

SHEET FOR SEALING HOLLOW ELECTRONIC DEVICE AND METHOD FOR
PRODUCING HOLLOW ELECTRONIC DEVICE PACKAGE

BACKGROUND OF THE INVENTION

Field of the Invention

[0001]

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

Description of the Related Art

[0002]

Conventionally, when a hollow electronic device package is produced by subjecting a hollow electronic device having a hollow structure between an electronic device and a substrate to resin sealing, a sheet-shaped sealing resin may be used as a sealing resin (for example, see Patent Document 1).

Prior Art Document

Patent Document

[0003]

Patent Document: JP-A-2006-19714

SUMMARY OF THE INVENTION

[0004]

Examples of a method for producing the package include a method of disposing a sheet-shaped sealing resin on at least one electronic device disposed on an adherend, thereafter applying pressure in a direction in which the electronic device and the sheet-shaped sealing resin are moved closer to each other to embed the electronic device in the sheet-shaped sealing resin, and thereafter thermally curing the sheet-shaped sealing resin.

[0005]

When the above-mentioned method is employed, a part of the sealing resin enters a hollow part between the electronic device and the adherend. However, the variation between packages in the entering amount of the resin is disadvantageously large.

[0006]

The present invention has been made in view of the above-mentioned problem, and an object thereof is to provide a sheet for sealing a hollow electronic device which can suppress variation between packages in the amount of a resin entering a hollow part between an electronic device and an adherend.

It is another object of the present invention to provide a method for producing a hollow electronic device package which can suppress variation between packages in the amount of a resin entering a hollow part between an electronic device and an adherend.

SUMMARY OF THE INVENTION

[0007]

In order to achieve the above-mentioned object, the present inventors have first diligently studied the reason for variation between packages in the amount of a resin entering a hollow part. As a result, it was found that, when the above-mentioned method is employed, after an electronic device is embedded into a sealing resin and the sealing resin is thermally cured, first, a part of the sealing resin has a viscosity reduced with heat, and flows and enters into the hollow part, and then the sealing resin has a viscosity increased with thermal curing, which stops the entering of the resin. The inventors also found that the flowage amount of the resin when the resin is thermally cured is largely different between packages, and is difficult to control.

[0008]

The present inventors have found that when the following constitution is employed, the above-mentioned problem can be solved, and have completed the present invention.

[0009]

That is, a sheet for sealing a hollow electronic device according to the present invention is characterized in that:

loss tangent $\tan \delta$ at 50 to 90°C is 0.3 or more and 0.8 or less;

a storage modulus at 50 to 90°C is 1.0×10^5 Pa or less;

loss tangent $\tan \delta$ at 150°C is 0.35 or less; and

a storage modulus at 150°C is 1.0×10^6 Pa or less.

[0010]

Since the loss tangent $\tan \delta$ at 50 to 90°C is 0.3 or more according to the constitution, the sheet for sealing a hollow electronic device is viscous when the electronic device is embedded. Therefore, a resin can be made to enter into a hollow part between the electronic device and an adherend during embedding.

Since the loss tangent $\tan \delta$ at 50 to 90°C is 0.8 or less, the resin can be prevented from excessively entering into the hollow part when the electronic device is embedded.

Since the storage modulus at 50 to 90°C is 1.0×10^5 or less, the resin can be made to enter into the hollow part between the electronic device and the adherend when the electronic device is embedded.

Since the loss tangent $\tan \delta$ at 150°C is 0.35 or less, the sheet for sealing a hollow electronic device is elastic during thermal curing. Therefore, the flowage of the resin during thermal curing can be suppressed.

Since the storage modulus at 150°C is 1.0×10^6 or less, the resin is less likely to flow with respect to external pressure, which can provide suitable resin flowage.

That is, according to the constitution, the resin can be made to ingress into the hollow part in embedding, during which the ingress amount of the resin into the hollow part is easily

controlled, and the moving amount of the resin, which is hardly controlled when the resin is thermally cured, can be suppressed. As a result, variation among packages in the amount of the resin entering into the hollow part can be further suppressed.

[0011]

A method for producing a hollow electronic device package according to the present invention includes the steps of:

preparing a laminated body having an adherend and an electronic device fixed on the adherend with a bump interposed therebetween;

preparing the sheet for sealing a hollow electronic device;

disposing the sheet for sealing a hollow electronic device on the electronic device of the laminated body;

embedding the electronic device into the sheet for sealing a hollow electronic device by heat pressing; and

thermally curing the sheet for sealing a hollow electronic device after the embedding step to obtain a sealed body.

[0012]

Since the sheet for sealing a hollow electronic device is used according to the constitution, the resin can be made to seep into the hollow part at an embedding time at which the seeping amount of the resin into the hollow part is easily controlled, and the moving amount of the resin which is hardly controlled when the resin is thermally cured can be suppressed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a schematic sectional view showing a sheet for sealing a hollow electronic device according to an embodiment of the present invention;

Fig. 2A is a schematic sectional view for illustrating procedures for measuring an ingress amount X1 and an ingress amount Y1;

Fig. 2B is a top view of Fig. 2A;

Fig. 3 is a schematic sectional view for illustrating procedures for measuring the ingress amount X1 and the ingress amount Y1;

Fig. 4 is a schematic sectional view for illustrating procedures for measuring the ingress amount X1 and the ingress amount Y1;

Fig. 5 is a schematic sectional view for illustrating procedures for measuring the ingress amount X1 and the ingress amount Y1;

Fig. 6 is a partially enlarged view of Fig. 5;

Fig. 7 is a schematic sectional view for illustrating a method for producing a hollow electronic device package according to an embodiment of the present invention;

Fig. 8 is a schematic sectional view for illustrating the method for producing a hollow electronic device package according to the present embodiment;

Fig. 9 is a schematic sectional view for illustrating the method for producing a hollow electronic device package according to the present embodiment;

Fig. 10 is a schematic sectional view for illustrating the method for producing a hollow electronic device package according to the present embodiment; and

Fig. 11 is a schematic sectional view for illustrating the method for producing a hollow electronic device package according to the present embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014]

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

[0015]

(Sheet for Sealing Hollow Electronic Device)

Fig. 1 is a schematic sectional view showing a sheet for sealing a hollow electronic device according to an embodiment of the present invention. As shown in Fig. 1, a sheet 11 for sealing a hollow electronic device (hereinafter, also referred to as a "sealing sheet 11") is typically provided in a state where the sealing sheet 11 is laminated on a separator 11a such as a polyethylene terephthalate (PET) film. The separator 11a may be subjected to a mold releasing treatment in order to easily

peel off the sealing sheet 11.

