

DESCRIPTION

TITLE OF THE INVENTION: RESIN SHEET FOR SEALING ELECTRONIC
COMPONENT, RESIN-SEALED SEMICONDUCTOR DEVICE, AND PRODUCTION
METHOD FOR RESIN-SEALED SEMICONDUCTOR DEVICE

5

TECHNICAL FIELD

[0001]

The present invention relates to a resin sheet for sealing
an electronic component, a resin-sealed semiconductor device,
10 and a production method for a resin-sealed semiconductor
device.

BACKGROUND ART

[0002]

15

In the production of a semiconductor device, resin
sealing has been conventionally performed so that the resin can
cover an electronic component such as a semiconductor chip that
has been mounted on various types of substrates such as a lead
frame and a circuit board. The resin-sealed semiconductor
20 device produced in this way has a problem that the reliability
deteriorates when the water-absorbing property of the sealing
resin is high. Accordingly, a sealing resin having low
water-absorbing property has been conventionally used to
improve the reliability of the resin-sealed semiconductor
25 device.

[0003]

On the other hand, a polypropylene-based resin sheet that is resistant to moisture permeation has been conventionally known (for example, refer to Patent Document 1). The
5 polypropylene-based resin sheet described in Patent Document 1 is used for various types of packages and containers.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

10 [0004]

Patent Document 1: JP-A-07-148853

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

15 [0005]

However, there has been a problem that there is a case where the reliability is not improved even when a sealing resin having low water-absorbing property is used in the production of a resin-sealed semiconductor device.

20 [0006]

The present invention was made in consideration of the above-described problem, and an object thereof is to provide a resin sheet for sealing an electronic component that is capable of improving the reliability of the resin-sealed
25 semiconductor device and a highly reliable resin-sealed

semiconductor device.

MEANS FOR SOLVING THE PROBLEM

[0007]

5 The present inventors made investigations to solve the above-described problem. As a result, they found that the moisture permeability of the sealing resin is involved in the reliability of the resin-sealed semiconductor device, and completed the present invention.

10 [0008]

 That is, the resin sheet for sealing an electronic component according to the present invention is a resin sheet for sealing an electronic component that is used to produce a resin-sealed semiconductor device, containing 70 to 93% by
15 weight of an inorganic filler to the entire resin sheet for sealing an electronic component, wherein the moisture permeability of the resin sheet after thermal curing when the resin sheet has a thickness of 250 μm is 300 $\text{g/m}^2\cdot 24$ hours or less under conditions of a temperature of 85°C, a humidity of
20 85%, and a duration of 168 hours.

[0009]

 Conventionally, the reliability of the resin-sealed semiconductor device has been considered to depend on the water-absorbing property of the sealing resin, and the moisture
25 permeability has not been investigated. Because of this, there

has been a situation in which the reliability of the resin-sealed semiconductor device cannot be secured even when the water-absorbing property of the sealing resin is low. As a result of extensive investigation of the present inventors, it was found that the reliability of the resin-sealed semiconductor device is improved when the moisture permeability of the sealing resin is low. The present inventors assume that this is because water hardly reaches the electronic component from outside when the moisture permeability of the sealing resin is low. That is, they assume that the reliability of the resin-sealed semiconductor device deteriorates when a sealing resin having high moisture permeability is used even if it has a low water-absorbing property, because water eventually reaches the electronic component.

[0010]

According to the above-described configuration, because the resin sheet for sealing an electronic component contains 70 to 93% by weight of an inorganic filler to the entire resin sheet for sealing an electronic component and the moisture permeability of the resin sheet after thermal curing when the resin sheet has a thickness of 250 μm is 300 $\text{g/m}^2 \cdot 24$ hours or less under conditions of a temperature of 85°C, a humidity of 85%, and a duration of 168 hours, water hardly reaches the electronic component from outside. As a result, the reliability of the resin-sealed semiconductor device can be

improved. The evaluation conditions for the moisture permeability are a temperature of 85°C, a humidity of 85%, and a duration of 168 hours because these conditions meet the Level 1 condition that is the severest water-absorbing property condition in a moisture sensitivity level test (MSL test) for a semiconductor package.

When the thickness of the resin sheet is not 250 μm, the moisture permeability at a thickness of 250 μm under conditions of a temperature of 85°C, a humidity of 85%, and a duration of 168 hours is calculated from the following formula 1.

$$\text{(Formula 1) } A = (250 - D) \times 0.101$$

(A: Moisture Permeability, D: Thickness (μm) of Sample)

[0011]

In the above-described configuration, the moisture permeability of the resin sheet after thermal curing when the resin sheet has a thickness of 250 μm is preferably 100 g/m²·24 hours or less under conditions of a temperature of 60°C, a humidity of 90%, and a duration of 168 hours. When the moisture permeability of the resin sheet after thermal curing when the resin sheet has a thickness of 250 μm is 100 g/m²·24 hours or less under conditions of a temperature of 60°C, a humidity of 90%, and a duration of 168 hours, the reliability of the resin-sealed semiconductor device can be further improved. The evaluation conditions for the moisture permeability are a temperature of 60°C, a humidity of 90%, and a duration of 168

hours because these conditions are one of the severest conditions in a high-temperature and high-humidity shelf test for a semiconductor package.

When the thickness of the resin sheet is not 250 μm , the
5 moisture permeability at a thickness of 250 μm under conditions of a temperature of 60°C, a humidity of 90%, and a duration of 168 hours is calculated from the following formula 2.

$$\text{(Formula 2) } A - (250 - D) \times 0.010$$

(A: Moisture Permeability, D: Thickness (μm) of Sample)

10 [0012]

In the above-described configuration, the resin sheet for sealing an electronic component is preferably produced by kneading and extrusion. Because the resin sheet for sealing an electronic component of the present invention contains 70
15 to 93% by weight of an inorganic filler to the entire resin sheet for sealing an electronic component, it is difficult to be molded into a sheet shape. Accordingly, kneading and extrusion can be employed for producing a uniform sheet with few voids (air bubbles). As a result, low moisture permeation property
20 can be further achieved.

