

DESCRIPTION

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

TECHNICAL FIELD

[0001]

The present invention relates to a hollow sealing sheet, a method for manufacturing the hollow sealing sheet, and a method for manufacturing a hollow package.

BACKGROUND ART

[0002]

For production of a hollow package for a semiconductor or the like, typically a procedure is employed in which one or more electronic components fixed to a substrate, a temporary fixing material or the like are sealed with a sealing resin, and the sealed product is diced as necessary so that a package is formed per each electronic component. A sheet-shaped sealing resin having good handling ability is used as the sealing resin. A technique of blending a sheet for sealing with a filler by kneading is proposed as a method for increasing the blending amount of a filler for an improvement in the performance of a hollow sealing sheet (Patent Document 1).

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0003]

Patent Document 1: JP-A-2013-7028

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0004]

In recent years, micro electronic components referred to as MEMS such as an SAW (Surface Acoustic Wave) filter, a CMOS (Complementary Metal Oxide Semiconductor) sensor, and an accelerometer have been developed along with a semiconductor package. These electronic components generally have a hollow structure for propagating a surface elastic wave, maintaining an optical system, and securing the movability or the like of a movable member. It is necessary to maintain a hollow structure during sealing so that the operation reliability of the movable member and the connection reliability of an element are secured. The correspondence of the hollow sealing sheet to a hollow package which has such a hollow structure is also required.

[0005]

It is an object of the present invention to provide a hollow sealing sheet from which a highly reliable hollow package can be produced; and a method for producing a hollow package.

MEANS FOR SOLVING THE PROBLEMS

[0006]

As a result of intensive studies, the present inventors have found that the above problems can be solved by employing the following constitution and thereby completed the present invention.

[0007]

That is, the present invention provides a hollow sealing sheet for hollow-sealing an electronic component. The hollow sealing sheet contains a resin, and has a controlled resin ingress property into a hollow part at 40°C or higher and 100°C or lower.

[0008]

Since the hollow sealing sheet has a controlled resin ingress property into the hollow part at 40°C or higher and 100°C or lower, the resin ingress into the hollow part is suppressed during hollow sealing, and thereby a highly reliable hollow package can be produced.

[0009]

In the hollow sealing sheet, when the resin is filled into a molding die having a slit having a width of 20 μm and the resin is pressurized at a pressure of 10 kg/cm^2 and a temperature of 150°C for 10 minutes, an amount of resin ingress into the slit is preferably 3 mm or less. Thereby, the resin ingress property into a predetermined slit under heating and pressurization are

suppressed, and a hollow package having higher reliability can be produced. The amount of resin ingress is measured according to the description of EXAMPLES.

[0010]

In the hollow sealing sheet, when the amount of resin ingress into a slit having a width of 1 μm or more and 100 μm or less is plotted with respect to the slit width, a minimum value is preferably present in the plot. Although not made clear, a mechanism of the presence of the minimum value is presumed as follows. For example, when the hollow sealing sheet contains microparticles having a dilatancy-imparting property, such as an inorganic filler or elastomer particles, a dilatancy-like action is exhibited in a slit peripheral area, which suppresses the resin ingress into the slit. When the slit width is sufficiently greater than the particle diameter of each of the microparticles, the dilatancy-like action is decreased, which causes easy resin ingress with microparticles into the slit to increase the amount of resin ingress. As the slit width is decreased, the dilatancy-like action is increased, and the amount of resin ingress is also decreased. The amount of resin ingress has the minimum value at a point. When the slit width is equal to or less than a certain value, the ingress of the microparticles into the slit is regulated, which causes the ingress of only the resin component into the slit. Since the case of the resin alone causes a decreased dilatancy-like action,

the amount of resin ingress is increased. When a force applied to the hollow sealing sheet is constant, more resin is extruded into the slit as the slit width is decreased. As a result, the amount of resin ingress is increased. Thus, it is supposed that there is a minimum value in the plot of the amount of resin ingress with respect to the slit width. By utilizing the phenomenon, the composition of the hollow sealing sheet can be designed so as to maximize the dilatancy-like action with respect to the gap spacing of the hollow part, and the resin ingress into the hollow part can be more efficiently regulated. Therefore, a highly reliable hollow package can be produced.

[0011]

In the sealing sheet, the minimum value is preferably 2 mm or less. Thereby, the resin ingress property can be more highly suppressed, and the reliability of the hollow package can be further improved.

[0012]

The present invention provides a method for producing a hollow package, the method including: a stacking step of stacking the hollow sealing sheet onto one or more electronic components so as to cover the electronic components while maintaining a hollow part; and a sealing member forming step of curing the hollow sealing sheet to form a sealing member.

[0013]

Since the hollow sealing sheet having a controlled resin

ingress property into the hollow part is used in the production method of the present invention, a hollow package that is highly reliable as a whole can be produced while the hollow part is satisfactorily secured.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014]

Fig. 1 is a schematic cross sectional view showing a hollow sealing sheet according to one embodiment of the present invention.

Fig. 2A is a schematic cross sectional view showing one step of a method for producing a hollow package according to one embodiment of the present invention.

Fig. 2B is a schematic cross sectional view showing one step of a method for producing a hollow package according to one embodiment of the present invention.

Fig. 2C is a schematic cross sectional view showing one step of a method for producing a hollow package according to one embodiment of the present invention.

Fig. 3 is a SEM observation image of a cutting surface of a hollow sealing sheet in an example of the present invention.

Fig. 4A is a schematic cross sectional view of a molding die for measuring an amount of resin ingress into a slit of a molding die.

