DESCRIPTION

TITLE OF THE INVENTION: METHOD OF MANUFACTURING ELECTRONIC COMPONENT DEVICE

TECHNICAL FIELD

[0001]

The present invention relates to a method of manufacturing an electronic component device.

BACKGROUND ART

[0002]

In recent years, a sealing sheet has been known which is used to seal an electronic component mounted on a mounted substrate (for example, refer to Patent Document 1).

[0003]

Patent Document 1 describes that a sealing sheet is arranged on an electronic component that is mounted on a mounted substrate and the sealing sheet is pressed in a prescribed condition to embed the electronic component into the sealing sheet, and then the sealing sheet is cured to produce an electronic component device in which the electronic component is sealed.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0004]

Patent Document 1: JP-A-2013-7028

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0005]

When the electronic component is embedded into the sealing sheet, high followability is desired of the sealing sheet to the electronic component from the viewpoint of reducing defects that may occur in the process after the embedding.

[0006]

The present invention has been made in consideration of the above-described problem, and an object thereof is to provide a method of manufacturing an electronic component device, which is capable of improving the followability of a sealing sheet to an electronic component.

MEANS FOR SOLVING THE PROBLEMS

[0007]

The present inventors have found that the above-described object can be achieved by adopting the following configuration, and completed the present invention.

[0008]

That is, the present invention is a method of manufacturing an electronic component device, comprising:

a step A of preparing a laminate with a plurality of electronic components mounted on a body to be mounted;

a step B of preparing a thermosetting sealing sheet having an outer circumferential length of 500 mm or more;

a step C of arranging the laminate on a heating plate with a surface on which the electronic components are mounted facing upward and arranging the sealing sheet on a surface of the laminate where the electronic components are mounted; and

a step D of performing hot press to embed the electronic components into the sealing sheet after the step C.

[0009]

According to the method of manufacturing an electronic component device of the present invention, the laminate is arranged on the heating plate with a surface on which the electronic components are mounted facing upward and the sealing sheet is arranged on a surface of the laminate where the electronic components are mounted (step C). After that, hot press is performed to embed the electronic components into the sealing sheet (step D). Therefore, a step of embedding the electronic components into the sealing sheet is performed in the state in which the laminate is interposed between the heating plate and the sealing sheet. Since the laminate is interposed between the heating plate and the sealing sheet, heat of the heating plate is not easily transferred to the sealing sheet. As a result, the sealing sheet is not easily thermally cured, and the viscosity of the sealing sheet is kept low. That is, high fluidity of the sealing sheet can be maintained. The embedding step is performed with the sealing sheet with high

fluidity. As a result, the followability of the sealing sheet to the electronic component can be improved.

Particularly, when the plurality of electronic components are sealed with the sealing sheet having a large area with the outer circumferential length being 500 mm or more, higher followability is desired of the sealing sheet to the electronic component.

Since the laminate is interposed between the heating plate and the sealing sheet in the present invention, sufficient followability can be secured of the sealing sheet to the electronic component even when the plurality of electronic components are sealed with the sealing sheet having a large area with the outer circumferential length being 500 mm or more.

The outer circumferential length of the sealing sheet refers to the whole outer circumferential length of the sealing sheet. For example, when the sealing sheet is rectangular, it refers to [(Length) × 2 + (Width) × 2], and when the sealing sheet is circular, it refers to the whole circumference [2 × π × (Radius)].

[0010]

In the above-described configuration, a kneaded product is preferably applied to form the sealing sheet. When the kneaded product is applied to form the sealing sheet, the thickness of the sealing sheet can be easily adjusted. Air can be suppressed from being included when the sealing sheet is formed. Particularly, when the sealing sheet is formed having

a large area with the outer circumferential length being 500 mm or more, air can be remarkably suppressed from being included. Therefore, according to the above-described configuration, a sealing sheet can be obtained which is easily adjusted in thickness and high in yield. As a result, the reliability can be improved of the electronic component device that is manufactured by using the sealing sheet.

[0011]

In the above-described configuration, the sealing sheet preferably has a minimum melt viscosity at 0 to 200°C of 100,000 Pa•s or less. If the minimum melt viscosity of the sealing sheet at 0 to 200°C is 100,000 Pa•s or less, the embedding property of the electronic component into the sealing sheet is improved.

