

DESCRIPTION

TITLE OF THE INVENTION: SHEET-FORM THERMOSETTING RESIN
COMPOSITION FOR SEALING ELECTRONIC COMPONENT, RESIN-SEALED
SEMICONDUCTOR DEVICE, AND METHOD OF MANUFACTURING RESIN-SEALED
SEMICONDUCTOR DEVICE

TECHNICAL FIELD

[0001]

The present invention relates to a sheet-form thermosetting resin composition for sealing an electronic component, a resin-sealed semiconductor device, and a method of manufacturing a resin-sealed semiconductor device.

BACKGROUND ART

[0002]

Conventionally, sealing of a semiconductor element and electronic components such as a capacitor and a resistance element on a mounting substrate has been performed by transfer-sealing with a powdery epoxy resin composition; potting, dispensing, printing with a liquid epoxy resin composition, a silicon resin; etc. However, sheet-sealing has been proposed in recent years using a sheet-form thermosetting resin composition as a less expensive and simple sealing method.

[0003]

For example, Patent Document 1 describes an epoxy resin

composition that contains a specified composite metal hydroxide, etc. and meets the flame retardancy regulation (UL94V-0). However, the strength of the resin composition after curing has not been considered. Accordingly, a sheet-form thermosetting resin composition has not been considered that meets the flame retardancy regulation (UL94V-0) and has excellent strength.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0004]

Patent Document 1: JP-A-2003-82241

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005]

The present invention has been made in consideration of the above-described problems, and an object thereof is to provide a sheet-form thermosetting resin composition for sealing an electronic component, which meets the flame retardancy regulation (UL94V-0) and has excellent strength after curing.

MEANS FOR SOLVING THE PROBLEMS

[0006]

The present invention relates to a sheet-form

thermosetting resin composition for sealing an electronic component, comprising silica in an amount of 70 to 93% by weight to a whole of the sheet-form thermosetting resin composition for sealing an electronic component; meeting the flame retardancy regulation (UL94V-0); and having a three-point bending strength of 80 MPa or more at normal temperature after the resin composition is cured under heating at 150°C for 1 hour.

[0007]

The sheet-form thermosetting resin composition for sealing an electronic component of the present invention contains a specified amount of silica, meets the flame retardancy regulation (UL94V-0), and has strength in a specified range after curing. The resin composition meets the flame retardancy regulation (UL94V-0) so that it has excellent flame retardancy. The strength of the resin composition after curing falls within a specified range so that a highly reliable resin-sealed semiconductor device can be manufactured.

[0008]

The silica preferably has an average particle size of 0.1 to 30 μm . This makes it possible to obtain a sheet-form thermosetting resin composition for an electronic component having excellent fluidity at molding.

[0009]

The sheet-form thermosetting resin composition for sealing an electronic component of the present invention

preferably has a viscosity of 5×10^3 Pa·s or less at 90°C before curing. If the viscosity is 5×10^3 Pa·s or less at 90°C before curing, the resin composition having excellent moldability can be obtained.

[0010]

The sheet-form thermosetting resin composition for sealing an electronic component of the present invention is preferably manufactured by kneading extrusion. If silica is compounded in a specified amount, it becomes difficult to mold the resin composition into a sheet form. However, the resin composition can be easily molded into a sheet form by kneading extrusion.

[0011]

The sheet-form thermosetting resin composition for sealing an electronic component of the present invention preferably contains a phosphazene flame retardant. If a metal hydroxide such as magnesium hydroxide for a flame retardant is compounded to the resin composition for meeting the flame retardancy regulation (UL94V-0), the resin strength decreases. In the present invention, excellent flame retardancy can be obtained and strength after curing can be suitably adjusted to a specified range by compounding a phosphazene flame retardant in the resin composition.

[0012]

The present invention also relates to a resin-sealed

semiconductor device that is obtained using the sheet-form thermosetting resin composition for sealing an electronic component.

[0013]

The present invention also relates to a method of manufacturing a resin-sealed semiconductor device comprising a step of sealing an electronic component using the sheet-form thermosetting resin composition for sealing an electronic component.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a view showing a state of a flame retardancy test.

Fig. 2 is a view showing a state of a three-point bending strength test.

MODE FOR CARRYING OUT THE INVENTION

[0015]

The sheet-form thermosetting resin composition for sealing an electronic component of the present invention contains silica in an amount of 70 to 93% by weight to a whole of the sheet-form thermosetting resin composition for sealing an electronic component; meets the flame retardancy regulation (UL94V-0); and has a three-point bending strength of 80 MPa or

more at normal temperature after the resin composition is cured under heating at 150°C for 1 hour. The sheet-form thermosetting resin composition for sealing an electronic component has excellent flame retardancy and strength after curing. The resin composition contains a phosphazene flame retardant as necessary to thereby obtain flame retardancy and strength after curing more suitably.