[0016]

In the present embodiment, the case where the separator is laminated only on one surface of the sheet for sealing a hollow electronic device will be described, but the present invention is not limited to this example. The separator may be laminated on each of both surfaces of the sheet for sealing a hollow electronic device. In this case, the sealing sheet can be used after one of the separators is peeled off immediately before use. In the present invention, the sheet for sealing a hollow electronic device may be provided alone without being laminated on the separator. Other layers may be laminated on the sheet for sealing a hollow electronic device as long as the advantageous effects of the present invention are not impaired.

[0017]

In the sealing sheet 11, the loss tangent $\tan \delta$ at 50 to 90°C is 0.3 or more and 0.8 or less, preferably 0.4 or more and 0.75 or less, and more preferably 0.5 or more and 0.7 or less. Since the loss tangent $\tan \delta$ at 50 to 90°C is 0.3 or more, the sealing sheet 11 is viscous when the electronic device is embedded. Therefore, the resin can be made to enter into the hollow part between the electronic device and the adherend during embedding. Since the loss tangent $\tan \delta$ at 50 to 90°C is 0.8 or less, the resin can be prevented from excessively entering into the hollow part when the electronic device is embedded. A specific method

for measuring the loss tangent $\tan \delta$ is based on the method described in Examples.

[0018]

In the sealing sheet 11, the storage modulus at 50 to 90°C is 1.0×10^5 Pa or less, preferably 8.0×10^4 Pa or less, and more preferably 7.0×10^4 Pa or less. Since the storage modulus at 50 to 90°C is 1.0×10^5 or less, the resin can be made to enter into the hollow part between the electronic device and the adherend when the electronic device is embedded. In the sealing sheet 11, the storage modulus at 50 to 90°C is preferably 7.0×10^2 Pa or more, and more preferably 1.0×10^3 Pa or more from the viewpoint of providing a suitable hollow sealing structure. A specific method for measuring the storage modulus is based on the method described in Examples.

[0019]

In the sealing sheet 11, the loss tangent $\tan \delta$ at 150°C is 0.35 or less, preferably 0.33 or less, and more preferably 0.3 or less. Since the loss tangent $\tan \delta$ at 150°C is 0.35 or less, the sheet for sealing a hollow electronic device is elastic during thermal curing. Therefore, the flowage of the resin during thermal curing can be suppressed.

[0020]

In the sealing sheet 11, the storage modulus at 150°C is 1.0×10^6 Pa or less, preferably 1.0×10^5 Pa or less, and more preferably 8×10^4 Pa or less. Since the storage modulus at

150°C is 1.0×10^6 Pa or less, the resin is less likely to flow with respect to external pressure.

[0021]

Examples of methods for controlling the loss tangent $\tan \delta$ at 50 to 90°C, the storage modulus at 50 to 90°C, the loss tangent $\tan \delta$ at 150°C, and the storage modulus at 150°C in the sealing sheet 11 include a method for adjusting the kind and content of the following thermoplastic resin, and the content of an inorganic filler, or the like, and a method for adjusting the loss tangent and the storage modulus according to a stirring condition when a varnish or a kneaded product for forming the sealing sheet 11 is produced.

[0022]

In the sealing sheet 11, the ingress amount X1 measured according to procedures of the following steps A to G is preferably 0 μm or more and 30 μm or less, more preferably 3 μm or more and 25 μm or less, and still more preferably 5 μm or more and 23 μm or less. The value (Y1 - X1) obtained by subtracting the ingress amount X1 from the ingress amount Y1 is preferably 30 μm or less, more preferably 15 μm or less, and still more preferably 10 μm or less.

[0023]

Step A of preparing a dummy chip mounting substrate having a glass substrate (having a length of 6 cm, a width of 10 cm, and a thickness of 1.3 mm) and 4 dummy chips mounted on the glass

substrate with a resin bump sandwiched therebetween, the dummy chips having the following specification;

step B of preparing a sheet for sealing a hollow electronic device having a length of 1 cm, a width of 1 cm, and a thickness of 220 μm as a sample;

step C of disposing the sample on the dummy chip of the dummy chip mounting substrate;

step D of embedding the dummy chip into the sample under the following embedding conditions;

step E of measuring the seeping amount X1 of a resin constituting the sample into a hollow part between the dummy chip and the glass substrate after the step D;

step F of allowing the sample to stand at 170°C in a hot-air drier for 2 hour after the step E to thermally cure the sample, thereby obtaining a sealed body sample; and

step G of measuring the seeping amount Y1 of the resin into the hollow part in the sealed body sample.

<Specification of Dummy Chip>

The dummy chip has a length of 3 mm, a width of 3 mm, and a thickness of 200 μm , and has a resin bump having a height of 50 μm formed thereon. A distance W between adjacent chips is 0.5 mm.

<Embedding Conditions>

pressing method: flat-plate pressing

temperature: 90°C

pressing force: 1.2 MPa

degree of vacuum during pressing: 10 torr

pressing time: 1 minute

[0024]

Hereinafter, a method for obtaining the seeping amount X1 and the value obtained by subtracting the seeping amount X1 from the seeping amount Y1 will be described.

[0025]

Fig. 2A is a schematic sectional view for illustrating procedures for measuring an ingress amount X1 and an ingress amount Y1. Fig. 2B is a top view of Fig. 2A. Figs. 3 to 5 are schematic sectional views for describing procedures for measuring the seeping amount X1 and the seeping amount Y1. Fig. 6 is a partially enlarged view of Fig. 5.

[0026]

(Step A)

In step A, as shown in Fig. 2A and Fig. 2B, a dummy chip mounting substrate 115 is prepared, in which 4 dummy chips 113 is mounted on a glass substrate 112 (having a length of 6 cm, a width of 10 cm, and a thickness of 1.3 mm) with a resin bump 113a sandwiched therebetween. The specification of the dummy chips 113 are as follows. More specifically, the dummy chip mounting substrate 115 is prepared by a method described in Examples.

<Specification of Dummy Chip 113>

The chip has a length of 3 mm, a width of 3 mm, and a thickness of 200 μm , and has a resin bump 113a formed thereon and having a height of 50 μm . A distance W between adjacent chips is 0.5 mm.

[0027]

(Step B)

In Step B, as shown in Fig. 3, a sample 111 having a length of 2 cm, a width of 2 cm, and a thickness of 210 μm is prepared. The sample 111 having a length of 2 cm, a width of 2 cm, and a thickness of 210 μm is produced using the same material as that of the sealing sheet 11. In the present embodiment, the case where the sample 111 is laminated on a separator 111a will be described. The sample 111 can be produced by, for example, first producing a sealing sheet 11 having a length of 10 cm or more, a width of 10 cm or more, and a thickness of 220 μm , and then cutting the sealing sheet 11 into a piece having a length of 2 cm, a width of 2 cm, and a thickness of 210 μm . The sealing sheet 11 itself does not need to have a length of 2 cm, a width of 2 cm, and a thickness of 210 μm .