EFFECT OF THE INVENTION

[0012]

The present invention can provide a method of manufacturing an electronic component, which is capable of improving the followability of a sealing sheet to an electronic component.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a schematic cross sectional view for explaining a method of manufacturing an electronic component device according to one embodiment of the present invention.

Fig. 2 is a schematic cross sectional view for explaining the method of manufacturing an electronic component device according to one embodiment of the present invention.

Fig. 3 is a schematic cross sectional view for explaining the method of manufacturing an electronic component device according to one embodiment of the present invention.

Fig. 4 is a schematic cross sectional view for explaining the method of manufacturing an electronic component device according to one embodiment of the present invention.

Fig. 5 is a schematic cross sectional view for explaining the method of manufacturing an electronic component device according to one embodiment of the present invention.

Fig. 6 is a schematic cross sectional view for explaining the method of manufacturing an electronic component device according to one embodiment of the present invention.

Fig. 7 is a schematic front view for explaining a method of evaluating an embedding property in examples.

MODE FOR CARRYING OUT THE INVENTION

[0014]

An embodiment of the present invention will be explained below with reference to the drawings. However, the present invention is not limited only to these embodiments.

[0015]

A method of manufacturing an electronic component device according to the present embodiment includes at least:

a step A of preparing a laminate with a plurality of electronic components mounted on a body to be mounted;

a step B of preparing a thermosetting sealing sheet having an outer circumferential length of 500 mm or more;

a step C of arranging the laminate on a heating plate with a surface on which the electronic components are mounted facing upward and arranging the sealing sheet on a surface of the laminate where the electronic components are mounted; and

a step D of performing hot press to embed the electronic components into the sealing sheet after the step C.

[0016]

The electronic component is not especially limited as long as it is mounted on a body to be mounted and exhibits a function as an electronic component. Examples of the electronic component include a SAW (Surface Acoustic Wave) filter; MEMS (Micro Electro Mechanical Systems) such as a pressure sensor and a vibration sensor; an IC such as an LSI; a semiconductor element such as a transistor; a capacitor; and an electronic device such as a resistor.

[0017]

The body to be mounted is not especially limited. Examples thereof include a printed circuit board and a semiconductor wafer.

[0018]

A specific example of the laminate includes a laminate in which CoW (Chip on Wafer) connection is performed between

a semiconductor element (for example, a semiconductor chip) as the electronic component and a semiconductor wafer as the body to be mounted.

[0019]

Below, a case is explained in which a semiconductor chip is used as the electronic component and a semiconductor wafer is used as the body to be mounted.

[0020]

Figs. 1 to 6 are schematic cross sectional views for explaining the method of manufacturing an electronic component device according to one embodiment of the present invention.

[0021]

[Step of preparing laminate]

As shown in Fig. 1, in the method of manufacturing an electronic component device according to the present embodiment, first, a laminate 20 with a plurality of semiconductor chips 23 mounted on a semiconductor wafer 22 is prepared (step A). A semiconductor wafer on which a circuit is formed can be diced with a known method into pieces to form the semiconductor chip 23. A known apparatus such as a flip-chip bonder or a die bonder can be used to mount the semiconductor chip 23 on the semiconductor wafer 22. The semiconductor chip 23 and the semiconductor wafer 22 are electrically connected to each other through a protrusion electrode such as a bump (not shown in the drawing). The distance between the semiconductor chip 23 and the semiconductor wafer 22 can be appropriately set, and it is

generally about 15 to 50 μm. The distance between the semiconductor chip 23 and the semiconductor wafer 22 may be filled with a sealing resin (underfill).

[0022]

[Step of preparing sealing sheet]

In the method of manufacturing an electronic component device according to the present embodiment, as shown in Fig. 2, a thermosetting sealing sheet 10 is prepared which has an outer circumferential length of 500 mm or more (step B). The sealing sheet 10 may be laminated on a support such as a polyethylene terephthalate (PET) film. In this case, a release treatment may be performed on the support to peel the sealing sheet 10 easily.

