

DESCRIPTION

TITLE OF THE INVENTION: SHEET FOR SEALING HOLLOW TYPE ELECTRONIC
DEVICE AND METHOD OF MANUFACTURING HOLLOW TYPE ELECTRONIC
DEVICE PACKAGE

TECHNICAL FIELD

[0001]

The present invention relates to a sheet for sealing a hollow type electronic device and a method of manufacturing a hollow type electronic device package.

BACKGROUND ART

[0002]

Conventionally, when a hollow type electronic device in which a hollow structure is formed between the electronic device and the substrate is sealed with resin to produce a hollow type electronic device package, a sealing resin having a sheet shape can be used (for example, refer to Patent Document 1).

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0003]

Patent Document 1: JP-A-2006-19714

SUMARRY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004]

In the hollow type electronic device package, the hollow type electronic device may be affected by various types of ionic impurities derived from the sheet-shaped sealing resin that is used for sealing. Especially, in the hollow type electronic device package, the ionic impurities that exude from the sheet-shaped sealing resin are easily accumulated in the hollow space. With that effect, the characteristics as a hollow type electronic device (such as sensor characteristics when it is used as a pressure sensor, a vibration sensor, etc. and filter characteristics when it is used as an SAW filter, etc.) may not be sufficiently exhibited. Because of that, a sealing resin has been desired having a small content of ionic impurities.

[0005]

The present invention has been made in consideration of the above-described problem, and an object thereof is to provide a sheet for sealing a hollow type electronic device, the sheet having a small exuding amount of ionic impurities, and a method of manufacturing a hollow type electronic device package having a small exuding amount of ionic impurities.

MEANS FOR SOLVING THE PROBLEMS

[0006]

The present inventors have found that the above-described

object can be achieved by adopting the following configuration, and completed the present invention.

[0007]

That is, the present invention is a sheet for sealing a follow type electronic device, satisfying at least one of (a) to (d) below:

(a) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a chloride ion concentration of less than 30 ppm on a mass basis;

(b) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a sodium ion concentration of less than 10 ppm on a mass basis;

(c) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a phosphate ion concentration of less than 30 ppm on a mass basis; and

(d) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a sulfate ion concentration of less

than 5 ppm on a mass basis.

[0008]

The sheet for sealing a hollow type electronic device according to the present invention satisfies at least one of the above-described (a) to (d). Therefore, the exuding amount of ion impurities (at least one of chloride ions, sodium ions, phosphate ions (PO_4^{3-}), and sulfate ions (SO_4^{2-})) is decreased. As a result, deterioration of the characteristics of a hollow type electronic device package that is manufactured by using the sheet for sealing a hollow type electronic device is suppressed, and the product reliability can be improved.

[0009]

In the above-described configuration, the sheet for sealing a hollow type electronic device has a moisture permeability of preferably $500 \text{ g/m}^2 \cdot 24 \text{ hours}$ or less after thermal curing when a thickness of the sheet is made to be $250 \mu\text{m}$ under a condition of a temperature of 85°C , a humidity of 85%, and a duration of 168 hours.

[0010]

The present inventors have found out as follows: when there is a large amount of moisture that permeates the sheet for sealing a hollow type electronic device and reaches the hollow part, even if the exuding amount of ionic impurities is small when the sheet is immersed in the ion exchange water, the ionic impurities may be dissolved in the moisture to flow into

the electronic device side, and may be accumulated on the electronic device. If the moisture permeability of the sheet for sealing a follow type electronic device is $500 \text{ g/m}^2 \cdot 24 \text{ hours}$ or less after thermal curing when the thickness of the sheet is made to be $250 \text{ }\mu\text{m}$ under a condition of a temperature of 85°C , a humidity of 85%, and a duration of 168 hours, it is difficult for the moisture to penetrate into the hollow part from outside. As a result, the ionic impurities dissolved in the moisture are suppressed from reaching the electronic device from outside.