[0013]

The resin-sealed semiconductor device according to the present invention includes an adherend, a semiconductor chip that is flip-chip bonded to the adherend, and a resin sheet for
25 sealing an electronic component that seals the semiconductor

chip, the resin sheet for sealing an electronic component contains 70 to 93% by weight of an inorganic filler to the entire resin sheet for sealing an electronic component, the moisture permeability of the resin sheet after thermal curing when the
5 resin sheet has a thickness of 250 μm is 300 $\text{g}/\text{m}^2 \cdot 24$ hours or less under conditions of a temperature of 85°C, a humidity of 85%, and a duration of 168 hours, and an empty space is formed between the adherend and the semiconductor chip.

[0014]

10 It is structurally necessary to form an empty space between the adherend and the semiconductor chip in some of MEMSs (Micro Electro Mechanical Systems) such as an acceleration sensor, a pressure sensor, and a gyro sensor, and a surface acoustic wave filter (SAW filter). However, once water
15 penetrates into the empty space from outside, it is difficult to remove the water and the reliability of the resin-sealed semiconductor device deteriorates due to the water.

[0015]

According to the above-described configuration, because
20 the resin sheet for sealing an electronic component contains 70 to 93% by weight of an inorganic filler to the entire resin sheet for sealing an electronic component and the moisture permeability of the resin sheet after thermal curing when the resin sheet has a thickness of 250 μm is 300 $\text{g}/\text{m}^2 \cdot 24$ hours or
25 less under conditions of a temperature of 85°C, a humidity of

85%, and a duration of 168 hours, water hardly penetrates into the empty space between the adherend and the semiconductor chip from outside. As a result, the reliability of the resin-sealed semiconductor device can be improved.

5 [0016]

The resin-sealed semiconductor device according to the present invention includes the resin sheet for sealing an electronic component.

[0017]

10 According to the above-described configuration, because the resin sheet for sealing an electronic component contains 70 to 93% by weight of an inorganic filler to the entire resin sheet for sealing an electronic component and the moisture permeability of the resin sheet after thermal curing when the
15 resin sheet has a thickness of 250 μm is 300 $\text{g}/\text{m}^2 \cdot 24$ hours or less under conditions of a temperature of 85°C, a humidity of 85%, and a duration of 168 hours, water hardly reaches the electronic component from outside. As a result, the reliability of the resin-sealed semiconductor device can be
20 improved.

[0018]

The production method for a resin-sealed semiconductor device according to the present invention includes the step of laminating a resin sheet for sealing an electronic component
25 from a semiconductor chip side so that the resin sheet covers

a semiconductor chip that is flip-chip bonded to an adherend, the resin sheet for sealing an electronic component contains 70 to 93% by weight of an inorganic filler to the entire resin sheet for sealing an electronic component, and the moisture permeability of the resin sheet after thermal curing when the resin sheet has a thickness of 250 μm is 300 $\text{g}/\text{m}^2 \cdot 24$ hours or less under conditions of a temperature of 85°C, a humidity of 85%, and a duration of 168 hours.

[0019]

According to the above-described configuration, because the resin sheet for sealing an electronic component contains 70 to 93% by weight of an inorganic filler to the entire resin sheet for sealing an electronic component and the moisture permeability of the resin sheet after thermal curing when the resin sheet has a thickness of 250 μm is 300 $\text{g}/\text{m}^2 \cdot 24$ hours or less under conditions of a temperature of 85°C, a humidity of 85%, and a duration of 168 hours, water hardly reaches the electronic component from outside in the produced resin-sealed semiconductor device. As a result, the reliability of the resin-sealed semiconductor device can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

Fig. 1 is a schematic cross-sectional view showing one example of the resin sheet for sealing an electronic component

according to the present embodiment.

Fig. 2 is a schematic cross-sectional view for illustrating the production method for the resin-sealed semiconductor device according to the present embodiment.

5 Fig. 3 is a schematic cross-sectional view for illustrating the production method for the resin-sealed semiconductor device according to the present embodiment.

Fig. 4 is a schematic cross-sectional view for illustrating the production method for the resin-sealed semiconductor device according to the present embodiment.

10 Fig. 5 is a schematic cross-sectional view for illustrating the production method for the resin-sealed semiconductor device according to the present embodiment.

Fig. 6 is a schematic cross-sectional view for illustrating the production method for the resin-sealed semiconductor device according to the present embodiment.

MODE FOR CARRYING OUT THE INVENTION

[0021]

20 The embodiments of the present invention will be explained by referring to the drawings. However, the present invention is not limited to these examples. Fig. 1 is a schematic cross-sectional view showing one example of the resin sheet for sealing an electronic component according to the present embodiment. In the drawings of the present description,

some portions that are unnecessary for the explanation are omitted, and there are portions that are enlarged or shrunk to make the explanation easy.

[0022]

5 (Resin sheet for sealing electronic component)

As shown in Fig. 1, a resin sheet 2 for sealing an electronic component has a sheet shape. The resin sheet 2 for sealing an electronic component is used in the production of a resin-sealed semiconductor device (for example, a resin-sealed semiconductor device 50 shown in Fig. 6).

[0023]

The moisture permeability of the resin sheet 2 for sealing an electronic component after thermal curing when the resin sheet 2 has a thickness of 250 μm is 300 $\text{g}/\text{m}^2 \cdot 24$ hours or less under conditions of a temperature of 85°C, a humidity of 85%, and a duration of 168 hours. It is preferably 200 $\text{g}/\text{m}^2 \cdot 24$ hours or less, and more preferably 100 $\text{g}/\text{m}^2 \cdot 24$ hours or less. A smaller moisture permeability is more preferable, but the moisture permeability is 1 $\text{g}/\text{m}^2 \cdot 24$ hours or more, for example. Because the moisture permeability after thermal curing when the resin sheet 2 has a thickness of 250 μm is 300 $\text{g}/\text{m}^2 \cdot 24$ hours or less under conditions of a temperature of 85°C, a humidity of 85%, and a duration of 168 hours, water hardly reaches the electronic component from outside. As a result, the reliability of the resin-sealed semiconductor device having the resin sheet 2 for

sealing an electronic component can be improved.

