

DESCRIPTION

TITLE OF THE INVENTION: METHOD OF MANUFACTURING SEMICONDUCTOR
DEVICE

TECHNICAL FIELD

[0001]

The present invention relates to a method of
manufacturing a semiconductor device.

BACKGROUND ART

[0002]

A method of manufacturing a fan-out type wafer level chip
size package has been known in which a plurality of
semiconductor chips that are arranged on a pressure-sensitive
adhesive sheet are collectively sealed with a sealing resin to
form a sealed body including the plurality of semiconductor
chips and the sealing resin that covers the plurality of
semiconductor chips, the pressure-sensitive adhesive sheet is
then peeled from the sealed body, and a rewiring layer is formed
on the surface of the sealed body to which the
pressure-sensitive adhesive sheet is pasted.

PRIOR ART DOCUMENT

PATENT DOCUMENTS

[0003]

Patent Document 1: JP-A-2001-308116

Patent Document 2: US 2006/0183269

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0004]

An insulating layer is formed on a sealed body in some cases. An example of a method of forming the insulating layer is a method of pasting a thin film such as a dry film resist on the sealed body. With this method, the film thickness can be easily controlled as compared with a conventional method of coating a sealed body with a liquid insulating material, and this method is suitable for broad and collective sealing.

[0005]

On the other hand, when a compression molding method using liquid or granular sealing resin is adopted as a method of collectively sealing a plurality of semiconductor chips, the semiconductor chips are embedded in a pressure-sensitive adhesive sheet due to pressure accompanied with flowing of the sealing resin, etc., and a difference is generated on the surface of the sealed body. When a thin film for forming an insulating layer is pasted to the sealed body having a large difference, the thin film may break. The damage of the thin film is a critical issue and is a cause of a decrease in yield.

[0006]

The positional deviation of an electronic component (the positional deviation in the direction along the surface of the pressure-sensitive adhesive sheet) occurs due to pressure accompanied with flowing of the sealing resin, etc. The positional deviation of an electronic component is also a cause of a decrease in yield.

[0007]

The present invention solves the above-described problems, and an object thereof is to provide a method of manufacturing a semiconductor device that can reduce the positional deviation of an electronic component and can reduce embedding of the electronic component in a pressure-sensitive adhesive sheet.

MEANS FOR SOLVING THE PROBLEMS

[0008]

The present invention relates to a method of manufacturing a semiconductor device, the method including a laminating step of disposing a resin sheet on an electronic component temporarily fixing body including a pressure-sensitive adhesive sheet and a plurality of electronic components that are arranged on the pressure-sensitive adhesive sheet; and a sealing step of pressing a laminate obtained in the laminating step at 0.03 to 3 MPa to form a sealed body including the plurality of electronic components and the resin

sheet that covers the plurality of electronic components.

[0009]

The laminate is pressed at a relatively low pressure of 3 MPa or less using the resin sheet in the present invention, so that the positional deviation of the electronic component can be reduced. Further, embedding of the electronic component in the pressure-sensitive adhesive sheet can be reduced, and the difference on the surface of the sealed body can be made small. Therefore, the yield can be improved. The effect of improving the yield is especially large when the electronic components are collectively sealed using a large-sized pressure-sensitive adhesive sheet. The laminate is pressed at 0.03 MPa or more, so that the space between the electronic components can be satisfactorily filled.

[0010]

A pressing temperature in the sealing step is preferably 60 to 150°C. When the laminate is pressed at 150°C or lower, the positional deviation of the electronic component can be reduced, and embedding of the electronic component in the pressure-sensitive adhesive sheet can be reduced. When the laminate is pressed at 60°C or higher, the space between the electronic components can be satisfactorily filled.

[0011]

A resin sheet having a minimum viscosity of 30 to 8,000 Pa·s at 60 to 150°C is preferably used. When the resin sheet

having a minimum viscosity of 30 Pa·s or more is used, flowing of resin at sealing can be suppressed, and overflow of resin to the outside of the sealing area can be prevented. When the resin sheet having a minimum viscosity of 8,000 Pa·s or less is used, the positional deviation of the electronic component can be reduced, and embedding of the electronic component in the pressure-sensitive adhesive sheet can be reduced. Further, the space between the electronic components can be satisfactorily filled.

[0012]

Normally, the method of manufacturing a semiconductor device of the present invention further includes a peeling step of peeling the pressure-sensitive adhesive sheet from the sealed body. According to the method of manufacturing a semiconductor device of the present invention, a difference between the electronic component and the resin sheet in the sealed body can be 3 μm or less. When the difference is 3 μm or less, the damage of the thin film for forming an insulating layer can be prevented.

[0013]

A deviation (chip shift) of the electronic component before and after the sealing step is preferably 15 μm or less.

EFFECT OF THE INVENTION

[0014]

According to the present invention, the positional deviation of the electronic component can be reduced, and embedding of the electronic component in the pressure-sensitive adhesive sheet can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a schematic cross sectional view of an electronic component temporarily fixing body.

Fig. 2 is a schematic plan view of the electronic component temporarily fixing body.

Fig. 3 is a schematic cross sectional view of a resin sheet.

Fig. 4 is a schematic view showing one step of manufacturing a semiconductor device.

Fig. 5 is a schematic view showing one step of manufacturing a semiconductor device.

Fig. 6 is a schematic view showing one step of manufacturing a semiconductor device.

Fig. 7(a) is a schematic cross sectional view of a sealed body.

Fig. 7(b) is an enlarged view of a portion that is circled with two short-dashed line in Fig. 7(a).

