Industry Co., Ltd., and the

like. One type of the curing agents may be used alone, or two or more types thereof may be used together.

[0046] In a compounding amount of the epoxy resin and the phenolic resin, an equivalent ratio of an epoxy equivalent and a hydroxyl group equivalent is preferably 0.6 to 1.5, is more preferably 0.7 to 1.4, and is even more preferably 0.8 to 1.3, from the viewpoint of attaining high die shear strength (shear strength). By setting a compounding ratio to be in the range described above, both of curing properties and fluidity are easily attained to a sufficiently high level.

[0047] [Elastomer]

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.

[0048] As the elastomer, an acrylic resin is preferable, and 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 cross-linkable functional group, such as glycidyl acrylate or glycidyl methacrylate, is more preferable, from the viewpoint of the moldability of the film. Among the acrylic resins, an epoxy group-containing (meth)acrylic acid ester copolymer and epoxy group-containing acrylic rubber are preferable, and the epoxy group-containing acrylic rubber is more preferable. The epoxy group-containing acrylic rubber is rubber having an epoxy group that contains acrylic acid ester as a main component and mainly contains a copolymer such as butyl

acrylate and acrylonitrile, and a copolymer such as ethyl acrylate and acrylonitrile, and the like. Note that, the acrylic resin may have not only the epoxy group but also a cross-linkable functional group such as alcoholic or phenolic hydroxyl group and carboxyl group.

[0049] Examples of a commercially available product of the acrylic resin include SG-70L, SG-708-6, WS-023 EK30, SG-280 EK23, and a SG-P3 solvent-changed product (Product Name, acrylic rubber, Weight Average Molecular Weight: 800000, Tg: 12°C, Solvent: cyclohexanone), manufactured by Nagase ChemteX Corporation, a SG-P3 low-molecular-weight product (Product Name, manufactured by Nagase ChemteX Corporation, acrylic rubber, Weight Average Molecular Weight: 300000, Tg: 12°C, Solvent: cyclohexanone), and the like.

[0050] A glass transition temperature (Tg) of the acrylic resin is preferably -50 to 50°C, and is more preferably -30 to 30°C, from the viewpoint of the moldability of the film. A weight average molecular weight (Mw) of the acrylic resin is preferably 100000 to 3000000, and is more preferably 500000 to 2000000, from the viewpoint of the moldability of the film. Here, Mw indicates a value that is measured by gel permeation chromatography (GPC) and is converted by using a calibration curve of standard polystyrene. Note that, there is a tendency that a highly elastic bonding adhesive piece can be formed by using the acrylic resin having a narrow molecular weight distribution.

[0051] The amount of acrylic resin contained in the thermosetting resin composition is preferably 10 to 200 parts by mass, and is more preferably 20 to 100 parts by mass, with respect to the total of 100 parts by mass of the epoxy resin and an epoxy resin curing agent, from the viewpoint of

attaining high die shear strength (shear strength).

[0052] It is preferable that the amount of acrylic resin contained in the thermosetting resin composition is 50 parts or more by mass with respect to the total of 100 parts by mass of the epoxy resin and the epoxy resin curing agent, from the viewpoint of attaining a high shear viscosity.

[0053] [Inorganic Filler]

Examples of the inorganic filler include aluminum hydroxide, magnesium hydroxide, calcium carbonate, magnesium carbonate, calcium silicate, magnesium silicate, calcium oxide, magnesium oxide, aluminum oxide, aluminum nitride, aluminum borate whisker, boron nitride, crystalline silica, amorphous silica, and the like. One type of the inorganic fillers may be used alone, or two or more types thereof may be used together.

[0054] An average particle diameter of the inorganic filler is preferably 0.005 μm to 1.0 μm, and is more preferably 0.05 to 0.5 μm, from the viewpoint of attaining high die shear strength (shear strength). It is preferable that the surface of the inorganic filler is chemically modified, from the viewpoint of attaining high die shear strength (shear strength). Examples of a material for chemically modifying the surface include a silane coupling agent and the like. Examples of the type of functional group 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, an ethoxy group, and the like.