[0024]

The moisture permeability of the resin sheet 2 for sealing an electronic component after thermal curing when the resin sheet 2 has a thickness of 250 μm is preferably 100 $\text{g}/\text{m}^2 \cdot 24$ hours or less under conditions of a temperature of 60°C, a humidity of 90%, and a duration of 168 hours. It is more preferably 50 $\text{g}/\text{m}^2 \cdot 24$ hours or less, and further preferably 20 $\text{g}/\text{m}^2 \cdot 24$ hours or less. A smaller moisture permeability is more preferable, but the moisture permeability is 0.5 $\text{g}/\text{m}^2 \cdot 24$ hours or more, for example. When the moisture permeability after thermal curing when the resin sheet 2 has a thickness of 250 μm is 100 $\text{g}/\text{m}^2 \cdot 24$ hours or less under conditions of a temperature of 60°C, a humidity of 90%, and a duration of 168 hours, the reliability of the resin-sealed semiconductor device having the resin sheet 2 for sealing an electronic component can be improved.

[0025]

A resin composition that forms the resin sheet 2 for sealing an electronic component is not especially limited as long as it can be used to seal an electronic component (for example, a semiconductor chip 5). However, a resin composition containing the following components A to E is preferable.

Component A: epoxy resin

Component B: phenol resin

25 Component C: elastomer

Component D: inorganic filler

Component E: curing accelerator

[0026]

(Component A)

5 The epoxy resin (component A) is not particularly limited. Various kinds of epoxy resins can be used such as, for example, a triphenylmethane-type epoxy resin, a cresol novolac-type epoxy resin, a biphenyl-type epoxy resin, a modified bisphenol A-type epoxy resin, a bisphenol
10 A-type epoxy resin, a bisphenol F-type epoxy resin, a modified bisphenol F-type epoxy resin, dicyclopentadiene-type epoxy resin, a phenol novolac-type epoxy resin and a phenoxy resin. These epoxy resins may be used alone or in combination of two or more thereof.

15 [0027]

 An epoxy resin which has an epoxy equivalent of 150 to 250 and a softening point or melting point of 50 to 130°C and is solid at ordinary temperature is preferred from the viewpoint of securing toughness after curing of the epoxy
20 resin and reactivity of the epoxy resin, and particularly a triphenylmethane-type epoxy resin, a cresol novolac-type epoxy resin and a biphenyl-type epoxy resin are preferred from the viewpoint of reliability.

[0028]

25 A modified bisphenol A-type epoxy resin having a flexible backbone of an acetal group, a polyoxyalkylene group or the like

is preferred from the viewpoint of low stress, and a modified bisphenol A-type epoxy resin having an acetal group can be especially suitably used because it is liquid and has good handling characteristics.

5 [0029]

The content of the epoxy resin (Component A) is preferably 1 to 10% by weight to the entire resin sheet for sealing an electronic component, and it is more preferably 2 to 5% by weight.

10 [0030]

(Component B)

The phenol resin (component B) is not particularly limited as long as it causes a curing reaction with the epoxy resin (component A). For example, a phenol novolac resin, a
15 phenol aralkyl resin, a biphenyl aralkyl resin, a dicyclopentadiene-type phenol resin, a cresol novolac resin, a resol resin and the like are used. These phenol resins may be used alone or in combination of two or more thereof.

[0031]

20 As the phenol resin, a phenol resin having a hydroxyl equivalent of 70 to 250 and a softening point of 50 to 110°C is preferably used from the viewpoint of reactivity with the epoxy resin (component A), and particularly a phenol novolac resin can be suitably used because of its high curing reactivity.

25 A phenol resin having low hygroscopicity, such as a phenol

aralkyl resin and a biphenyl aralkyl resin, can also be suitably used from the viewpoint of reliability.

[0032]

The epoxy resin (component A) and the phenol resin
5 (component B) are blended in such a ratio that the total amount of hydroxyl groups in the phenol resin (component B) is preferably 0.7 to 1.5 equivalents, more preferably 0.9 to 1.2 equivalents, based on 1 equivalent of epoxy groups in the epoxy resin (component A) from the viewpoint of curing reactivity.

10 [0033]

(Component C)

The elastomer (Component C) that is used together with the epoxy resin (Component A) and the phenol resin (Component B) gives plasticity that is necessary for sealing the
15 semiconductor chip 5 to the resin composition when the resin sheet for sealing an electronic component is formed into a sheet shape, and the structure of the elastomer is not limited as long as the elastomer exhibits an action of giving plasticity. For example, various kinds of acryl-based copolymers such as a
20 polyacrylic acid ester, styrene acrylate-based copolymers, rubber polymers such as butadiene rubber, styrene-butadiene rubber (SBR), ethylene-vinyl acetate copolymer (EVA), isoprene rubber and acrylonitrile rubber can be used. Particularly, an acryl-based copolymers is preferably used because it is easily
25 dispersed in the epoxy resin (component A) and has high

reactivity with the epoxy resin (A component), so that the heat resistance and strength of the resin sheet for sealing an electronic component obtained can be improved. They may be used alone or in combination of two or more thereof.

5 [0034]

The acryl-based copolymer can be synthesized by, for example, radical-polymerizing an acrylic monomer mixture prepared at a predetermined mixing ratio using a usual method. As a method for radical polymerization, a solution
10 polymerization method using an organic solvent as a solvent, or suspension polymerization method of performing polymerization while dispersing a raw material monomer in water is used. Examples of the polymerization initiator used at this time include 2,2'-azobisisobutyronitrile,
15 2,2'-azobis-(2,4-dimethylvaleronitrile), 2,2'-azobis-4-methoxy-2,4-dimethylvaleronitrile and other azo-based or diazo-based polymerization initiators, and peroxide-based polymerization initiators such as benzoyl peroxide and methyl ethyl ketone peroxide. In the case of
20 suspension polymerization, it is desirable to use a dispersant such as, for example, polyacrylamide or polyvinyl alcohol.

[0035]

The content of the elastomer (Component C) is preferably 1 to 10% by weight to the entire resin sheet for sealing an
25 electronic component, and it is more preferably 2 to 5% by weight.

By making the content of the elastomer (Component C) 1% by weight or more, the sheet can have flexibility and toughness. By making the content of the elastomer (Component C) 10% by weight or less, a molded product strength required for a package can
5 be exhibited.

[0036]

The weight ratio of the elastomer (Component C) to the epoxy resin (Component A) (Weight of Component C/Weight of Component A) is preferably 0.3 to 2, and more preferably 0.7
10 to 1.5. By making the weight ratio 0.3 or more, the sheet can have toughness and flexibility. On the other hand, by making the weight ratio 2 or less, the reliability of the package after curing can be maintained.