[0028]

(Step C)

In step C, as shown in Fig. 4, the sample 111 is disposed on the dummy chip 113 of the dummy chip mounting substrate 115. For example, the dummy chip mounting substrate 115 is disposed on a lower heating plate 122 in a state where a surface of the

dummy chip mounting substrate 115 fixed to the dummy chip 113 faces up, and the sample 111 is disposed on a surface of the dummy chip 113. In this step, the dummy chip mounting substrate 115 may be first disposed on the lower heating plate 122, and the sample 111 may be then disposed on the dummy chip mounting substrate 115. Alternatively, the sample 111 may be first laminated on the dummy chip mounting substrate 115, and a laminate of the dummy chip mounting substrate 115 and the sample 111 may be then disposed on the lower heating plate 122.

[0029]

(Step D)

After step C, in step D, as shown in Fig. 5, the dummy chip 113 is embedded (sealed) into the sample 111 under the following embedding conditions. Specifically, under the following embedding conditions, heat pressing is carried out by the lower heating plate 122 and the upper heating plate 124 of a flat-plate press to embed the dummy chip 113 into the sample 111. Then, the sample 111 is allowed to stand under atmospheric pressure at normal temperature (25°C). The standing time is set to be within 24 hours.

<Embedding Conditions>

pressing method: flat-plate pressing

temperature: 90°C

pressing force: 1.2 MPa

degree of vacuum during pressing: 10 torr

pressing time: 1 minute

[0030]

(Step E)

After step D, in step E, the seeping amount X1 of a resin constituting the sample 111 into a hollow part 114 between the dummy chip 113 and the glass substrate 112 is measured (see Fig. 6). The seeping amount X1 is defined as the maximum distance of the resin seeping into the hollow part 114 from an end of the dummy chip 113.

[0031]

(Step F)

After the step E, a structure in which the dummy chip 113 is embedded into the sample 111 is allowed to stand at 170°C in a hot-air drier for 1 hour to thermally cure the sample 111, thereby obtaining a sealed body sample.

[0032]

(Step G)

After the step F, the seeping amount Y1 of the resin into the hollow part 114 in the sealed body sample is measured. The seeping amount Y1 is defined as the maximum distance of the resin seeping into the hollow part 114 from the end of the dummy chip 113.

[0033]

Then, the value obtained by subtracting the seeping amount X1 from the seeping amount Y1 is obtained.

[0034]

In this way, the methods for obtaining the seeping amount X1 and the value obtained by subtracting the seeping amount X1 from the seeping amount Y1 have been described.

[0035]

As described above, in the sealing sheet 11, the ingress amount X1 measured according to procedures of the steps A to G is preferably 0 μm or more and 30 μm or less. The value obtained by subtracting the ingress amount X1 from the ingress amount Y1 is preferably 30 μm or less.

When the ingress amount X1 is 0 μm or more and 30 μm or less, the resin can be made to moderately ingress into the hollow part between the electronic device and the adherend when the electronic device is embedded into the sealing sheet 11 in the production of the actual hollow electronic device package.

When the value obtained by subtracting the ingress amount X1 from the ingress amount Y1 is 30 μm or less, the flowage of the resin in the hollow part can be suppressed when the sealing sheet 11 is thermally cured in the production of the actual hollow electronic device package. The physical properties of the sealing sheet 11 are evaluated using the seeping amount X1 and the value obtained by subtracting the seeping amount X1 from the seeping amount Y1 in order to evaluate the physical properties under the conditions simulating the production of the actual hollow electronic device package. However, naturally, the

conditions in these evaluations may be different from the conditions when the actual hollow electronic device package is produced.

[0036]

The seeping amount Y1 is preferably 90 μm or less, and more preferably 60 μm or less. In the hollow electronic device package, in many cases, an active face formed on a bump or an electronic device is provided so as to be separated by 90 μm or more on an inner side in the hollow part direction from an end of the electronic device. Therefore, when the seeping amount Y1 is set to 90 μm or less, the hollow electronic device package can be reliably operated.

[0037]

The sealing sheet 11 preferably contains an epoxy resin and a phenol resin. This case gives a good thermosetting performance to the sheet.

[0038]

The epoxy resin is not particularly limited. The resin may be an epoxy resin that may be of various types, examples thereof including triphenylmethane type epoxy resin, cresol novolak type epoxy resin, biphenyl type epoxy resin, modified bisphenol A type epoxy resin, bisphenol A type epoxy resin, bisphenol F type epoxy resin, modified bisphenol F type epoxy resin, dicyclopentadiene type epoxy resin, phenol novolak type epoxy resin, and phenoxy resin. These epoxy resins may be singly

or in any combination of two or more thereof.

[0039]

In order for the epoxy resin to ensure toughness after set, and ensure reactivity, the epoxy resin is preferably a resin having an epoxy equivalent of 150 to 250 and a softening point or melting point of 50 to 130°C to be in a solid form at any ordinary temperature. Of the above-mentioned examples, bisphenol F type epoxy resin, bisphenol A type epoxy resin, biphenyl type epoxy resin and others are more preferred from the viewpoint of shapability and reliability.

[0040]

The phenol resin is not particularly limited as far as the resin is a phenol resin which is combined with the epoxy resin to cause a setting reaction between the two resins. Examples thereof include phenol novolak resin, phenol aralkyl resin, biphenyl aralkyl resin, dicyclopentadiene type phenol resin, cresol novolak resin and resol resin. These phenol resins may be used singly or in any combination of two or more thereof.

[0041]

The phenol resin is preferably a resin having a hydroxyl equivalent of 70 to 250 and a softening point of 50 to 110°C from the viewpoint of reactivity with the epoxy resin. Of the above-mentioned examples, phenol novolak resin is preferred since the resin is high in setting reactivity and is inexpensive. From the viewpoint of reliability, preferred is also a phenol

resin low in hygroscopicity, such as phenol aralkyl resin or biphenyl aralkyl resin.

[0042]

About the blend ratio between the epoxy resin and the phenol resin, the phenol resin is blended with the epoxy resin to set the total amount of hydroxyl groups in the phenol resin into the range of 0.9 to 1.2 equivalents per equivalent of epoxy groups in the epoxy resin.