Fig. 8 is a schematic view showing one step of manufacturing a semiconductor device.

Fig. 9 is a schematic view showing one step of manufacturing a semiconductor device.

Fig. 10 is a schematic view showing one step of manufacturing a semiconductor device.

Fig. 11 is a schematic view showing one step of manufacturing a semiconductor device.

MODE FOR CARRYING OUT THE INVENTION

[0016]

One example of the method of manufacturing a semiconductor device of the present invention will be explained in detail below.

[0017]

[Preparing step]

First, an electronic component temporarily fixing body 32 and a resin sheet 31 are prepared.

[0018]

(Electronic component temporarily fixing body 32)

As shown in Figs. 1 and 2, the electronic component temporarily fixing body 32 includes a pressure-sensitive adhesive sheet 3 and electronic components 33 arranged on the pressure-sensitive adhesive sheet 3.

[0019]

The pressure-sensitive adhesive sheet 3 includes a support 3b and a pressure-sensitive adhesive layer 3a that is

laminated on the support 3b (refer to Fig. 1). A plurality of electronic components 33 are arranged on the pressure-sensitive adhesive layer 3a (refer to Figs. 1 and 2).

[0020]

The electronic component 33 is not especially limited, and examples thereof include a semiconductor, a capacitor, a sensor device, a light-emitting element, and a vibrating element. Among these, a semiconductor chip is preferable because the advantage of highly efficient production can be easily obtained due to broad molding using the resin sheet 31.

[0021]

The number of electronic components arranged on the pressure-sensitive adhesive sheet 3 is not especially limited as long as the number thereof is two or more. For example, the number of electronic components is 100 or more. The upper limit of the number of electronic components is not especially limited; however, the number of electric components is normally 10,000 or less. The layout of the electronic components 33 is not especially limited.

[0022]

The pressure-sensitive adhesive layer 3a is not especially limited, and a thermally peelable pressure-sensitive adhesive layer, a radiation curing pressure-sensitive adhesive layer, an ultraviolet curing pressure-sensitive adhesive layer, etc. can be used. The

material of the support 3b is not especially limited. Examples thereof include metal materials such as SUS and plastic materials such as polyimide, polyamideimide, polyether ether ketone, and polyethersulfone.

[0023]

The shape of the pressure-sensitive adhesive sheet 3 is not especially limited, and the shape can be an approximately polygonal shape, an approximately circular shape, etc. The approximately polygonal shape and the approximately circular shape are each the shape of the pressure-sensitive adhesive sheet 3 as viewed in planar view.

[0024]

The approximately polygonal shape includes not only a polygonal shape but also a shape that is similar to a polygonal shape. Specifically, besides the polygonal shape, the approximately polygonal shape includes a shape that is similar to a polygonal shape in which at least one of its corners is rounded, a shape that is similar to a polygonal shape in which at least one of its sides or at least a part of its sides is curved, etc. The approximately polygon shape is preferably an approximately rectangular shape or an approximately square shape.

[0025]

The length of at least one side of the pressure-sensitive adhesive sheet 3 having an approximately polygonal shape is

preferably 300 mm or more. This makes it possible to effectively manufacture a semiconductor device 38. The upper limit of the length of one side is not especially limited; however, it is for example 700 mm or less.

[0026]

The approximately circular shape includes not only a circular shape but also a shape that is similar to a circular shape. Specifically, besides a perfect circular shape, the approximately circular shape includes an oval shape, a shape that is similar to a circular shape in which unevennesses are formed on at least one portion of its circumference, a shape that is similar to a circular shape in which a line portion (a straight line portion) is formed on at least one portion of its circumference, a shape that is similar to a circular shape in which a wave line portion is formed on at least one portion of its circumference, etc.

[0027]

The diameter or the minor axis of the pressure-sensitive adhesive sheet 3 having an approximately circular shape is preferably 300 mm or more. This makes it possible to effectively manufacture a semiconductor device 38. The upper limit of the diameter or the minor axis is not especially limited; however, it is for example 16 inches or less.

[0028]

The area of the pressure-sensitive adhesive sheet 3 (the

area of the pressure-sensitive adhesive sheet 3 as viewed in planar view) is for example preferably 70,000 mm² to 500,000 mm² from the point that the semiconductor device 38 can be effectively manufactured.

[0029]

The method of arranging the plurality of electronic components 33 on the pressure-sensitive adhesive sheet 3 is not especially limited, and the electronic components 33 may be arranged by using for example a flip-chip bonder, a die bonder, etc.

[0030]

(Resin sheet 31)

As shown in Fig. 3, the resin sheet 31 has a sheet shape.

[0031]

The minimum viscosity of the resin sheet 31 at 60 to 150°C is preferably 30 Pa·s or more, more preferably 2,000 Pa·s or more, and further preferably 5,000 Pa·s or more. If the minimum viscosity is 30 Pa·s or more, the flowing of resin at sealing can be suppressed, and the overflow of resin to the outside of the sealing area can be prevented. The minimum viscosity is preferably 8,000 Pa·s or less, and more preferably 7,000 Pa·s or less. If the minimum viscosity is 8,000 Pa·s or less, the positional deviation of the electronic component 33 can be reduced, and embedding of the electronic component 33 in the pressure-sensitive adhesive sheet 3 can be reduced. Further,

the space between the electronic components 33 can be satisfactorily filled.

The minimum viscosity at 60 to 150°C can be measured with the method described in the examples.

[0032]

The minimum viscosity at 60 to 150°C can be controlled by the content of a silica filler, etc. For example, the content of a silica filler is increased to increase the minimum viscosity.