[0037]

15 (Component D)

The inorganic filler (Component D) is not especially limited, and various types of conventionally known fillers can be used. Examples include powders of quartz glass, talc, silica (such as fused silica and crystalline silica), alumina,
20 aluminum nitride, and silicon nitride. These may be used alone or in combination of two or more thereof.

[0038]

Among these, a silica powder is preferably used from the viewpoint that it has low moisture permeation property. Above
25 all, a fused silica powder is more preferably used. Examples

of the fused silica powder include a spherical fused silica powder and a crushed fused silica powder. A spherical fused silica powder is especially preferably used from the viewpoint of fluidity. Among these, a powder having an average particle size of 0.1 to 50 μm is preferably used, and a powder having an average particle size of 0.3 to 25 μm is especially preferably used.

[0039]

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

[0040]

The content of the inorganic filler (Component D) is preferably 70 to 93% by weight, more preferably 75 to 90% by weight, and further preferably 80 to 88% by weight to the entire resin sheet for sealing an electronic component. Because the moisture permeation property of the inorganic filler is low, the moisture permeability of the resin sheet 2 for sealing an electronic component can be made low by making the content of the inorganic filler 70% by weight or more. On the other hand, by making the content of the inorganic filler 93% by weight or less, the resin sheet 2 for sealing an electronic component can be easily made to have a sheet shape.

[0041]

(Component E)

The curing accelerator (component E) is not particularly limited as long as it causes curing of the epoxy resin and the phenol resin to proceed, but organic phosphorus-based compounds
5 such as triphenylphosphine and tetraphenylphosphonium tetraphenylborate, and imidazole-based compounds are suitably used from the viewpoint of curability and keeping quality. These curing accelerators may be used alone or in combination with other curing accelerators.

10 [0042]

The content of the curing accelerator (component E) is preferably 0.1 to 5 parts by weight based on 100 parts by weight of the total of the epoxy resin (component A) and the phenol resin (component B).

15 [0043]

(Other components)

A flame retardant component may be added to the resin composition in addition to Components A to E. Examples of the flame retardant component include organic phosphorus-based
20 flame retardants such as phosphazene, and various types of metal hydroxides such as aluminum hydroxide, magnesium hydroxide, iron hydroxide, calcium hydroxide, tin hydroxide, and composite metal hydroxides. The organic phosphorus-based flame retardant is preferable from the viewpoint of dispersibility
25 of the flame retardant in the resin composition. However, there

may be a case where aluminum hydroxide or magnesium hydroxide is used from the viewpoint of being capable of exhibiting flame retardancy with a relatively small addition amount or in terms of cost. These flame retardant components may be used alone
5 or in combination.

[0044]

The epoxy resin composition may appropriately contain other additives such as pigments including carbon black as necessary in addition to the components described above.

10 [0045]

(Production method for resin sheet for sealing electronic component)

A procedure of a production method for the resin sheet 2 for sealing an electronic component is explained below when
15 the resin sheet 2 for sealing an electronic component is a sheet-shaped thermosetting resin layer.

[0046]

First, an epoxy resin composition is prepared by mixing the components described above. The mixing method is not
20 particularly limited as long as the components are uniformly dispersed and mixed. Thereafter, for example, a varnish prepared by dissolving or dispersing the components in an organic solvent or the like is applied and formed into a sheet. Alternatively, a kneaded product may be prepared by kneading
25 the blend components directly with a kneader or the like, and

extruded to be formed into a sheet.

[0047]

As a specific preparation procedure using a varnish, the components A to E and other additives as necessary are
5 appropriately mixed in accordance with a usual method, and the mixture is uniformly dissolved or dispersed in an organic solvent to prepare a varnish. Then, the varnish is applied onto a support of polyester or the like, and dried, whereby the resin sheet 2 for sealing an electronic component can be obtained.
10 A release sheet such as a polyester film may be laminated as necessary for protecting the surface of the resin sheet for sealing an electronic component. The release sheet is peeled off at the time of sealing.

[0048]

15 The organic solvent is not particularly limited, and various kinds of previously known organic solvents, for example, methyl ethyl ketone, acetone, cyclohexanone, dioxane, diethyl ketone, toluene, ethyl acetate and the like can be used. They may be used alone or in combination of two or more thereof.
20 Normally, it is preferred to use the organic solvent in such a manner that the solid concentration of the varnish ranges from 30 to 60% by weight.

[0049]

The thickness of the sheet after drying of the organic
25 solvent is not particularly limited, but is normally set to

preferably 5 to 100 μm , more preferably 20 to 70 μm , from the viewpoint of uniformity of the thickness and the amount of a residual solvent.

[0050]

5 On the other hand, when kneading is used, components including the components A to E and other additives as necessary are mixed using known means such as a mixer, and the mixture is then melt-kneaded to prepare a kneaded product. The method for performing melt-kneading is not particularly limited, and
10 examples thereof include methods of performing melt-kneading by a known kneader such as a mixing roll, a pressure kneader or an extruder. Kneading conditions are not particularly limited as long as the temperature is equal to or higher than the softening points of the components described above, and the
15 temperature is, for example, 30 to 150°C, and preferably 40 to 140°C, further preferably 60 to 120°C when considering the heat-curability of the epoxy resin, and the time is, for example, 1 to 30 minutes, preferably 5 to 15 minutes. In this way, a kneaded product can be prepared.

20 [0051]

 Through molding the resulting kneaded product by extrusion molding, the resin sheet 2 for sealing an electronic component can be obtained. Specifically, the kneaded product after melt-kneading is extrusion-molded while it is kept at a
25 high temperature without being cooled, whereby the resin sheet

2 for sealing an electronic component can be formed. The extrusion method for this purpose is not particularly limited, and examples thereof include a T die extrusion method, a rolling method, a roll kneading method, a co-extrusion method and a calender molding method. The extrusion temperature is not particularly limited as long as it is equal to or higher than the softening points of the components described above, but the extrusion temperature is, for example, 40 to 150°C, preferably 50 to 140°C, further preferably 70 to 120°C when considering the heat curability and moldability of the epoxy resin. In this way, the resin sheet 2 for sealing an electronic component can be formed.