[0016]

The resin component that can be used in the present invention is not especially limited, and examples thereof include an epoxy resin, a phenol resin, and a thermoplastic resin.

[0017]

The epoxy resin is not particularly limited, and examples thereof include triphenyl methane type epoxy resin, cresol novolak type epoxy resin, biphenyl type epoxy resin, modified bisphenol A type epoxy resin, bisphenol A type epoxy resin, bisphenol F type epoxy resin, modified bisphenol F type epoxy resin, dicyclopentadiene type epoxy resin, phenol novolak type epoxy resin, phenoxy resin, and other various epoxy resins. These epoxy resins may be used alone or in combination of two or more thereof.

[0018]

The epoxy resin is preferably an epoxy resin which is in a solid form at room temperature, and has an epoxy equivalent

of 150 to 250 and a softening point or melting point of 50°C to 130°C in order to certainly attain a desired toughness after curing and reactivity. Particularly preferred are triphenylmethane type epoxy resin, cresol novolak type epoxy resin, and biphenyl type epoxy resin from the viewpoint of the reliability.

[0019]

From the viewpoint of low stress, the epoxy resin is preferably a modified bisphenol A type epoxy resin having a flexible skeleton such as an acetal group or a polyoxyalkylene group. A modified bisphenol A type epoxy resin having an acetal group is especially preferably used because it is liquid and easily handled.

[0020]

From the point of flexibility in the sheet-form thermosetting resin composition for sealing an electronic component, a bisphenol F type epoxy resin is especially preferable.

[0021]

The epoxy resin has an epoxy equivalent of preferably 150 g/eq. or more, and more preferably 170 g/eq. or more. On the other hand, the epoxy resin has an epoxy equivalent of preferably 300 g/eq. or less, and more preferably 250 g/eq. or less.

The epoxy equivalent of the epoxy resin can be measured

with the method defined in JIS K 7236-2009.

[0022]

The content of the epoxy resin is preferably 20% by weight or more, and more preferably 30% by weight or more to 100% by weight of the resin component. The content of the epoxy resin is preferably 60% by weight or less, and more preferably 50% by weight or less.

[0023]

The phenol resin is not particularly limited as far as the resin causes a curing reaction with the epoxy resin. Examples thereof include phenol novolak resin, phenol aralkyl resin, biphenyl aralkyl resin, dicyclopentadiene type phenol resin, cresol novolak resin, and resol resin. These phenol resins may be used alone or in combination of two or more thereof.

[0024]

The phenol resin is preferably a resin having a hydroxyl equivalent of 70 to 250 and a softening point of 50°C to 110°C (preferably 70°C to 90°C) from the viewpoint of the reactivity thereof with the epoxy resin. The phenol resin is in particular preferably phenol novolak resin because the resin is high in curing reactivity. Moreover, from the viewpoint of the reliability, the phenol resin is a low-hygroscopicity phenol resin such as phenol aralkyl resin, or biphenyl aralkyl resin can be preferably used.

[0025]

The phenol resin has a hydroxy equivalent of preferably 70 g/eq. or more, and more preferably 90 g/eq. or more. On the other hand, the phenol resin has a hydroxy equivalent of preferably 300 g/eq. or less, and more preferably 250 g/eq. or less.

[0026]

Regarding the blend ratio between the epoxy resin and the phenol resin, the entire amount of the hydroxyl groups in the phenol resin is preferably from 0.7 to 1.5 equivalents, more preferably 0.9 to 1.2 equivalents per equivalent of epoxy groups in the epoxy resin from the viewpoint of the curing reactivity therebetween.

[0027]

The total content of the epoxy resin and the phenol resin is preferably 50% by weight or more, more preferably 60% by weight or more, and further preferably 65% by weight or more to 100% by weight of the resin component. If the total content is 50% by weight or more, the resin strength necessary for electronic component use can be suitably secured.

The total content of the epoxy resin and the phenol resin is preferably 98% by weight or less, and more preferably 95% by weight or less to 100% by weight of the resin component. If the total content is 98% by weight or less, a sheet-form thermosetting resin composition for sealing an electronic component having good moldability is obtained.

[0028]

The sheet-form thermosetting resin composition of the present invention preferably contains a thermoplastic resin. This suitably provides flexibility and strength after curing.

[0029]

Examples of the thermoplastic resin include natural rubber, butyl rubber, isoprene rubber, chloroprene rubber, ethylene/vinyl acetate copolymer, ethylene/acrylic acid copolymer, ethylene/acrylic ester copolymer, polybutadiene resin, polycarbonate resin, thermoplastic polyimide resin, polyamide resins such as 6-nylon and 6,6-nylon, phenoxy resin, acrylic resin, saturated polyester resins such as PET and PBT, polyamideimide resin, and fluorine-containing resin. Other examples thereof include styrene/isobutylene/styrene block copolymer. These thermoplastic resins may be used alone or in combination of two or more thereof. Among these, a styrene/isobutylene/styrene block copolymer is preferable from the points that adhering strength and resin strength can be suitably secured and a highly reliable resin-sealed semiconductor device can be manufactured.