Fig. 4B is a plan view of a lower die of the molding die.

Fig. 4C is a schematic cross sectional view showing a measurement procedure for measuring the amount of resin ingress into the slit of the molding die.

MODE FOR CARRYING OUT THE INVENTION

[0015]

<<First Embodiment>>

[Hollow sealing sheet]

A hollow sealing sheet according to the present embodiment will be described with reference to Fig. 1. Fig. 1 is a sectional view schematically showing a hollow sealing sheet according to one embodiment of the present invention. A hollow sealing sheet 11 is typically provided in a state of being laminated on a support 11a such as a polyethylene terephthalate (PET) film. The support 11a may be subjected to a mold release treatment for easily peeling off the hollow sealing sheet 11.

[0016]

A hollow sealing sheet 11 has a controlled resin ingress property into a hollow part 14 (see Fig. 2A) at 40°C or higher and 100°C or lower. Therefore, the hollow part 14 can be secured in a hollow package 18 (see Fig. 2C) obtained using the hollow sealing sheet 11, and the operation reliability and connection reliability of the electronic component can be obtained at a high level.

[0017]

When a resin for forming the hollow sealing sheet 11 is filled into a molding die having a slit having a width of 20 μm and the resin is pressurized at a pressure of 10 kg/cm^2 and a temperature of 150°C for 10 minutes, an amount of resin ingress into the slit is preferably 3 mm or less, and more preferably 2 mm or less. By setting the resin ingress property under heating and pressurization within the above range, a hollow package having higher reliability can be produced.

[0018]

When the amount of resin ingress into a slit having a width of 1 μm or more and 100 μm or less is plotted with respect to the slit width in the hollow sealing sheet 11, a minimum value is preferably present in the plot. This allows the composition design of the hollow sealing sheet for minimizing the amount of resin ingress into the hollow part, and thereby a more highly reliable hollow package can be produced.

[0019]

In the sealing sheet, the minimum value is preferably 2 mm or less, and more preferably 1 mm or less. Thereby, the resin ingress property can be more highly suppressed, and the reliability of the hollow package can be further improved.

[0020]

The hollow sealing sheet has a coefficient of linear expansion of, preferably 15 ppm/K or less at 20°C after being heat-cured at 150°C for 1 hour, and more preferably 10 ppm/K

or less. Thereby, the warpage of a hollow package can be satisfactorily suppressed. A method for measuring the coefficient of linear expansion is as follows. An uncured hollow sealing sheet having a width of 4.9 mm, a length of 25 mm, and a thickness of 0.2 mm is cured at 150°C for 1 hour. The cured resin sheet is set in TMA8310 (manufactured by Rigaku Corporation), to measure a coefficient of linear expansion of the resin sheet at a tensile load of 4.9 mN and a temperature increase rate of 10°C/min.

[0021]

A resin composition for forming the hollow sealing sheet is not particularly limited as long as it can suitably impart the above characteristics and can be used for resin-sealing an electronic component such as a semiconductor chip. Above all, the resin composition preferably contains a regulating material capable of regulating the resin flow near the hollow part. An elastomer, a high-viscosity substance such as a high-viscosity epoxy resin or a high-viscosity phenol resin, and microparticles having a dilatancy-imparting property such as an inorganic filler can be suitably used as the regulating material.

[0022]

The viscosity of the high-viscosity substance may be appropriately set in consideration of the degree of regulation of the resin flow, workability, and the like. The viscosity

of the high-viscosity substance is preferably 2000 Pa·s or more and 30000 Pa·s or less, and more preferably 5000 Pa·s or more and 25000 Pa·s or less at 80°C. The viscosity can be measured by a parallel plate method using a viscoelasticity measuring instrument ARES manufactured by TA Instruments. In more detail, the viscosity is measured at 50 to 200°C under conditions of a gap of 100 μm , a rotating plate diameter of 20 mm, and a rotating speed of 10 s^{-1} . The viscosity is obtained by reading the value at 80°C in the measurement.

[0023]

A resin composition which forms the hollow sealing sheet is not particularly limited as long as the resin composition can suitably provide characteristics described above, can be used for resin-sealing of an electronic component such as a semiconductor chip, and contains an elastomer. From the viewpoint of improving the heat resistance and stability of the cured hollow sealing sheet, preferably, the resin composition further contains a thermosetting resin in addition to the elastomer. Specific examples of the preferred resin composition include epoxy resin compositions containing components A to E shown below.

Component A: epoxy resin

Component B: phenol resin

Component C: elastomer

Component D: organic filler

Component E: curing accelerator

[0024]

(Component A)

An epoxy resin (component A) as the thermosetting resin 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 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.

[0025]

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 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.

[0026]

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.

[0027]

When the weight average molecular weight of the epoxy resin is increased, the viscosity is also increased, and the epoxy resin itself can act as the regulating material. The weight average molecular weight is not particularly limited as long as the epoxy resin can act as the regulating material, and is preferably 150 or more, and more preferably 300 or more.

[0028]

The content of the epoxy resin (component A) is preferably set in a range of 1 to 10% by weight based on the total amount of the epoxy resin composition.

[0029]

(Component B)

The phenol resin (component B) is not particularly limited as long as it can be used as the thermosetting resin and it causes a curing reaction with the epoxy resin (component A). For example, a phenol novolac resin, a 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.

[0030]

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. 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.

[0031]

The epoxy resin (component A) and the phenol resin (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.