[0023]

(Sealing sheet)

The sealing sheet 10 has an outer circumferential length of 500 mm or more, and preferably 800 mm or more. The upper limit of the outer circumferential length of the sealing sheet 10 is not especially limited; however, it can be for example 3,000 mm or less in consideration of practical range. When a plurality of semiconductor chips 23 are sealed with the sealing sheet 10 having a large area with the outer circumferential length being 500 mm or more, higher followability is desired of the sealing sheet 10 to the semiconductor chip 23. As described later, since the laminate 20 is interposed between a heating plate 32 and the sealing sheet 10 in the present

embodiment (refer to Fig. 3), sufficient followability can be secured of the sealing sheet 10 to the semiconductor chip 23 even when the plurality of semiconductor chips 23 are sealed with the sealing sheet 10 having a large area with the outer circumferential length being 500 mm or more.

[0024]

The sealing sheet 10 preferably contains an epoxy resin and a phenol resin as a curing agent. This provides a good thermal curing property.

[0025]

The epoxy resin is not especially limited. For example, various kinds of epoxy resins can be used such as 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 A-type epoxy resin, a bisphenol F-type epoxy resin, a modified bisphenol F-type epoxy resin, a 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.

[0026]

From the viewpoint of securing the toughness of the epoxy resin after curing and the reactivity of the epoxy resin, epoxy resins are preferable which are solid at normal temperature and have an epoxy equivalent of 150 to 200 and a softening point or melting point of 50 to 130°C. Among these epoxy resins, a triphenylmethane-type epoxy resin, a cresol novolac-type epoxy

resin, and a biphenyl-type epoxy resin are more preferable from the viewpoint of reliability.

[0027]

The phenol resin is not especially limited as long as it initiates curing reaction with the epoxy resin. For example, there can be used a phenol novolac resin, a phenolaralkyl resin, a biphenylaralkyl resin, a dicyclopentadiene-type phenol resin, a cresol novolac resin, a resol resin, etc. These phenol resins may be used alone or in combination of two or more thereof.

[0028]

From the viewpoint of the reactivity with the epoxy resin, phenol resins are preferably used which have a hydroxy group equivalent of 70 to 250 and a softening point of 50 to 110°C. Among these phenol resins, a phenol novolac resin is more preferably used from the viewpoint of its high curing reactivity. Further, phenol resins having low moisture absorbability can be also preferably used such as a phenolaralkyl resin and a bisphenylaralkyl resin from the viewpoint of reliability.

[0029]

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 amount of the hydroxy 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.

[0030]

The total content of the epoxy resin and the phenol resin in the sealing sheet 10 is preferably 2.5% by weight or more, and more preferably 3.0% by weight or more. If the content is 2.5% by weight or more, good adhering strength to the electronic component and the body to be mounted can be obtained. The total content of the epoxy resin and the phenol resin in the sealing sheet 10 is preferably 20% by weight or less, and more preferably 10% by weight or less. If the content is 20% by weight or less, moisture absorbability can be decreased.

[0031]

The sealing sheet 10 preferably contains a thermoplastic resin. This makes it possible to provide a handling property when the sealing sheet 10 is uncured and low stress property to the cured product.

[0032]

Examples of the thermoplastic resin include natural rubber, butyl rubber, isoprene rubber, chloroprene rubber, an ethylene-vinylacetate copolymer, an ethylene-acrylic acid copolymer, an ethylene-acrylate copolymer, a polybutadiene resin, a polycarbonate resin, a thermoplastic polyimide resin, polyamide resins such as 6-nylon and 6,6-nylon, a phenoxy resin, an acrylic resin, saturated polyester resins such as PET and PBT, a polyamideimide resin, a fluororesin, and a styrene-isobutylene-styrene block copolymer. These thermoplastic resins may be used alone or in combination of two or more thereof. Among these, a styrene-isobutylene-styrene

block copolymer is preferable from the viewpoint of its low stress property and low moisture absorption.

[0033]

The content of the thermoplastic resin in the sealing sheet 10 is preferably 1.5% by weight or more, and more preferably 2.0% by weight. If the content is 1.5% by weight or more, the flexibility can be obtained. The content of the thermoplastic resin in the sealing sheet 10 is preferably 6% by weight or less, and more preferably 4% by weight or less. If the content is 4% by weight or less, the adhesion with the electronic component and the body to be mounted is good.