[0030]

The content of the thermoplastic resin is preferably 2% by weight or more, and more preferably 5% by weight or more to 100% by weight of the resin component. If the content is 2% by weight or more, flexibility and strength after curing is

suitably obtained. The content of the thermoplastic resin is preferably 50% by weight or less, and more preferably 40% by weight or less to 100% by weight of the resin component. If the content is 50% by weight or less, flame retardancy is suitably obtained.

[0031]

The kind of the silica is not especially limited; however, fused silica powders are preferably used from the point of having excellent filling properties and fluidity. Examples of the fused silica powders include spherical fused silica powders and crashed and fused silica powders. However, spherical fused silica powders are especially preferably used from the viewpoint of fluidity.

[0032]

The silica has an average particle size of preferably 0.1 μm or more, and more preferably 0.3 μm or more. If the average particle size is 0.1 μm or more, good moldability is obtained having less influence on a decrease of flow. The silica has an average particle size of preferably 30 μm or less, and more preferably 20 μm or less. If the average particle size is 20 μm or less, a highly reliable resin-sealed semiconductor device can be manufactured having less damage to the electronic component at molding.

The average particle size can be obtained by measurement on a sample that is extracted arbitrarily from the population

using a laser diffraction-scattering type particle size distribution measuring apparatus.

[0033]

The content of the silica is 70% by weight or more, preferably 80% by weight or more, and more preferably 85% by weight or more to a whole of the sheet-form thermosetting resin composition. If the content is 70% by weight or more, flame retardancy and strength after curing is suitably obtained. The content of the silica is 93% by weight or less, and preferably 90% by weight or less to the total of the sheet-form thermosetting resin composition. If the content is 93% by weight or less, good moldability is obtained having less influence on a decrease of flow.

[0034]

The sheet-form thermosetting resin composition of the present invention preferably contains a phosphazene flame retardant. If a metal hydroxide such as magnesium hydroxide for a flame retardant is compounded to the resin composition, strength after curing decreases. However, a phosphazene flame retardant is compounded to the resin composition so that the strength after curing can be suitably adjusted to a specified range.

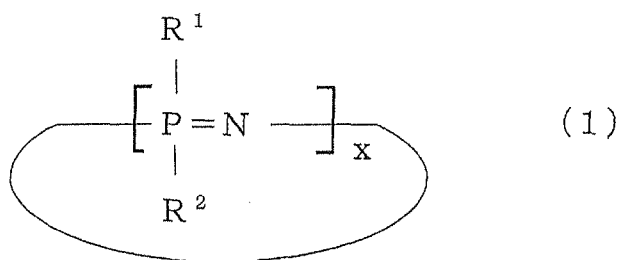
[0035]

The phosphazene flame retardant is not especially limited. However, a compound represented by Formula (1) or Formula (2)

is preferable because excellent flame retardancy and strength after curing can be obtained.

[0036]

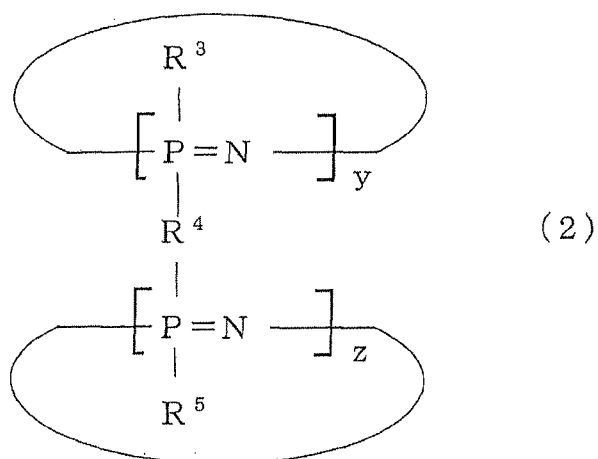
[Formula 1]



wherein, R^1 and R^2 are the same or different from each other, and represent an alkoxy group, a phenoxy group, an amino group, a hydroxy group, an allyl group, or a monovalent organic group having at least one selected from the group consisting of the above-mentioned groups; and x represents an integer of 3 to 25.

[0037]

[Formula 2]



wherein, R^3 and R^5 are the same or different from each other,

and represent an alkoxy group, a phenoxy group, an amino group, a hydroxy group, an allyl group, or a monovalent organic group having at least one selected from the group consisting of the above-mentioned groups; R^4 represents a divalent organic group having at least one selected from the group consisting of an alkoxy group, a phenoxy group, an amino group, a hydroxy group and an allyl group; y represents an integer of 3 to 25; and z represents an integer of 3 to 25.