[0052]

Among these, the resin sheet 2 for sealing an electronic component is preferably produced by kneading and extrusion from the viewpoint of moldability into a sheet shape because the resin sheet 2 for sealing an electronic component contains 70 to 93% by weight of an inorganic filler to the entire resin sheet 2 for sealing an electronic component. By producing the resin sheet 2 for sealing an electronic component by kneading and extrusion, a uniform sheet with few voids (air bubbles) or the like can be produced. As a result, low moisture permeation property can be further achieved.

[0053]

The resin sheet 2 for sealing an electronic component that

is obtained in this way may be used as a laminate as necessary to achieve a desired thickness. That is, the sheet-shaped resin composition may be used as a single layer structure or may be used as a laminate obtained by laminating sheets of the composition to have a multi-layer structure of two or more layers.

[0054]

(Production method for resin-sealed semiconductor device)

Next, the production method for the resin-sealed semiconductor device according to the present embodiment is explained below by referring to Figs. 2 to 6. Figs. 2 to 6 are schematic cross-sectional views for illustrating the production method for the resin-sealed semiconductor device according to the present embodiment.

[0055]

The production method for the semiconductor device at least has a step of laminating a resin sheet for sealing an electronic component from a semiconductor chip side so that the resin sheet covers a semiconductor chip that is flip-chip bonded to an adherend.

[0056]

[Mounting step]

As shown in Fig. 2, first, a semiconductor wafer 4 is bonded to a pressure-sensitive adhesive layer 32 of a dicing tape 3 including a substrate 31 and the pressure-sensitive

adhesive layer 32 laminated on the substrate 31, and the semiconductor wafer 4 is adhered and held to be fixed (a mounting step). The pressure-sensitive adhesive layer 32 is bonded to the backside of the semiconductor wafer 4. The backside of the semiconductor wafer 4 means the surface opposite to the circuit surface (referred to as a non-circuit surface, a non-electrode surface, or the like). The bonding method is not especially limited, but a method of pressure bonding is preferable. Pressure bonding is normally performed by pressing with a pressing means such as a pressure roll. A conventionally known dicing tape can be used as the dicing tape 3.

[0057]

Examples of the substrate 31 include polyolefins such as low density polyethylene, linear polyethylene, medium density polyethylene, high density polyethylene, ultralow density polyethylene, random copolymerized polypropylene, block copolymerized polypropylene, homo polypropylene, polybutene, and polymethylpentene; polyesters such as ethylene-vinyl acetate copolymer, ionomer resin, ethylene-(meth)acrylic acid copolymer, ethylene-(meth)acrylate (random, alternating) copolymer, ethylene-butene copolymer, ethylene-hexene copolymer, polyurethane, polyethylene terephthalate, and polyethylene naphthalate; polycarbonates; polyimides; polyether ether ketones; polyimides; polyetherimides; polyamides; fully aromatic polyamides; polyphenyl sulfides;

aramids (paper); glass; glass cloth; fluorine resin; polyvinyl chloride; polyvinylidene chloride; cellulose resin; silicone resin; metal (foil); and paper.

[0058]

5 An example of the pressure-sensitive adhesive that is used to form the pressure-sensitive adhesive layer 32 is a general pressure-sensitive adhesive such as an acrylic pressure-sensitive adhesive and a rubber-based pressure-sensitive adhesive. The pressure-sensitive adhesive layer 32 can be formed by an ultraviolet-ray curing-type pressure-sensitive adhesive. The degree of crosslinking of the ultraviolet-ray curing-type pressure-sensitive adhesive can be increased by irradiation with ultraviolet rays to easily decrease its adhesive strength. Therefore, pickup can be easily performed by irradiation with ultraviolet rays after the dicing step.

[0059]

[Dicing step]

20 Next, as shown in Fig. 3, dicing of the semiconductor wafer 4 is performed. With this operation, the semiconductor wafer 4 is individualized into a prescribed size (made into small pieces) to produce the semiconductor chip 5. Dicing is performed, for example, from the circuit surface side of the semiconductor wafer 4 by an ordinary method. The dicing apparatus used in this step is not especially limited, and a

conventionally known apparatus can be used.

[0060]

When expanding of the dicing tape 3 is performed, the expanding can be performed using a conventionally known
5 expanding apparatus. The expanding apparatus has a donut-shaped outer ring that can push the dicing tape 3 down with a dicing ring interposed therebetween and an inner ring that has a smaller diameter than the outer ring and that supports the dicing tape 3. With this expanding step, damage of the
10 semiconductor chip that is caused by contact of adjacent semiconductor chips can be prevented in the pickup step described later.

[0061]

[Pickup step]

15 In order to collect the semiconductor chip 5 that is adhered and fixed to the dicing tape 3, pickup of the semiconductor chip 5 is performed to peel the semiconductor chip 5 from the dicing tape 3 as shown in Fig. 4. The method of pickup is not especially limited, and various types of conventionally
20 known methods can be adopted. An example of the method is a method of pushing up an individual semiconductor chip 5 from the substrate 31 side with a needle and picking up the semiconductor chip 5 that has been pushed up with a pickup apparatus.

25 [0062]

[Flip-chip bonding step]

As shown in Fig. 5, the semiconductor chip 5 that has been picked up is fixed to the adherend such as a substrate by a flip-chip bonding method (a flip-chip mounting method).

5 Specifically, the semiconductor chip 5 is fixed to the adherend 6 by an ordinary method in such a manner that the circuit surface (referred to as a surface, a circuit pattern formation surface, an electrode formation surface, or the like) of the semiconductor chip 5 faces the adherend 6. For example,
10 electrical conduction between the semiconductor chip 5 and the adherend 6 is secured by melting a conductive material 61 for bonding (solder or the like) that is adhered to the connection pad of the adherend 6 while bringing a bump 51 that is formed on the circuit surface side of the semiconductor chip 5 into
15 contact with the conductive material 61 and pressing the conductive material 61 to fix the semiconductor chip 5 to the adherend 6 (a flip-chip bonding step). At this time, an empty space is formed between the semiconductor chip 5 and the adherend 6, and the distance between the empty spaces is
20 generally about 15 to 300 μm . After the semiconductor chip 5 is flip-chip bonded onto the adherend 6, the opposed surfaces of the semiconductor chip 5 and the adherend 6 or the empty space therebetween may be cleaned. The empty space may be sealed by filling with a sealing material (sealing resin or the like)
25 depending on the use of the semiconductor device, and it may

be left empty. However, because it is structurally necessary to form an empty space between the adherend and the semiconductor chip in MEMSs such as an acceleration sensor, a pressure sensor, and a gyro sensor, and a surface acoustic wave filter (SAW filter), the space is left empty when the semiconductor chip is used for these applications.