[0032]

When the weight average molecular weight of the phenol resin is increased, the viscosity is also increased, and the phenol resin itself can act as the regulating material. The weight average molecular weight is not particularly limited as long as the phenol resin can act as the regulating material, and is preferably 150 or more, and more preferably 300 or more.

[0033]

Herein, the weight average molecular weight can be

measured by the following method. In THF is dissolved 0.1 wt% of a sample, and the weight average molecular weight is measured in terms of polystyrene using GPC (gel permeation chromatography). The detailed measurement conditions are as follows.

<Measurement Conditions of Weight Average Molecular Weight>

GPC apparatus: HLC-8120GPC manufactured by Tosoh Corporation

column: (GMHHR-H) + (GMHHR-H) + (G2000HHR) manufactured by Tosoh Corporation

flow rate: 0.8 mL/min

concentration: 0.1 wt%

injection amount: 100 μ L

column temperature: 40°C

eluant: THF

[0034]

(Component C)

As an elastomer (component C) used with the epoxy resin (component A) and the phenol resin (component B), various acrylic copolymers and rubber components or the like can be used, for example. From the viewpoint that the dispersibility of the component C in the epoxy resin (component A), and the heat resistance, flexibility, and strength of the obtained hollow sealing sheet can be improved, the component C preferably

contains a rubber component. The rubber component is preferably at least one selected from the group consisting of a butadiene-based rubber, a styrene-based rubber, an acrylic rubber, and a silicone-based rubber. These may be used alone or in combinations of two or more. The elastomer which is the high-viscosity substance can suitably regulate the resin ingress into the hollow part.

[0035]

In the hollow sealing sheet 11, it is preferable that domains of an elastomer are dispersed and the maximum diameter of the domains is 20 μm or less. Thereby, the elastomer can function as microparticles having an action of regulating the flow of the resin (dilatancy-like action) near the hollow part, and can more efficiently suppress the resin ingress into the hollow part. The elastomer may locally aggregate or flocculate. From the viewpoint of a flow regulation function, it is preferable that the domains are entirely uniformly dispersed. The upper limit of the maximum diameter of the domains is not particularly limited as long as the upper limit is 20 μm or less, and preferably 15 μm or less, and more preferably 10 μm or less. From the viewpoint of the physical limit of miniaturization and the application of flexibility, the lower limit of the maximum diameter of the domains is preferably 0.1 μm or more, and more preferably 0.3 μm or more.

[0036]

The content of the elastomer (component C) is 1.0 to 3.5% by weight, preferably 1.5 to 3% by weight based on the total amount of the epoxy resin composition. If the content of the elastomer (component C) is less than 1.0% by weight, it becomes difficult to secure the plasticity and flexibility of the hollow sealing sheet 11, and further it becomes difficult to perform resin sealing while suppressing the warp of the hollow sealing sheet. If conversely the above-described content is more than 3.5% by weight, there is the tendency that the melt viscosity of the hollow sealing sheet 11 is increased to deteriorate the embedding property of an electronic component, and the strength and heat resistance of a cured body of the hollow sealing sheet 11 are reduced.

[0037]

The weight ratio of the elastomer (component C) to the epoxy resin (component A) (weight of component C / weight of component A) is preferably set in a range of 0.5 to 1.5. This is because if the weight ratio is less than 0.5, it becomes difficult to control the fluidity of the hollow sealing sheet 11, and if the weight ratio is more than 1.5, there is the tendency that the tackiness of the hollow sealing sheet 11 to an electronic component is deteriorated.

[0038]

A ratio E_e/E_t of a tensile modulus E_e of the elastomer to a tensile modulus E_t of the thermosetting resin at 60°C is

preferably 5×10^{-5} or more and 1×10^{-2} or less, and more preferably 1×10^{-4} or more and 5×10^{-3} or less. Thereby, a shear stress from a kneading member and the thermosetting resin effectively acts on the elastomer during kneading in the manufacture process of the hollow sealing sheet, which can provide the promotion of the minute elastomer. A method for measuring the tensile moduli E_e and E_t can be performed according to the following procedure. Each of sheets made of the elastomer and the thermosetting resin is cut out in a strip shape having a thickness of 200 μm , a length of 400 mm, and a width of 10 mm by a cutter knife to produce a measurement sample. The tensile modulus and loss elastic modulus of the measurement sample at -50 to 300°C are measured under conditions of a frequency of 1 Hz and a temperature increase rate of $10^\circ\text{C}/\text{min}$ using a solid viscoelasticity measuring device (Model: RSA-III manufactured by Rheometric Scientific, Inc.) The value of the tensile modulus at 60°C during the measurement is read, to obtain intended tensile moduli E_e and E_t .

[0039]

(Component D)

The inorganic filler (component D) is not particularly limited, various kinds of previously known fillers can be used, and examples thereof include powders of quartz glass, talc, silica (fused silica, crystalline silica, etc.), alumina, aluminum nitride, silicon nitride and boron nitride. They may

be used alone or in combination of two or more thereof. The inorganic filler can more efficiently impart the dilatancy-like action near the hollow part to the hollow sealing sheet.

[0040]

Particularly, silica powders are preferably used because the thermal linear expansion coefficient of a cured body of the epoxy resin composition is reduced to thereby reduce internal stress, and resultantly the warp of the hollow sealing sheet 11 after sealing of an electronic component can be suppressed, and among silica powders, 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, but a spherical fused silica powder is especially preferably used from the viewpoint of fluidity. Particularly, those having an average particle diameter of 54 μm or less are preferably used, those having an average particle diameter ranging from 0.1 to 30 μm are further preferably used, and those having an average particle diameter ranging from 0.5 to 20 μm are especially preferably used.