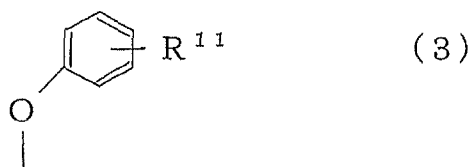
[0038]

Examples of the alkoxy group of R^1 and R^2 include a methoxy group, an ethoxy group, a n-propoxy group, an isopropoxy group, a n-butoxy group and a t-butoxy group. Among these, an alkoxy group having 4 to 10 carbon atoms is preferable.

[0039]

An example of the phenoxy group of R^1 and R^2 includes a group represented by Formula (3).

[Formula 3]



wherein, R^{11} represents hydrogen, a hydroxy group, an alkyl group, an alkoxy group, a glycidyl group, or a monovalent organic group having at least one selected from the group consisting of the above-mentioned groups.

[0040]

Examples of the alkyl group of R^{11} include a methyl group, an ethyl group, a n-propyl group, an isopropyl group, a n-butyl group, an iso-butyl group, a sec-butyl group, a tert-butyl group, a pentyl group, a hexyl group, a heptyl group, a 2-ethylhexyl group, an octyl group, a nonyl group, a decyl group, an undecyl group, a dodecyl group, a tridecyl group, a tetradecyl group, a pentadecyl group and an octadecyl group. Examples of the alkoxy group of R^{11} include the same groups as the alkoxy group of R^1 and R^2 .

[0041]

A phenoxy group is preferable, and a group represented by Formula (3) is more preferable as R^1 and R^2 de to the reason that flame retardancy and strength after curing is suitably obtained.

[0042]

x represents an integer of 3 to 25; however, x is preferably 3 to 10, and more preferably 3 and 4 due to the reason that flame retardancy and strength after curing is suitably obtained.

[0043]

In Formula (2), examples of the alkoxy group of R^3 and R^5 include a methoxy group, an ethoxy group, a n-propoxy group, an isopropoxy group, a n-butoxy group and a t-butoxy group. Among these, an alkoxy group having 4 to 10 carbon atoms is preferable.

[0044]

An example of the phenoxy group of R^3 and R^5 includes a group represented by Formula (3).

[0045]

The monovalent organic group of R^3 and R^5 having at least one selected from the group consisting of the alkoxy group, the phenoxy group, the amino group, the hydroxy group and the allyl group is not especially limited.

[0046]

A phenoxy group is preferable, and a group represented by Formula (3) is more preferable as R^3 and R^5 due to the reason that flame retardancy and strength after curing is suitably obtained.

[0047]

Examples of the alkoxy group which the divalent organic group of R^4 has include a methoxy group, an ethoxy group, a n-propoxy group, an isopropoxy group, a n-butoxy group and a t-butoxy group. Among these, an alkoxy group having 4 to 10 carbon atoms is preferable.

[0048]

An example of the phenoxy group which the divalent organic group of R^4 has includes a group represented by Formula (3).

[0049]

y represents an integer of 3 to 25; however, y is preferably 3 to 10 due to the reason that flame retardancy and

strength after curing is suitably obtained.

[0050]

z represents an integer of 3 to 25; however, z is preferably 3 to 10 due to the reason that flame retardancy and strength after curing is suitably obtained.

[0051]

The content rate of phosphorus element in the phosphazene flame retardant is preferably 12% by weight or more from the viewpoint of exhibiting flame retardant effect even in a small amount.

[0052]

The content of the phosphazene flame retardant is preferably 0.05% by weight or more, more preferably 0.1% by weight or more, and further preferably 0.2% by weight or more to the total of the sheet-form thermosetting resin composition. If the content is 0.05% by weight or more, flame retardancy is suitably obtained. The content of the phosphazene flame retardant is preferably 30% by weight or less, more preferably 20% by weight or less, and further preferably 5% by weight or less to the total of the sheet-form thermosetting resin composition. If the content is 30% by weight or less, there is less deterioration of the physical properties (specifically, deterioration of the physical properties such as a glass transition temperature and a high temperature resin strength) of the cured product, and a highly reliable resin-sealed

semiconductor device is obtained.

[0053]

The sheet-form thermosetting resin composition of the present invention preferably contains a curing promoter. The curing promoter is not particularly limited as far as the promoter is an agent for promoting the curing. The curing promoter is preferably an organic phosphorous compound, such as triphenylphosphine or tetraphenylphosphonium tetraphenyl borate, or an imidazole compound from the viewpoint of curing-promotion performance and storability.

[0054]

The content of the curing accelerator is preferably 0.1 to 5 parts by weight to the total of 100 parts by weight of the epoxy resin and the phenol resin.