[0033]

The resin sheet 31 used in the present invention preferably contains an epoxy resin and a phenol resin.

[0034]

The epoxy resin is not especially limited. For example, various kinds of epoxy resin can be used such as a triphenylmethane epoxy resin, a cresol novolak epoxy resin, a biphenyl epoxy resin, a modified bisphenol A epoxy resin, a bisphenol A epoxy resin, a bisphenol F epoxy resin, a modified bisphenol F epoxy resin, a dicyclopentadiene epoxy resin, a phenol novolak epoxy resin, and a phenoxy resin. These epoxy resins may be used alone or in combination of two or more thereof.

[0035]

From the viewpoint of ensuring the toughness of the epoxy resin after curing and the reactivity of the epoxy resin, epoxy resins are preferable which are solid at room temperature and

have an epoxy equivalent of 100 to 250 and a softening point or melting point of 50 to 130°C. Among these, a bisphenol epoxy resin, a triphenylmethane epoxy resin, a cresol novolak epoxy resin, a biphenyl epoxy resin, etc. are preferable from the viewpoint of reliability. The softening point or the melting point is more preferably 70 to 100°C.

[0036]

The phenol resin is not especially limited as long as it initiates curing reaction with the epoxy resin. Examples of the phenol resin to be used include a phenol novolak resin, a phenolaralkyl resin, a biphenylaralkyl resin, a dicyclopentadiene phenol resin, a cresol novolak resin, and a resol resin. These phenol resins may be used alone or in combination of two or more thereof.

[0037]

From the viewpoint of reactivity with the epoxy resin, phenol resins are preferable which have a hydroxyl group equivalent of 70 to 250 and a softening point of 50 to 110°C. Among these, a phenol novolak resin is preferable from the viewpoint of its high curing reactivity. Further, a phenol resin having low moisture absorption is also preferably used such as a phenolaralkyl resin or a biphenylaralkyl resin from the viewpoints of reliability and low warping property. The softening point is more preferably 50 to 80°C.

[0038]

For the compounding ratio of the phenol resin to the epoxy resin, the epoxy resin and the phenol resin are preferably compounded so that the total of the hydroxyl group in the phenol resin is 0.7 to 1.5 equivalents, and more preferably 0.9 to 1.2 equivalents to 1 equivalent of the epoxy group in the epoxy resin.

[0039]

The total content of the epoxy resin and the phenol resin in the resin sheet 31 is preferably 4% by weight or more. If the total content is 4% by weight or more, a cured product having excellent reliability can be obtained. The total content of the epoxy resin and the phenol resin in the resin sheet 31 is preferably 18% by weight or less, and more preferably 12% by weight or less. If the total content is 18% by weight or less, a cured product having small warping can be obtained.

[0040]

The resin sheet 31 preferably contains a curing accelerator.

[0041]

The curing accelerator is not especially limited as long as it promotes the curing reaction. However, from the viewpoints of curing property and storage property, organophosphate compounds such as triphenylphosphine and tetraphenylphosphonium tetraphenylborate; and an imidazole compound can be suitably used. These curing accelerators may

be used alone or in combination with other curing accelerators.

[0042]

The content of the curing accelerator is preferably 0.5 parts by weight or more, and more preferably 1 part by weight or more to the total 100 parts by weight of the epoxy resin and the phenol resin. If the content is 0.5 parts by weight or more, the curing reaction is sufficiently promoted. The content of the curing accelerator is preferably 10 parts by weight or less, and more preferably 5 parts by weight or less. If the content is 10 parts by weight or less, a good storage property can be obtained when the resin sheet 31 is stored under refrigeration, etc.

[0043]

The resin sheet 31 preferably contains an elastomer.

[0044]

The elastomer is used for giving the resin sheet 31 the flexibility that is necessary for sealing the electronic components. The structure of the elastomer is not especially limited as long as the elastomer exhibits the action of giving the resin sheet 31 the flexibility. Examples of the elastomer include various kinds of acrylic copolymers such as polyacrylic ester; styrene acrylate copolymer; rubbery polymers such as butadiene rubber, styrene-butadiene rubber (SBR), ethylene-vinylacetate copolymer (EVA), isoprene rubber, and acrylonitrile rubber. Among these, acrylic, styrenic, and

butadiene rubber can be preferably used from the viewpoints that these can be easily dispersed into the epoxy resin, and the heat resistance and strength of the resin sheet 31 obtained can be improved. These may be used alone or in combination of two or more thereof.

[0045]

The content of the elastomer is preferably 15 parts by weight or more, and more preferably 20 parts by weight or more to the total 100 parts by weight of the epoxy resin and the phenol resin. If the content is 15 parts by weight or more, voids to be entrained due to a decrease in resin viscosity at molding can be reduced or suppressed, and warping after curing can be reduced or suppressed. The content of the elastomer is preferably 200 parts by weight or less, and more preferably 100 parts by weight or less. If the content is 200 parts by weight or less, a decrease in resin strength after curing can be prevented, and the reliability of the semiconductor device can be ensured.

[0046]

The resin sheet 31 preferably contains an inorganic filler.

[0047]

Examples of the inorganic filler include quartz glass, talc, silica (such as fused silica and crystalline silica), alumina, aluminum nitride, silicon nitride, and boron nitride.

Among these, silica and alumina are preferable, and silica is more preferable because the linear expansion coefficient can be satisfactorily decreased. As silica, fused silica is preferable, and spherical fused silica is more preferable because of excellent fluidity.