[0063]

Various types of substrates such as a lead frame and a circuit substrate (a wiring circuit substrate or the like) can be used as the adherend 6. The material of the substrate is not especially limited, but examples include a ceramic substrate and a plastic substrate. Examples of the plastic substrate include an epoxy substrate, a bismaleimide triazine substrate, and a polyimide substrate.

15 [0064]

In the flip-chip bonding step, the materials of the bump and the conductive material are not especially limited, but examples include solder (alloys) such as tin-lead metal materials, tin-silver metal materials, tin-silver-copper metal materials, tin-zinc metal materials, and tin-zinc-bismuth metal materials; gold metal materials; and copper metal materials.

[0065]

In the flip-chip bonding step, the conductive material is melted to connect the bump on the circuit surface side of

the semiconductor chip 5 with the conductive material on the surface of the adherend 6. The temperature of the conductive material at melting is normally about 260°C (for example, 250°C to 300°C).

5 [0066]

Next, a sealing step is performed for sealing the space between the flip-chip bonded semiconductor chip 5 and the adherend 6 as necessary. The sealing step is performed using a sealing resin for underfilling. The sealing conditions are
10 not especially limited, and thermal curing of the sealing resin is normally performed by heating at 175°C for 60 to 90 seconds. However, the present invention is not limited to this, and curing can be performed at 165°C to 185°C for a few minutes.
[0067]

15 The sealing resin for underfilling is not especially limited as long as it is a resin having an insulation property (an insulating resin), and it can be appropriately selected from sealing materials such as known sealing resins. However, an insulating resin having elasticity is more preferable.

20 Examples of the sealing resin for underfilling include a resin composition containing an epoxy resin. Examples of the epoxy resin include the epoxy resins mentioned above. The sealing resin for underfilling of the resin composition containing an epoxy resin may contain, as the resin component, a thermosetting
25 resin (a phenol resin or the like) other than the epoxy resin,

a thermoplastic resin, or the like besides the epoxy resin. The phenol resin can also be used as a curing agent for the epoxy resin, and examples of this type of phenol resin include the phenol resins mentioned above.

5 [0068]

[Laminating step of resin sheet for sealing electronic component]

In the laminating step of the resin sheet for sealing an electronic component, the resin sheet 2 for sealing an
10 electronic component is laminated on the adherend 6 from the semiconductor chip 5 side so that the resin sheet 2 covers the semiconductor chip 5 (refer to Fig. 6). The resin sheet 2 for sealing an electronic component functions as a sealing resin to protect the semiconductor chip 5 and elements associated with
15 the semiconductor chip 5 from the external environment.

[0069]

The method of laminating the resin sheet 2 for sealing an electronic component is not especially limited. Examples include a method of extrusion-molding a melted and kneaded resin
20 composition for forming the resin sheet for sealing an electronic component, mounting the extrusion-molded resin composition on the adherend 6 from the semiconductor chip 5 side, and pressing the extrusion-molded resin composition to form and laminate the resin sheet for sealing an electronic component
25 simultaneously; a method of applying the resin composition for

forming the resin sheet for sealing an electronic component to the adherend 6 from the semiconductor chip 5 side and drying the resin composition; and a method of applying the resin composition to a release-treated sheet, forming the
5 resin sheet 2 for sealing an electronic component by drying the coating film, and transferring the resin sheet 2 for an electronic component to the adherend 6 from the semiconductor chip 5 side.

[0070]

10 Because the resin sheet 2 for sealing an electronic component has a sheet shape, the semiconductor chip 5 can be embedded only by bonding the resin sheet 2 to the adherend 6 from the semiconductor chip 5 side when covering the semiconductor chip 5, and the production efficiency of
15 the semiconductor device can be improved. In this case, the resin sheet 2 for sealing an electronic component can be laminated on the adherend 6 by a known method such as hot press and laminator. For the hot pressing condition, the temperature is 40°C to 120°C for example, and
20 preferably 50°C to 100°C; the pressure is 50 to 2,500 kPa for example, and preferably 100 to 2,000 kPa; and the duration is 0.3 to 10 minutes for example, and preferably 0.5 to 5 minutes. In consideration of improvement of the tackiness and the followability of the resin sheet 2 for
25 sealing an electronic component to the semiconductor chip 5, pressing is preferably performed under a reduced pressure condition (for example, 10 to 2,000 Pa).

[0071]

After the resin sheet 2 for sealing an electronic component is laminated on the adherend 6 from the semiconductor chip 5 side in this manner, the resin sheet 2 for sealing an electronic component is cured. The curing of the resin sheet 2 for sealing an electronic component is performed at a temperature of 120°C to 190°C for a heating time of 1 to 60 minutes at a pressure of 0.1 to 10 MPa. With this operation, the resin-sealed semiconductor device 50 can be obtained.

Especially when the sealing resin for underfilling is not used between the adherend 6 and the semiconductor chip 5, it is possible to produce a resin-sealed semiconductor device 50 in which an empty space 52 is formed between the adherend 6 and the semiconductor chip 5.

[0072]

In the above-described embodiment, a case is explained in which the resin sheet for sealing an electronic component is used to produce a flip-chip type semiconductor device. However, the resin sheet for sealing an electronic component of the present invention is not limited to this example, and it can also be used to produce a semiconductor device in which the backside of the semiconductor chip is bonded to the adherend.

[0073]

In the above-described embodiment, a case is explained

in which nothing is bonded to the backside of the semiconductor chip. However, the present invention is not limited to this example, and a film for the backside of a flip-chip type semiconductor may be bonded to the backside of the semiconductor chip. The film for the backside of a flip-chip type semiconductor is used to protect the backside (the backside that is exposed) of the semiconductor chip when the semiconductor chip is mounted to the substrate by flip-chip bonding, and a conventionally known film for the backside of a flip-chip type semiconductor can be adopted.