As described above, in addition to a decrease in the exuding amount of the ionic impurities of the sheet for sealing a follow type electronic device, the moisture permeability can be made small to further improve the product reliability of the follow type electronic device package that is manufactured by using the sheet for sealing a follow type electronic device. The reason why the evaluation condition of the moisture permeability is made to be a temperature of 85°C , a humidity of 85%, and a duration of 168 hours is because this condition meets the Level 1 condition that is the severest moisture absorption condition in the moisture sensitive level test (MSL test) of a semiconductor package.

When the thickness is not $250 \text{ }\mu\text{m}$, the moisture permeability at a thickness of $250 \text{ }\mu\text{m}$ under a condition of a temperature of 85°C , a humidity of 85%, and a duration of 168 hours is calculated from the following formula 1.

(Formula 1) $A - (250 - D) \times 0.101$

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

[0011]

In the above-described configuration, the sheet for sealing a hollow type electronic device preferably contains 70 to 90% by volume of an inorganic filler to the entire sheet for sealing a hollow type electronic device. If the content of the inorganic filler is 70% by volume or more to the entire sheet for sealing a hollow type electronic device, the moisture permeability can be easily decreased. On the other hand, if the content of the inorganic filler is 90% by volume or less to the entire sheet for a hollow type electronic device, the flexibility, fluidity, and adhesion become better.

[0012]

In the above-described configuration, the sheet for sealing a hollow type electronic device preferably contains an ion scavenger. When the sheet contains the ion scavenger, the ionic impurities can be further suppressed from reaching the electronic device.

[0013]

In the above-described configuration, the ion scavenger is preferably a hydrotalcites-based compound. The hydrotalcites-based compound has an ion scavenging property without containing a heavy metal such as antimony.

[0014]

A method of manufacturing a hollow type electronic device package according to the present invention comprises:

a laminating step of laminating the resin sheet for sealing a hollow type electronic device described above on a hollow type electronic device so that the resin sheet covers one or a plurality of the hollow type electronic devices that are mounted on a substrate; and

a sealing body forming step of curing the resin sheet for sealing a hollow type electronic device to form a sealing body.

A hollow type electronic device package that is manufactured by using the resin sheet for sealing a hollow type electronic device has a small exuding amount of ion impurities. Therefore, deterioration of the characteristics of the hollow type electronic device package that is manufactured by using the resin sheet for sealing a hollow type electronic device is suppressed, and the product reliability can be improved.

EFFECT OF THE INVENTION

[0015]

The present invention can provide a sheet for sealing a hollow type electronic device having a small exuding amount of ionic impurities and a method of manufacturing a hollow type electronic device package having a small exuding amount of ionic impurities.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a cross sectional view schematically showing a sheet for sealing a hollow type electronic device according to one embodiment of the present invention.

Fig. 2A is a view schematically showing one step of a method of manufacturing a hollow type electronic device package according to one embodiment of the present invention.

Fig. 2B is a view schematically showing one step of the method of manufacturing a hollow type electronic device package according to one embodiment of the present invention.

Fig. 2C is view schematically showing one step of the method of manufacturing a hollow type electronic device package according to one embodiment of the present invention.

MODE FOR CARRYING OUT THE INVENTION

[0017]

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.

[0018]

[Sheet for sealing hollow type electronic device]

[0019]

Fig. 1 is a cross sectional view schematically showing a sheet for sealing a hollow type electronic device according

to one embodiment of the present invention. Typically, a sheet for sealing a hollow type electronic device 11 (also referred to as "a sealing sheet 11" below) is provided in the form in which the sealing sheet 11 is laminated on a support 11a such as a polyethylene terephthalate (PET) film. A release treatment may be performed on the support 11a for easily peeling the sealing sheet 11.

[0020]

The sealing sheet 11 satisfies at least one of the following (a) to (d):

(a) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a chloride ion concentration of less than 30 ppm on a mass basis;

(b) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a sodium ion concentration of less than 10 ppm on a mass basis;

(c) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a phosphate ion concentration of less than 30 ppm on a mass basis; and

(d) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a sulfate ion concentration of less than 5 ppm on a mass basis.