[0048]

The average particle size of the inorganic filler is preferably 0.1 μm or more, more preferably 0.5 μm or more, further preferably 5 μm or more, and especially preferably 10 μm or more. The average particle size of the inorganic filler is preferably 50 μm or less, and more preferably 25 μm or less.

The average particle size can be obtained, for example, by measurement on a sample that is extracted arbitrarily from the population using a laser diffraction-scattering type particle size distribution measuring apparatus.

[0049]

The content of the inorganic filler in the resin sheet 31 is preferably 70% by volume or more, and more preferably 74% by volume or more. If the content is 70% by volume or more, the water absorption of the cured product can be reduced, and the semiconductor device 38 having good reliability can be obtained. On the other hand, the content of the inorganic filler is preferably 90% by volume or less, and more preferably 85% by volume or less. If the content is 90% by volume or less, the flexibility of the resin sheet 31 can be maintained, and

crack and breakage in handling can be prevented.

[0050]

The content of the inorganic filler can be also explained by using "% by weight" as a unit. The content of silica is explained typically by using "% by weight" as a unit.

Silica normally has a specific gravity of 2.2 g/cm^3 . Therefore, the preferred range of the content (% by weight) of silica is as follows.

That is, the content of silica in the resin sheet 31 is preferably 81% by weight or more, and more preferably 84% by weight or more. The content of silica in the resin sheet 31 is preferably 94% by weight or less, and more preferably 91% by weight or less.

[0051]

Alumina normally has a specific gravity of 3.9 g/cm^3 . Therefore, the preferred range of the content (% by weight) of alumina is as follows.

That is, the content of alumina in the resin sheet 31 is preferably 88% by weight or more, and more preferably 90% by weight or more. The content of alumina in the resin sheet 31 is preferably 97% by weight or less, and more preferably 95% by weight or less.

[0052]

The resin sheet 31 preferably contains a coloring agent. When the resin sheet 31 contains a coloring agent, a marking

property for identifying a semiconductor device after sealing can be ensured. The marking method is not especially limited; however, various methods of laser marking are preferable such as CO₂ laser, YAG laser, and green laser.

[0053]

The coloring agent is not especially limited, and for example, a pigment or a dye can be used. A pigment is preferably used from the viewpoints of cost and good visibility that can be easily obtained at marking. The pigment is not especially limited, and may be an inorganic pigment or an organic pigment.

[0054]

Examples of the inorganic pigment include ceramic pigments such as glass fine powers, glass balloon, and ceramic beads; metal fine piece pigments such as aluminum, iron, zirconium, and cobalt; metal oxide pigments such as titanium oxide, magnesium oxide, barium oxide, calcium oxide, zinc oxide, zirconium oxide, yttrium oxide, indium oxide, sodium titanate, silicon oxide, nickel oxide, manganese oxide, chromium oxide, iron oxide, copper oxide, cerium oxide, and aluminum oxide; composite oxide pigments such as iron oxide-manganese oxide, iron oxide-chromium oxide, and copper oxide-magnesium oxide; metal pigments such as Si, Al, Fe, magnesium, manganese, nickel, titanium, chromium, and calcium; alloy pigments such as iron-chromium, bismuth-manganese, iron-manganese, and manganese-yttrium; mica; silicon nitride; a bright pigment; and

barium sulfate.

[0055]

Examples of the organic pigment include an azo pigment, an azomethine pigment, a lake pigment, a thioindigo pigment, an anthraquinone pigment, a perylene pigment, a perinone pigment, a diketopyrrolopyrrole pigment, a dioxane pigment, a phthalocyanine pigment, a quinophthalone pigment, a quinacridone pigment, an isoindoline pigment, an isoindolinone pigment, and a carbon pigment.

[0056]

The content of the pigment is preferably 0.5 parts by weight or more, and more preferably 1 part by weight or more to the total 100 parts by weight of the epoxy resin and the phenol resin. If the content is 0.5 parts by weight or more, a marking property for identifying a semiconductor device after sealing can be ensured. The content of the pigment is preferably 10 parts by weight or less, and more preferably 5 parts by weight or less. If the content is 10 parts by weight or less, the resin strength can be ensured which is necessary after curing.

[0057]

The resin sheet 31 preferably contains a flame retardant.

[0058]

The flame retardant is not especially limited; however, examples thereof include metal hydroxides such as aluminum hydroxide, magnesium hydroxide, iron hydroxide, calcium

hydroxide, and tin hydroxide; and a phosphazene compound. Among these, a phosphazene compound is preferable because the resin viscosity at molding and the strength after curing can be satisfactorily adjusted within the specified range. An example of the phosphazene compound includes FP-100 (manufactured by FUSHIMI Pharmaceutical Co., Ltd.).

[0059]

The content of the flame retardant is preferably 5 parts by weight or more, and more preferably 15 parts by weight or more to the total 100 parts by weight of the epoxy resin and the phenol resin. If the content is 5 parts by weight or more, sufficient flame retardance can be obtained. The content of the flame retardant is preferably 50 parts by weight or less, and more preferably 30 parts by weight or less. If the content of the flame retardant is 50 parts by weight or less, a decrease in resin strength after curing and a decrease in glass transition temperature can be kept minimum, and the reliability of the semiconductor device 38 can be ensured.

[0060]

Besides each component described above, other additives such as a silane coupling agent can be compounded in the resin sheet 31 as necessary.

[0061]

For example, the resin sheet 31 can be manufactured as follows.