[0055]

The sheet-form thermosetting resin composition of the present invention may appropriately contain other additives such as pigments including carbon black, a silane coupling agent and a metal hydroxide as necessary besides the above-described components.

[0056]

The smaller the content of the metal hydroxide is, the better it is in the sheet-form thermosetting resin composition of the present invention. The content of the metal hydroxide is preferably 5% by weight or less, more preferably 1% by weight

or less, and further preferably 0% by weight to the total of the sheet-form thermosetting resin composition. If the content is 5% by weight or less, strength after curing can be suitably adjusted to a specified range.

[0057]

[Method of manufacturing sheet-form thermosetting resin composition]

The sheet-form thermosetting resin composition of the present invention can be manufactured, for example, as follows.

First, each material for the sheet described before is uniformly dispersed and mixed to prepare a resin composition. Then, the prepared resin composition is formed into a sheet. Examples of the forming method include a method of extrusion-molding the prepared resin composition to be formed into a sheet (kneading-extrusion); and a method of dissolving or dispersing the prepared resin composition into an organic solvent, etc. to prepare varnish, applying this varnish onto a substrate such as polyester, and drying the varnish to make a sheet (solvent application). In the solvent application, a plurality of layers of the obtained sheet-form thermosetting resin composition are laminated as necessary to obtain a sheet-form thermosetting resin composition with a prescribed thickness. A release sheet such as a polyester film may be pasted to a surface of the sheet-form thermosetting resin composition to protect the surface of the sheet-form

thermosetting resin composition as necessary, and the release sheet may be peeled therefrom at sealing.

[0058]

Examples of the organic solvent to be used when the varnish is prepared include methyl ethyl ketone, acetone, cyclohexanone, dioxane, diethylketone, toluene and ethylacetate. These may be used alone or in combination of two or more thereof. Normally, the organic solvent is preferably used so that the solid content concentration of the varnish falls within a range of 60 to 90% by weight.

[0059]

The sheet-form thermosetting resin composition of the present invention is made by kneading extrusion, so that the resin composition can be easily molded into a sheet form and a uniform sheet with less voids (air bubbles) etc. can be made.

[0060]

An example of the method of making the resin composition by kneading extrusion includes a method of melt-kneading each component described above with a known kneader such as a mixing roll, a pressure kneader, or an extruder to prepare a kneaded product, and extruding the obtained kneaded product to be formed into a sheet form.

In the kneading conditions, the temperature is preferably the softening point or higher of each component described above, and it is for example 30 to 150°C. If the thermosetting

properties of the epoxy resin are considered, the temperature is preferably 40 to 140°C, and more preferably 60 to 120°C. The time is for example 1 to 30 minute(s), and preferably 5 to 15 minutes. Accordingly, the kneaded product can be prepared.

[0061]

The obtained kneaded product is subjected to extrusion molding to obtain a sheet-form thermosetting resin composition. Specifically, the kneaded product after melt-kneading is subjected to extrusion molding in a high temperature state without being cooled to obtain a sheet-form thermosetting resin composition. The extrusion method is not especially limited, and examples thereof include a plate pressing method, a T-die extrusion method, a rolling method, a roll kneading method, an inflation extrusion method, a co-extrusion method and a calendar molding method. The extrusion temperature is preferably the softening point or higher of each component described above. If the thermosetting properties of the epoxy resin are considered, the extrusion temperature is for example 40 to 150°C, preferably 50 to 140°C, and more preferably 70 to 120°C. Accordingly, a sheet-form thermosetting resin composition can be formed.

[0062]

The thickness of the sheet-form thermosetting resin composition of the present invention is not especially limited; however, it is preferably 0.1 mm to 1 mm, and preferably 0.1

mm to 0.7 mm. When the thickness falls within this range, the electronic component can be suitably sealed.

[0063]

The sheet-form thermosetting resin composition of the present invention meets the flame retardancy regulation of U.S. UL Standard (UL94V-0).

[0064]

The sheet-form thermosetting resin composition of the present invention preferably has a viscosity of 5×10^5 Pa's or less at 40°C before curing. If the viscosity is 5×10^5 Pa's or less, the resin composition is excellent in processability into a sheet form or a roll form, and the resin composition can be formed into a sheet form or a roll form. The lower limit of the viscosity is not especially limited; however, it is preferably 3×10^2 Pa's or more. If the viscosity is 3×10^2 Pa's or more, the resin composition is excellent in handling properties.

[0065]

The sheet-form thermosetting resin composition of the present invention preferably has a viscosity of 5×10^3 Pa's or less at 90°C before curing. If the viscosity is 5×10^3 Pa's or less, good moldability can be obtained. The lower limit of the viscosity is not especially limited; however, it is preferably 3×10^2 Pa's or more. If the viscosity is 3×10^2 Pa's or more, the molding is possible while maintaining the

corner shape of the resin.

[0066]

The viscosity before curing can be measured with the method described in examples.