[0074]

In the above-described embodiment, a case is explained in which the resin sheet for sealing an electronic component is laminated from the semiconductor chip side so that it covers the semiconductor chip that is flip-chip bonded to the adherend. However, the resin sheet for sealing an electronic component of the present invention is not limited to cover the semiconductor chip, and it may be laminated so that it covers other electronic components (for example, a capacitor, a resistance, and the like). That is, the resin sheet for sealing an electronic component of the present invention is not limited to embed the semiconductor chip, and it may be used to embed other electronic components.

EXAMPLES

[0075]

In the following, the present invention is explained in detail with reference to examples. However, the present invention is not limited to the following examples as long as they do not go beyond the gist of the present invention. Any of "part(s)" in each example is based on weight as long as there is no specific description.

[0076]

<Production of kneaded material of resin sheet for sealing electronic component>

(Example 1)

The following components were kneaded at 120°C for 5 minutes with a biaxial kneading machine to prepare a kneaded material.

15 [0077]

Component A (epoxy resin): Bisphenol F type epoxy resin (YSLV-80XY manufactured by Tohto Kasei Co., Ltd.) 3.38 parts

20 Component B (phenol resin): Phenol resin having a biphenylaralkyl skeleton (MEH7851SS manufactured by Meiwa Plastic Industries, Ltd.) 3.58 parts

Component C (elastomer): Thermoplastic elastomer (product name: SIBSTER 072T manufactured by Kaneka Corporation) 3.04 parts

25 Component D (inorganic filler): Spherical silica

(product name: FB-9454FC manufactured by DENKI KAGAKU KOGYO
KABUSHIKI KAISHA, average particle size 20 μ m) 88 parts

Component E (curing accelerator): Imidazole-based
catalyst as a curing catalyst (2PHZ-PW manufactured by Shikoku
5 Chemicals Corporation) 0.119 part

Other Component 1: Carbon black (#3030B manufactured by
Mitsubishi Chemical Corporation) 0.3 part

Other Component 2: Flame retardant (phenoxyphosphazene
oligomer, product name: FP-100 manufactured by FUSHIMI
10 Pharmaceutical Co., Ltd.) 1.58 parts
[0078]

Next, the kneaded material was extrusion-molded so that
the extrusion-molded product had a fixed thickness (250 μ m in
Example 1) by vacuum pressing. The vacuum pressing was
15 performed under conditions of pressing for 5 minutes (pressure:
2 MPa) in a vacuum chamber heated to 90°C. With this operation,
a resin sheet for sealing an electronic component according to
Example 1 was obtained. After that, the resin sheet was heated
at 150°C for 1 hour to be cured.

20 [0079]

(Examples 2 to 6 and Comparative Example 1)

Resin sheets for sealing an electronic component
according to Examples 2 to 6 and Comparative Example 1 were
obtained in the same manner as in Example 1 except that the
25 compounding amounts were changed as in Table 1. After that,

the resin sheets were heated at 150°C for 1 hour to be cured.

[0080]

(Example 7)

The following components were dissolved in 400 parts by
5 weight of methyl ethyl ketone, and the resultant mixture was
mixed to be uniform with a homogenizer.

[0081]

Component A-1 (epoxy resin 1): (EXA-4850-150
manufactured by DIC Corporation) 3.62 parts

10 Component A-2 (epoxy resin 2): Novolak type epoxy resin
(EPPN501HY manufactured by Dainippon Ink and Chemicals, Inc.)
1.53 parts

Component B (phenol resin): (GS-200 manufactured by Gunei
Chemical Industry Co., Ltd.) 1.84 parts

15 Component C (elastomer): Butyl acrylate 86 parts, acrylic
copolymer having a weight average molecular weight of 750,000
consisting of 7 parts of acrylonitrile and 7 parts of glycidyl
methacrylate 17.02 parts

Component D (inorganic filler): Spherical silica (SO-E2
20 manufactured by Admatechs Company Limited, average particle
size 0.5 μ m) 75 parts

Component E (curing accelerator): Imidazole-based
catalyst as a curing catalyst (2PHZ-PW manufactured by Shikoku
Chemicals Corporation) 0.25 part

25 Other Component: Carbon black (#20 manufactured by

Mitsubishi Chemical Corporation) 0.74 part

[0082]

Next, the formulation was applied using a comma coater, and it was dried to remove the solvent to give a resin sheet
5 having a thickness of 50 μm . After that, five resin sheets were laminated with a roll laminator heated to 70°C to give a resin sheet for sealing an electronic component according to Example 7 having a thickness of 250 μm . After that, the resin sheet was heated at 150°C for 1 hour to be cured for the measurement
10 of the moisture permeability.

[0083]

(Comparative Examples 2 and 3)

Resin sheets for sealing an electronic component according to Comparative Examples 2 and 3 were obtained in the
15 same manner as in Example 7 except that the compounding amounts were changed as in Table 2. After that, the resin sheets were heated at 150°C for 1 hour to be cured.

[0084]

<Measurement of moisture permeability>

20 According to the regulation of JIS Z 0208 (a cup method), the moisture permeability was measured for each of the resin sheets for sealing an electronic component (after thermal curing) that were produced in the examples and the comparative examples. The measurement conditions were as follows. The
25 results are shown in Tables 1 and 2.

(Measurement Condition 1)

Temperature 85°C, humidity 85%, duration 168 hours, thickness of the resin sheet for sealing an electronic component: 250 μm

(Measurement Condition 2)

- 5 Temperature 60°C, humidity 90%, duration 168 hours, thickness of the resin sheet for sealing an electronic component: 250 μm
[0085]

<Results of evaluation of reliability>

10 A sample was prepared, in which 25 Si chips each having a size of 1 mm x 1 mm x 0.2 mm (thickness) were bonded by gold bumps on an alumina substrate having a thickness of 0.5 mm by ultrasonic bonding (5 chips x 5 rows, distance between chips: 0.5 mm, gap between the bottom surface of the chip and the substrate: 20 μm).