First, each material to be compounded in the resin sheet 31 described above is uniformly dispersed and mixed to prepare a resin composition. The prepared resin composition is formed into a sheet shape. Examples of the forming method include a method of extrusion-molding the prepared resin composition to be formed into a sheet shape (kneading-extrusion); and a method of dissolving or dispersing the prepared resin composition into an organic solvent, etc. to prepare varnish, applying this varnish on a base such as a polyester base, etc., and drying the varnish to be formed into a sheet shape (solvent application).

[0062]

In the solvent application, a plurality of layers of the obtained resin sheets 31 are laminated as necessary, and the thickness of the laminate is adjusted. 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. A release-treated base is preferably used as the base.

[0063]

When the resin sheet 31 is manufactured by

kneading-extrusion, the resin sheet 31 can be easily formed into a sheet shape, and a uniform sheet with less voids (air bubbles), etc. can be made. A preferred example of the method of manufacturing the resin sheet 31 by kneading-extrusion includes a method of kneading each component described above (such as epoxy resin, phenol resin, curing accelerator, elastomer, and inorganic filler) with a kneader, etc. to prepare a kneaded product, and pressing or extruding the obtained kneaded product to be formed into a sheet shape. This makes it possible to fill the resin sheet 31 highly with the inorganic filler. A release sheet such as a polyester film may be pasted to the resin sheet 31 as necessary to protect the surface of the resin sheet 31.

[0064]

The thickness of the resin sheet 31 is not especially limited; however, from the viewpoint of thickness uniformity, the thickness is preferably 50 μm or more, more preferably 100 μm or more, further preferably 200 μm or more, still more preferably 300 μm or more, and especially preferably 400 μm or more. The thickness of the resin sheet 31 is preferably larger than the height of the electronic component 33. When the thickness of the resin sheet 31 is larger than the height of the electronic component 33, the electronic component 33 can be embedded. On the other hand, the thickness of the resin sheet 31 is preferably 2,000 μm or less, and more preferably 1,000 μm or less.

[0065]

[Laminating step]

As shown in Fig. 4, the resin sheet 31 is disposed on the electronic component temporarily fixing body 32 to obtain a laminate 34 in the laminating step. The laminate 34 includes the electronic component temporarily fixing body 32 and the resin sheet 31 that is disposed on the electronic component temporarily fixing body 32.

[0066]

[Sealing step]

As shown in Fig. 5, the laminate 34 is pressed at 0.03 to 3 MPa to collectively seal the plurality of electronic components 33 with the resin sheet 31. This provides a sealed body 35. The sealed body 35 includes the plurality of electronic components 33 and the resin sheet 31 that covers the plurality of electronic components 33. The sealed body 35 is in contact with the pressure-sensitive adhesive sheet 3.

[0067]

The pressing pressure is 0.03 MPa or more, and preferably 0.1 MPa or more. The pressing pressure is 0.03 MPa or more, so that the space between the electronic components 33 can be satisfactorily filled. On the other hand, the pressing pressure is 3 MPa or less, preferably 2 MPa or less, and more preferably 1.5 MPa or less. The pressing is performed at a relatively low pressure of 3 MPa or less, so that the positional

deviation of the electronic component 33 can be reduced, and embedding of the electronic component 33 in the pressure-sensitive adhesive sheet 3 can be reduced.

[0068]

The pressing temperature is not especially limited; however, it is preferably 150°C or lower, more preferably 130°C or lower, further preferably 120°C or lower, and especially preferably 110°C or lower. If the pressing temperature is 150°C or lower, the positional deviation of the electronic component 33 can be reduced, and embedding of the electronic component 33 in the pressure-sensitive adhesive sheet 3 can be reduced. The pressing temperature is preferably 60°C or higher, and more preferably 80°C or higher. If the pressing temperature is 60°C or higher, the space between the electronic components 33 can be satisfactorily filled.

[0069]

The pressing time is not especially limited; however, it is for example 0.5 to 30 minutes, and preferably 1 to 10 minutes.

[0070]

The pressing is preferably performed under a reduced pressure atmosphere. This makes it possible to suppress the generation of voids at molding. The pressure can be reduced with a conventionally known method.

[0071]

The pressure under a reduced pressure atmosphere,

specifically an atmospheric pressure at pressing, is preferably 0.1 kg/cm² or less, and more preferably 0.01 kg/cm² or less. If the pressure is 0.1 kg/cm² or less, the generation of voids at molding can be suppressed. The lower limit of the pressure under a reduced pressure atmosphere is not especially limited; however, it is for example 0.0001 kg/cm² or more.

[0072]

The pressing method is normally a pressing method using parallel flat plates. The pressing using parallel flat plates can be performed using a conventionally known pressing machine using parallel flat plates.

[0073]

In the pressing using parallel flat plates, the temperature distribution and the pressure distribution are important. It is also important to adjust the parallel accuracy of the pressing plates. These may be appropriately adjusted.

[0074]

Then, the sealed body 35 is heated to cure the resin sheet 31.

[0075]

The heating temperature is preferably 100°C or higher, and more preferably 110°C or higher. On the other hand, the upper limit of the heating temperature is preferably 150°C or lower, more preferably 140°C or lower, and especially preferably 130°C or lower. The heating time is preferably 10 minutes or

more, and more preferably 30 minutes or more. On the other hand, the upper limit of the heating time is preferably 360 minutes or less, and more preferably 180 minutes or less. When the sealed body 35 is heated, pressure is preferably applied. The pressure is preferably 0.1 MPa or more, and more preferably 0.5 MPa or more. On the other hand, the upper limit of the pressure is preferably 10 MPa or less, and more preferably 5 MPa or less.