[0067]

The sheet-form thermosetting resin composition of the present invention has a three-point bending strength of 80 MPa or more at normal temperature after the resin composition is cured under heating at 150°C for 1 hour. If the three-point bending strength is 80 MPa or more, the resin is hardly cracked so that a highly reliable resin-sealed semiconductor device is obtained. The three-point bending strength is preferably 100 MPa or more.

The upper limit of the three-point bending strength is not especially limited; however, it is for example 200 MPa or less, and preferably 180 MPa or less. If the three-point bending strength is 200 MPa or less, the cured product is excellent in processability.

The three-point bending strength can be measured with the method described in examples. The normal temperature as used herein is 23°C.

[0068]

The three-point bending strength can be controlled by the kind of the flame retardant, the content of the silica, the content of the thermosetting resin, the epoxy equivalent of the

epoxy resin, the hydroxy equivalent of the phenol resin, etc. For example, the three-point bending strength can be increased by using a phosphazene flame retardant, increasing the amount of the silica, increasing the amount of the thermosetting resin, using an epoxy resin having large epoxy equivalent, using a phenol resin having large hydroxy equivalent, etc.

[0069]

The sheet-form thermosetting resin composition of the present invention is used to seal electronic components such as a semiconductor wafer, a semiconductor chip, a capacitor and a resistance. Among these, the resin composition can be used suitably to seal a semiconductor wafer and a semiconductor chip. The sheet-form thermosetting resin composition of the present invention can function as a sealing resin to protect an electronic component and elements attached thereto from the external environment.

[0070]

The sealing method is not especially limited, and a conventionally known method can be used. Typical examples thereof are a method of embedding an electronic component in a sheet-form thermosetting resin composition and a method of covering an electronic component with a softened sheet-form thermosetting resin composition.

[0071]

For example, hot press is performed with a parallel planar

method on a laminate having a support plate, a chip temporary fixing body having a temporary fixing material laminated on the support plate and a semiconductor chip that is temporary fixed on the temporary fixing material, and a sheet-form thermosetting composition arranged on the chip temporary fixing body, so that the electronic component can be embedded in the sheet-form thermosetting resin component. The material of the support plate is not especially limited, and examples thereof include metal materials such as SUS and plastic materials such as polyimide, polyamideimide, polyether ether ketone and polyether sulfone. The temporary fixing material is not especially limited; however, a thermal-releasable pressure-sensitive adhesive such as a thermo-expandable pressure-sensitive adhesive is normally used due to the reason that it can be easily peeled.

[0072]

For example, hot press is performed with a parallel planar method on a laminate structure having a substrate, an electronic component arranged on the substrate, and a sheet-form thermosetting composition arranged on the electronic component, so that the electronic component can be embedded in the sheet-form thermosetting resin component. The substrate is not especially limited, and examples thereof include a glass fabric-epoxy resin copper clad laminate plate, an iron-nickel alloy plate and a semiconductor wafer.

[0073]

The sheet-form thermosetting resin composition is mounted so as to cover the electronic component on the substrate, and the sheet-form thermosetting resin composition is thermally cured to seal the electronic component.

[0074]

The resin-sealed semiconductor device obtained in this method has excellent flame retardancy and strength after curing, and high reliability.

EXAMPLES

[0075]

The present invention is explained in detail with reference to the examples below. However, the present invention is not limited to the following examples, and includes variations of these examples as long as their purpose is not frustrated. "Part(s)" in each example is on a weight basis as long as there is no special notation to indicate otherwise.

[0076]

The components used in the examples will be described.

Epoxy resin: YSLV-80XY manufactured by Nippon Steel Chemical Co., Ltd. (Bisphenol F type epoxy resin: epoxy equivalent 191, softening point 80°C)

Phenol resin: MEH7851SS manufactured by Meiwa Plastic Industries, Ltd. (Phenol aralkyl resin: hydroxy equivalent 203,

softening point 67°C)

Catalyst: 2PHZ-PW manufactured by Shikoku Chemicals Corporation (imidazole catalyst)

Spherical fused silica: FB-9454 manufactured by DENKI KAGAKU KOGYO KABUSHIKI KAISHA (fused spherical silica, average particle size 20 μm)

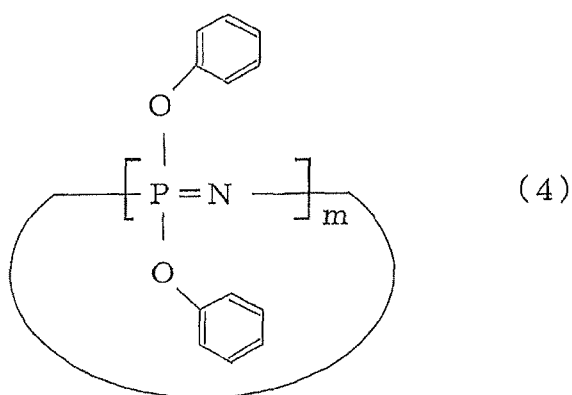
Carbon black: #20 manufactured by Mitsubishi Chemical Corporation