[0055] The content of the inorganic filler is preferably 20 to 200 parts by mass, and is more preferably 30 to 100 parts by mass, with respect to 100 parts by mass of resin components of the thermosetting resin composition,

from the viewpoint of attaining high die shear strength (shear strength).

[0056] [Curing Accelerator]

Examples of the curing accelerator include imidazoles and derivatives thereof, an organic phosphorus-based compound, secondary amines, tertiary amines, a quaternary ammonium salt, and the like. An imidazole-based compound is preferable from the viewpoint of attaining high die shear strength (shear strength). Examples of the imidazoles include 2-methyl imidazole, 1-benzyl-2-methyl imidazole, 1-cyanoethyl-2-phenyl imidazole, 1-cyanoethyl-2-methyl imidazole, and the like. One type of the curing accelerators may be used alone, or two or more types thereof may be used together.

[0057] The content of the curing accelerator in the thermosetting resin composition is preferably 0.04 to 3 parts by mass, and is more preferably 0.04 to 0.2 parts by mass, with respect to the total of 100 parts by mass of the epoxy resin and the epoxy resin curing agent, from the viewpoint of attaining high die shear strength (shear strength).

[0058] <Second Embodiment>

FIG. 9 is a sectional view schematically illustrating a second embodiment of the semiconductor device. In the semiconductor device 100 according to the first embodiment, the chip T1 is separated from the bonding adhesive piece Tc, whereas in a semiconductor device 200 according to this embodiment, the chip T1 is in contact with the bonding adhesive piece Tc. That is, the bonding adhesive piece Tc is in contact with the upper surface of the chip T1 and the upper surface of the support piece Dc. For example, the position of the upper surface of the chip T1 can be coincident with the position of the upper surface of the support

piece Dc by suitably setting the thickness of the support piece formation film D.

[0059] In the semiconductor device 200, the chip T1 is connected to the substrate 10 by flip chip connection but not wire bonding. Note that, even in a case where the chip T1 is connected to the substrate 10 by the wire bonding, the chip T1 can be in contact with the bonding adhesive piece Tc insofar as the wire w is embedded in the bonding adhesive piece Ta configuring the bonding adhesive piece-attached chip T2a together with the chip T2.

Examples

[0060] Hereinafter, the present disclosure will be described by Examples, but the present invention is not limited to these Examples.

[0061] [Preparation of Support Piece Formation Film]

<Preparation of Varnish>

Materials shown in Table 1 were used at compositional ratios (Unit: parts by mass) shown in Table 1. Cyclohexanone was added to an epoxy resin, a phenolic resin, and an inorganic filler, and was stirred and mixed. The content of the cyclohexanone was adjusted such that a solid content ratio was 40 mass% in a varnish to be finally obtained. An elastomer was added thereto, a coupling agent and a curing accelerator were further added, and stirring was performed until each component was homogeneous to prepare varnishes A to E.

[0062] The details of each component shown in Table 1 are as follows:

· Epoxy Resin: YDCN-700-10 (Product Name, manufactured by Nippon Steel & Sumikin Chemical Co., Ltd., an o-cresol novolac type epoxy resin, Epoxy Equivalent: 209 g/eq);

· EXA-830CRP (Product Name, manufactured by DIC Corporation, a bisphenol F type epoxy resin, Epoxy Equivalent: 159 g/eq);

· Phenolic Resin (Curing Agent): HE-100C-30 (Product Name, manufactured by AIR WATER INC., a phenol aralkyl type phenolic resin, Hydroxyl Group Equivalent: 170 g/eq);

· Phenolic Resin (Curing Agent): PSM-4326 (Product Name, manufactured by Gunei Chemical Industry Co., Ltd., a phenol novolac type phenolic resin, Hydroxyl Group Equivalent: 105 g/eq);

· Inorganic Filler: AEROSIL R972 (Product Name, manufactured by NIPPON AEROSIL CO., LTD., silica, an average particle diameter of 0.016 μm);

· Inorganic Filler: SC2050-HLG (Product Name, manufactured by Admatechs Company Limited, a silica filler dispersion liquid, an average particle diameter of 0.50 μm);

· Elastomer: a SG-P3 solvent-changed product (Product Name, manufactured by Nagase ChemteX Corporation, acrylic rubber, Weight Average Molecular Weight: 800000, Tg: 12°C, Solvent: cyclohexanone);