[0041]

The average particle diameter can be derived by making a measurement with a laser diffraction scattering grain size distribution measuring device using a sample that is randomly extracted from a population.

[0042]

The content of the inorganic filler (component D) is preferably 70 to 90% by volume (81 to 94% by weight since a silica particle has a specific gravity of 2.2 g/cm³), more preferably 74 to 85% by volume (84 to 91% by weight in the case of a silica particle), and still more preferably 76 to 83% by volume (85 to 90% by weight in the case of a silica particle) based on the total amount of the epoxy resin composition. If the content of the inorganic filler (component D) is less than 70% by volume, there is the tendency that the warp of the hollow sealing sheet 11 is increased because the linear expansion coefficient of a cured body of the epoxy resin composition is increased. On the other hand, if the above-described content is more than 90% by volume, there is the tendency that tackiness with an electronic component is reduced because the plasticity and fluidity of the hollow sealing sheet 11 are deteriorated.

[0043]

(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 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.

[0044]

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).

[0045]

(Other components)

To the epoxy resin composition may be added a flame retardant component in addition to the components A to E. As the flame retardant component, various kinds of metal hydroxides such as, for example, aluminum hydroxide, magnesium hydroxide, iron hydroxide, calcium hydroxide, tin hydroxide and conjugated metal hydroxides can be used.

[0046]

The average particle diameter of the metal hydroxide is preferably 1 to 10 μm , further preferably 2 to 5 μm from the viewpoint of securing appropriate fluidity when the epoxy resin composition is heated. If the average particle diameter of the metal hydroxide is less than 1 μm , it becomes difficult to uniformly disperse the metal hydroxide in the epoxy resin composition, and sufficient fluidity may not be achieved during heating of the epoxy resin composition. If the average particle diameter is more than 10 μm , there is the tendency that the flame retardant effect is reduced because the surface area per added amount of the metal hydroxide (component E) is decreased.

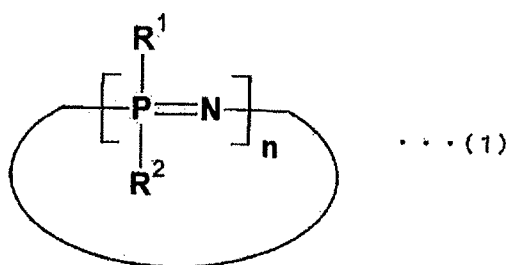
[0047]

As the flame retardant component, not only the above-mentioned metal hydroxides but also a phosphazene compound can be used. As the phosphazene compound, for example, SPR-100, SA-100 and SP-100 (each manufactured by Otsuka Chemical Co., Ltd.), FP-100 and FP-110 (each manufactured by FUSHIMI Pharmaceutical Co., Ltd.) and the like are available as commercial products.

[0048]

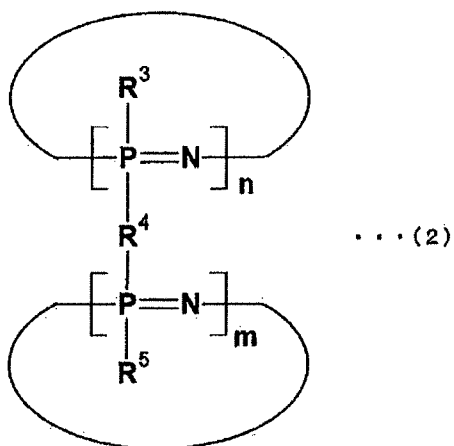
A phosphazene compound represented by the formula (1) or (2) is preferred because it exhibits a flame retardant effect even in a small amount, and the content of phosphorus elements contained in the phosphazene compound is preferably 12% by weight or more.

[Formula 1]



(wherein, n is an integer of 3 to 25, R^1 and R^2 are the same or different, and are each a monovalent organic group having a functional group selected from the group consisting of an alkoxy group, a phenoxy group, an amino group, a hydroxyl group and an allyl group.)

[Formula 2]

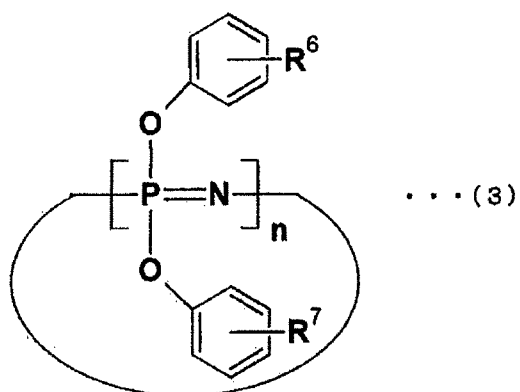


(wherein, n and m are each independently an integer of 3 to 25. R³ and R⁵ are the same or different, and are each a monovalent organic group having a functional group selected from the group consisting of an alkoxy group, a phenoxy group, an amino group, a hydroxyl group and an allyl group. R⁴ is a divalent organic group having a functional group selected from the group consisting of an alkoxy group, a phenoxy group, an amino group, a hydroxyl group and an allyl group.)

[0049]

A cyclic phosphazene oligomer represented by the formula (3) is preferably used from the viewpoint of stability and suppression of generation of voids.

[Formula 3]



(wherein, n is an integer of 3 to 25, and R⁶ and R⁷ are the same or different, and are each hydrogen, a hydroxyl group, an alkyl group, an alkoxy group or a glycidyl group.)