[0043]

The lower limit of the total content by percentage of the epoxy resin and the phenol resin in the sealing sheet 11 is preferably 2% by weight, more preferably 3% by weight. When the lower limit is 2% by weight, the sealing sheet can satisfactorily gain adhering strength to an electronic device, a substrate and others. In the meantime, the upper limit of the total content by percentage is preferably 25% by weight, more preferably 20% by weight. When the lower limit is 25% by weight, the sealing sheet can be decreased in hygroscopicity.

[0044]

The sealing sheet 11 preferably contains a thermoplastic resin. This case makes it possible to improve the sealing sheet in heat resistance, flexibility, and strength.

[0045]

Examples of the thermoplastic resin include natural rubber, butyl rubber, isoprene rubber, chloroprene rubber,

ethylene/vinyl acetate copolymer, ethylene/acrylic acid copolymer, ethylene/acrylate copolymer, polybutadiene resin, polycarbonate resin, thermoplastic polyimide resin, polyamide resins such as 6-nylon and 6,6-nylon, phenoxy resin, acrylic resin, saturated polyester resins such as PET and PBT, polyamideimide resin, fluororesin, and styrene/isobutylene/styrene block copolymer. These thermoplastic resins may be used singly or in any combination of two or more thereof. Of these resins, acrylic resin is preferred since the resin causes the sealing sheet to gain flexibility easily, and is good in dispersibility in the epoxy resin.

[0046]

The acrylic resin is not particularly limited, and may be a polymer (acrylic copolymer) made from components including one or more acrylates or methacrylates (each) having a linear or branched alkyl group having 30 or less carbon atoms, particularly, 4 to 18 carbon atoms. Examples of the alkyl group include methyl, ethyl, propyl, isopropyl, n-butyl, t-butyl, isobutyl, amyl, isoamyl, hexyl, heptyl, cyclohexyl, 2-ethylhexyl, octyl, isooctyl, nonyl, isononyl, decyl, isodecyl, undecyl, lauryl, tridecyl, tetradecyl, stearyl, octadecyl, and dodecyl groups.

[0047]

The glass transition temperature (T_g) of the acrylic resin

is preferably 50°C or lower, more preferably from -70 to 20°C, even more preferably from -50 to 0°C. By setting the glass transition temperature to 50°C or lower, the sheet can be caused to have flexibility.

[0048]

About the acrylic resin, the weight-average molecular weight is preferably 50000 or more, more preferably from 100000 to 2000000, even more preferably from 300000 to 1600000. When the weight-average molecular weight is 50000 or more, the sealing sheet 11 can be made higher in viscosity and flexibility. The weight-average molecular weight is a value obtained by making a measurement according to GPC (gel permeation chromatography) and making a calculation in terms of the molecular weight of polystyrene.

[0049]

One or more different monomers that are combined with the (meth)acrylate(s) to produce the polymer are not particularly limited. Examples thereof include carboxyl-group-containing monomers, such as acrylic acid, methacrylic acid, carboxyethyl acrylate, carboxypentyl acrylate, itaconic acid, maleic acid, fumaric acid, and crotonic acid; acid anhydride monomers, such as maleic anhydride, and itaconic anhydride; hydroxyl-group-containing monomers, such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate, 4-hydroxybutyl (meth)acrylate, 6-hydroxyhexyl (meth)acrylate,

8-hydroxyoctyl (meth)acrylate, 10-hydroxydecyl (meth)acrylate, 12-hydroxylauryl (meth)acrylate, and (4-hydroxymethylcyclohexyl)-methyl acrylate; sulfonic-acid-group-containing monomers, such as styrenesulfonic acid, allylsulfonic acid, 2-(meth)acrylamide-2-methylpropanesulfonic acid, (meth)acrylamidepropanesulfonic acid, sulfopropyl (meth)acrylate, and (meth)acryloyloxynaphthalenesulfonic acid; and phosphate-group-containing monomers, such as 2-hydroxyethylacryloyl phosphate. It is particularly preferred that the different monomer(s) is/include at least one selected from carboxyl-group-containing monomers, glycidyl-group-containing (epoxy-group-containing) monomers, and hydroxyl-group-containing monomers since the different monomer(s) can react with the epoxy resin to heighten the sealing sheet 11 in viscosity.

[0050]

The content of the thermoplastic resin in the sealing sheet 11 is preferably 5% by weight or more, and more preferably 7% by weight or more. When the content is 8% by weight or more, the plasticity and flexibility of the sealing sheet are obtained. When the content is 5% by weight or more, the resin is viscous, which provides easier control of the flowage of the resin.

The content of the thermoplastic resin in the sealing sheet 11 is preferably 20% by weight or less, and more preferably 18%

by weight or less. When the content is 18% by weight or less, the adhesion of the sealing sheet to the electronic device or the substrate is good.

[0051]

The content of the organic component (the total content of the epoxy resin, phenol resin, and thermoplastic resin) in the sealing sheet 11 is preferably 20% by weight or more, and more preferably 25% by weight or more. When the content is 20% by weight or more, the resin is viscous, which provides easy control of the flowage of the resin. The content of the organic component in the sealing sheet 11 is 60% by weight or less, preferably 55% by weight or less, and more preferably 50% by weight or less. When the content is 45% by weight or less, the sealing strength after curing can be secured.

[0052]

The sealing sheet 11 preferably contains an inorganic filler.

[0053]

The inorganic filler is not particularly limited, and may be an inorganic filler that may be of various types known in the prior art. Examples thereof include respective powders of quartz glass, talc, silica (such as fused silica or crystalline silica), alumina, aluminum nitride, silicon nitride, and boron nitride. These fillers may be used singly or in any combination of two or more thereof. Silica or alumina is preferred, and

silica is more preferred since the filler can satisfactorily decrease the linear expansion coefficient of the sealing sheet 11.

[0054]

The species of silica is preferably silica powder, more preferably fused silica powder. Examples of the fused silica powder include spherical fused silica powder, and crushed fused silica powder. From the viewpoint of fluidity, spherical fused silica powder is preferred.

[0055]

The sealing sheet 11 preferably contains 40 to 60 % by volume of the inorganic filler. The content is more preferably 42% by volume or more, and still more preferably 44% by volume or more. The sealing sheet 11 contains 40 to 60% by volume of the inorganic filler, which provides easy control of the flowage of the resin.

[0056]

When the inorganic filler is silica, the content by percentage of the inorganic filler can also be described, using the unit of "% by weight". The silica content by percentage in the sealing sheet 11 is preferably from 50 to 75% by weight, more preferably from 60 to 70% by weight.

[0057]

The average particle diameter of the inorganic filler is preferably 20 μm or less, more preferably from 0.1 to 15 μm ,

in particular preferably from 0.5 to 10 μm .