[0076]

[Peeling step]

As shown in Fig. 6, the pressure-sensitive adhesive sheet 3 is peeled from the sealed body 35 in the peeling step. This provides exposure of the electronic components 33. The peeling method is not especially limited; however, the adhesive strength of the pressure-sensitive adhesive layer 3a is preferably lowered, and then the pressure-sensitive adhesive sheet 3 is peeled. For example, when the pressure-sensitive adhesive layer 3a is a thermally peelable pressure-sensitive adhesive layer, the pressure-sensitive adhesive layer 3a is heated to lower the adhesive strength of pressure-sensitive adhesive layer 3a, and then the pressure-sensitive adhesive sheet 3 is peeled.

[0077]

As shown in Fig. 7, the sealed body 35 has a difference D between the electronic component 33 and the resin sheet 31. The laminate 34 is pressed at relatively low pressure to obtain

the sealed body 35, so that the difference D is relatively small or the difference D is not present. Specifically, the difference D is normally 3 μm or less. Accordingly, the damage of the thin film for forming an insulating layer can be prevented.

[0078]

The laminate 34 is pressed at relatively low pressure to obtain the sealed body 35, so that the positional deviation (chip shift) of the electronic component 33 is small. Specifically, the chip shift is normally 15 μm or less.

For example, the position of the electronic component 33 before the laminate 34 is pressed is compared with the position of the electronic component 33 after the laminate 34 is pressed to obtain the chip shift. The value of chip shift as used herein is an average value of the measurement results for 100 pieces of the electronic components 33. Specifically, the chip shift can be measured with the method described in the examples.

[0079]

[Grinding step]

In the grinding step, the sealed body 35 is grinded to form a grinded body 36 (refer to Fig. 8).

Specifically, the surface of the sealed body 35 is grinded which is opposite to the surface where the pressure-sensitive adhesive sheet 3 is formed.

[0080]

After the grinding, the surface of the grinded body 36 where the pressure-sensitive adhesive layer 3a is formed is cleaned by plasma treatment, etc.

[0081]

[Rewiring forming step]

In the rewiring forming step, a rewiring 39 that connects with the electronic component 33 is formed on the grinded body 36, and an insulating layer is formed on the surface of the grinded body 36 where the rewiring 39 is formed (refer to Fig. 9).

[0082]

Specifically, a metal seed layer is formed on the grinded body 36 by using a known method such as a vacuum film forming method, and the rewiring 39 is formed with a semi-additive method, etc. Thereafter, an insulating layer such as polyimide or polybenzoxazole (PBO) is formed on the surface of the grinded body 36 where the rewiring 39 is formed.

[0083]

For example, a film such as a dry film resist can be laminated to form the insulating layer. The thickness of the film is not especially limited; however, it is normally 5 to 50 μm .

[0084]

[Bump forming step]

A bumping process is performed for forming a bump 37 on

the rewiring 39 (refer to Fig. 10). The bumping process is performed with a known method such as solder ball or solder plating. The material of the bump 37 is not especially limited; however, examples thereof include solders (alloy) such as a tin-lead metal material, a tin-silver metal material, a tin-silver-copper metal material, a tin-zinc metal material, and a tin-zinc-bismuth metal material; a gold metal material; and a copper metal material.

[0085]

[Dicing step]

The laminate is diced which includes the elements such as the electronic component 33, the resin sheet 31, and rewiring 39 (refer to Fig. 11). This provides the semiconductor device 38 in the form of individualized pieces.

[0086]

The manufacturing example explained above includes the grinding step of grinding the sealed body 34; however, Variation Example 1 does not include the grinding step of grinding the sealed body 34. In the manufacturing example explained above, the rewiring 39 is formed, and then the insulating layer is formed; however, in Variation Example 2, the insulating layer is formed on the sealed body 35, and then the rewiring 39 is formed on the insulation layer.

EXAMPLES

[0087]

The present invention will be explained in detail below by way of examples; however, the invention is not limited to the following examples as long as it does not deviate from its purpose.

[0088]

[Examples 1 and 2 and Comparative Example 1]

(Components for use in producing thermosetting resin sheet)

The components will be explained which are used to produce a thermosetting resin sheet.

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

Phenol resin: MEH-7851-SS manufactured by Meiwa Plastic Industries, Ltd. (phenol resin having biphenylaralkyl skeleton, hydroxyl group equivalent 203 g/eq., softening point 67°C)

Elastomer: SIBSTER 102T manufactured by Kaneka Corporation (styrene-isobutylene-styrene block copolymer)

Curing accelerator: Curezol 2PHZ-PW (2-phenyl-4,5-dihydroxymethylimidazole) manufactured by Shikoku Chemicals Corporation

Pigment: Carbon Black #20 manufactured by Mitsubishi Chemical Corporation

Flame retardant: Rapitle FP-100 manufactured by FUSHIMI Pharmaceutical Co., Ltd.

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

[0089]

(Production of thermosetting resin sheet)

Each of the components was blended with a mixer according to the compounding ratio described in Table 1, and the components were melt-kneaded at 120°C for 2 minutes with a biaxial kneader, and the kneaded product was extruded from a T die to produce a thermosetting resin sheet having a thickness of 500 μm .

[0090]

(Evaluation of minimum viscosity at 60 to 150°C)

A sample having a thickness 500 μm and a diameter of 8 mm was cut out from the thermosetting resin sheet. The minimum viscosity of the sample was measured using a dynamic viscoelasticity measuring apparatus ARES manufactured by TA Instruments at a temperature rising rate of 10°C, a temperature range of 60 to 150°C, and a measurement frequency of 0.1 Hz. The results are shown in Table 1.