[0021]

The sealing sheet 11 satisfies at least one of the above-described (a) to (d). Therefore, the exuding amount of ion impurities (at least one of chloride ions, sodium ions, phosphate ions, and sulfate ions) is decreased. As a result, deterioration of the characteristics of a hollow type electronic device package that is manufactured by using the sheet for sealing a hollow type electronic device 11 is suppressed, and the product reliability can be improved. Examples of the method for satisfying at least one of the (a) to (d) may include a method of selecting a material having a small content of the ion impurities and a method of containing an ion scavenger that can scavenge the ion impurities when the sealing sheet 11 is manufactured.

[0022]

The chloride ion concentration is preferably less than 20 ppm. The smaller the chloride ion concentration is, the more preferable it is, and for example, the concentration is 1 ppm or more.

The sodium ion concentration is preferably less than 7

ppm. The smaller the sodium ion concentration is, the more preferable it is, and for example, the concentration is 0.1 ppm or more.

The phosphate ion concentration is preferably less than 20 ppm. The smaller the phosphate ion concentration is, the more preferable it is, and for example, the concentration is 1 ppm or more.

The sulfate ion concentration is preferably less than 3 ppm. The smaller the sodium ion concentration is, the more preferable it is, and for example, the concentration is 0.1 ppm or more.

[0023]

The sealing sheet 11 has a moisture permeability of preferably $500 \text{ g/m}^2 \cdot 24 \text{ hours}$ or less, preferably $400 \text{ g/m}^2 \cdot 24 \text{ hours}$ or less, and further preferably $300 \text{ g/m}^2 \cdot 24 \text{ hours}$ or less after thermal curing when the thickness of the sealing sheet 11 is made to be $250 \mu\text{m}$ under a condition of a temperature of 85°C , a humidity of 85%, and a duration of 168 hours. The smaller the moisture permeability is, the more preferable it is, and for example, the moisture permeability is $1 \text{ g/m}^2 \cdot 24 \text{ hours}$ or more. If the moisture permeability is $500 \text{ g/m}^2 \cdot 24 \text{ hours}$ or less after thermal curing when the thickness of the sealing sheet 11 is made to be $250 \mu\text{m}$ under a condition of a temperature of 85°C , a humidity of 85%, and a duration of 168 hours, it is difficult for the moisture to penetrate into the hollow part

from outside. As a result, the ionic impurities dissolved in the moisture are suppressed from reaching the electronic device from outside.

As described above, in addition to a decrease in the exuding amount of the ionic impurities of the sheet for sealing a follow type electronic device, the moisture permeability can be made small to further improve the product reliability of the follow type electronic device package that is manufactured by using the sheet for sealing a follow type electronic device.

[0024]

Next, the composition of the sealing sheet 11 is explained.

[0025]

The sealing sheet 11 preferably contains an epoxy resin and a phenol resin. This makes it possible to provide a good thermal curing property.

[0026]

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.

[0027]

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.

[0028]

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.

[0029]

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.

[0030]

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.

[0031]

The total content of the epoxy resin and the phenol resin in the sealing sheet 11 is preferably 2.0% by weight or more, and more preferably 3.0% by weight or more. If the content is 2.0% by weight or more, good adhering strength to the electronic device, the substrate, etc. can be obtained. The total content of the epoxy resin and the phenol resin in the sealing sheet 11 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.

[0032]

The sealing sheet 11 preferably contains a thermoplastic resin. This makes it possible to provide a handling property when the sealing sheet 11 is uncured and low stress property to the cured product.

[0033]

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.

[0034]

The content of the thermoplastic resin in the sealing sheet 11 is preferably 1.0% by weight or more, and more preferably 1.5% by weight. If the content is 1.0% by weight or more, the flexibility can be obtained. The content of the thermoplastic resin in the sealing sheet 11 is preferably 3.5% by weight or less, and more preferably 3% by weight or less. If the content is 3.5% by weight or less, the adhesion with the electronic device and the substrate is good.

