

TITLE OF THE INVENTION

SEALABLE ADHESIVE SHEET

BACKGROUND OF THE INVENTION

Field of the Invention

[0001]

The present invention relates to a sealable adhesive sheet.

Description of Related Art

[0002]

Conventionally, it has been known that an electronic element (electronic device) that is mounted on a board is sealed by a sealable resin sheet, so that an electronic device is produced.

[0003]

For example, a method for producing an electronic device package has been proposed in which an electronic device sealable resin sheet is laminated on an electronic device, and next, the electronic device sealable resin sheet is cured to form a sealing body (ref: for example, Japanese Unexamined Patent Publication No. 2017-98353).

SUMMARY OF THE INVENTION

[0004]

The electronic device sealable sheet seals a semiconductor chip, and adheres to a surface of the board that is exposed from the semiconductor chip to be fixed thereto. In this manner, the electronic device package having excellent reliability can be produced. Thus, the electronic device sealable sheet is required to have excellent adhesive properties with respect to the board.

[0005]

The present invention provides a sealable adhesive sheet having excellent adhesive properties with respect to a board.

[0006]

The present invention (1) includes a sealable adhesive sheet configured to seal an electronic element mounted on a board and adhere to the board containing an adhesive composition, wherein a generation amount of an outgas at the time of heating the sealable adhesive sheet at 150°C for 30 minutes with respect to the sealable adhesive sheet before heating is 500 ppm or more.

[0007]

The present invention (2) includes the sealable adhesive sheet described in (1), wherein the adhesive composition contains a thermosetting component, an inorganic filler, and a coupling

agent.

[0008]

The present invention (3) includes the sealable adhesive sheet described in (2), wherein the mixed amount of the coupling agent with respect to 100 parts by mass of the total amount of the thermosetting component and the inorganic filler is 1 part by mass or more.

[0009]

The present invention (4) includes the sealable adhesive sheet described in (2) or (3), wherein the coupling agent is a silane coupling agent containing an epoxy group.

[0010]

The present invention (5) includes the sealable adhesive sheet described in any one of (1) to (4) further containing a remaining solvent, wherein a ratio of the remaining solvent in the sealable adhesive sheet is 5 ppm or more.

[0011]

The sealable adhesive sheet of the present invention contains the adhesive composition, so that the adhesive properties with respect to the board are excellent.

[0012]

Also, the generation amount of the outgas at the time of heating the sealable adhesive sheet of the present invention at 150°C for 30 minutes is the above-described lower limit or more, so that the adhesive properties of a cured adhesive sheet that is a cured body of the sealable adhesive sheet with respect to the board can be improved by the sufficient amount of outgas.

[0013]

Thus, the sealable adhesive sheet has excellent reliability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

FIG. 1 shows a cross-sectional view of a semiconductor element sealable adhesive sheet that is one embodiment of a sealable adhesive sheet of the present invention.

FIGS. 2A to 2B show process drawings of a method for producing a semiconductor element package by using the semiconductor element sealable adhesive sheet shown in FIG. 1 to seal a semiconductor element and to adhere to a board:

FIG. 2A illustrating a step of preparing the semiconductor element and the semiconductor element sealable adhesive sheet and

FIG. 2B illustrating a step of sealing the semiconductor element and adhering to the board by the semiconductor element sealable adhesive sheet.

FIGS. 3A to 3B show schematic views of the measurement of the adhesive strength in Examples:

FIG. 3A illustrating a cross-sectional view and

FIG. 3B illustrating a plan view.

DETAILED DESCRIPTION OF THE INVENTION

[0015]

A semiconductor element sealable adhesive sheet that is one embodiment of a sealable adhesive sheet of the present invention is described with reference to FIGS. 1 to 2B.

[0016]

A semiconductor element sealable adhesive sheet 1 is a sealable adhesive sheet for sealing a semiconductor element 3 as one example of an electronic element (ref: FIG. 2A) that is mounted on a board 2 and adhering to the board 2.

[0017]

The semiconductor element sealable adhesive sheet 1 is a component for producing a semiconductor element package 4 (ref: FIG. 2B) to be described later, and is not the semiconductor element package 4 itself. The semiconductor element sealable adhesive sheet 1 does not include the semiconductor element 3 and the board 2 that is mounted with the semiconductor element 3, and to be specific, is an industrially available device whose component alone can be circulated.

[0018]

The semiconductor element sealable adhesive sheet 1 is not a cured adhesive sheet 10 after sealing the semiconductor element 3 (ref: FIG. 2B) (described later), that is, a sheet before sealing the semiconductor element 3.

[0019]

As shown in FIG. 1, the semiconductor element sealable adhesive sheet 1 has a generally plate shape (film shape) extending in a direction perpendicular to a thickness direction (plane direction). The semiconductor element sealable adhesive sheet 1 includes an adhesive surface 5 as one example of a one-side surface that is positioned at one side in the thickness direction and a first facing surface 6 as one example of the other-side surface that faces the adhesive surface 5 in the thickness direction. Both of the adhesive surface 5 and the first facing surface 6 have a flat surface and are in parallel with each other.

[0020]

The adhesive surface 5 is a surface (lower surface) that is positioned at one side in the

thickness direction of the semiconductor element sealable adhesive sheet 1, and as shown in FIG. 2B, is a contact surface (one-side surface in the thickness direction) in contact with the semiconductor element 3 and the board 2 to adhere thereto when the semiconductor element sealable adhesive sheet 1 seals the semiconductor element 3.

[0021]

Meanwhile, the first facing surface 6 is a non-contact surface (the other-side surface in the thickness direction) (upper surface) that is disposed so as to face a to-be-adhered surface 8 (described later) of the board 2 at spaced intervals thereto in the thickness direction without contact with the semiconductor element 3 when the semiconductor element sealable adhesive sheet 1 seals the semiconductor element 3.

[0022]

The semiconductor element sealable sheet 1 contains an adhesive composition. To be specific, a material for the semiconductor element sealable adhesive sheet 1 is the adhesive composition (sealing adhesive composition). The adhesive composition contains, for example, a thermosetting component, an inorganic filler, and a coupling agent.