- 15 Next, sealing of the Si chips was performed by vacuum pressing using the resin sheets for sealing an electronic component that were produced in the examples and the comparative examples (sealing conditions: 50°C, 1 MPa, 1 minute, degree of vacuum 1,000 Pa), and the chips were cured at 150°C for 1 hour.
- 20 With this operation, a cured product was obtained in which an empty space was formed in the lower part of each chip. After that, the cured product was separated into individual packages by dicing. The moisture absorption of the packages was performed under conditions of 85°C, 85%, and 168 hours by the
- 25 method according to the MSL1 (Moisture Sensitivity Level) test

of the JEDEC. After that, a moisture absorption reflow test was performed at 260°C three times in an IR reflow machine. After the test, the packages were observed with an ultrasonic microscope, and a package in which peeling was observed between the substrate and the resin was marked x, and a package in which peeling was not observed was marked O. The results are shown in Tables 1 and 2.

[0086]

[Table 1]

		Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Comparative Example 1
Epoxy Resin (Parts)	YSLV-80XY	3.38	7.04	5.08	4.21	2.54	1.97	9.01
Phenol Resin (Parts)	MEH-7851SS	3.58	7.46	5.34	4.51	2.66	2.10	9.55
Elastomer (Parts)	SIBSTAR 072T	3.04	6.33	4.57	3.79	2.29	1.77	8.11
Curing Accelerator (Parts)	2PHZ-PW	0.12	0.25	0.18	0.15	0.09	0.07	0.32
Flame Retardant (Parts)	FP-100	1.58	3.29	2.38	1.97	1.19	0.92	4.21
Carbon Black (Parts)	#3030B	0.3	0.63	0.45	0.37	0.23	0.17	0.80
Inorganic Filler (Parts)	FB9454FC	88	75	82	85	91	93	68
Total (Parts)		100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moisture Permeability (g/m ² ·24 hr)	85°C, 85%, 168 hr	30	230	95	53	27	24	350
	60°C, 90%, 168 hr	8	78	29	13	7	5	120
Result of Reliability Test	Peeling of Resin/Substrate after Moisture Absorption Reflow Test (MSL1 Condition)	O	O	O	O	O	O	x

[0087]

[Table 2]

		Example 7	Comparative Example 2	Comparative Example 3
Epoxy Resin 1 (Parts)	EXA-4850-150	3.62	5.9	5.09

Epoxy Resin 2 (Parts)	EPPN-501HY	1.53	2.5	2.16
Phenol Resin (Parts)	GS-200	1.84	3	2.59
Elastomer (Parts)	Acrylic Copolymer	17.02	27.7	23.79
Curing Accelerator (Parts)	2PHZ-PW	0.25	0.4	0.34
Carbon Black (Parts)	#20	0.74	1.2	1.03
Inorganic Filler (Parts)	SO-E2	75	59.3	65
Total (Parts)		100	100	100
Moisture Permeability (g/m ² ·24 hr)	85°C, 85%, 168 hr	290	760	470
	60°C, 90%, 168 hr	85	420	240
Result of Reliability Test	Peeling of Resin/Substrate after Moisture Absorption Reflow Test (MSL1 Condition)	○	x	x

DESCRIPTION OF REFERENCE SIGNS

[0088]

- 2 Resin sheet for sealing electronic component
- 5 3 Dicing tape
- 31 Substrate
- 32 Pressure-sensitive adhesive layer
- 4 Semiconductor wafer
- 5 Semiconductor chip
- 10 51 Bump formed on circuit surface side of semiconductor chip
- 5
- 52 Empty space
- 6 Adherend
- 61 Conductive material for bonding adhered to connection pad
- 15 of adherend 6

CLAIMS

1. A resin sheet for sealing an electronic component that is used to produce a resin-sealed semiconductor
5 device,

comprising 70 to 93% by weight of an inorganic filler to the entire resin sheet for sealing an electronic component and

one or more phenol resins selected from a phenol
10 novolac resin, a phenol aralkyl resin and a biphenyl aralkyl resin, wherein

the moisture permeability of the resin sheet after thermal curing when the resin sheet has a thickness of 250 μm is 300 $\text{g/m}^2 \cdot 24$ hours or less under conditions of a
15 temperature of 85°C, a humidity of 85%, and a duration of 168 hours; and

the resin sheet is produced by kneading and extrusion.

20 2. The resin sheet for sealing an electronic component according to claim 1, wherein

the moisture permeability of the resin sheet after thermal curing when the resin sheet has a thickness of 250 μm is 100 $\text{g/m}^2 \cdot 24$ hours or less under conditions of a
25 temperature of 60°C, a humidity of 90%, and a duration of 168 hours.

3. A resin-sealed semiconductor device, comprising:
an adherend;

a semiconductor chip that is flip-chip bonded to the adherend; and

a resin sheet for sealing an electronic component that seals the semiconductor chip, wherein

5 the resin sheet for sealing an electronic component is produced by kneading and extrusion and comprises 70 to 93% by weight of an inorganic filler to the entire resin sheet for sealing an electronic component and one or more phenol resins selected from a phenol novolac resin, a phenol
10 aralkyl resin and a biphenyl aralkyl resin,

the moisture permeability of the resin sheet after thermal curing when the resin sheet has a thickness of 250 μm is 300 $\text{g/m}^2 \cdot 24$ hours or less under conditions of a temperature of 85°C, a humidity of 85%, and a duration of
15 168 hours, and

an empty space is formed between the adherend and the semiconductor chip.

4. A resin-sealed semiconductor device comprising
20 the resin sheet for sealing an electronic component according to claim 1 or 2.

5. A production method for a resin-sealed semiconductor device, comprising the step of:

25 laminating a resin sheet for sealing an electronic component from a semiconductor chip side so that the resin sheet covers a semiconductor chip that is flip-chip bonded to an adherend, wherein

the resin sheet for sealing an electronic component is
30 produced by kneading and extrusion and comprises 70 to 93%

by weight of an inorganic filler to the entire resin sheet for sealing an electronic component and one or more phenol resins selected from a phenol novolac resin, a phenol aralkyl resin and a biphenyl aralkyl resin, and

- 5 the moisture permeability of the resin sheet after thermal curing when the resin sheet has a thickness of 250 μm is 300 $\text{g/m}^2 \cdot 24$ hours or less under conditions of a temperature of 85°C, a humidity of 85%, and a duration of 168 hours.