[0035]

The sealing sheet 11 preferably contains an inorganic filler.

[0036]

The inorganic filler is not especially limited, and various kinds of conventionally known fillers can be used. Examples thereof include powders 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.

[0037]

As silica, silica powders are preferable, and fused silica powders 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, powders 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.

[0038]

The content of the inorganic filler in the sealing sheet 11 is preferably 70 to 90% by volume, and more preferably 74

to 85% by volume to the entire sealing sheet 11. If the content of the inorganic filler is 70% by volume or more to the entire sealing sheet 11, the moisture permeability can be easily decreased. On the other hand, if the content of the inorganic filler is 90% by volume or less to the entire sealing sheet 11, the flexibility, fluidity, and adhesion become better.

[0039]

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

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

That is, the content of silica in the sealing sheet 11 is preferably 81% by weight or more, and more preferably 84% by weight or more. The content of silica in the sealing sheet 11 is preferably 94% by weight or less, and more preferably 91% by weight or less.

[0040]

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

That is, the content of alumina in the sealing sheet 11 is preferably 88% by weight or more, and more preferably 90% by weight or more. The content of alumina in the sealing sheet

11 is preferably 97% by weight or less, and more preferably 95% by weight or less.

[0041]

The sealing sheet 11 preferably contains an ion scavenger. When the sealing sheet 11 contains the ion scavenger, the ionic impurities can be further suppressed from reaching the electronic device.

[0042]

Examples of the ion scavenger include a hydrotalcites-based compound, bismuth hydroxide, and antimony pentoxide. These may be used alone or in combination of two or more thereof. Among these, a hydrotalcites-based compound can be preferably used from the viewpoint of having ion scavenging property without containing a heavy metal.

[0043]

The ion scavenger has an average particle size in a range of preferably 0.1 to 50 μm from the viewpoint of fluidity. 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.

[0044]

The content ratio of the ion scavenger is preferably set in a range of 0.01 to 2% by weight, and especially preferably 0.01 to 1% by weight to the entire sealing sheet 11. When the

content ratio of the ion scavenger is 0.01% by weight or more to the entire sealing sheet 11, a sufficient ion scavenging property can be obtained. When the content ratio of the ion scavenger is 2% by weight or less to the entire sealing sheet 11, the package can be prevented from being stained when being molded.

[0045]

The sealing sheet 11 preferably contains a curing accelerator.

[0046]

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 11 can be produced satisfactorily.

[0047]

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.

[0048]

The sealing sheet 11 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.

[0049]

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.

[0050]

The content of the flame retardant component in the sealing sheet 11 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 11 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.

[0051]

The sealing sheet 11 preferably contains a silane coupling agent. The silane coupling agent is not especially limited, and an example includes 3-glycidoxypropyl trimethoxysilane.

[0052]

The content of the silane coupling agent in the sealing sheet 11 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.

[0053]

The sealing sheet 11 preferably contains a pigment. The pigment is not especially limited, and an example thereof includes carbon black.

[0054]

The content of the pigment in the sealing sheet 11 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.

[0055]

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

[0056]

The sealing sheet 11 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, the uniformity of the sheet thickness is high and the moisture permeability can be easily lowered.

[0057]

The thickness of the sealing sheet 11 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.

[0058]

The method of manufacturing the sealing sheet 11 is not especially limited. Examples thereof include a method of preparing a kneaded product of the resin composition for forming the sealing sheet 11 and plastic-working the obtained kneaded product into a sheet shape; and a method of applying a resin composition that is dissolved or dispersed in a solvent for forming the sealing sheet 11 (varnish) to a separator, etc., followed by drying. When the method is adopted of plastic-working the kneaded product into a sheet shape, the

sealing sheet 11 can be produced without using a solvent. Therefore, the effect on the hollow type electronic device (for example, an SAW filter 13) from the volatilized solvent can be suppressed.

[0059]

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 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.