[0023]

The thermosetting component is a binder component that bonds the inorganic fillers to each other in the semiconductor element sealable adhesive sheet 1 (adhesive composition). The thermosetting component cures by heating and improves the hardness of the adhesive composition to develop the adhesive strength in the adhesive composition. Preferably, an epoxy thermosetting component (described later) is used.

[0024]

The thermosetting component contains, for example, a main agent (sealing resin), a curing agent, and a curing accelerator.

[0025]

Examples of the main agent include epoxy resin, phenol resin, melamine resin, vinyl ester resin, cyanoester resin, maleimide resin, and silicone resin. As the main agent, in view of heat resistance or the like, preferably, an epoxy resin is used. When the main agent is the epoxy resin, the thermosetting component, along with the curing agent (epoxy curing agent) and the curing accelerator (epoxy curing accelerator) to be described later, constitutes the epoxy thermosetting component.

[0026]

The main agent is a gas generation component that generates a main agent-derived gas

(vaporized substance of the main agent (preferably, epoxy resin)) when the semiconductor element sealable adhesive sheet 1 is heated to seal the semiconductor element 3.

[0027]

Examples of the epoxy resin include bifunctional epoxy resins such as bisphenol A epoxy resin, bisphenol F epoxy resin, modified bisphenol A epoxy resin, modified bisphenol F epoxy resin, and biphenyl epoxy resin and trifunctional or more of multifunctional epoxy resins such as phenol novolak epoxy resin, cresol novolak epoxy resin, trishydroxyphenyl methane epoxy resin, tetraphenylol ethane epoxy resin, and dicyclopentadiene epoxy resin. These epoxy resins can be used alone or in combination of two or more.

[0028]

Preferably, a bifunctional epoxy resin is used alone, and to be specific, a bisphenol F epoxy resin is used alone.

[0029]

The epoxy equivalent of the epoxy resin is, for example, 10 g/eq. or more, preferably 100 g/eq. or more, and for example, 300 g/eq. or less, preferably 250 g/eq. or less.

[0030]

The softening point of the main agent (preferably, epoxy resin) is, for example, 50°C or more, preferably 70°C or more, and for example, 110°C or less, preferably 90°C or less.

[0031]

The ratio of the main agent (preferably, epoxy resin) in the adhesive composition is, for example, 1 mass% or more, preferably 2 mass% or more, and for example, 30 mass% or less, preferably 10 mass% or less. The ratio of the main agent (preferably, epoxy resin) in the thermosetting component is, for example, 50 mass% or more, preferably 60 mass% or more, and for example, 90 mass% or less, preferably 10 mass% or less.

[0032]

When the ratio of the main agent (preferably, epoxy resin) is the above-described lower limit or more, a sufficient amount of main agent-derived gas is emitted, and a desired amount of outgas can be generated.

[0033]

The curing agent (preferably, epoxy resin curing agent) is a component that cures the above-described main agent by heating. Examples of the curing agent include phenol resins such as phenol novolak resin.

[0034]

As the ratio of the curing agent, when the main agent is the epoxy resin and the curing agent is the phenol resin, the total amount of the hydroxyl group in the phenol resin with respect to 1 equivalent of the epoxy group in the epoxy resin is adjusted to be, for example, 0.7 equivalent or more, preferably 0.9 equivalent or more, and for example, 1.5 equivalent or less, preferably 1.2 equivalent or less. To be specific, the mixed amount of the curing agent with respect to 100 parts by mass of the main agent is, for example, 30 parts by mass or more, preferably 50 parts by mass or more, and for example, 75 parts by mass or less, preferably 60 parts by mass or less.

[0035]

The curing accelerator is a catalyst (thermosetting catalyst) (preferably, epoxy resin curing accelerator) that promotes curing of the main agent by heating, and examples thereof include organic phosphorus compounds and imidazole compounds such as 2-phenyl-4-methyl-5-hydroxy methyl imidazole (2P4MHZ). Preferably, an imidazole compound is used. The mixed amount of the curing accelerator with respect to 100 parts by mass of the main agent is, for example, 0.05 parts by mass or more and for example, 5 parts by mass or less.

[0036]

The inorganic filler is inorganic particles for improving the strength of the semiconductor element sealable adhesive sheet 1 and imparting excellent toughness thereto. Examples of a material for the inorganic filler include inorganic compounds such as quartz glass, talc, silica, alumina, aluminum nitride, silicon nitride, and boron nitride. These can be used alone or in combination of two or more. Preferably, silica is used.

[0037]

The shape of the inorganic filler is not particularly limited, and examples of the shape thereof include generally sphere shape, generally plate shape, generally needle shape, and amorphous shape. Preferably, a generally sphere shape is used.

[0038]

An average value (in the case of a generally sphere shape, average particle size) M of the maximum length of the inorganic filler is, for example, 50 μm or less, preferably 20 μm or less, more preferably 10 μm or less, and for example, 0.1 μm or more, preferably 0.5 μm or more. The average particle size M is, for example, obtained as a D50 value (50% accumulation in median diameter) based on the particle size distribution obtained by a particle size distribution measurement method in a laser scattering method.

[0039]

The inorganic filler can include a first filler and a second filler having an average value M2 of the maximum length that is smaller than an average value M1 of the maximum length of the first filler.

[0040]

The average value (in the case of a generally sphere shape, average particle size) M1 of the maximum length of the first filler is, for example, 1 μm or more, preferably 3 μm or more, and for example, 50 μm or less, preferably 30 μm or less.

[0041]

The average value (in the case of a generally sphere shape, average particle size) M2 of the maximum length of the second filler is, for example, below 1 μm , preferably 0.8 μm or less, and for example, 0.01 μm or more, preferably 0.1 μm or more.

[0042]

The ratio (M1/M2) of the average value of the maximum length of the first filler to the average value of the maximum length of the second filler is, for example, 2 or more, preferably 5 or more, and for example, 50 or less, preferably 20 or less.

[0043]

The material for the first filler and that for the second filler may be the same or different from each other. Preferably, the material for the first filler and that for the second filler are the same, and to be specific, silica.

[0044]

Furthermore, the surface of the inorganic filler may be partially or entirely subjected to surface treatment by a silane coupling agent or the like. Preferably, the first filler that is not subjected to surface treatment and the second filler that is subjected to surface treatment are used in combination.