[0091]

(Production of sealed body and evaluation of chip shift)

A circular glass plate having a diameter of 300 mm was prepared in which one reference point was marked by laser. A pressure-sensitive adhesive layer (REVALPHA manufactured by

Nitto Denko Corporation) was provided on the glass plate to obtain a pressure-sensitive adhesive sheet. One hundred pieces of semiconductor chips (semiconductor chip size: 5 mm square (thickness 300 μm)) were arranged on the pressure-sensitive sheet at even intervals by using die bonder SPA-300 (manufactured by Shinkawa). The position of each semiconductor chip (semiconductor chip position before molding) that was arranged on the pressure-sensitive sheet was measured by using SmartScope CNC500 manufactured by Optical Gaging Products, Inc. with the reference point on the glass plate being a zero point.

Next, the thermosetting resin sheet was disposed on the semiconductor chips that were arranged on the pressure-sensitive adhesive sheet to form a laminate. The laminate was pressed with the molding condition described in Table 1 by using a pressing machine using parallel flat plates, and the semiconductor chips were collectively sealed with the thermosetting resin sheet to obtain a sealed body. The sealed body was heated at 120°C for 3 hours to be cured.

Thereafter, the position of each semiconductor chip (semiconductor chip position after molding) was measured from the backside of the glass plate by using SmartScope CNC500 manufactured by Optical Gaging Products, Inc. (the measurement was performed with the reference point on the glass plate being a zero point)

The semiconductor chip position after molding was compared with the semiconductor chip position before molding to obtain the shift (deviation width) of the semiconductor chip. The average values of the deviation widths of each semiconductor chip are shown in Table 1.

[0092]

(Evaluation of difference D)

The difference D (the difference between the semiconductor chip and the thermosetting resin sheet) for the sealed body was measured. A surface profiler (Dektak 8M) manufactured by Veeco was used in the measurement. The average values of the differences D of each semiconductor chip are shown in Table 1.

[0093]

(Evaluation of filling property)

Whether or not voids are present on the glass plate was visually observed for the sealed body. The case in which no void is present was determined as "O", and the case in which voids are present was determined as "x". The results are shown in Table 1.

[0094]

(Comprehensive determination)

The case in which all of the following conditions were satisfied was determined as "O", and the case in which any one of the following conditions was not satisfied was determined

as "x". The results are shown in Table 1.

Condition (1): Chip shift is 15 μm or less.

Condition (2): Difference D is 3 μm or less.

Condition (3): Evaluation result of filling property is "O".

[0095]

[Table 1]

(Thermosetting Resin Sheet)

		Example 1	Example 2	Comparative Example 1
Compounding Ratio (parts by weight)	Epoxy Resin YSLV-80XY	3.3	3.3	3.3
	Phenol Resin MEH-7851SS	3.5	3.5	3.5
	Elastomer SIBSTAR 102T	3	3	3
	Curing Accelerator 2PHZ-PW	0.6	0.6	0.6
	Pigment Carbon Black #20	0.3	0.3	0.3
	Flame Retardant Rapitile FP-100	1	1	1
	Inorganic Filler FB-9454FC	88	88	88
Molding Condition	Pressing Pressure (MPa)	0.1	1	4
	Pressing Temperature ($^{\circ}\text{C}$)	100	100	100
	Pressing Time (min)	2	2	2
	Reduced Pressure Atmosphere (kg/cm^2)	0.006	0.006	0.006
Evaluation	Chip Shift (μm)	4	6	12
	Surface Difference (μm)	0.1	0.3	3.2
	Filling Property	O	O	O
	Comprehensive Determination	O	O	x
	Minimum Viscosity ($\text{Pa}\cdot\text{s}$) at 60 to 150 $^{\circ}\text{C}$	6400	6400	6400

[0096]

In Examples 1 and 2 and Comparative Example 1, a resin sheet was used which was highly filled with the inorganic filler and had relatively high viscosity. It has been considered to be difficult to make the surface difference be small because the semiconductor chip is easily embedded in the

pressure-sensitive adhesive sheet having high viscosity.

However, it is made clear from Examples 1 and 2 and Comparative Example 1 that the pressing pressure can be adjusted to 0.03 to 3 MPa to reduce the surface difference, and that the pressing pressure can be adjusted to 0.03 to 3 MPa to reduce the chip shift.

[0097]

[Comparative Examples 2 and 3]

(Components for use in producing liquid thermosetting resin)

The components will be explained which are used to produce a liquid thermosetting resin.

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

Liquid epoxy resin: Epikote 828 manufactured by Mitsubishi Chemical Corporation (bisphenol A-type epoxy resin, epoxy equivalent 200 g/eq.)

Phenol resin: MEH-8000H manufactured by Meiwa Plastic Industries, Ltd. (liquid modified phenol novolak resin, hydroxyl group equivalent 139 to 143 g/eq.)

[0098]

(Production of liquid thermosetting resin)

Each of the components was stirred for 7 minutes at 2,000 rpm with a rotation and revolution mixer according to the compounding ratio described in Table 2 to produce a liquid

thermosetting resin.