[0034]

The sealing sheet 10 preferably contains an inorganic filler.

[0035]

The inorganic filler is not especially limited, and various kinds of conventionally known fillers can be used. Examples thereof include powers of quartz glass, talc, silica (such as fused silica and crystalline silica), alumina, aluminum nitride, silicon nitride, and boron nitride. These may be used alone or in combination of two or more kinds. Among these, silica and alumina are preferable, and silica is more preferable due to the reason that the linear expansion coefficient can be satisfactorily decreased.

[0036]

As silica, silica powers are preferable, and fused silica

powers are more preferable. Examples of the fused silica powders include spherical fused silica powders and crushed and fused silica powders. However, spherical fused silica powders are preferable from the viewpoint of fluidity. Among these, powers having an average particle size of 10 to 30 μm are preferable, and powders having an average particle size of 15 to 25 μm are more preferable.

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.

[0037]

The content of the inorganic filler in the sealing sheet 10 is preferably 85 to 95% by weight, and more preferably 88 to 95% by weight to the entire sealing sheet 10. If the content of the inorganic filler is 85% by weight or more to the entire sealing sheet 10, a low coefficient of thermal expansion can be obtained to suppress the mechanical damage due to thermal impact. On the other hand, if the content of the inorganic filler is 95% by weight or less to the entire sealing sheet 10, the flexibility, fluidity, and adhesion become better.

[0038]

The sealing sheet 10 preferably contains a curing accelerator.

[0039]

The curing accelerator is not especially limited as long

as it promotes curing of the epoxy resin and the phenol resin, and examples of the curing accelerator include organophosphate compounds such as triphenylphosphine and tetraphenylphosphonium tetraphenylborate; and imidazole compounds such as 2-phenyl-4,5-dihydroxymethylimidazole and 2-phenyl-4-methyl-5-hydroxymethylimidazole. Among these, 2-phenyl-4,5-dihydroxymethylimidazole is preferable due to the reason that the curing reaction does not rapidly proceed even when the temperature increases during kneading and the sealing sheet 10 can be produced satisfactorily.

[0040]

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

[0041]

The sealing sheet 10 preferably contains a flame retardant component. This makes it possible to reduce an expansion of combustion when the sealing sheet 11 catches fire due to short circuit of the parts or heat generation. Examples of the flame retardant component include various kinds of metal hydroxides such as aluminum hydroxide, magnesium hydroxide, iron hydroxide, calcium hydroxide, tin hydroxide, and composite metal hydroxide; and a phosphazene flame retardant.

[0042]

From the viewpoint of exhibiting flame retardancy even with a small amount, the content of phosphorus element in the

phosphazene flame retardant is preferably 12% by weight or more.

[0043]

The content of the flame retardant component in the sealing sheet 10 is preferably 10% by weight or more, and more preferably 15% by weight or more in the entire organic component (excluding inorganic filler). If the content is 10% by weight or more, the flame retardancy can be obtained satisfactorily. The content of the thermoplastic resin in the sealing sheet 10 is preferably 30% by weight or less, and more preferably 25% by weight or less. If the content is 30% by weight or less, deterioration in the physical properties (deterioration in physical properties such as glass transition temperature and resin strength at high temperature) of the cured product tends to be suppressed.

[0044]

The sealing sheet 10 preferably contains a silane coupling agent. The silane coupling agent is not especially limited, and an example includes 3-glycidoxypropyl trimethoxysilane.

[0045]

The content of the silane coupling agent in the sealing sheet 10 is preferably 0.1 to 3% by weight. If the content is 0.1% by weight or more, the strength of the cured product is sufficiently made high, so that the water absorption can be lowered. If the content is 3% by weight or less, the amount of outgas can be decreased.

[0046]

The sealing sheet 10 preferably contains a pigment. The pigment is not especially limited, and an example thereof includes carbon black.