[0045]

The ratio of the inorganic filler (in the case of the use of the first filler and the second filler in combination, the total amount thereof) in the semiconductor element sealable adhesive sheet 1 (adhesive composition) is, for example, 50 mass% or more, preferably above 50 mass%, more preferably 55 mass% or more, further more preferably 60 mass% or more, and for example, 95 mass% or less, preferably 90 mass% or less, more preferably 85 mass% or less, further more preferably 75 mass% or less, even more preferably 70 mass% or less, particularly preferably below 70 mass%.

[0046]

When the ratio of the inorganic filler is above the above-described lower limit, the toughness of the semiconductor element sealable adhesive sheet 1 can be ensured.

[0047]

Meanwhile, when the ratio of the inorganic filler is below the above-described upper limit, the fragility of the semiconductor element sealable adhesive sheet 1 can be suppressed, and the semiconductor element 3 can be surely sealed.

[0048]

When the inorganic filler contains the above-described first filler and second filler, the ratio of the first filler in the adhesive composition is, for example, 40 mass% or more, preferably above 50 mass%, and for example, 80 mass% or less, preferably 70 mass% or less.

[0049]

When the inorganic filler contains the above-described first filler and second filler, the mixed amount of the second filler with respect to 100 parts by mass of the first filler is, for example, 30 parts by mass or more, preferably 45 parts by mass or more, more preferably 50 parts by mass or more, further more preferably above 50 parts by mass, and for example, below 100 parts by mass, preferably 80 parts by mass or less, more preferably 70 parts by mass or less, further more preferably 60 parts by mass or less.

[0050]

When the mixed amount of the second filler is above the above-described lower limit, or below the above-described upper limit, a relatively large gap between the first fillers can be efficiently filled with the second filler, the semiconductor element sealable adhesive sheet 1 having excellent toughness, and furthermore, the cured adhesive sheet 10 can be obtained.

[0051]

The coupling agent is a reactive component for forming the cured adhesive sheet 10 having toughness by coupling (chemically bonding) the thermosetting component (among all, main agent and curing agent) with (the surface of) the inorganic filler (preferably, silica). The coupling agent is also a gas generation component that generates a coupling agent-derived gas (gas obtained by vaporizing the coupling agent and gas of a product material ($R'_{4-n}Si - OH_n$) (ref: the next formula (1) for the details of the chemical formula) produced by a hydrolysis reaction (described later) of the coupling agent) and a remaining solvent-derived gas (though described later, preferably, solvent gas derived from a solvent such as alcohol (ROH) produced by subjecting an alkoxy group to hydrolysis reaction with water in the air) when the semiconductor element sealable adhesive sheet 1 is heated to seal the semiconductor element 3.

Both of the coupling agent-derived gas and the remaining solvent-derived gas described above along with the above-described main agent-derived gas (vaporized substance of the epoxy resin) constitute (are included in) the outgas.

[0052]

The coupling agent has at least two types of reactive groups of a first reactive group that reacts with the main agent and a second reactive group that reacts with the inorganic filler in one molecule. Examples of the first reactive group include epoxy group, vinyl group, (meth)acryloyl group, amino group, isocyanate group, and mercapto group. These first reactive groups may be used alone or in combination of two or more. As the first reactive group, preferably, an epoxy group is used. As the second reactive group, an alkoxy group or the like is used.

[0053]

To be specific, the coupling agent is, for example, a silane coupling agent.

[0054]

The silane coupling agent is, for example, represented by the following formula (1).

[0055]



In formula (1), R represents an alkyl group having a carbon number of 1 or more and 2 or less such as methyl and ethyl. R' represents a group having a first reactive group (preferably, an epoxy group to be described later). "n" represents, for example, an integer of 1 or more and 3 or less, preferably, an integer of 1 or 2.

[0056]

To be specific, an example of the silane coupling agent includes a silane coupling agent containing, as the above-described first reactive group, an epoxy group, a vinyl group, a (meth)acryloyl group, an amino group, an isocyanate group, a mercapto group, or the like. To be specific, examples of the silane coupling agent include silane coupling agent containing an epoxy group, silane coupling agent containing a vinyl group, silane coupling agent containing a (meth)acryloyl group, silane coupling agent containing an amino group, silane coupling agent containing an isocyanate group, and silane coupling agent containing a mercapto group.

[0057]

Examples of the silane coupling agent containing an epoxy group include 3-glycidoxy dialkyl dialkoxy silanes such as 3-glycidoxy propyl methyl dimethoxy silane and 3-glycidoxy propyl methyl diethoxy silane and 3-glycidoxy alkyl trialkoxy silanes such as 3-glycidoxy propyl

trimethoxy silane and 3-glycidoxy propyl triethoxy silane.

[0058]

Examples of the silane coupling agent containing a vinyl group include vinyl trimethoxy silane and vinyl triethoxy silane.

[0059]

Examples of the silane coupling agent containing a (meth)acryloyl group include silane coupling agents containing a methacryloyl group such as 3-methacryloxy propyl methyl dimethoxy silane, 3-methacryloxy propyl trimethoxy silane, 3-methacryloxy propyl methyl diethoxy silane, and 3-methacryloxy propyl triethoxy silane and silane coupling agents containing an acryloyl group such as 3-acryloxy propyl trimethoxy silane.

[0060]

Examples of the silane coupling agent containing an amino group include N-2-(aminoethyl)-3-aminopropyl methyl dimethoxy silane, N-2-(aminoethyl)-3-aminopropyl trimethoxy silane, 3-aminopropyl trimethoxy silane, 3-aminopropyl triethoxy silane, 3-triethoxysilyl-N-(1,3-dimethyl-butylidene) propylamine, and N-phenyl-3-aminopropyl trimethoxy silane.

[0061]

Examples of the silane coupling agent containing an isocyanate group include 3-isocyanatepropyl triethoxy silane.

[0062]

Examples of the silane coupling agent containing a mercapto group include 3-mercaptopropyl methyl dimethoxy silane and 3-mercaptopropyl trimethoxy silane.

[0063]

As the coupling agent, preferably, a silane coupling agent containing an epoxy group is used, more preferably, a 3-glycidoxy alkyl trialkoxy silane is used.