[0060]

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/cm² or less, and more preferably 0.05 kg/cm² or less. The lower limit of the pressure under reduced pressure is not especially limited; however, it is 1×10^{-4} kg/cm² or more.

[0061]

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.

[0062]

The sealing sheet 11 is used to seal an electronic device that requires hollow sealing (for example, a SAW (Surface Acoustic Wave) filter; MEMS (Micro Electro Mechanical Systems) such as a pressure sensor and a vibration sensor). Among these, the sealing sheet 11 is especially suitably used for sealing a SAW filter.

[0063]

The sealing method is not especially limited, and a conventionally known method can be used for sealing. An example thereof includes a method of laminating (mounting) the sealing sheet 11 that is not cured on a substrate so that the sealing sheet 11 covers the hollow type electronic device on the substrate and curing the sealing sheet 11 to seal the hollow

type electronic device. The substrate is not especially limited, and examples thereof include a printed circuit board, a ceramic substrate, a silicon substrate, and a metal substrate.

[0064]

[Method of manufacturing hollow type electronic device package]

Each of Figs. 2A to 2C is a view showing one step of a method of manufacturing a hollow type electronic device package according to one embodiment of the present invention. In the present embodiment, hollow sealing is performed on a SAW filter 13 as a hollow type electronic device that is mounted on a printed circuit board 12 by using the sealing sheet 11 to produce a hollow type electronic device package.

[0065]

(SAW filter mounted substrate preparing step)

In the SAW filter mounted substrate preparing step, the printed circuit board 12 is prepared on which a plurality of the SAW filters 13 are mounted (refer to Fig. 2A). A piezoelectric crystal in which a prescribed comb-shaped electrode is formed is diced into individual pieces with a known method to form the SAW filter 13. The SAW filter 13 can be mounted on the printed circuit board 12 with a known apparatus such as a flip-chip bonder or a die bonder. The SAW filter 13 is electrically connected to the printed circuit board 12 through a projected electrode 13a such as a bump. A hollow part 14 is maintained between the SAW filter 13 and the printed

circuit board 12 so as not to inhibit propagation of a surface acoustic wave on the surface of the SAW filter. The distance between the SAW filter 13 and the printed circuit board 12 can be appropriately set, and is generally about 15 to 50 μm .

[0066]

(Sealing step)

In the sealing step, the sealing sheet 11 is laminated on the printed circuit board 12 so that the sealing sheet 11 covers the SAW filter 13 to perform resin sealing on the SAW filter 13 with the sealing sheet 11 (refer to Fig. 2B). The sealing sheet 11 functions as a sealing resin for protecting the SAW filter 13 and the elements attached to the filter from the external environment.

[0067]

The method of laminating the sealing sheet 11 on the printed circuit board 12 is not especially limited, and a known method can be used such as hot press or laminator. For the hot pressing condition, 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 device package in which an electronic device is embedded in a thermosetting sealing sheet 16. In consideration of improvement of the tackiness and followability of the sealing sheet 11 to the SAW

filter 13 and the printed circuit board 12, pressing is preferably performed under a reduced pressure condition (for example 0.1 to 5 kPa).

[0068]

(Sealing body forming step)

In the sealing body forming step, the sealing sheet 11 is subjected to a thermal curing treatment to form a sealing body 15 (refer to Fig. 2B).

[0069]

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.

[0070]

(Dicing step)

Subsequently, the sealing body 15 may be diced (refer to Fig. 2C). This makes it possible to provide an electronic

device package 18 for each SAW filter 13.

[0071]

(Substrate mounting step)

A rewiring and a bump are formed for the electronic device package 18 as necessary to perform the substrate mounting step of mounting the electronic device package 18 to a separate substrate (not shown in the drawing). The electronic device package 18 can be mounted to the substrate by using a known apparatus such as a flip-chip bonder or a die bonder.

EXAMPLES

[0072]

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.

[0073]

The components used in the examples will be explained.

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

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

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

Ion scavenger: DHT-4A manufactured by Kyowa Chemical Industry Co., Ltd.