[0047]

The content of the pigment in the sealing sheet 10 is preferably 0.1 to 2% by weight. If the content is 0.1% by weight or more, a good marking property can be obtained when marking is performed by laser marking, etc. If the content is 2% by weight or less, the strength of the cured product is sufficiently made high.

[0048]

Other additives besides each component described above can be appropriately compounded in the resin composition as necessary.

[0049]

The minimum melt viscosity of the sealing sheet 10 at 0 to 200°C is preferably 100,000 Pa·s or less, and more preferably 50,000 Pa·s or less. If the minimum melt viscosity of the sealing sheet 10 at 0 to 200°C is 100,000 Pas or less, the embedding property of the semiconductor chip 23 (electronic component) into the sealing sheet 10 can be improved. The minimum melt viscosity of the sealing sheet 10 at 0 to 200°C is preferably 1,000 Pa·s or more, more preferably 10,000 Pa·s or more, further preferably more than 20,000 Pa·s, and especially preferably more than 25,000 Pa·s. If the minimum

melt viscosity of the sealing sheet 10 at 0 to 200°C is 1,000 Pa•s or more, the outer circumferential part (part where no electronic component is located directly underneath) of the sealing sheet 10 is suppressed from hanging down when the sealing sheet 10 is arranged on the laminate 20, and the sealing sheet 10 can be suppressed from being pressed in the state in which air is trapped between the sealing sheet and the mounted substrate. As a result, voids are not easily generated in the electronic component device that is obtained after pressing. The minimum melt viscosity of the sealing sheet 10 at 0 to 200°C can be controlled by the addition amounts of the thermoplastic resin, the thermosetting resin, the inorganic filler, etc.

[0050]

The sealing sheet 10 may have a single layered structure or a multilayered structure in which two or more sealing sheets are laminated. However, a single layered structure is preferable due to the reason that there is no possibility of generating interlayer peeling and the uniformity of the sheet thickness is high.

[0051]

The thickness of the sealing sheet 10 is not especially limited; however, it is for example 50 μm to 2,000 μm from the viewpoint of using the sheet as a sealing sheet.

[0052]

The method of manufacturing the sealing sheet 10 is not especially limited; however, preferred examples are a method

of preparing a kneaded product of the resin composition for forming the sealing sheet 10 and applying the obtained kneaded product and a method of subjecting the obtained kneaded product to plastic-working to be formed into a sheet shape. This makes it possible to produce the sealing sheet 10 without using a solvent. Therefore, the effects on the electronic component (semiconductor chip 23) from the volatilized solvent can be suppressed.

[0053]

Specifically, each component described later is melted and kneaded with a known kneader such as a mixing roll, a pressure kneader, or an extruder to prepare a kneaded product, and the obtained kneaded product is applied or plastic-worked into a sheet shape. As a kneading condition, the temperature is preferably the softening point or higher of each component described above, and is for example 30 to 150°C. When the thermal curing property of the epoxy resin is considered, the temperature is preferably 40 to 140°C, and more preferably 60 to 120°C. The time is for example 1 to 30 minutes, and preferably 5 to 15 minutes.

[0054]

The kneading is preferably performed under a reduced pressure condition (under reduced pressure atmosphere). This makes it possible to remove gas, and to prevent invasion of gas into the kneaded product. The pressure under the reduced pressure condition is preferably 0.1 kg/cm^2 or less, and more

preferably 0.05 kg/cm^2 or less. The lower limit of the pressure under reduced pressure is not especially limited; however, it is 1 X 10^{-4} kg/cm^2 or more.

[0055]

When the kneaded product is applied to form the sealing sheet 10, the kneaded product after being melt-kneaded is preferably applied while it is at high temperature without being cooled. The application method is not especially limited, and examples thereof include bar coating, knife coating, and slot-die coating. The application temperature is preferably the softening point or higher of each component described above. When the thermal curing property and molding property of the epoxy resin are considered, the temperature is for example 40 to 150°C, preferably 50 to 140°C, and more preferably 70 to 120°C.