Silane coupling agent: KBM-403 manufactured by Shin-Etsu Chemical Co., Ltd. (3-glycidoxypropyltrimethoxysilane)

Elastomer (thermoplastic resin): SIBSTER 072T manufactured by Kaneka Corporation (styrene-isobutylene-styrene block copolymer)

Flame retardant A: FP-100 manufactured by FUSHIMI Pharmaceutical Co., Ltd. (phosphazene flame retardant: compound represented by Formula (4))

[Formula 4]



wherein, m represents an integer of 3 or 4.

Flame retardant B: Z-10 manufactured by Tateho Chemical Industries Co., Ltd. (magnesium hydroxide for flame retardant)
[0077]

[Production of resin sheet]

Examples 1 and 2 and Comparative Examples 1 to 4

According to the compounding ratios described in Table 1, each component was kneaded at 120°C for 10 minutes with a biaxial kneader to prepare a kneaded product. Next, the kneaded product was extrusion-molding to obtain a resin sheet having a thickness of 0.8 mm.

[0078]

Example 3

According to the compounding ratio described in Table 1, each component was mixed with a mixed liquid containing methyl ethyl ketone and toluene with a ratio of 5 : 5 to produce a mixture having a component concentration of 90% by weight. The mixture was stirred at 200 rpm for 10 minutes using a planetary centrifugal mixer (THINKY MIXER manufactured by THINKY) to obtain varnish for application. The varnish for application was applied onto a silicone-treated PET (MRF50 manufactured by Mitsubishi Chemical Corporation) having a thickness of 50 μm , and the resultant was dried at 110°C for 10 minutes with a hot air dryer to obtain a sheet having a thickness of 10 μm . Eight sheets were laminated at a roll temperature of 90°C and a speed of 0.4 m/min with a vacuum laminator to obtain a resin sheet

having a thickness of 0.8 mm. The reason why the mixed liquid containing methyl ethyl ketone and toluene was used is because SIBSTAR 072T serving as an elastomer is hardly dissolved in methyl ethyl ketone.

[0079]

[Evaluation]

The following evaluations were performed using the obtained resin sheets. The results are shown in Table 1.

[0080]

<Flame retardancy>

A method of measuring flame retardancy will be described with reference to Fig. 1.

Fig. 1 is a view showing a state of a flame retardancy test.

[0081]

First, apparatuses and the like will be described which were used in the flame retardancy test.

Chamber: windless test box

Ring stand with clamp

Industrial methane gas

Dry absorbent cotton: 50.8 mm X 50.8 mm X 6.4 mm

Thermohygrostat: $23 \pm 2^{\circ}\text{C}$, humidity $50 \pm 5\%$

[0082]

Production of test piece

A test piece 1 with 127 mm X 12.7 mm X 1/32 inch was cut

out from the resin sheet. The test piece 1 was left in a thermohygrostat ($23 \pm 2^{\circ}\text{C}$, humidity $50 \pm 5\%$) for 48 hours or more, and was used in the flame retardancy test (pre-treatment).

[0083]

Procedure of flame retardancy test

A ring stand with a clamp was arranged in a chamber, and the test piece 1 was attached to a clamp 2. A dry absorbent cotton 3 was placed underneath the test piece 1.

Then, a burner 4 was ignited, and the flame was adjusted to a blue flame. The burner 4 was placed underneath the test piece 1, and a flame 5 was applied to the lower part of the test piece 1 for 10 seconds. At this time, a height 11 of the flame 5 from the top of the burner 4 was 20 ± 1 mm; a distance 12 between the test piece 1 and the top of the burner 4 was 10 ± 1 mm; and a distance 13 between the test piece 1 and the dry absorbent cotton 3 was 300 ± 10 mm. The flame 5 was removed from the test piece 1, and the flaming combustion time was measured.

After the flame of the test piece 1 expired (after the flaming combustion time was measured), the flame was brought into contact again with the lower part of the test piece 1 for 10 seconds. After the flame 5 was removed from the test piece 1, the flaming combustion time and the glowing combustion time were measured.

[0084]

Requirements for flame retardancy regulation (UL94V-0)

The requirements for the flame retardancy regulation (UL94V-0) are as follows. For the test piece 1 of each example, the case where all of the requirements were satisfied was marked as O, and the case where all of the requirements were not satisfied was marked as x. The results are shown in Table 1.

1) Each flaming combustion time is 10 seconds or less.

2) The total flaming combustion time is 50 seconds or less when the flame is brought into contact with a set of five test pieces 1 ten times in total.