The inorganic filler may be an inorganic filler composed of two or more inorganic filler species different from each other in average particle diameter. In the case of the two or more inorganic filler species different in average particle diameter, the wording "the average particle diameter of the inorganic filler is preferably 20 μm or less" means that the average particle diameter of the whole of the inorganic filler species is 20 μm or less.

[0058]

The form of the inorganic filler is not particularly limited, and may be any form such as a spherical (or elliptical), polyhedral, polygonal columnar, flat, or indeterminate form. The form is preferably a spherical form since the filler can attain a highly filled state in the vicinity of a hollow structure, and have an appropriate fluidity.

[0059]

It is preferable for the inorganic filler contained in the sealing sheet 11 to have two peaks in a particle size distribution thereof measured by a laser diffraction scattering method. This inorganic filler can be obtained, for example, by mixing two inorganic filler species different from each other in average particle diameter with each other.

The use of the inorganic filler, which has two peaks in the particle size distribution, makes it possible to fill the

inorganic filler to have a high density. As a result, the content by percentage of the inorganic filler can be made larger.

The two peaks are not particularly limited. It is preferred that larger-particle-diameter one of the two peaks is present in a range in which the particle diameter is from 3 to 30 μm while the other, which is smaller in particle diameter, is present in a range in which that is from 0.1 to 1 μm . When the particle diameters of the peaks are in the respective numerical ranges, the content by percentage of the inorganic filler can be made still larger.

Specifically, through the following process, the particle size distribution is obtained:

(a) The sealing sheet 11 is put into a crucible, and the crucible is intensely heated at 700°C in the air atmosphere for 2 hours to be incinerated.

(b) The resultant ash content is dispersed in pure water; the ash-dispersed water is subjected to ultrasonic treatment for 10 minutes; and then the (volume-reference) particle size distribution of the filler is obtained, using a laser diffraction scattering type particle size distribution measuring instrument ("LS 13 320" in a wet manner, manufactured by Beckman Coulter, Inc.).

In the composition of the sealing sheet 11, the compositions other than the inorganic filler are organic components, so that substantially the whole of the organic

components is lost by the intensely heating treatment. Thus, the measurement is made under a condition that the resultant ash content is regarded as the inorganic filler. The calculation of the average particle diameter is also made simultaneously with the analysis of the particle size distribution.

[0060]

It is preferred in the sealing sheet 11 that the inorganic filler is beforehand surface-treated with the silane coupling agent.

[0061]

The silane coupling agent is not particularly limited as far as the agent is a compound which has a methacryloxy group or acryloxy group and which is a compound with which an inorganic filler can be surface-treated. Specific examples of the silane coupling agent include

3-methacryloxypropylmethyldimethoxysilane,

3-methacryloxypropyltrimethoxysilane,

3-methacryloxypropylmethyldiethoxysilane,

3-methacryloxypropyltriethoxysilane,

methacryloxyoctyltrimethoxysilane, and

methacryloxyoctyltriethoxysilane. Of these examples,

3-methacryloxypropyltrimethoxysilane is preferred from the viewpoint of reactivity and costs.

[0062]

When the surface of the inorganic filler is treated with

the silane coupling agent, an outgas (for example, methanol) is generated. Thus, at a stage before the sealing sheet 11 is produced, the inorganic filler is beforehand surface-treated with the silane coupling agent. This treatment makes it possible to exclude any outgas to some extent at this stage. As a result, when the sealing sheet 11 is produced, the outgas volume confined inside the sealing sheet can be controlled into a low level so that the generation of voids can be decreased.

[0063]

When the sealing sheet 11 contains the inorganic filler surface-treated beforehand with the compound having a methacryloxy group or acryloxy group as the silane coupling agent, it is preferred that the inorganic filler is beforehand surface-treated with the silane coupling agent in an amount of 0.5 to 2 parts by weight for 100 parts by weight of the inorganic filler. When the inorganic filler is subjected to a surface treatment using the silane coupling agent, the viscosity of the sealing sheet 11 can be suppressed from becoming too high. When the amount of the silane coupling agent is increased, the generated amount of outgas is also increased. Therefore, even if the inorganic filler is previously subjected to a surface treatment, the performance of the sealing sheet 11 is deteriorated by the outgas generated when the sealing sheet 11 is produced. On the other hand, when the amount of the silane coupling agent is decreased, the viscosity may be too high. Thus,

when the inorganic filler is beforehand surface-treated with the silane coupling agent in an amount of 0.5 to 2 parts by weight for 100 parts by weight of the inorganic filler, the sealing sheet can be appropriately lowered in viscosity and can be further restrained from being lowered in performance by the outgas. [0064]

When the sealing sheet 11 contains the inorganic filler surface-treated beforehand with the compound having a methacryloxy group or acryloxy group as the silane coupling agent and further the inorganic filler is an inorganic filler containing two inorganic filler species different from each other in average particle diameter, it is preferred that at least a species smaller in average particle diameter, out of the two filler species, is beforehand surface-treated with the silane coupling agent. Since the inorganic filler species smaller in average particle diameter is large in specific surface area, the rise in viscosity can be further restrained.

When the used inorganic filler is a mixture obtained by mixing two inorganic filler species different from each other in average particle diameter with each other, it is more preferred that both of a species smaller in average particle diameter out of the two species and the other, which is larger in average particle diameter, are beforehand surface-treated with the silane coupling agent. In this case, the rise in the viscosity can be further restrained.

[0065]

The sealing sheet 11 preferably contains a curing promoter.

[0066]

The curing accelerator is not particularly limited as long as the curing accelerator advances the curing of the epoxy resin and the phenol resin, but the curing accelerator preferably has a reaction start temperature which can be set to 130°C or less. Examples of the curing accelerator include

2-phenyl-4-methyl-5-hydroxymethyl imidazole and

2,4-diamino-6-[2'-methylimidazolyl-(1')]-ethyl-s-triazine.

When a curing accelerator having a reaction start temperature which can be set to 130°C or less is used, the thermal curing is started at 130°C or less. Therefore, the ingress amount (moving amount) of the resin in the hollow part between the electronic device and the adherend can be further reduced after the electronic device is embedded until the thermal curing is completed. Among these, from the viewpoint of a reaction temperature and preservability,

2-phenyl-4-methyl-5-hydroxymethyl imidazole is preferable.

In this specification, the reaction start temperature means a temperature at which heat generation starts in DSC measurement (it is not a temperature at an intersection point of a tangent line at an inflection point present between a reaction start point and a peak, and a baseline).