[0056]

When forming the sealing sheet 10 by plastic-working the kneaded product, the kneaded product after melt-kneaded is preferably subjected to plastic-working while it is at high temperature without being cooled. The plastic-working process is not especially limited, and examples thereof include flat plate pressing, T-die extrusion, screw-die extrusion, rolling, roll kneading, inflation extrusion, coextrusion, and calendar molding. The temperature for plastic-working is preferably the softening point or higher of each component described above. When the thermal curing property and molding property of the epoxy resin are considered, the temperature is for example 40

to 150°C, preferably 50 to 140°C, and more preferably 70 to 120°C.

[0057]

The resin, etc. for forming the sealing sheet 10 may be dissolved and dispersed in an appropriate solvent to prepare varnish. This varnish may be applied to obtain the sealing sheet 10.

[0058]

[Step of arranging sealing sheet and laminate]

After the step (step A) of preparing the laminate and the step (step B) of preparing the sealing sheet, as shown in Fig. 3, the laminate 20 is arranged on a lower heating plate 32 with a surface on which the semiconductor chips 23 are mounted facing upward and the sealing sheet 10 is arranged on a surface of the laminate 20 where the semiconductor chips 23 are mounted (step C). In this step C, the laminate 20 may be first arranged on the lower heating plate 32, and after that, the sealing sheet 10 may be arranged on the laminate 20, or the sealing sheet 10 may be first laminated on the laminate 20, and after that, this laminated product in which the laminate 20 and the sealing sheet 10 are laminated may be arranged on the lower heating plate 32.

[0059]

[Step of embedding electronic component into sealing sheet]

After the step C, as shown in Fig. 4, hot press is performed with the lower heating plate 32 and an upper heating plate 34 to embed the semiconductor chip 23 (electronic component) into the sealing sheet 10 (step D). The sealing sheet 10 functions

as a sealing resin for protecting the semiconductor chip 23 and the elements attached to the chip from the external environment. This provides a structure 26 in which the semiconductor chip 23 that is mounted on the semiconductor wafer 22 is embedded into the sealing sheet 10.

[0060]

For the hot pressing condition when the semiconductor chip 23 is embedded into the sealing sheet 10, the temperature is for example 40 to 100°C, and preferably 50 to 90°C; the pressure is for example 0.1 to 10 MPa, and preferably 0.5 to 0.8 MPa; and the duration is for example 0.3 to 10 minutes, and preferably 0.5 to 5 minutes. This makes it possible to provide an electronic component device in which the semiconductor chip 23 is embedded in the sealing sheet 10. In consideration of improvement of the tackiness and followability of the sealing sheet 10 to the semiconductor chip 23 and the semiconductor wafer 22, pressing is preferably performed under a reduced pressure condition.

For the reduced pressure condition, the pressure is for example 0.1 to 5 kPa, and preferably 0.1 to 100 Pa; and the reduced pressure maintaining time (time from start of reducing pressure to start of pressing) is for example 5 to 600 seconds, and preferably 10 to 300 seconds.

[0061]

[Thermal curing step]

Next, a thermal curing process is performed on the sealing

sheet 10 to form an electronic component device 28 (refer to Fig. 5). Specifically, the structure 26 in which the semiconductor chip 23 that is mounted on the semiconductor wafer 22 is embedded into the sealing sheet 10 is entirely heated to obtain a sealing body 28.

[0062]

For a condition of the thermal curing treatment, the heating temperature is preferably 100°C or higher, and more preferably 120°C or higher. On the other hand, the upper limit of the heating temperature is preferably 200°C or lower, and more preferably 180°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 180 minutes or less, and more preferably 120 minutes or less. A pressure may be applied as necessary. 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.

[0063]

[Dicing step]

Subsequently, the sealing body 28 may be diced (refer to Fig. 6). This makes it possible to provide an electronic component device 29 for each semiconductor chip 23.

[0064]

[Substrate mounting step]

A rewiring and a bump are formed for the electronic

component device 29 (on the surface opposite to the semiconductor chip 23 of the semiconductor wafer 22) as necessary to perform the substrate mounting step of mounting the electronic component device 29 on a separate substrate (not shown in the drawing). The electronic component device 29 can be mounted on the separate substrate by using a known apparatus such as a flip-chip bonder or a die bonder. The substrate mounting step is performed to obtain an FOWLP (Fan-Out Wafer Level Package).