[0050]

As the cyclic phosphazene oligomer represented by the above formula (3), for example, FP-100 and FP-110 (each manufactured by FUSHIMI Pharmaceutical Co., Ltd.) and the like are available as commercial products.

[0051]

The content of the phosphazene compound is preferably 10 to 30% by weight based on the total amount of organic components including the epoxy resin (component A), the phenol resin (component B) and the elastomer (component D) and the curing accelerator (component E) and the phosphazene compound (other components) which are contained in the epoxy resin composition. That is, if the content of the phosphazene compound is less than 10% by weight based on the total amount of the organic components, there is the tendency that the flame retardancy of the hollow sealing sheet 11 is deteriorated, and followability to the

unevenness of an adherend (e.g., a substrate on which an electronic component is mounted) is deteriorated, leading to generation of voids. If the content is more than 30% by weight of the total amount of the organic components, there is the tendency that tacking easily occurs on the surface of the hollow sealing sheet 11, so that workability is deteriorated, e.g., it becomes difficult to perform positioning to an adherend.

[0052]

The above-mentioned metal hydroxide and phosphazene compound can also be used in combination to obtain the hollow sealing sheet 11 which is excellent in flame retardancy while retaining flexibility required for sheet sealing. By using the metal hydroxide and the phosphazene compound in combination, sufficient flame retardancy when only the metal hydroxide is used and sufficient flexibility when only the phosphazene compound is used can be obtained.

[0053]

Among the above-described flame retardants, it is desirable to use an organic flame retardant from the viewpoint of deformability of a hollow sealing sheet during molding of resin-sealing, followability to the unevenness of an electronic component and an adherend, and adhesion to the electronic component and the adherend, and particularly a phosphazene-based flame retardant is suitably used.

[0054]

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

[0055]

(Method for Manufacturing Hollow sealing sheet)

A method for manufacturing a hollow sealing sheet will be described below. A method for manufacturing a hollow sealing sheet of the present embodiment includes: a kneading step of preparing a kneaded product containing an elastomer; and a forming step of forming the kneaded product in a sheet shape to obtain the hollow sealing sheet.

[0056]

(Kneading Step)

First, an epoxy resin composition is prepared by mixing the components described above. The mixing method is not particularly limited as long as the components are uniformly dispersed and mixed. Thereafter, a kneaded product is prepared by kneading the blend components containing an elastomer directly with a kneader or the like. In this case, kneading is preferably performed so that the elastomer of the hollow sealing sheet is dispersed in a form of domains and a maximum diameter of the domains is set to 20 μm or less.

[0057]

Specifically, 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 examples thereof include methods of performing melt-kneading by a known kneader such as a mixing roll, a pressure kneader or an extruder. As the above-mentioned kneader, for example, a kneader can be suitably used, which includes a kneading screw having, a portion where in a part of a shaft direction, the protrusion amount of a screw blade from a screw shaft is smaller than the protrusion amount of a screw blade from a screw shaft in other portions, or a kneading screw having, in a part of a shaft direction, no screw blade. In the portion where the protrusion amount of a screw blade is small or the portion having no screw blade, the shearing force and stirring level are lowered, and consequently the compression ratio of a kneaded product is increased, so that entrapped air can be removed, thus making it possible to suppress generation of pores in the kneaded product obtained.

[0058]

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 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.

[0059]

When the kneader is used for kneading, a ratio r/t of the number of rotations for kneading r (rpm) to a kneading treatment amount t (kg/hr) is preferably 60 or more, and more preferably 70 or more. When the ratio r/t is 60 or more, a sufficient shear stress is applied to kneading raw materials containing the elastomer, which can efficiently provide the promotion of the minute elastomer. The number of rotations for kneading r (rpm) is preferably 200 to 1000 rpm, and the kneading treatment amount t (kg/hr) is preferably 3 to 20 kg/hr.

[0060]

(Molding step)

Through molding the resulting kneaded product into a sheet-like shape by extrusion molding, the hollow sealing sheet 11 can be obtained. Specifically, the kneaded product after melt-kneading is extrusion-molded while it is kept at a high temperature without being cooled, whereby the hollow sealing sheet 11 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 hollow sealing sheet 11 can be formed.

[0061]

The thickness of the hollow sealing sheet 11 is not particularly limited, and is preferably 100 to 2000 μm . In the above-mentioned range, the electronic component can be satisfactorily sealed. The reduction in the thickness of the resin sheet can provide a reduction in an amount of heat generation, which is less likely to cause shrinkage on curing. As a result, the amount of the warpage of the package can be reduced, and a more reliable hollow package is obtained.

[0062]

The hollow sealing sheet thus obtained may be laminated as necessary so as to have a desired thickness, and used. In other words, the hollow sealing sheet may be used in the form of a monolayer structure, or may be used as a laminate formed by laminating the hollow sealing sheet into a multilayer structure having two or more layers.

[0063]

[Method for producing hollow package]

Next, a method for producing a hollow package according to this embodiment, which uses the hollow sealing sheet described above, will be described with reference to Figs. 2A

to 2C. Figs. 2A to 2C are sectional views each schematically showing one step of a method for producing a hollow package according to one embodiment of the present invention. In this embodiment, electronic components mounted on a substrate are hollow sealed with a hollow sealing sheet to prepare a hollow package. In this embodiment, SAW filters are used as an electronic component, and a printed wiring substrate is used as an adherend, but elements other than those mentioned above may be used. For example, elements which have a movable part and require a hollow part, such as a capacitor, a sensor device, a light emitting element, a vibration element and the like, can be used as the electronic component, and a lead frame, a tape carrier or the like can be used as the adherend. Regardless of which of the elements is used, a high level of protection of the electronic component by resin sealing can be achieved.