[0067]

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

[0068]

The sealing sheet 11 may contain a flame retardant, as required. This case makes it possible to decline burning expansion when the sheet catches fire by a short circuit or heat-generation of the member concerned. Examples of the flame retardant include various metal hydroxides such as aluminum hydroxide, magnesium hydroxide, iron hydroxide, calcium hydroxide, tin hydroxide, and complex metal hydroxides; and phosphazene flame retardants.

[0069]

The sealing sheet 11 preferably contains a pigment. The pigment is not particularly limited, and may be, for example, carbon black.

[0070]

The content by percentage of the pigment in the sealing sheet 11 is preferably from 0.1 to 2% by weight. When the content by percentage is 0.1% or more by weight, the sheet gains a good marking performance. When the content by percentage is 2% or less by weight, the sealing sheet can ensure strength after cured.

[0071]

An additional additive other than the above-mentioned individual components may be appropriately blended into the resin

composition, as required.

[0072]

The thickness of the sealing sheet 11 is not particularly limited, and may be, for example, from 100 to 2000 μm . When the thickness is in this range, an electronic device can be satisfactorily sealed with the sheet.

[0073]

The sealing sheet 11 may have a mono-layered structure or a multi-layered structure in which two or more sealing sheets are laminated onto each other.

[0074]

[Method for Producing Sheet for Sealing Hollow Electronic Device]

The sealing sheet 11 can be formed by dissolving or dispersing resins and others for forming the sealing sheet 11 into an appropriate solvent to prepare a varnish, painting this varnish into a predetermined thickness onto the separator 11a to form a paint film, and then drying the paint film under predetermined conditions. The method for the painting is not particularly limited, and may be, for example, roll painting, screen painting, or gravure painting. The drying conditions are, for example, as follows: the drying temperature is from 70 to 160°C; and the drying period is from 1 to 30 minutes. The sealing sheet 11 may be formed by painting the varnish onto a support to form a paint film, and then drying the paint film under the above-mentioned drying conditions. Thereafter, the

sealing sheet 11 together with the support is bonded onto the separator 11a. When the sealing sheet 11 contains, in particular, the above-mentioned thermoplastic resin (acrylic resin), epoxy resin and phenol resin, all of these components are dissolved into a solvent and then the resultant is painted and dried. Examples of the solvent include methyl ethyl ketone, ethyl acetate, and toluene. The sealing sheet 11 may be produced by kneading extrusion. Examples of the production method according to the kneading extrusion include a method of melt-kneading components for forming the sealing sheet 11 in a known kneading machine such as a mixing roll, a pressure kneader, or an extruder to prepare a kneaded product, and subjecting the obtained kneaded product to plastic processing to form a sheet product.

Specifically, the kneaded product after melt-kneading is extrusion-molded while it is kept at a high temperature without being cooled, whereby the sealing sheet 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 preferably equal to or higher than the softening points of the components described above. The extrusion temperature is, for example, 40 to 150°C, preferably 50 to 140°C, and more preferably 70 to 120°C in consideration of the thermal curability and

moldability of the epoxy resin. In this way, the sealing sheet 11 can be formed.

[0075]

[Method for Producing Hollow Electronic Device Package]

A method for producing a hollow electronic device package according to the present embodiment includes at least the steps of:

preparing a laminate having an adherend and an electronic device fixed on the adherend with a bump sandwiched therebetween;

preparing a sheet for sealing a hollow electronic device;

disposing the sheet for sealing a hollow electronic device on the electronic device of the laminate;

embedding the electronic device into the sheet for sealing a hollow electronic device by heat pressing; and

thermally curing the sheet for sealing a hollow electronic device after the embedding step to obtain a sealed body.

[0076]

The adherend is not particularly limited, and is, for example, a printed wiring substrate, a ceramic substrate, a silicon substrate, or a metallic substrate. In the present embodiment, SAW chips 13 mounted on a printed wiring substrate 12 are sealed with the sealing sheet 11 while hollows are created. In this way, a hollow package is produced. The SAW chips 13 are each a chip having a surface acoustic waver (SAW) filter. That is, in the present embodiment, a case where the electronic

device of the present invention is a chip having a surface acoustic wave (SAW) filter will be described.

[0077]

Figs. 7 to 11 are schematic sectional views for describing a method for producing a hollow electronic device package according to an embodiment of the present invention.

[0078]

(Step of Providing Laminate)

In the method for producing a hollow package according to the present embodiment, first, a laminate 15 is provided, which includes a printed circuit board 12 and a plurality of SAW chips 13 (SAW filters 13) mounted on the printed circuit board 12 (see Fig. 7). The SAW chips 13 can be formed by dicing a piezoelectric crystal on which predetermined comb-shaped electrodes are formed, in a known manner, to be made into individual pieces. In order to mount the SAW chips 13 onto the printed wiring substrate 12, a flip chip bonder, a die bonder or any other known machine is usable. The SAW chips 13 are electrically connected to the printed wiring substrate 12 through bumps 13a. Between each of the SAW chips 13, and the printed wiring substrate 12, a hollow region 14 is maintained not to hinder the transmission of surface acoustic waves in the front surface of the SAW filter. The distance between the SAW chip 13 and the printed wiring substrate 12 (the width of the hollow region) can be appropriately set, and is generally from about

10 to 100 μm .

[0079]

(Step of Providing Sheet for Sealing Hollow Electronic Device)

In the method for producing a hollow package according to the present embodiment, a sealing sheet 11 (see Fig. 1) is provided.

[0080]

(Step of Disposing Sheet for Sealing Hollow Electronic Device)

Next, as shown in Fig. 8, the laminate 15 is disposed on a lower heating plate 22 with the surface on which the SAW chips 13 are fixed facing up, and the sealing sheet 11 is disposed on the surfaces of the SAW chips 13. In this step, the laminate 15 may be first disposed on the lower heating plate 22, followed by disposing the sealing sheet 11 on the laminate 15.

Alternatively, the sealing sheet 11 may be first laminated on the laminate 15, followed by disposing a laminated product of the laminate 15 and the sealing sheet 11 on the lower heating plate 22.

[0081]

(Step of Embedding Electronic Device into Sheet for Sealing Hollow Electronic Device)

Next, as shown in Fig. 9, heat pressing is carried out with a lower heating plate 22 and an upper heating plate 24 to embed a SAW chip 13 into the sealing sheet 11. The lower heating plate 22 and the upper heating plate 24 may be those of a flat-plate

press. The sealing sheet 11 functions as a sealing resin for protecting the SAW chip 13 and elements associated with the SAW chip 13 from the external environment.