[0064]

The ratio of the coupling agent in the adhesive composition is, for example, 0.2 mass% or more, preferably 0.5 mass% or more, more preferably 1.0 mass% or more, and for example, 10 mass% or less, preferably 5 mass% or less. The mixed amount of the coupling agent with respect to 100 parts by mass of the total amount of the thermosetting component and the inorganic filler is, for example, 0.2 parts by mass or more, preferably 0.5 parts by mass or more, more preferably 1 part by mass or more, and for example, 10 parts by mass or less, preferably 5 parts by mass or less.

[0065]

When the ratio and/or the mixed amount of the coupling agent are/is the above-described lower limit or more, a sufficient amount of coupling agent-derived gas and remaining solvent-derived gas are emitted, and a desired amount of outgas can be generated, while the thermosetting component can be surely coupled with the inorganic filler.

[0066]

Meanwhile, when the ratio and/or the mixed amount of the coupling agent are/is the above-described upper limit or less, there is less concern of deposition (bleedout) toward the surface (the adhesive surface 5 and the first facing surface 6) after the production of the semiconductor element sealable adhesive sheet 1, and a stable varnish (described later) can be produced.

[0067]

An additive such as thermoplastic resin and pigment can be also added to the adhesive composition at an appropriate ratio.

[0068]

The thermoplastic resin is a component for improving the flexibility of the cured adhesive sheet 10 at the time of heating.

[0069]

Examples of the thermoplastic resin include natural rubber, butyl rubber, isoprene rubber, chloroprene rubber, ethylene-vinyl acetate copolymer, ethylene-acrylic acid copolymer, ethylene-acrylate copolymer, polybutadiene resin, polycarbonate resin, thermoplastic polyimide resin, polyamide resin (6-nylon, 6,6-nylon, or the like), phenoxy resin, acrylic resin, saturated polyester resin (PET or the like), polyamide imide resin, fluorine resin, and styrene-isobutylene-styrene block copolymer. These thermoplastic resins can be used alone or in combination of two or more.

[0070]

As the thermoplastic resin, preferably, in view of improvement of the dispersibility with the main agent (preferably, epoxy resin), an acrylic resin is used.

[0071]

An example of the acrylic resin includes a carboxyl group-containing (meth)acrylate copolymer (preferably, carboxyl group-containing acrylate copolymer) obtained by polymerizing a monomer component containing an alkyl (meth)acrylate having a straight-chain or branched alkyl group and another monomer (copolymerizable monomer).

[0072]

An example of the alkyl group includes an alkyl group having a carbon number of 1 to 6 such as methyl, ethyl, propyl, isopropyl, n-butyl, t-butyl, isobutyl, pentyl, and hexyl.

[0073]

Examples of the other monomer include carboxyl group-containing monomers such as acrylic acid, methacrylic acid, carboxyethyl acrylate, carboxypentyl acrylate, itaconic acid, maleic acid, fumaric acid, and crotonic acid.

[0074]

The weight average molecular weight of the thermoplastic resin is, for example, 100,000 or more, preferably 300,000 or more, and for example, 1,000,000 or less, preferably 800,000 or less. The weight average molecular weight is calibrated with standard polystyrene based on gel permeation chromatography (GPC).

[0075]

The ratio (solid content ratio) of the thermoplastic resin is adjusted so as not to block the thermal curing of the adhesive composition, and to be specific, the ratio (solid content ratio) of the thermoplastic resin with respect to the adhesive composition is, for example, 1 mass% or more, preferably 2 mass% or more, more preferably 3.5 mass% or more, and for example, 10 mass% or less, preferably 5 mass% or less, more preferably 4 mass% or less.

[0076]

The thermoplastic resin may be prepared by being diluted with an appropriate solvent.

[0077]

Examples of the pigment include black pigments such as carbon black. The average particle size of the pigment is, for example, 0.001 μm or more and for example, 1 μm or less. The ratio of the pigment with respect to the adhesive composition is, for example, 0.1 mass% or more, and for example, 2 mass% or less.

[0078]

To prepare the adhesive composition, the thermosetting component, the inorganic filler, the coupling agent, and if necessary, the additive are blended to be mixed. Preferably, the above-described each of the components and a solvent are blended to be mixed, thereby preparing a varnish.

[0079]

The solvent is not particularly limited, and examples thereof include ketones such as methyl ethyl ketone, aromatic solvents such as toluene, esters such as ethyl acetate, and alcohols

such as methanol and ethanol. Preferably, a ketone is used.

[0080]

The solvent preferably has a low molecular weight, and to be specific, the molecular weight thereof is, for example, 300 or less, preferably 200 or less, more preferably 100 or less, and for example, 20 or more, preferably 50 or more. When the molecular weight of the solvent is the above-described upper limit or less and lower limit or more, a remaining solvent-derived gas (gas derived from the solvent) that constitutes a portion of the outgas is sufficiently generated, and a desired amount of outgas can be generated.

[0081]

The mixed amount of the solvent is appropriately set, and with respect to 100 parts by mass of the total amount (total amount of the thermosetting component, the inorganic filler, the silane coupling agent, and the additive) (that is, the total amount of the solid content) of the above-described components is, for example, 5 parts by mass or more, preferably 25 parts by mass or more, more preferably 75 parts by mass or more, and for example, 1000 parts by mass or less, preferably 500 parts by mass or less. When the mixed amount of the solvent is the above-described lower limit or more, a remaining solvent-derived gas (gas derived from the solvent) that constitutes a portion of the outgas is sufficiently generated, and a desired amount of outgas can be generated. When the mixed amount of the solvent is the above-described upper limit or less, the relatively thick semiconductor element sealable adhesive sheet 1 can be easily produced by application, drying, or the like.

[0082]

Next, a method for producing the semiconductor element sealable adhesive sheet 1 is described.

[0083]

To produce the semiconductor element sealable adhesive sheet 1, for example, first, the above-described varnish is prepared. Next, as shown in FIG. 1, the varnish is applied to a first peeling sheet 15 to be dried. The drying conditions are the conditions in which the thermosetting component is not cured (to be specific, not completely cured), and a large portion of solvent (not all of the solvent) is removed. To be specific, the heating temperature is, for example, 40°C or more, preferably 70°C or more, and for example, 130°C or less, preferably 120°C or less, and the heating time is, for example, 10 seconds or more, preferably 1 minute or more, and for example, 15 minutes or less, preferably 10 minutes or less.