[0064]

(SAW Chip Mounting Substrate Providing Step)

In an SAW chip mounting substrate providing step, a printed wiring substrate 12 on which a plurality of SAW chips 13 are mounted is prepared (see Fig. 2A). The SAW chips 13 can be formed by dicing a piezoelectric crystal on which a predetermined comb-shaped electrode is formed, into individual pieces by a known method. For mounting the SAW chips 13 onto the printed wiring substrate 12, a known device such as a flip chip bonder or a die bonder can be used. The SAW chip 13 and

the printed wiring substrate 12 are electrically connected via a bump electrode 13a such as a bump. Between the SAW chip 13 and the printed wiring substrate 12, a hollow portion 14 is maintained so that the propagation of the surface elastic wave on the surface of the SAW chip is not impaired. A distance between the SAW chip 13 and the printed wiring substrate 12 is determined according to the specification of each element, and is generally about 15 to 50 μm .

[0065]

(Sealing step)

In a sealing step, the hollow sealing sheet 11 is laminated to the printed wiring substrate 12 so as to cover the SAW chips 13, and the SAW chips 13 are resin-sealed with the hollow sealing sheet (see Fig. 2B). The hollow sealing sheet 11 serves as a sealing resin for protecting the SAW chips 13 and elements associated therewith from the external environment.

[0066]

In this embodiment, by employing the hollow sealing sheet 11, the SAW chips 13 can be embedded and covered merely by bonding the hollow sealing sheet 11 onto the printed wiring substrate 12, so that the production efficiency of the hollow package can be improved. In this case, the hollow sealing sheet 11 can be laminated on the printed wiring substrate 12 by a known method such as heat pressing or a laminator. For heat pressing

conditions, the temperature is, for example, 40 to 100°C, preferably 50 to 90°C, the pressure is, for example, 0.1 to 10 MPa, preferably 0.5 to 8 MPa, and the time is, for example, 0.3 to 10 minutes, preferably 0.5 to 5 minutes. When considering the adhesion and followability of the hollow sealing sheet 11 to the SAW chips 13 and the printed wiring substrate 12, it is preferred to perform pressing preferably under a reduced pressure condition (e.g., 0.1 to 5 kPa).

[0067]

Since the minute domains of the elastomer are dispersed in the hollow sealing sheet 11, the infiltration of the resin component to the hollow portion 14 is suppressed, and the operation reliability and connection reliability of the SAW chip 13 can be improved.

[0068]

(Sealed body forming step)

In a sealed body forming step, the hollow sealing sheet is subjected to a heat curing treatment to form a sealed body 15 (see Fig. 2B). Regarding conditions for the heat curing treatment of the hollow sealing sheet, the heating temperature is preferably 100°C to 200°C, more preferably 120°C to 180°C, the heating time is preferably 10 minutes to 180 minutes, more preferably 30 minutes to 120 minutes, and a pressure may be applied as necessary. When a pressure is applied, a pressure of preferably 0.1 MPa to 10 MPa, more preferably 0.5 MPa to 5

MPa can be employed.

[0069]

(Dicing Step)

Thereafter, a sealed body 15 including elements such as the hollow sealing sheet 11, the printed wiring substrate 12, and the SAW chips 13 may be diced (see Fig. 2C). Thereby, a hollow package 18 can be obtained per each SAW chip 13. The sealed body 15 is usually diced in a state where the sealed body 15 is fixed by a conventionally known dicing sheet.

[0070]

(Substrate Mounting Step)

A substrate mounting step of subjecting the hollow package 18 obtained as described above to rewiring and bump formation, and mounting the hollow package 18 on another substrate (not shown) can be performed as necessary. For mounting the hollow package 18 on the substrate, a known device such as a flip chip bonder or a die bonder can be used.

[0071]

<<Second Embodiment>>

In the first embodiment, blended components are kneaded with a kneader or the like to prepare a kneaded product, and the kneaded product is formed into a sheet by extrusion molding. On the other hand, in the present embodiment, a varnish prepared by dissolving or dispersing components in an organic solvent or the like is applied and formed into a sheet. In the applying

method, a sheet can be formed in a state where the elastomer is dissolved or dispersed in the solvent or the like, which can provide the minute domain size of the elastomer.

[0072]

As a specific preparation procedure using a varnish, the components A to E and other additives as necessary are 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 hollow sealing sheet 11 can be obtained. A release sheet such as a polyester film may be laminated as necessary for protecting the surface of the hollow sealing sheet. The release sheet is peeled off at the time of sealing.

[0073]

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. Normally, it is preferred to use the organic solvent in such a manner that the solid concentration of the varnish ranges from 30 to 95% by weight.

[0074]

The thickness of the sheet after drying of the organic

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.

EXAMPLES

[0075]

Preferred Examples of the present invention will be illustratively described in detail below. However, for the materials, the blending amounts, and the like described in Examples, the scope of the present invention is not intended to be limited thereto unless definitely specified. The part(s) means "part(s) by weight".

[0076]

[Example 1]

(Production of Hollow sealing sheet)

The following components were blended by a mixer. The blended components were melt-kneaded at 110°C for 10 minutes with the number of rotations for kneading set to 300 rpm and a kneading treatment amount set to 5 kg/hr by a biaxial kneader. The melt-kneaded product was then extruded from a T die to produce a hollow sealing sheet having a thickness of 200 μm .