[0082]

The embedding step is preferably performed so that the seeping amount X2 of a resin constituting the sealing sheet 11 into a hollow part 14 between a SAW filter 13 and a printed-circuit board 12 is set to 0 μm or more and 40 μm or less. The seeping amount X2 is preferably 0 μm or more and 30 μm or less. A seeping amount X2 of 0 μm or more and 40 μm or less can be achieved by adjusting the viscosity of the sealing sheet 11 or adjusting heat pressing conditions. More specific examples thereof include a method of setting a relatively high pressure and a relatively high temperature.

[0083]

Specifically, the heat pressing conditions when the SAW chip 13 is embedded into the sealing sheet 11 are different according to the viscosity of the sealing sheet 11, or the like. The temperature is preferably 40 to 150°C, and more preferably 60 to 120°C. The pressure is, for example, 0.1 to 10 MPa, and preferably 0.2 to 5 MPa. The time is, for example, 0.3 to 10 minutes, and preferably 0.5 to 5 minutes. Examples of the heat pressing method include parallel flat-plate pressing and roll pressing. Of these, the parallel flat-plate pressing is preferable. By setting the heat pressing conditions within the

numerical value range, the seeping amount X2 is easily set within the numerical value range.

[0084]

In view of improvements in the tackiness and followability of the sealing sheet 11 to the SAW chips 13 and the printed circuit board 12, pressing under decompression conditions is preferable.

As the decompression conditions, the pressure is 0 to 20 Torr, for example, and preferably 5 to 10 Torr; and the decompression retention time (time from the start of decompression to the start of pressing) is 5 to 600 seconds, for example, and preferably 10 to 300 seconds.

[0085]

(Separator Peeling-Off Step)

Next, the separator 11a is peeled off when the sealing sheet 11 is used in a state where the separator 11a is attached to one surface of the sealing sheet 11 as in the present embodiment (see Fig. 10).

[0086]

(Step of Carrying Out Thermal Curing to Obtain Sealed Body)

Next, the sealing sheet 11 is thermally cured to obtain a sealed body 25.

The step of obtaining the sealed body is preferably performed as follows. Specifically, when the ingress amount of the resin into the hollow part 14 after the step of obtaining the sealed body 25 is defined as Y2, the value obtained by

subtracting the ingress amount X2 from the ingress amount Y2 is set to 30 μm or less. The value obtained by subtracting the ingress amount X2 from the ingress amount Y2 is preferably 25 μm or less. A value obtained by subtracting the ingress amount X2 from the ingress amount Y2 of 30 μm or less can be achieved by adjusting the viscosity of the sealing sheet 11 before being cured or adjusting the constituent material of the sealing sheet 11 so that a curing rate during heating is increased. Specifically, for example, the value can be achieved by selecting the curing accelerator.

[0087]

Specifically, the conditions for the thermal curing treatment is different according to the viscosity and constituent material of the sealing sheet 11. The heating temperature is preferably 100°C or more, and more preferably 120°C or more. The upper limit of the heating temperature is preferably 200°C, more preferably 180°C. The heating period is preferably 10 minutes or longer, more preferably 30 minutes or longer. The upper limit of the heating period is preferably 180 minutes, more preferably 120 minutes. As required, the workpiece may be pressurized. The pressure therefor is preferably 0.1 MPa or more, more preferably 0.5 MPa or more. The upper limit of the pressure is preferably 10 MPa, more preferably 5 MPa. By setting the conditions of the thermal curing treatment within the numerical value range, the flowage distance of the resin

from the end of the embedding step to the end of the thermal curing step, i.e., the value obtained by subtracting the seeping amount X2 from the seeping amount Y2 is easily set to 30 μm or less.

[0088]

When only one SAW filter 13 as the electronic device is sealed, the sealed body 25 can be produced as one hollow electronic device package. When a plurality of SAW filters 13 are collectively sealed, the SAW filters 13 are divided into each filter, and thereby the SAW filter can be produced as one hollow electronic device package. That is, when a plurality of SAW filters 13 are collectively sealed as in the present embodiment, the following constitution may be further performed.

[0089]

(Dicing Step)

The sealed body 25 may be subjected to dicing after the thermal curing step (see Fig. 6). Thereby, a hollow package 18 (hollow electronic device package) can be obtained for each SAW chip 13.

[0090]

(Substrate mounting step)

As required, a substrate mounting step may be performed in which bumps are formed on any one or each of the hollow packages 18 and then the resultant is mounted onto a separate substrate (not illustrated). In order to mount the hollow package 18 onto

the substrate, a flip chip bonder, a die bonder or any other known machine is usable.

[0091]

In the above-described embodiment, the case has been described where the hollow electronic device of the present invention is the SAW chip 13 which is a semiconductor chip having a movable part. However, the hollow electronic device of the present invention is not limited to this example as long as the hollow electronic device has a hollow part formed between the adherend and the electronic device. For example, the hollow electronic device may be a semiconductor chip having micro electro mechanical systems (MEMS) such as a pressure sensor and a vibration sensor as the movable part.

The case where the electronic device is embedded by the parallel plate pressing using the sheet for sealing a hollow electronic device has been described in the above-described embodiment, but the present invention is not limited to this example. A laminated product of an electronic device and a sheet for sealing a hollow electronic device may be sealed by a release film in a vacuum chamber in a vacuum state, followed by introducing a gas having a pressure higher than atmospheric pressure into the chamber, to embed the electronic device in the thermosetting sealing sheet of the sheet for sealing a hollow electronic device. Specifically, an electronic device may be embedded in a thermosetting sealing sheet of a sheet for sealing a hollow

electronic device by a method described in JP-A-2013-52424.

Examples

[0092]

Hereinafter, preferred working examples of the present invention will be demonstrated in detail. However, materials, blend amounts and others that are described in the examples do not limit the scope of this invention as far as the claims do not include a restricted recitation thereabout.