· Elastomer: a SG-P3 low-molecular-weight product (Product Name, manufactured by Nagase ChemteX Corporation, acrylic rubber, Weight Average Molecular Weight: 300000, Tg: 12°C, Solvent: cyclohexanone);

· Coupling Agent: A-189 (Product Name, manufactured by GE Toshiba Silicones Co., Ltd., γ-mercaptopropyl trimethoxy silane);

· Coupling Agent: A-1160 (Product Name, manufactured by GE Toshiba Silicones Co., Ltd., γ-ureidopropyl triethoxy silane); and

· Curing Accelerator: CUREZOL 2PZ-CN (Product Name,

manufactured by SHIKOKU CHEMICALS CORPORATION, 1-cyanoethyl-2-phenyl imidazole).

[0063] Table 1

Material		Varnish A	Varnish B	Varnish C	Varnish D	Varnish E
Epoxy resin	YDCN-700-10	13.5	11.4	5.4	16.2	15.2
Phenolic resin	HE-100C-30	-	-	16.2	14.2	14.2
	PSM-4326	11.0	9.0	13.3	23.2	22.2
Inorganic filler	R972	8.0	8.0	-	-	-
	SC2050-HLG	-	-	49.8	29.3	29.3
Elastomer	SG-P3 Solvent-changed product	66.0	70.0	14.9	8.4	18.7
	SG-P3 Low-molecular -weight product	-	-	-	8.4	-
Coupling agent	A-189	0.4	0.4	0.1	0.1	0.1
	A-1160	1.15	1.23	0.26	0.20	0.20
Curing accelerator	2PZ-CN	0.03	0.05	0.05	0.03	0.07

[0064] <Preparation of Support Piece Formation Film>

(Example 1)

The varnish A was filtered with a 100-mesh filter and was vacuum-defoamed. As a base material film, a polyethylene terephthalate (PET) film having a thickness of 38 μm that had been subjected to a mold release treatment was prepared, and the varnish A after being vacuum-defoamed was applied onto the PET film. The applied varnish A was heated and dried in two stages at 90°C for 5 minutes, and then, at 130°C for 5 minutes to obtain a support piece formation film of Example 1 in a B-stage state. A coating amount of the varnish A was adjusted such that the thickness was 50 μm.

[0065] (Example 2)

A support piece formation film of Example 2 was obtained as with Example 1, except that the varnish A was changed to the varnish B.

[0066] (Example 3)

A support piece formation film of Example 3 was obtained as with Example 1, except that the varnish A was changed to the varnish C.

[0067] (Comparative Example 1)

A support piece formation film of Comparative Example 1 was obtained as with Example 1, except that the varnish A was changed to the varnish D.

[0068] (Comparative Example 2)

A support piece formation film of Comparative Example 2 was obtained as with Example 1, except that the varnish A was changed to the varnish E.

[0069] [Evaluation of Support Piece Formation Film]

<Measurement of Shear Viscosity>

Each of the support piece formation films (having a thickness of 50 μm) of Examples 1 to 3 and Comparative Examples 1 and 2 was cut to have a predetermined size to prepare four film pieces. The four film pieces were laminated on a hot plate at 60°C by using a rubber roll to prepare a specimen having a thickness of 200 μm. The obtained specimen was punched with a ϕ9 mm of a punch, and a shear viscosity of each of the support piece formation films at a measurement temperature of 120°C was measured in the following condition by using a shear viscosimeter (manufactured by TA Instruments Japan Inc., Product Name: ARES-G2). Results are shown in Table 1.

· Measurement Frequency: 1 Hz

· Temperature Increase Rate: 5°C/minute

· Measurement Temperature: 35 to 130°C

· Axial Force: 100 gf (0.98 N)

[0070] <Evaluation of Support Stability>

(Preparation of Substrate with Support Piece)

Each of the support piece formation films (having a thickness of 50 μm) of Examples 1 to 3 and Comparative Examples 1 and 2 was pasted to an adhesive film including a base material film and an adhesive layer (the thickness of the adhesive layer was 10 μm, manufactured by Hitachi Chemical Co., Ltd.) to prepare a laminate film. The obtained laminate film was singulated by using a fully automatic dicer DFD-6361 (manufactured by DISCO CORPORATION). A dicing blade ZH05-SD4000-N1-xx-BB (manufactured by DISCO CORPORATION) was used. A cutting conditions were a number of blade rotations of 4000

rpm, a cutting rate of 50 mm/second, and a size of 6 mm × 3 mm. Next, a support piece was picked up by using a pickup collet.