3) The flaming combustion or the glowing combustion does not reach the clamp 2.

4) The dry absorbent cotton 3 placed underneath the test piece 1 is not ignited by flaming drips.

5) The glowing combustion time is within 30 seconds.

[0085]

<Resin strength (three-point bending strength)>

A method of measuring resin strength will be described with reference to Fig. 2.

Fig. 2 is a view showing a state of a three-point bending strength test.

[0086]

A test piece 51 with 10 mm (width) X 40 mm (length) X 1 mm (thickness) was cut out from the resin sheet which had been cured under heating at 150°C for 1 hour. Then, using an autograph AG-500C (manufactured by Shimadzu Corporation), the

test piece 51 was mounted on a support 52 having a distance 61 between the points of application 20 mm, a pressing metal fitting 53 was applied to the center of the test piece 51, and a load was applied in a direction perpendicular to the test piece 51 (loading speed 5 mm/min) to measure the three-point bending strength of the test piece 51. The measurement was performed at normal temperature.

The results are shown in Table 1.

[0087]

<Flexibility>

The viscosity of the resin sheet at each of 40°C and 90°C was measured using a viscoelasticity measurement apparatus ARES manufactured by TA Instruments (measurement conditions: parallel plate having diameter of 8 mm, temperature rising speed 10°C/min, frequency 1 Hz, distortion 5%). The results are shown in Table 1.

[0088]

[Table 1]

			Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
Compounding (Solid Content Ratio) (parts by weight)	Epoxy Resin	YSLV-80XY	4.3	3.4	3.4	4.4	4.4	4.4	4.4
	Phenol Resin	MEH7851SS	4.3	3.6	3.6	4.5	4.5	4.4	4.5
	Catalyst	2PHZ-PW	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Spherical Fused Silica	FB-9454	89.0	87.9	87.9	85.5	83.3	89.0	86.7
	Carbon Black	#20	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Silane Coupling Agent	KBM-403	0.9	0.1	0.1	0.9	0.8	0.9	0.9
	Elastomer	SIBSTAR 072T	1.0	3.0	3.0	1.0	1.0	1.0	1.0
	Flame Retardant A	FP-100	0.3	1.8	1.8	-	-	0.1	-
	Flame Retardant B	Z-10	-	-	-	3.5	5.8	-	2.3
Total			100	100	100	100	100	100	100
Sheet Production			Kneading Extrusion	Kneading Extrusion	Solvent Application	Kneading Extrusion	Kneading Extrusion	Kneading Extrusion	Kneading Extrusion
Evaluation	Flame Retardancy (Thickness: 1/32 inch)		○	○	○	○	○	×	×
	Resin Strength [MPa]		107	130	110	58	64	110	68
	Flexibility	Viscosity (40°C) [Pa·s]	4.5×10^5	3.5×10^5	4.3×10^5	-	-	-	-
		Viscosity (90°C) [Pa·s]	2.0×10^3	2.6×10^3	3.4×10^3	-	-	-	-

DESCRIPTION OF REFERENCE SIGNS

[0089]

- 1 Test Piece
- 2 Clamp
- 3 Dry Absorbent Cotton
- 4 Burner
- 5 Flame
- 11 Height of Flame
- 12 Distance between Test Piece and Top of Burner
- 13 Distance between Test Piece and Dry Absorbent Cotton
- 21 127 mm
- 22 12.7 mm
- 51 Test Piece
- 52 Support
- 52 Pressing Metal Fitting
- 61 Distance between Points of Application
- 62 Loading Direction

CLAIMS

1. A sheet-form thermosetting resin composition for sealing an electronic component,
comprising silica in an amount of 70 to 93% by weight to a whole of the sheet-form thermosetting resin composition for sealing an electronic component;
meeting the flame retardancy regulation (UL94V-0); and
having a three-point bending strength of 80 MPa or more at normal temperature after the resin composition is cured under heating at 150°C for 1 hour.
2. The sheet-form thermosetting resin composition for sealing an electronic component according to claim 1, wherein the silica has an average particle size of 0.1 to 30 μm .
3. The sheet-form thermosetting resin composition for sealing an electronic component according to claim 1 or 2, having a viscosity of 5×10^3 Pa·s or less at 90°C before curing.
4. The sheet-form thermosetting resin composition for sealing an electronic component according to any one of claims 1 to 3, which is manufactured by kneading extrusion.
5. The sheet-form thermosetting resin composition for

sealing an electronic component according to any one of claims 1 to 4, containing a phosphazene flame retardant.

6. A resin-sealed semiconductor device obtained using the sheet-form thermosetting resin composition for sealing an electronic component according to any one of claims 1 to 5.

7. A method of manufacturing a resin-sealed semiconductor device, comprising a step of:

sealing an electronic component using the sheet-form thermosetting resin composition for sealing an electronic component according to any one of claims 1 to 5.