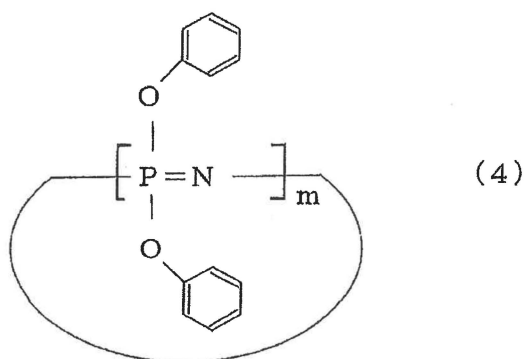
Inorganic filler: FB-9454FC manufactured by DENKI KAGAKU KOGYO KABUSHIKI KAISHA (fused spherical silica, average particle size 20 μm)

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

Carbon black: #20 manufactured by Mitsubishi Chemical Corporation

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

[Formula 1]



wherein, m represents an integer of 3 or 4

Curing accelerator: 2PHZ-PW manufactured by Shikoku

Chemicals Corporation

(2-phenyl-4,5-dihydroxymethylimidazole)

[0074]

Examples 1 and 2

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/cm²) with a roll kneader to prepare a kneaded product. Then, the obtained kneaded product was formed into a sheet shape by flat plate pressing to produce a sealing sheet having the thickness shown in Table 1.

[0075]

Example 3

Each component was compounded into a solvent (methylethylketone (MEK) : Toluene = 1 : 1 in weight ratio) according to the compounding described in Table 1 to obtain a coating liquid having a non-solvent component concentration of 90%.

The obtained coating liquid was applied with a comma coater onto the release-treated surface of a polyester film A (MRF-50 manufactured by Mitsubishi Polyester Film Inc.) having a thickness of 50 μm, and then dried so that the thickness of the coated film became 50 μm after drying. Then, the release-treated surface of a polyester film B (MRF-38 manufactured by Mitsubishi Polyester Film Inc.) having a

thickness of 38 μm was pasted to the varnish after drying to prepare a thin sealing sheet.

After that, five thin sealing sheets were laminated by using a roll laminator while appropriately peeling the polyester films A and B to prepare a sealing sheet having a thickness of 250 μm .

[0076]

Comparative Example 1

Each component was compounded according to the compounding ratio described in Table 1, and methylethylketone that is the same amount as the total amount of each component was added thereto to prepare a varnish. The obtained varnish was applied with a comma coater onto the release-treated surface of a polyester film A (MRF-50 manufactured by Mitsubishi Polyester Film Inc.) having a thickness of 50 μm , and then dried so that the thickness of the varnish became 50 μm after drying. Then, the release-treated surface of a polyester film B (MRF-38 manufactured by Mitsubishi Polyester Film Inc.) having a thickness of 38 μm was pasted to the varnish after drying to prepare a thin sealing sheet.

After that, five thin sealing sheets were laminated by using a roll laminator while appropriately peeling the polyester films A and B to prepare a sealing sheet having a thickness of 250 μm .

[0077]

The following evaluations were conducted using the obtained sealing sheets. The results are shown in Table 1.

[0078]

[Measurement of extraction concentration of ionic impurities]

Each of the sealing sheets of the examples and the comparative example was cut into a piece having a weight of 5 g, the piece was placed in a hermetically-sealing type Teflon (registered trademark) container in a cylindrical shape having a diameter of 58 mm and a height of 37 mm, and 50 ml of ion exchange water was added thereto. After that, it was left at 121°C and 2 atmospheric pressure for 20 hours. After the film was removed, chloride ion concentration, sodium ion concentrate, phosphate ion concentration, and sulfate ion concentration in the ion exchange water were measured using DX320 and DX500 each manufactured by Dionex. The results are shown in Table 1.