[0084]

In this manner, the semiconductor element sealable adhesive sheet 1 is produced in a state of being supported by the first peeling sheet 15. Thereafter, a second peeling sheet 16 is disposed at the opposite side to the first peeling sheet 15 with respect to the semiconductor element sealable adhesive sheet 1. That is, the semiconductor element sealable adhesive sheet 1 is produced in a state of being sandwiched between the first peeling sheet 15 and the second peeling sheet 16 in the thickness direction. The adhesive surface 5 and the first facing surface 6 of the semiconductor element sealable adhesive sheet 1 are in contact with the first peeling sheet 15 and the second peeling sheet 16, respectively.

[0085]

Each of the first peeling sheet 15 and the second peeling sheet 16 has flexibility, and has a sheet shape extending in the plane direction. Examples of a material for the first peeling sheet 15 and the second peeling sheet 16 include resins such as polyethylene terephthalate and polyimide, and metals such as stainless steel. Preferably, a resin is used. The surfaces (contact surfaces in contact with the semiconductor element sealable adhesive sheet 1) of the first peeling sheet 15 and the second peeling sheet 16 may be subjected to peeling treatment. Each of the thickness of the first peeling sheet 15 and the second peeling sheet 16 is, for example, 1 μm or more, preferably 10 μm or more, and for example, 1000 μm or less, preferably 500 μm or less.

[0086]

On the other hand, the semiconductor element sealable adhesive sheet 1 can be also produced from the adhesive composition (composition substantially not containing the solvent) by kneading and extruding without preparing a varnish. The first peeling sheet 15 and the second peeling sheet 16 are disposed on the semiconductor element sealable adhesive sheet 1 after extruding.

[0087]

Preferably, the varnish is prepared, and the semiconductor element sealable adhesive sheet 1 is formed by the application thereof. When the semiconductor element sealable adhesive sheet 1 is formed from the varnish, a desired amount of outgas (among all, the remaining solvent-derived gas based on the solvent) can be generated.

[0088]

The thermosetting component in the semiconductor element sealable adhesive sheet 1 is, for example, in a B-stage state (semi-cured state that is not a state of being completely cured). The B-stage state is a state between an A-stage in which the thermosetting component is liquid

and a C-stage in which the thermosetting component is completely cured. The B-stage state is a state in which the curing and the gelation of the thermosetting component slightly progress, and the compressive elastic modulus thereof is smaller than that of the C-stage.

[0089]

In this manner, the semiconductor element sealable adhesive sheet 1 is produced in a state where the adhesive surface 5 and the first facing surface 6 are supported (protected) by the first peeling sheet 15 and the second peeling sheet 16, respectively.

[0090]

In the semiconductor element sealable adhesive sheet 1, preferably, the remaining of the solvent is allowed. That is, the semiconductor element sealable adhesive sheet 1 contains the remaining solvent. Conventionally, the remaining solvent is an unpreferable component in the semiconductor element sealable adhesive sheet 1. However, in one embodiment, the remaining solvent is rather preferably allowed.

[0091]

The remaining solvent contains, for example, a solvent additionally blended at the time of the preparation of the varnish, an alcohol (ROH such as methanol and ethanol (ref: the following formula (2)) produced by subjecting the coupling agent to hydrolysis reaction with water in the air, or the like.

[0092]

The hydrolysis reaction of the coupling agent is represented by the following formula (2).

[0093]



In formula (2), R, R', and "n" are the same as those illustrated in the above-described formula (1).

[0094]

The ratio of the remaining solvent in the semiconductor element sealable adhesive sheet 1 based on the mass is, for example, 5 ppm or more, preferably 10 ppm or more, more preferably 20 ppm or more, further more preferably 30 ppm or more, and for example, 500 ppm or less, preferably 200 ppm or less.

[0095]

When the ratio of the remaining solvent is the above-described lower limit or more, a desired amount of outgas to be described next is generated, and the adhesive properties of the adhesive surface 5 with respect to the board 2 can be improved.

[0096]

The ratio of the remaining solvent is measured based on the methyl ethyl ketone conversion of GC-MS, and the details thereof are described in Examples later.

[0097]

The generation amount of the outgas when the semiconductor element sealable adhesive sheet 1 is heated at 150°C for 30 minutes with respect to the semiconductor element sealable adhesive sheet 1 before heating based on the mass is 500 ppm or more, preferably 750 ppm or more, more preferably 1,000 ppm or more, further more preferably 1,250 ppm or more, further more preferably 1,300 ppm or more, further more preferably 1,400 ppm or more, further more preferably 1,500 ppm or more, and for example, 10,000 ppm or less, preferably 5,000 ppm or less.

[0098]

The above-described heating conditions (heating at 150°C for 30 minutes) are one example of the conditions for obtaining the cured adhesive sheet 10 by completely curing the semiconductor element sealable adhesive sheet 1, and to be specific, also one example of the conditions for obtaining the cured adhesive sheet 10 adhering to (in contact with) the board 2.

[0099]

Conventionally, the outgas is an unpreferable component that is generated when the cured adhesive sheet 10 is obtained from the semiconductor element sealable adhesive sheet 1. However, in one embodiment, the generation of a large amount of outgas is rather required.

[0100]

The outgas is a low molecular weight (low molecular weight of, for example, 300 or less, preferably 200 or less, and for example, 20 or more, preferably 50 or more) organic gas that is generated from the semiconductor element sealable adhesive sheet 1 (to be more specific, sheet in the middle of transferring of the semiconductor element sealable adhesive sheet 1 to the cured adhesive sheet 10, or the cured adhesive sheet 10) under the above-described heating conditions (to be specific, the heating conditions for obtaining the cured adhesive sheet 10).

[0101]

To be specific, the outgas contains, for example, the above-described main agent-derived gas, coupling agent-derived gas, remaining solvent-derived gas (solvent gas derived from the remaining solvent), or the like.

[0102]

The outgas is measured with purge and trap gas chromatography, and the detailed

conditions thereof are described in Examples later.

[0103]

The thickness of the semiconductor element sealable adhesive sheet 1 is not particularly limited, and for example, 100 μm or more, and for example, 2000 μm or less.

[0104]

Next, a method for producing the semiconductor element package 4 by sealing the semiconductor element 3 by using the semiconductor element sealable adhesive sheet 1 is described.