[0077]

Epoxy resin: bisphenol F-type epoxy resin (YSLV-80XY
(epoxy equivalent: 200 g/eq.; softening point: 80°C)

manufactured by Nippon Steel Chemical Co., Ltd.)

3.4 Parts

Phenol resin: phenol resin having a biphenyl aralkyl backbone (MEH-7851-SS (hydroxyl equivalent: 203 g/eq.; softening point: 67°C) manufactured by MEIWA PLASTIC INDUSTRIES, LTD.)

3.6 Parts

Elastomer: (METABLEN C-132E manufactured by Mitsubishi Rayon Co., Ltd.)

2.3 Parts

Inorganic filler: spherical fused silica (FB-9454FC manufactured by DENKI KAGAKU KOGYO KABUSHIKI KAISHA)

87.9 Parts

Silane coupling agent: epoxy group-containing silane coupling agent (KBM-803 manufactured by Shin-Etsu Chemical Co., Ltd.)

0.5 Part

Carbon black (MA600 manufactured by Mitsubishi Chemical Corporation)

0.1 Part

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

1.8 Parts

Curing accelerator: imidazole-based catalyst (2PHZ-PW manufactured by SHIKOKU CHEMICALS CORPORATION)

0.4 Part

[0078]

[Example 2]

A hollow sealing sheet was produced in the same manner as in Example 1 except that a kneading treatment amount was set to 3.5 kg/hr.

[0079]

[Example 3]

A hollow sealing sheet was produced in the same manner as in Example 1 except that the number of rotations for kneading was set to 500 rpm.

[0080]

[Example 4]

A hollow sealing sheet was produced in the same manner as in Example 1 except that the number of rotations for kneading was set to 1000 rpm.

[0081]

[Example 5]

The same components and blending amounts as Example 1 were dissolved or dispersed in a 1:1 mixed solvent of methyl ethyl ketone and toluene to produce a varnish having a solid content of 40% by weight.

[0082]

The varnish was applied onto a PET film subjected to a mold release treatment so that the thickness of a coated film

after drying of the solvent was 50 μm , and the coated film was dried at 120°C for 3 minutes to obtain a resin sheet having a thickness of 50 μm . The obtained resin sheet was laminated to a thickness of 200 μm using a laminator to produce a hollow sealing sheet having a thickness of 200 μm .

[0083]

[Comparative Example 1]

A hollow sealing sheet was produced in the same manner as in Example 1 except that the number of rotations for kneading was set to 100 rpm.

[0084]

[Comparative Example 2]

A hollow sealing sheet was produced in the same manner as in Example 1 except that the number of rotations for kneading was set to 50 rpm.

[0085]

(Evaluation of Flexibility of Hollow sealing sheet)

Each of the hollow sealing sheets of Examples and Comparative Examples was cut out to a width of 60 mm $\times$ a length of 60 mm. The hollow sealing sheet was slowly bent by 90 degrees in a state where both end parts of the hollow sealing sheet (sides facing in plane view) were held, and the flexibility of the hollow sealing sheet was estimated according to the following criteria. The results are shown in Table 1.

O: The hollow sealing sheet was not broken even if the

hollow sealing sheet was bent by 90 degrees.

△: The hollow sealing sheet was cracked when the hollow sealing sheet was bent by 90 degrees.

×: The hollow sealing sheet was broken when the hollow sealing sheet was bent by 90 degrees.

[0086]

(Observation of Domains of Elastomer)

The produced hollow sealing sheet was heat-cured for 1 hour at 150°C, and then slowly cooled to room temperature. Thereafter, the obtained cured product was cut by a cutter. The cutting plane was polished by an automatic polishing device manufactured by Buehler, and the polished cutting plane was observed by SEM (2000 magnifications). Fig. 3 shows a SEM observation image of the cutting plane of the hollow sealing sheet of Example 1. In the SEM observation image, black regions represent the domains of the elastomer. Then, the maximum diameter of the domains was determined by selecting 50 black domains of the elastomer at random, measuring the maximum diameters of the domains, and taking the average value thereof. Examples 2 to 5 and Comparative Examples 1 and 2 were similarly subjected to SEM observation and maximum diameter measurement. The results of the maximum diameter measurement are shown in Table 1.

[0087]

(Measurement of Amount of Resin Ingress in Molding Die

Having Slit)

The amount of resin ingress into a slit was measured using a molding die having a slit shown in Figs. 4A to 4C. As shown in Fig. 4A, a molding die 100 includes a disk-shaped lower die 110 having a U-shaped section and having an arising portion in an outer circumferential portion of the disk, and a disk-shaped upper die 120. A slit S, and a hollow part for receiving a resin 200 are formed between the lower die 110 and the upper die 120. A charging inlet O for the resin 200 which is a measurement sample is provided at the center of the upper die 120. As shown in Fig. 4B, a plurality of grooves 111 are formed on the upper surface of the arising portion of the lower die 110 at a predetermined depth from the upper surface in plan view. When the grooves 111 are combined with the upper die 120, the cut depth of each of the grooves 111 provides a predetermined width of the slit S.

[0088]

As shown in Fig. 4C, the following procedure was employed as an actual measurement procedure for the amount of resin ingress. The resin 200 was charged into the molding die 100 from the charging inlet O, and a pressure rod 130 was then inserted into the charging inlet O. When the resin 200 was pressurized by the rod 130 while the molding die 100 was entirely heated, the resin 200 was evaluated according to the degree of ingress of the resin 200 into the slit S. A distance L between

the inner circumferential end part of the slit S and the maximum arrival point of the resin 200 at that time was measured as the amount of resin ingress. Measurement conditions are shown below, and the results are shown in Table 1.