[0065]

According to the method of manufacturing an electronic component device of the present embodiment, the laminate 20 is arranged on the lower heating plate 32 with a surface on which the semiconductor chips 23 are mounted facing upward and the sealing sheet 10 is arranged on a surface of the laminate 20 where the semiconductor chips 23 are mounted (step C). After that, hot press is performed to embed the semiconductor chips 23 into the sealing sheet 10 (step D). Therefore, a step of embedding the semiconductor chips 23 into the sealing sheet 10 is performed in the state in which the laminate 20 is interposed between the lower heating plate 32 and the sealing sheet 10. Since the laminate 20 is interposed between the lower heating plate 32 and the sealing sheet 10, heat of the lower heating plate 32 is not easily transferred to the sealing sheet 10. As a result, the sealing sheet 10 is not easily thermally cured, and the viscosity of the sealing sheet 10 is kept low. That

is, high fluidity of the sealing sheet 10 can be maintained. The embedding step is performed with the sealing sheet 10 with high fluidity. As a result, the followability of the sealing sheet 10 to the semiconductor chip 23 can be improved.

Particularly, when the plurality of semiconductor chips 32 are sealed with the sealing sheet 10 having a large area with the outer circumferential length being 500 mm or more, higher followability is desired of the sealing sheet 10 to the semiconductor chip 23.

Since the laminate 20 is interposed between the lower heating plate 32 and the sealing sheet 10 in the present embodiment, sufficient followability can be secured of the sealing sheet 10 to the semiconductor chip 23 even when the plurality of semiconductor chip 23 are sealed with the sealing sheet 10 having a large area with the outer circumferential length being 500 mm or more.

[0066]

In the above-described embodiment, a case is explained where the semiconductor chip 23 is used as the electronic component of the present invention and the semiconductor wafer 22 is used as the body to be mounted. However, the present invention is not limited to this example, one other than the semiconductor chip may be used as the electronic component. When one other than the semiconductor wafer is used as the body to be mounted, the method of manufacturing an electronic component device described above can be also adopted.

EXAMPLES

[0067]

The preferred examples of this invention will be explained in detail below. However, the materials, the compounding amounts, etc. described in the examples are not intended to be limited thereto in the scope of this invention unless otherwise specified.

[0068]

The components used in the examples will be explained.

Epoxy resin a: 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 a: MEH-7851-SS (phenol resin having biphenylaralkyl skeleton, hydroxy group equivalent 203 g/eq., softening point 67°C)

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

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

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

[0069]

(Production of sealing sheet)

Examples 1 and 2 and Comparative Example 1

Each component was compounded according to the compounding ratio described in Table 1, and the mixture was melt-kneaded at 60 to 120°C for 10 minutes under a reduced pressure condition (0.01 kg/cm^2) with a roll kneader to prepare a kneaded product. Then, the obtained kneaded product was applied by slot-die coating at 120°C and formed into a sheet shape to produce a sealing sheet having the thickness shown in Table 1. The outer circumferential length of the sealing sheet of any of the examples and the comparative example was 1,400 mm (350 mm long × 350 mm wide).

[0070]

(Measurement of minimum melt viscosity)

The minimum value of the melt viscosity at 0 to 200°C was defined as the minimum melt viscosity when each sample was measured using a viscoelasticity measuring apparatus ARES (manufactured by Rheometric Scientific, Inc.). The measurement condition was as follows: rising temperature rate of 10°C/min, distortion of 20%, and frequency of 0.1 Hz. The results are shown in Table 1.

[0071]

(Preparation of substrate with electronic component mounted)

A substrate with an electronic component mounted was prepared. A semiconductor wafer having a diameter of 300 mm and a thickness of 700 μm was used for the substrate. For the

electronic component, a semiconductor chip having a length of 10 mm, a width of 10 mm, and a thickness of 500 μm was used. Fourteen pieces × fourteen pieces of semiconductor chips were mounted vertically and horizontally on the substrate in 10 mm intervals (distance between edge of one electronic component and edge of the adjacent electronic component). The height of the bump was 50 μm.