[0105]

The method for producing the semiconductor element package 4 includes a step (ref: FIG. 2A) of preparing the semiconductor element 3, a step (ref: FIGS. 1 and 2A) of preparing the semiconductor element sealable adhesive sheet 1, and a step (ref: FIG. 2B) of obtaining the semiconductor element package 4 by sealing the semiconductor element 3 by the semiconductor element sealable adhesive sheet 1.

[0106]

In this method, as shown in FIG. 2A, first, the semiconductor element 3 is prepared.

[0107]

The semiconductor element 3 is not particularly limited, and various semiconductor elements are used. The semiconductor element 3 has, for example, a generally flat plate shape extending in the plane direction. A plurality of terminals (not shown) that are disposed at spaced intervals to each other in the plane direction are provided on a one-side surface (lower surface) in the thickness direction of the semiconductor element 3.

[0108]

The semiconductor element 3 is mounted on the to-be-adhered surface 8 (upper surface) (described later) of the board 2. To be specific, the semiconductor element 3 is, for example, flip-chip mounted on the board 2 via the above-described terminal.

[0109]

The board 2 is a mounted board having a generally flat shape extending in the plane direction. The board 2 has the to-be-adhered surface 8 (upper surface) that is mounted with the semiconductor element 3 and a second facing surface 9 that is disposed at spaced intervals to the to-be-adhered surface 8 in the thickness direction.

[0110]

The to-be-adhered surface 8 is a surface in contact with the adhesive surface 5 of the cured

adhesive sheet 10 to be adhered thereto, and has a flat surface along the plane direction. The to-be-adhered surface 8 is a mounted surface that is mounted with the semiconductor element 3, and has a size surrounding the semiconductor element 3. That is, when viewed from the top, the to-be-adhered surface 8 of the board 2 has an overlapped region 11 that is overlapped with the semiconductor element 3 and a to-be-adhered region (exposed region) 12 that is not overlapped with the semiconductor element 3, is exposed from the board 2, and directly adheres to the cured adhesive sheet 10. The to-be-adhered surface 8 includes a board terminal (not shown) corresponding to the terminal (not shown) of the semiconductor element 3 in the overlapped region 11. In FIGS. 2A and 2B, though not shown, the overlapped region 11 is disposed at a minute spaced interval to the lower surface of the semiconductor element 3 in the thickness direction.

[0111]

The second facing surface 9 is in parallel with the to-be-adhered surface 8, and has a flat surface along the plane direction.

[0112]

In this method, separately, as shown in FIGS. 1 and 2A, the semiconductor element sealable adhesive sheet 1 is prepared. To be specific, as shown by an arrow and a phantom line in FIG. 1, the first peeling sheet 15 is peeled from the adhesive surface 5 of the semiconductor element sealable adhesive sheet 1.

[0113]

As shown by the arrow in FIG. 2A, and FIG. 2B, thereafter, the semiconductor element sealable adhesive sheet 1 is disposed on the semiconductor element 3 so that the adhesive surface 5 is in contact with the other-side surface (upper surface) in the thickness direction of the semiconductor element 3.

[0114]

As shown in FIG. 2B, next, the semiconductor element 3 is sealed by the semiconductor element sealable adhesive sheet 1.

[0115]

For example, by using a flat plate press (not shown) including a lower board and an upper board, the semiconductor element sealable adhesive sheet 1 is heated and pressurized, so that the semiconductor element 3 is sealed by the semiconductor element sealable adhesive sheet 1.

[0116]

Also, the semiconductor element sealable adhesive sheet 1 is thermally cured by the

above-described heating. To be specific, the adhesive composition of the semiconductor element sealable adhesive sheet 1 is completely cured (brought into a C-stage state) after once being softened.

[0117]

The heating conditions are the conditions in which the adhesive composition is completely cured. To be specific, the heating temperature is, for example, 85°C or more, preferably 100°C or more, and for example, 125°C or less, preferably 110°C or less. The heating time is, for example, 10 minutes or more, preferably 30 minutes or more, and for example, 300 minutes or less, preferably 180 minutes or less. The pressure is not particularly limited, and for example, 0.1 MPa or more, preferably 0.5 MPa or more, and for example, 10 MPa or less, preferably 5 MPa or less.

[0118]

The semiconductor element sealable adhesive sheet 1 is once softened to embed the semiconductor element 3. In other words, the semiconductor element 3 is embedded in the semiconductor element sealable adhesive sheet 1.

[0119]

The adhesive surface 5 of the semiconductor element sealable adhesive sheet 1 is in contact with the to-be-adhered region 12 in the to-be-adhered surface 8, while covering the upper surface and the peripheral side surfaces of the semiconductor element 3.

[0120]

In this manner, the semiconductor element 3 is sealed by the semiconductor element sealable adhesive sheet 1. The to-be-adhered region 12 of the board 2 is in contact (tight contact) with the semiconductor element sealable adhesive sheet 1.

[0121]

The semiconductor element sealable adhesive sheet 1 that seals the semiconductor element 3 and is in contact with the to-be-adhered region 12 of the board 2 is already in a state of being thermally cured (completely cured) (C-stage) by heating. Thus, the semiconductor element sealable adhesive sheet 1 is brought into the cured adhesive sheet 10. The cured adhesive sheet 10 is a cured body of the semiconductor element sealable adhesive sheet 1.

[0122]

The adhesive composition of the above-described semiconductor element sealable adhesive sheet 1 is completely cured, so that the adhesive strength of the cured adhesive sheet 10 with respect to the board 2 and the semiconductor element 3 can be developed.

[0123]

As shown by the arrow in FIG. 2B, thereafter, the second peeling sheet 16 is peeled from the first facing surface 6 of the cured adhesive sheet 10. That is, the first facing surface 6 is exposed.

[0124]

In this manner, the semiconductor element package 4 (cured adhesive structure 20) including the board 2, the semiconductor element 3, and the cured adhesive sheet 10 is obtained.

[0125]

The semiconductor element sealable adhesive sheet 1 contains the adhesive composition, so that it has excellent adhesive properties with respect to the board 2.

[0126]

The generation amount of the outgas at the time of heating the semiconductor element sealable adhesive sheet 1 at 150°C for 30 minutes is the above-described lower limit or more, so that the adhesive properties of the cured adhesive sheet 10 that is the cured body of the semiconductor element sealable adhesive sheet 1 with respect to the board 2 can be improved by the sufficient amount of outgas.