[0089]

<Measurement conditions>

heating temperature: 150°C

pressure: 10 kg/cm²

pressurizing time: 10 minutes

slit width: 1 μm, 5 μm, 10 μm, 20 μm, 50 μm

[0090]

(Evaluation of Infiltration Property of Resin to Package Hollow Portion)

SAW chips of the following specifications having aluminum comb-shaped electrodes were mounted on a glass substrate under the bonding conditions described below to produce an SAW chip mounting substrate.

[0091]

<SAW Chip>

Chip size: 1.4 × 1.1 mm square (thickness 150 μm)

Bump material: Au, thickness 30 μm

Bump number: 6 bumps

Chip number: 100 pieces (10 pieces × 10 pieces)

[0092]

<Bonding Conditions>

Device: manufactured by Panasonic Electric Works Co., Ltd.

Bonding conditions: 200°C, 3 N, 1 second (ultrasonic output 2W)

[0093]

Each of hollow sealing sheets was attached on the obtained SAW chip mounting substrate by vacuum pressing under the heating/pressing conditions shown below.

[0094]

<Attachment Conditions>

Temperature: 60°C

Pressing force: 4 MPa

Degree of vacuum: 1.6 kPa

Pressing time: 1 minute

[0095]

After releasing to atmospheric pressure, the hollow sealing sheet was heat-cured in a hot air dryer at 150°C for 1 hour to obtain a sealed body. An amount of infiltration of a resin to the hollow portion between the SAW chip and the glass substrate was measured by an electron microscope ("Digital Microscope" (trade name) manufactured by KEYENCE CORPORATION, 200 magnifications) from the glass substrate side. The position of the end part of the SAW chip before being sealed by the hollow sealing sheet was confirmed and stored by the electron microscope from the glass substrate side. The amount

of infiltration of the resin was determined by observing the end part by the electron microscope from the glass substrate side again after sealing, comparing observation images before and after sealing, and measuring the maximum attained distance of the resin infiltrating into the hollow portion from the end part of the SAW chip confirmed before sealing. A case where the amount of infiltration of the resin was 20 μm or less was evaluated as "O", and a case where the amount of infiltration of the resin was more than 20 μm was evaluated as "x". The results are shown in Table 1.

[Table 1]

		Example 1	Example 2	Example 3	Example 4	Example 5	Comparative Example 1	Comparative Example 2
Number of rotations for kneading [rpm]		300	300	500	1000	coating	100	50
Kneading treatment amount [kg/hr]		5	3.5	5	5		5	5
Evaluation of flexibility		○	○	○	○	○	△	△
Maximum diameter of elastomer domain [μm]		15	10	5	3	13	30	50
Amount of resin ingress into die slit [mm]	Slit width: 1 μm	4	3	2	1	2.5	6	7
	Slit width: 5 μm	2	1.5	1	0.5	1.2	5	5.5
	Slit width: 10 μm	1.5	0.8	0.4	0.3	1.0	4.2	5
	Slit width: 20 μm	2.8	1	0.5	0.3	0.7	3.4	4.2
	Slit width: 50 μm	3	2.5	1.5	0.8	2.0	4.5	6
Evaluation of ingress of resin into hollow part	Amount of resin ingress [μm]	20	15	10	8	12	30	100
	Judgment	○	○	○	○	○	×	×

[0096]

As can be seen from Table 1, the hollow sealing sheets of Examples 1 to 5 had good flexibility. On the other hand, Comparative Examples 1 and 2 had poor flexibility causing cracks. The amount of resin ingress into the slit of the die in Examples 1 to 5 was less than that in Comparative Examples 1 and 2. Furthermore, in the SAW chip packages of Examples 1 to 5, it is found that the ingress of the resin component of the hollow sealing sheet into the hollow part is suppressed, and a high-quality hollow package can be produced. In each of Comparative Examples 1 and 2, the amount of resin ingress into the hollow part was more than 20 μm .

DESCRIPTION OF REFERENCE SIGNS

[0097]

- 11: hollow sealing sheet
- 11a: support
- 13: SAW chip
- 14: hollow part
- 15: sealing member
- 18: hollow package
- 100: molding die
- 110: lower die
- 111: groove
- 120: upper die

130: rod
200: resin
L: amount of resin ingress
O: charging inlet
S: slit

CLAIMS

1. A hollow sealing sheet for hollow-sealing an electronic component,

the hollow sealing sheet containing a resin, and having a controlled resin ingress property into a hollow part at 40°C or higher and 100°C or lower.

2. The hollow sealing sheet according to claim 1, wherein when the resin is filled into a molding die having a slit having a width of 20 μm and the resin is pressurized at a pressure of 10 kg/cm² and a temperature of 150°C for 10 minutes, an amount of resin ingress into the slit is 3 mm or less.

3. The hollow sealing sheet according to claim 2, wherein when the amount of resin ingress into a slit having a width of 1 μm or more and 100 μm or less is plotted with respect to the slit width, a minimum value is present in the plot.

4. The hollow sealing sheet according to claim 3, wherein the minimum value is 2 mm or less.

5. A method for producing a hollow package, the method comprising:

a stacking step of stacking the hollow sealing sheet

according to any one of claims 1 to 4 onto one or more electronic components so as to cover the electronic components while maintaining a hollow part; and

a sealing member forming step of curing the hollow sealing sheet to form a sealing member.