[0072]

(Production of evaluation sample)

For Examples 1 and 2, the substrate was arranged on the lower heating plate of an instantaneous vacuum laminating apparatus VS008-1515 (manufactured by Mikado Technos Co., Ltd.) with a surface on which the electronic components are mounted facing upward, and the sealing sheet was arranged on top of the substrate. After that, hot press was performed under reduced pressure.

For Comparative Example 1, the sealing sheet was arranged on the lower heating plate of an instantaneous vacuum laminating apparatus VS008-1515 (manufactured by Mikado Technos Co., Ltd.), and the substrate was arranged on top of the sealing sheet with a surface on which the electronic components are mounted facing downward. After that, hot press was performed under reduced pressure. The hot pressing conditions are shown in Table 1.

After hot pressing, the laminate was heated in an oven at 150°C for 1 hour. After that, it was naturally cooled to room temperature (23°C) to produce an evaluation sample.

[0073]

(Evaluation of unevenness followability)

The thickness from the bottom surface of the substrate to the top surface of the sealing sheet was measured randomly at 30 points on each sample, using a measuring microscope system (CCS-CORE PLUS, manufactured by INNOTECH CORPORATION). A difference between the maximum value and the minimum value at the measurement was calculated. The evaluation was performed by marking the case as "○" when the difference is less than 50 μm, and the case as "△" when the difference is 50 μm or more and less than 100 μm, and the case as "×" when the difference is 100 μm or more. The results are shown in Table 1.

[0074]

(Evaluation of embedding property)

Each sample was polished by using an automatic polishing apparatus (AutoMet 250 and EcoMet 250 manufactured by BUEHLER), and the cross section of each sample was observed. Fig. 7 is a schematic front view for explaining a method of evaluating an embedding property in examples. The evaluation was performed from the cross-section observation by marking the case as "○" when a gap distance Z from the edge of the chip (refer to Fig. 7) is less than 200 μm, and the case as "△" when the distance Z is 200 μm or more and less than 500 μm, and the case as "×" when the distance Z is 500 μm or more. The results are shown in Table 1.

[0075]

[Table 1]

			Example 1	Example 2	Comparative Example 1
Compounding Ratio of Kneaded Product (% by weight)	Epoxy Resin	a	3.50%	2.00%	3.50%
	Phenol Resin	a	3.50%	2.00%	3.50%
	Inorganic Filler	a	89.0%	90.0%	89.0%
	Curing Accelerator	a	0.10%	0.10%	0.10%
	Thermoplastic Resin	a	3.90%	5.90%	3.90%
Film Formation		a	Application of Kneaded Product		
Thickness (μm)			600	600	600
Arrangement of Sealing Sheet			Top	Top	Bottom
Minimum Melt Viscosity [Pa·s]			30,000	120,000	30,000
Pressing Pressure			0.6 MPa	11 MPa	0.6 MPa
Pressing Time			60 Seconds	60 Seconds	60 Seconds
Pressing Temperature			90°C	90°C	90°C
Pressure at Reducing			10 Pa	10 Pa	10 Pa
Reduced Pressure Maintaining Time			180 Seconds	180 Seconds	180 Seconds
Evaluation	Evaluation of Unevenness Followability		○	△	×
	Evaluation of Embedding Property		○	△	○

DESCRIPTION OF REFERENCE SIGNS

[0076]

10 Sealing Sheet

20 Laminate

22 Semiconductor Wafer (Body to be Mounted)

23 Semiconductor Chip (Electronic Component)

28 Electronic Component Device

32 Lower Heating Plate

CLAIMS

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

a step A of preparing a laminate with a plurality of electronic components mounted on a body to be mounted;

a step B of preparing a thermosetting sealing sheet having an outer circumferential length of 500 mm or more;

a step C of arranging the laminate on a heating plate with a surface on which the electronic components are mounted facing upward and arranging the sealing sheet on a surface of the laminate where the electronic components are mounted; and

a step D of performing hot press to embed the electronic components into the sealing sheet after the step C.

2. The method of manufacturing a semiconductor device according to claim 1, wherein a kneaded product is applied to form the sealing sheet.

3. The method of manufacturing an electronic component device according to claim 1 or 2, wherein the sealing sheet has a minimum melt viscosity at 0 to 200°C of 100,000 Pa·s or less.