[0127]

It is presumed that this is because the outgas, to be specific, the outgas containing the main agent-derived gas, the coupling agent-derived gas, and the remaining solvent-derived gas, among all, the main agent-derived gas and the coupling agent-derived gas subject the exposed region 12 in the to-be-adhered surface 8 of the board 2 to surface treatment (react with each other in the exposed region 12), and in this manner, the adhesive strength of the to-be-adhered surface 8 with the adhesive surface 5 is improved.

[0128]

<Modified Example>

In the following each of the modified examples, the same reference numerals are provided for members and steps corresponding to those of the above-described one embodiment, and their detailed description is omitted. Each of the modified examples can achieve the same function and effect as that of one embodiment unless otherwise specified. Furthermore, one embodiment and each of the modified examples can be also appropriately used in combination.

[0129]

Although not shown, the plurality of semiconductor elements 3 can be also sealed by the semiconductor element sealable adhesive sheet 1. In this case, the cured adhesive sheet 10 that

seals the plurality of semiconductor elements 3 is cut with a dicing saw or the like.

[0130]

In one embodiment, the semiconductor element 3 as one example of an electronic element is sealed by the semiconductor element sealable adhesive sheet 1 as one example of a sealable adhesive sheet. However, the sealable adhesive sheet is not limited to this. Although not shown, for example, an electronic element sealable adhesive sheet that seals another electronic element may be also used. In this case, the electronic element is sealed by the electronic element sealable adhesive sheet, so that an electronic element package can be obtained.

Examples

[0131]

Next, the present invention is further described based on Examples and Comparative Examples below. The present invention is however not limited by the following Examples and Comparative Examples. The specific numerical values in mixing ratio (content ratio), property value, and parameter used in the following description can be replaced with upper limit values (numerical values defined as “or less” or “below”) or lower limit values (numerical values defined as “or more” or “above”) of corresponding numerical values in mixing ratio (content ratio), property value, and parameter described in the above-described “DETAILED DESCRIPTION OF THE INVENTION”.

[0132]

Each of the components and sheets used in Examples and Comparative Examples is shown in the following.

[0133]

Epoxy resin: YSLV-80XY (thermosetting component) (bisphenol F epoxy resin (bifunctional epoxy resin), epoxy equivalent: 200 g/eq., softening point: 80°C), manufactured by New Nippon Steel Chemical Co., Ltd.

Curing agent: LVR-8210DL (thermosetting component) (novolak phenol resin, epoxy resin curing agent, hydroxyl equivalent: 104 g/eq., softening point: 60°C), manufactured by Gunei Chemical Industry Co., Ltd.

Curing accelerator: 2PHZ-PW (thermosetting component) (2-phenyl-4,5-dihydroxy methyl imidazole), manufactured by SHIKOKU CHEMICALS CORPORATION, epoxy resin curing accelerator

First filler: FB-8SM (spherical melted silica powder (inorganic filler), average particle size: 15 μm), manufactured by Denka Company Limited

Second filler: inorganic filler obtained by subjecting SC220G-SMJ (average particle size of 0.5 μm) manufactured by Admatechs Company Limited to surface treatment with 3-methacryloxy propyl trimethoxy silane (trade name: KBM-503, manufactured by Shin-Etsu Chemical Co., Ltd.). Inorganic filler subjected to surface treatment with 1 part by mass of silane coupling agent with respect to 100 parts by mass of SC220G-SMJ

[0134]

Silane coupling agent: KBM-403, manufactured by Shin-Etsu Chemical Co., Ltd. (coupling agent containing an epoxy group) (3-glycidoxy propyl trimethoxy silane)

Thermoplastic resin: HME-2006M, manufactured by Negami Chemical Industrial Co., Ltd., carboxyl group-containing acrylate copolymer, weight average molecular weight: 600,000, methyl ethyl ketone solution having a concentration of solid content of 20 mass%

Pigment: #20 (carbon black), manufactured by Mitsubishi Chemical Corporation

Solvent: methyl ethyl ketone

[0135]

Examples 1 to 4 and Comparative Examples 1 to 2

In accordance with the mixing formulation described in Table 1, each of the components was dissolved and dispersed in methyl ethyl ketone, thereby obtaining a varnish.

[0136]

The varnish was applied to the surface of the first peeling sheet 15 to be then dried at 110°C for 5 minutes. In this manner, the semiconductor element sealable adhesive sheet 1 having a thickness of 260 μm was produced. Thereafter, the second peeling sheet 16 was disposed on the first facing surface 6 of the semiconductor element sealable adhesive sheet 1.

[0137]

In this manner, the first peeling sheet 15 and the second peeling sheet 16 are disposed on the adhesive surface 5 and the first facing surface 6, respectively, so that the semiconductor element sealable adhesive sheet 1 in a B-stage state was obtained.

[0138]

[Properties]

As for the semiconductor element sealable adhesive sheet 1, the following items were measured. The results are described in Table 1.

[0139]

(Measurement of Outgas)

The semiconductor element sealable adhesive sheet 1 having a size of 2 mm square was

collected as a sample, a vial bottle was charged with the sample, and the mass of the sample was weighed. Subsequently, the sample was heated at 150°C for 30 minutes. The outgas generated from the sample during this heating was caught in a cooled trapping tube to be heated, and the mass of all of the caught outgas was calculated by a calibration curve with methyl ethyl ketone as a standard material with gas chromatography (GC-MS) connected to a mass spectrometer. Subsequently, a value obtained by dividing the calculated mass of the outgas by the mass of the charged semiconductor element sealable adhesive sheet 1 was obtained as an outgas amount (unit: ppm) (dynamic head space method).

[0140]

As an outgas concentrating device, MSTD-258M manufactured by GL Sciences Inc. was used.

[0141]

The catching conditions of the outgas were as follows: the gas flow rate of the chamber purge: 340 mL/min of N₂ gas, and a catching time of 30 minutes.