[0071] Subsequently, two support pieces that were obtained were disposed on a solder resist substrate (manufactured by TAIYO HOLDINGS CO., LTD., Product Name: AUS-308), and were thermally compressed to obtain substrates with a support piece of Examples 1 to 3 and Comparative Examples 1 and 2. A thermal compression condition was a temperature of 120°C, a time of 1 second, and a pressure of 0.1 MPa. FIG. 10(a) is a top view illustrating an example of the substrate with a support piece used in Examples, and FIG. 10(b) is a sectional view taken along line b-b of FIG. 10(a). As illustrated in FIG. 10, a substrate 300 with a support piece includes a substrate 310, and two support pieces Da disposed on the substrate 310 to be in contact with both facing sides of the substrate 310.

[0072] (Preparation of Bonding Adhesive Piece-Attached Chip)

A dicing die bonding-integrated adhesive film including a film-shaped bonding adhesive and an adhesive film (Film-Shaped Bonding Adhesive: a thickness of 50 μm, Adhesive Film: a thickness of 110 μm, manufactured by Hitachi Chemical Co., Ltd.) and a silicon wafer having a thickness of 400 μm were prepared. The silicon wafer was laminated on the film-shaped bonding adhesive of the dicing die bonding-integrated adhesive film at a stage temperature of 70°C to prepare a dicing sample.

[0073] The obtained dicing sample was cut by using a fully automatic dicer DFD-6361 (manufactured by DISCO CORPORATION). The cutting was performed by a step cut method using two blades, and dicing blades ZH05-SD3500-N1-xx-DD and ZH05-SD4000-N1-xx-BB (both

are manufactured by DISCO CORPORATION) were used. A cutting condition was the number of blade rotations of 4000 rpm, a cutting rate of 50 mm/second, and a chip size of 6 mm × 12 mm. In the cutting, the first cutting was performed such that the silicon wafer of approximately 200 μm remained, and then, the second cutting was performed such that a cutout of approximately 20 μm was formed in the adhesive film. Next, a chip was picked up by using a pickup collet to obtain a bonding adhesive piece-attached chip.

[0074] (Preparation of Evaluation Sample)

The bonding adhesive piece of the bonding adhesive piece-attached chip was disposed on each support piece of the substrates with a support piece of Examples 1 to 3 and Comparative Examples 1 and 2 such that the substrate of the substrate with a support piece overlapped with the chip of the bonding adhesive piece-attached chip, and was thermally compressed. A thermal compression condition was a temperature of 120°C, a time of 1 second, and a pressure of 0.1 MPa. FIG. 10(c) is a sectional view illustrating an example of a laminated body used in Examples. As illustrated in FIG. 10(c), a laminated body 400 includes the substrate 300 with a support piece, and a bonding adhesive piece-attached chip T300a including a bonding adhesive piece Ta and a chip T300, and two support pieces Da disposed between the substrate 300 with a support piece and the bonding adhesive piece-attached chip T300a. Subsequently, the laminated body obtained by thermal compression was put in a drying machine, and was heated and cured 170°C for 1 hour to obtain evaluation samples of Examples 1 to 3 and Comparative Examples 1 and 2.

[0075] (Cross-Section Observation with Microscope)

The cross-sections of the prepared evaluation samples of Examples 1 to 3 and Comparative Examples 1 and 2 were observed with a microscope, and a variation in the heights of the support pieces was evaluated. A case where the support piece was not deformed or contracted, and the substrate and the chip were maintained in a parallel state was evaluated as "A", and a case where the support piece was deformed or contracted, and the substrate and the chip were not parallel to each other was evaluated as "B". Results are shown in Table 2.