[0079]

[Measurement of moisture permeability]

Each of the sealing sheets produced in the examples and the comparative example was thermally cured. For the thermal curing condition, the temperature was 150°C and the heating time was 60 minutes. After that, the moisture permeability of each of the sealing sheets (after thermal curing) produced in the examples and the comparative example was measured in accordance with the standard of JIS Z 0208 (cup method).

The measurement condition was as follows. The results

are shown in Table 1.

(Measurement condition)

Temperature 85°C

Humidity 85%

Duration 168 hours

Thickness of sealing sheet: 250 μm

[0080]

[Table 1]

			Example 1	Example 2	Example 3	Comparative Example 1
Compounding Ratio (parts by weight)	Epoxy Resin		3.3	3.3	3.3	13.7
	Phenol Resin		3.5	3.5	3.5	14.6
	Thermoplastic Resin		3	3	3	12.5
	Inorganic Filler		88	87.5	88	50
	Ion Scavenger		0	0.5	0	0
	Silane Coupling Agent		0.3	0.3	0.3	1.2
	Carbon Black		0.3	0.3	0.3	1.2
	Flame Retardant		1.5	1.5	1.5	6.3
	Curing Accelerator		0.1	0.1	0.1	0.5
Total			100	100	100	100
Manufacturing Method			Kneading	Kneading	Solvent Coating	Solvent Coating
Sheet Thickness (μm)			250	250	250	250
Content (% by volume) of Inorganic Filler in Sealing Sheet			80	79	80	35
Evaluation	Concentration of Ionic Impurities	Chloride Ion Concentration (ppm)	15	10	16	31
		Sodium Ion Concentration (ppm)	2.1	1.7	2.0	126
		Phosphate Ion Concentration (ppm)	0.7	0.6	0.7	34
		Sulfate Ion Concentration (ppm)	1.1	1.1	1.0	6
	Moisture Permeability (g/m ² ·24 hr)		30	35	30	550

DESCRIPTION OF REFERENCE SIGNS

[0081]

11 Sheet for Sealing Hollow Type Electronic Device
(Sealing Sheet)

11a Support

13 SAW Filter

15 Sealing Body

18 Hollow Type Electronic Device Package

CLAIMS

1. A sheet for sealing a hollow electronic device, satisfying at least one of (a) to (d) below:

(a) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a chloride ion concentration of less than 30 ppm on a mass basis;

(b) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a sodium ion concentration of less than 10 ppm on a mass basis;

(c) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a phosphate ion concentration of less than 30 ppm on a mass basis; and

(d) after a sheet for sealing a hollow electronic device having a weight of 5 g is immersed in 50 ml of ion exchange water and then left at 121°C and 2 atmospheric pressure for 20 hours, the ion exchange water has a sulfate ion concentration of less than 5 ppm on a mass basis.

2. The sheet for sealing a hollow type electronic device according to claim 1, wherein the sheet for sealing a hollow type electronic device has a moisture permeability of preferably $500 \text{ g/m}^2 \cdot 24 \text{ hours}$ or less after thermal curing when a thickness of the sheet is made to be $250 \text{ }\mu\text{m}$ under a condition of a temperature of 85°C , a humidity of 85%, and a duration of 168 hours.

3. The sheet for sealing a hollow type electronic device according to claim 1 or 2, wherein the sheet for sealing a hollow type electronic device contains 70 to 90% by volume of an inorganic filler to the entire sheet for sealing a hollow type electronic device.

4. The sheet for sealing a hollow type electronic device according to any one of claims 1 to 3, wherein the sheet for sealing a hollow type electronic device contains an ion scavenger.

5. The sheet for sealing a hollow type electronic device according to claim 4, wherein the ion scavenger is a hydrotalcites-based compound.

6. A method of manufacturing a hollow type electronic device package comprising:

a laminating step of laminating the resin sheet for sealing a hollow type electronic device according to any one of claims 1 to 5 on a hollow type electronic device so that the resin sheet covers one or a plurality of the hollow type electronic devices that are mounted on a substrate; and

a sealing body forming step of curing the resin sheet for sealing a hollow type electronic device to form a sealing body.