[0142]

As an analytical method, GC-MS of an analytical device was used; as the analytical conditions, DB-5MS of J&W capillary column was used in a column; the column temperature was defined as 40°C; and after holding for 3 minutes, the temperature was increased at a temperature rising rate of 9°C/min for 20 minutes until 220°C, and furthermore, the temperature was increased at a temperature rising rate of 10°C/min for 8 minutes until 300°C to be retained at 300°C for 3 minutes.

[0143]

The temperature of an injection port was defined as 250°C.

[0144]

As the carrier gas, He was used and the split ratio was defined as 1 to 10 at a flow rate of 1.5 mL/min.

[0145]

The MS analysis (mass analysis) was carried out by an electron ion method by using an analytical device (manufactured by Agilent, HP6890/5973-GC/MS).

[0146]

The temperature of a detector was defined as 230°C.

[0147]

(Measurement of Remaining Solvent)

The remaining solvent of the semiconductor element sealable adhesive sheet 1 was measured by the measurement based on the methyl ethyl ketone calibration of GC-MS.

[0148]

[Evaluation of Cured Adhesive Sheet]

The adhesive properties (measurement of the adhesive strength) of the cured adhesive sheet 10 were evaluated as follows.

[0149]

As shown in FIGS. 3A (cross-sectional view) and 3B (plan view), the board 2 consisting of an alumina board having a length of 50 mm, a width of 10 mm, and a thickness of 200 μm was prepared. The board 2 was not mounted with the semiconductor element 3, and a test board for measuring the adhesive strength.

[0150]

As shown by the phantom line and the arrow in FIG. 3A, next, the semiconductor element sealable adhesive sheet 1 having a size of 2 mm square was prepared, and the adhesive surface 5 of the semiconductor element sealable adhesive sheet 1 was attached to the surface of the board 2. Next, the attached laminate was heated at 150°C for 30 minutes. In this manner, the semiconductor element sealable adhesive sheet 1 adhered to the board 2 to be fixed thereto. In this manner, the cured adhesive structure 20 having the semiconductor element sealable adhesive sheet 1 and the board 2 was produced.

[0151]

Thereafter, the peeling strength of the semiconductor element sealable adhesive sheet 1 and the board 2 of the cured adhesive structure 20 was measured by using a universal bond tester (manufactured by Nordson Advanced Technology K.K., DAGE 4000). As shown in FIGS. 3A and 3B, the universal bond tester included a gauge 30 that was movable in a lengthwise direction. The gauge 30 had a pressing force surface 31 (one-side surface in the lengthwise direction) that was capable of pressing the cured adhesive sheet 10 at one side in the lengthwise direction.

[0152]

In the measurement of the peeling strength, the gauge 30 was disposed at one side in the lengthwise direction of the cured adhesive sheet 10 at a spaced interval (gap) of 50 μm to the surface of the board 2. Subsequently, the pressing force surface 31 of the gauge 30 was applied to the side surface (portion excluding the lower end portion) of the cured adhesive sheet 10, while the gauge 30 was moved to the other side in the lengthwise direction toward the cured adhesive sheet 10. Subsequently, the gauge 30 was pushed (pressurized) toward the other side

in the lengthwise direction.

[0153]

The strength (shear strength) at the time of peeling the cured adhesive sheet 10 from the board 2 was obtained as the adhesive strength.

[0154]

In addition, with a case where the cured adhesive sheet 10 was peeled from the board 2 as a fracture mode, a case where an interfacial peeling occurred between the cured adhesive sheet 10 and the board 2 was evaluated as “Excellent”, a case where a slight cohesive fracture occurred in the cured adhesive sheet 10 was evaluated as “Good”, and a case where a cohesive fracture occurred in the cured adhesive sheet 10 was evaluated as “Bad”.

[0155]

[Table 1]

Table 1

Type		Ex. 1	Ex. 2	Ex. 3	Ex. 4	Comp. Ex. 1	Comp. Ex. 2
Thermosetting Component	Main Agent	6.24	6.24	6.24	6.3	6.4	6.4
	Curing Agent	3.4	3.4	3.4	3.5	3.5	3.5
	Curing Accelerator	0.11	0.11	0.11	0.1	0.08	0.08
Inorganic Filler	First Filler	53.96	53.96	53.96	61	67.76	67.76
	Second Filler	29.05	29.05	29.05	26	20.24	20.24
Silane Coupling Agent		0.42	0.83	1.25	0.9	0.08	-
Mass Amount of Silane Coupling Agent to 100 parts of Total Amount of Thermosetting Component and Inorganic Filler		0.45	0.89	1.35	0.93	0.08	-
Additive	Thermoplastic Resin	6.49	6.08	5.66	1.9	1.58	1.66
	Pigment	0.33	0.33	0.33	0.3	0.36	0.36
Solvent		125	125	125	11.1	125	125
Total Amount of Solid Content		100	100	100	100	100	100
Outgas (ppm)		500	900	1500	1200	50	30
Remaining Solvent (ppm)		30	20	20	20	15	10
Adhesive Strength (25°C)	MPa	10	12	13	14	7	6
	Fracture Mode	Good	Good	Excellent	Good	Bad	Bad

[0156]

In Table 1, the numerical values are mixed amount unless otherwise specified.

[0157]

While the illustrative embodiments of the present invention are provided in the above description, such is for illustrative purpose only and it is not to be construed as limiting the scope of the present invention. Modification and variation of the present invention that will be obvious to those skilled in the art is to be covered by the following claims.

WHAT IS CLAIMED IS:

1. A sealable adhesive sheet configured to seal an electronic element mounted on a board and adhere to the board comprising:
an adhesive composition, wherein
a generation amount of an outgas at the time of heating the sealable adhesive sheet at 150°C for 30 minutes with respect to the sealable adhesive sheet before heating is 500 ppm or more.
2. The sealable adhesive sheet according to claim 1, wherein
the adhesive composition contains a thermosetting component, an inorganic filler, and a coupling agent.
3. The sealable adhesive sheet according to claim 2, wherein
the mixed amount of the coupling agent with respect to 100 parts by mass of the total amount of the thermosetting component and the inorganic filler is 1 part by mass or more.
4. The sealable adhesive sheet according to claim 2, wherein
the coupling agent is a silane coupling agent containing an epoxy group.
5. The sealable adhesive sheet according to claim 1 further comprising:
a remaining solvent, wherein
a ratio of the remaining solvent in the sealable adhesive sheet is 5 ppm or more.