[0099]

(Evaluation of minimum viscosity at 60 to 150°C)

The liquid thermosetting resin was disposed on a plate having a diameter of 8 mm to obtain a sample having the plate and the liquid thermosetting resin disposed on the plate. The minimum viscosity of the sample was measured using a dynamic viscoelasticity measuring apparatus ARES manufactured by TA Instruments at a temperature rising rate of 10°C, a temperature range of 60 to 150°C, a measurement frequency of 0.1 Hz, and a gap of 500 μm . The results are shown in Table 2.

[0100]

(Production of sealed body and evaluation of chip shift)

A circular glass plate having a diameter of 300 mm was prepared in which one reference point was marked by laser. A pressure-sensitive adhesive layer (REVALPHA manufactured by Nitto Denko Corporation) was provided on the glass plate to obtain a pressure-sensitive adhesive sheet. One hundred pieces of semiconductor chips (semiconductor chip size: 5 mm square (thickness 300 μm)) were arranged on the pressure-sensitive sheet at even intervals by using die bonder SPA-300 (manufactured by Shinkawa). The position of each semiconductor chip (semiconductor chip position before molding) that was arranged on the pressure-sensitive sheet was measured by using SmartScope CNC500 manufactured by Optical

Gaging Products, Inc. with the reference point on the glass plate being a zero point.

Next, 25 cm³ of the liquid thermosetting resin was dripped on the pressure-sensitive adhesive sheet to obtain a structure including the pressure-sensitive adhesive sheet, the semiconductor chips arranged on the pressure-sensitive adhesive sheet, and the liquid thermosetting resin disposed on the pressure-sensitive sheet to cover the semiconductor chips. The structure was pressed with the molding condition described in Table 2 by using a pressing machine using parallel flat plates, and the semiconductor chips were collectively sealed with the thermosetting resin sheet to obtain a sealed body. The sealed body was heated at 120°C for 3 hours to be cured.

Thereafter, the position of each semiconductor chip (semiconductor chip position after molding) was measured from the backside of the glass plate by using SmartScope CNC500 manufactured by Optical Gaging Products, Inc. (the measurement was performed with the reference point on the glass plate being a zero point)

The semiconductor chip position after molding was compared with the semiconductor chip position before molding to obtain the shift (deviation width) of the semiconductor chip. The average values of the deviation widths of each semiconductor chip are shown in Table 2.

[0101]

(Evaluation of difference D, evaluation of filling property, and comprehensive determination)

The evaluation of the difference D, the evaluation of the filling property, and the comprehensive determination were performed in the same way as in Example 1. The results are shown in Table 2.

[0102]

[Table 2]

(Liquid Thermosetting Resin)

		Comparative Example 2	Comparative Example 3
Compounding Ratio (parts by weight)	Epoxy Resin YSLV-80XY	0.8	0.8
	Liquid Epoxy Resin Epikote 828	2.5	2.5
	Phenol Resin MEH-8000H	3.5	3.5
Molding Condition	Pressing Pressure (MPa)	1	4
	Pressing Temperature (°C)	100	100
	Pressing Time (min)	2	2
	Reduced Pressure Atmosphere (kg/cm ²)	0.006	0.006
Evaluation	Chip Shift (μm)	9	15
	Surface Difference (μm)	2.0	2.3
	Filling Property	x	○
	Comprehensive Determination	x	x
	Minimum Viscosity (Pa·s) at 60 to 150°C	30	30

[0103]

The pressing pressure was set low in Comparative Example 2, so that the positional deviation of the semiconductor chip was relatively small. However, because the liquid thermosetting resin was used in Comparative Example 2, the space between the semiconductor chips could not be filled. Because large pressing pressure was applied in Comparative Example 3,

the space between the semiconductor chips could be filled. However, the positional deviation of the semiconductor chip was large in Comparative Example 3.

[0104]

From the results in Tables 1 and 2, it is made clear that the surface difference can be made small and the positional deviation of the semiconductor chip can be made small when a thermosetting resin sheet is used as compared with the case where a liquid thermosetting resin is used when the press molding is performed at low pressure such as 1 MPa.

DESCRIPTION OF REFERENCE SIGNS

[0105]

- 3 Pressure-Sensitive Adhesive Sheet
- 3a Pressure-Sensitive Adhesive Layer
- 3b Support
- 31 Resin Sheet
- 32 Electronic Component Temporarily Fixing Body
- 33 Semiconductor Chip
- 34 Laminate
- 35 Sealed Body
- 36 Grinded Body
- 37 Bump
- 38 Semiconductor Device
- 39 Rewiring

CLAIMS

1. A method of manufacturing a semiconductor device, the method comprising:

a laminating step of disposing a resin sheet on an electronic component temporarily fixing body including a pressure-sensitive adhesive sheet and a plurality of electronic components that are arranged on the pressure-sensitive adhesive sheet; and

a sealing step of pressing a laminate obtained in the laminating step at 0.03 to 3 MPa to form a sealed body including the plurality of electronic components and the resin sheet that covers the plurality of electronic components.

2. The method of manufacturing a semiconductor device according to claim 1, wherein a pressing temperature in the sealing step is 60 to 150°C.

3. The method of manufacturing a semiconductor device according to claim 1 or 2, wherein a resin sheet having a minimum viscosity of 30 to 8,000 Pa·s at 60 to 150°C is used as the resin sheet.

4. The method of manufacturing a semiconductor device according to any of claims 1 to 3, further comprising:

a peeling step of peeling the pressure-sensitive adhesive sheet from the sealed body,

wherein a difference between the electronic component and the resin sheet in the sealed body is 3 μm or less.

5. The method of manufacturing a semiconductor device according to any of claims 1 to 4, wherein a deviation of the electronic component before and after the sealing step is 15 μm or less.