[0076] Table 2

Item		Exam. 1	Exam. 2	Exam. 3	Comp. Exam. 1	Comp. Exam. 2
Support piece formation film	Type of varnish	Varnish A	Varnish B	Varnish C	Varnish D	Varnish E
	Shear viscosity (120°C, Pa·s)	23000	27000	4500	400	1600
Cross-section observation with microscope		A	A	A	B	B

[0077] As shown in Table 2, in the evaluation samples of Examples 1 to 3 using the support piece formation film of which the shear viscosity at 120°C was 4000 Pa·s or more, a variation in the heights of the support pieces was suppressed, compared to the evaluation samples of Comparative Examples 1 and 2 using the support piece formation film of which the shear viscosity at 120°C was less than 4000 Pa·s. As described above, it was checked that in the manufacturing method for a semiconductor device of the present invention, it was possible to manufacture a semiconductor device in which a semiconductor chip to be laminated was capable of being stably supported.

Industrial Applicability

[0078] According to the present disclosure, a manufacturing method for a semiconductor device is provided in which in a manufacturing process of a semiconductor device having a dolmen structure, a step of preparing a support piece can be simplified, and a semiconductor chip to be laminated can be stably supported. In addition, according to the present disclosure, a manufacturing method for a support piece and a support piece formation laminate film are provided.

Reference Signs List

[0079] 1: base material film, 2: adhesive layer, 5: thermosetting resin layer, 10, 310: substrate, 20: support piece formation laminate film, 50: sealing material, 100, 200: semiconductor device, 300: substrate with support piece, 400: laminated body, D: support piece formation film, Da: support piece, Dc: support piece (cured product), T1: first chip, T2: second chip, T300: chip, T2a, T300a: bonding adhesive piece-attached chip, Ta: bonding adhesive piece, Tc: bonding adhesive piece (cured

product).

CLAIMS

1. A manufacturing method for a semiconductor device having a dolmen structure including a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed around the first chip, on the substrate, and a second chip supported by the plurality of support pieces and disposed to cover the first chip, the method comprising:

(A) preparing a laminate film including a base material film, an adhesive layer, and a support piece formation film, in this order;

(B) forming support pieces on a surface of the adhesive layer by singulating the support piece formation film;

(C) picking up the support piece from the adhesive layer;

(D) disposing a first chip on a substrate;

(E) disposing the plurality of support pieces around the first chip, on the substrate;

(F) preparing a bonding adhesive piece-attached chip including a second chip, and a bonding adhesive piece provided on one surface of the second chip; and

(G) constructing a dolmen structure by disposing the bonding adhesive piece-attached chip on surfaces of the plurality of support pieces,

wherein a shear viscosity of the support piece formation film at 120°C is 4000 Pa·s or more.

2. The manufacturing method for a semiconductor device according to claim 1,

wherein the support piece formation film comprises a thermosetting resin layer, and

the method further comprises heating the support piece formation

film or the support piece, before the (G).

3. A manufacturing method for a support piece used in a manufacturing process of a semiconductor device having a dolmen structure including a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed around the first chip, on the substrate, and a second chip supported by the plurality of support pieces and disposed to cover the first chip, the method comprising:

(A) preparing a laminate film including a base material film, an adhesive layer, and a support piece formation film, in this order;

(B) forming support pieces on a surface of the adhesive layer by singulating the support piece formation film; and

(C) picking up the support piece from the adhesive layer,

wherein a shear viscosity of the support piece formation film at 120°C is 4000 Pa·s or more.

4. The manufacturing method for a support piece according to claim 3,

wherein the support piece formation film comprises a thermosetting resin layer.

5. A support piece formation laminate film used in a manufacturing process of a semiconductor device having a dolmen structure including a substrate, a first chip disposed on the substrate, a plurality of support pieces disposed around the first chip, on the substrate, and a second chip disposed to be supported by the plurality of support pieces and to cover the first chip, the film comprising:

a base material film;

an adhesive layer; and

a support piece formation film, in this order,

wherein a shear viscosity of the support piece formation film at 120°C is 4000 Pa·s or more.

6. The support piece formation laminate film according to claim 5, wherein the support piece formation film comprises a thermosetting resin layer.