[0093]

Components used in the examples are described as follows:

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

Phenol resin: a product, LVR 8210 DL (novolak type phenol resin), manufactured by Gunnei Chemical Industry Co., Ltd.; hydroxyl equivalent: 104 g/eq., and softening point: 60°C;

Curing accelerator: 2P4MHZ-PW
(2-phenyl-4-hydroxymethyl-5-methylimidazole) manufactured by Shikoku Chemicals Corporation

Thermoplastic resin: HME-2006M manufactured by Negami Chemical Industrial Co., Ltd. (carboxyl group-containing acrylic ester copolymer, weight average molecular weight: about 600,000, glass transition temperature (T_g): -35°C)

Carbon black: #20 manufactured by Mitsubishi Chemical

Corporation

Inorganic filler A: SMCC5 manufactured by Admatechs Company Limited (average particle size: 5 μm , no surface treatment)

Inorganic filler B: FB-5SDC manufactured by DENKI KAGAKU KOGYO K.K. (spherical silica, average particle size: 5 μm)

Inorganic filler C: SC220 G-SMJ manufactured by Admatechs Company Limited (average particle size: 0.5 μm)

Inorganic Filler C: a product obtained by surface-treating SC220 G-SMJ manufactured by Admatechs (average particle diameter of 0.5 μm) with 3-methacryloxypropyltrimethoxysilane (KBM-503 (trade name) manufactured by Shin-Etsu Chemical Co., Ltd.) (surface-treated with 1 part by weight of a silane coupling agent based on 100 parts by weight of the inorganic filler C)

[0094]

[Production of Sheets for Sealing Electronic Device According to Examples and Comparative Examples]

According to the blending ratios of the sealing sheets shown in Table 1, components were dissolved and dispersed in methyl ethyl ketone as a solvent to obtain a varnish having a concentration of 85% by weight. The varnish was applied to a separator subjected to a silicone mold release treatment, and then dried at 110°C for 5 minutes. Thereby, a 52.5 μm -thick sheet was obtained. Four sheets obtained as described above were laminated to produce a 210 μm -thick hollow sealing sheet.

[0095]

(Measurement of Loss Tangent $\tan \delta$ of Sealing Sheet And Storage Modulus)

The loss tangent $\tan \delta$ and storage modulus of each of the sealing sheets produced in Examples and Comparative Examples were measured by a parallel plate method using a rheometer (MARS III manufactured by HAAKE Company). In more detail, the loss tangent $\tan \delta$ and the storage modulus were measured three times under conditions of gap: 0.8 mm; parallel plate diameter: 8 mm; frequency: 1 Hz; strain: 0.05%; and rate of temperature increase of 10°C/minute at a temperature of 50°C to 160°C. The averages of the values at 50°C, 90°C, 120°C, and 150°C at this time were defined as measured values. The results are shown in Table 1.

[0096]

(Evaluation of Seeping Properties of Resin into Package Hollow Part)

<Step A>

First, a dummy chip mounting substrate was prepared, which had a glass substrate (having a length of 6 cm, a width of 10 cm, and a thickness of 1.3 mm) and each of four dummy chips mounted on the glass substrate with a resin bump interposed therebetween. Each of the dummy chips had the following specification. A gap width between the glass substrate and the dummy chip was 50 μm .

<Specification of Dummy Chip>

The dummy chip has a length of 3 mm, a width of 3 mm, and

a thickness of 200 μm , and a resin bump (resin material: acrylic resin) having a height of 50 μm and a diameter of 10 μm is formed on the dummy chip. The number of the bumps per chip is 60. The bumps are disposed at pitches of 25 μm . The material of the dummy chip is a silicon wafer. A distance W between adjacent chips is 0.5 mm.

[0097]

Specifically, the dummy chip was mounted on the glass substrate under the following bonding conditions, to prepare the dummy chip mounting substrate.

<Bonding Conditions>

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

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

[0098]

<Step B>

The 210- μm -thick sealing sheets produced in the above Examples and Comparative Examples were cut into samples each having a length of 2 cm and a width of 2 cm.

[0099]

<Step C>

The sample was disposed on the dummy chip of the dummy chip mounting substrate.

[0100]

<Step D>

The dummy chip was embedded into the sample under the following embedding conditions.

<Embedding Conditions>

pressing method: flat-plate pressing

temperature: 90°C

pressure force: 1.2 MPa

degree of vacuum during pressing: 10 torr

pressing time: 1 minute

[0101]

<Step E>

After releasing to atmospheric pressure, the seeping amount X1 of a resin constituting the sample into the hollow part between the dummy chip and the glass substrate was measured. Specifically, the seeping amount X1 of the resin into the hollow part between the dummy chip and a ceramic substrate was measured by "Digital Microscope" (trade name) (200 magnification) manufactured by Keyence Corporation. The maximum attained distance of the resin seeping into the hollow part from the end part of the SAW chip was measured. The maximum attained distance was defined as the seeping amount X1 of the resin. When no resin seeped and the hollow part spread outside the SAW chip, the seeping amount of the resin was represented by minus (in Examples and Comparative Examples, no seeping amount represented by minus was present).

[0102]

<Step F>

After the step E, the sample was allowed to stand at 170°C in a hot-air drier for 2 hours. Thereby, the sample was thermally cured to obtain a sealed body sample.

[0103]

<Step G>

Then, the seeping amount Y1 of the resin into the hollow part in the sealed body sample was measured. The measuring method is the same as that of the seeping amount X1.

[0104]

Then, the value obtained by subtracting the seeping amount X1 from the seeping amount Y1 was obtained. The results are shown in Table 1. The case where the value obtained by subtracting the seeping amount X1 from the seeping amount Y1 was 25 μm or less was evaluated as "good". The case where the value was more than 25 μm was evaluated as "poor". The results are shown in Table 1.

[0105]

[Table 1]

		Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 2
Blending ratio (part by weight)	Epoxy resin	380.74	424.81	404.17	126.36	41.83
	Phenol resin	209.51	233.76	222.40	68.81	22.78
	Curing accelerator A	4.753	5.4320	5.4320	1.6296	3.395
	Thermoplastic resin	84	112	144	36	320
	Carbon black	21	24	24	7.2	12
	Inorganic filler A	1300	1200	1200	-	1600
	Inorganic filler B	-	-	-	1232	-
Total (part by weight)		2000	2000	2000	2000	2000
Thickness of sheet (μm)		210	210	210	210	210
Loss tangent tan δ	50°C	0.7097	0.6555	0.7448	0.7	0.5637
	90°C	0.5136	0.4863	0.444	0.5101	0.4546
	120°C	0.3655	0.3544	0.2684	0.3093	0.4732
	150°C	0.2945	0.2934	0.1619	0.1902	0.4801
Storage modulus (Pa)	50°C	21710	48080	49580	4381000	2525000
	90°C	11520	20570	20390	1203000	1362000
	120°C	9155	15650	17920	1379000	814700
	150°C	129800	19040	22150	2920000	576400
Seeping amount X1 (μm)		27	15	6	20	10
Seeping amount Y1 (μm)		30	15	6.1	120	48
[seeping amount Y1]-[seeping amount X1] (μm)		3	0	0.1	100	38
Evaluation of [seeping amount Y1]-[seeping amount X1]		○	○	○	x	x

What is claimed is:

1. A sheet for sealing a hollow electronic device,
wherein:

loss tangent $\tan \delta$ at 50 to 90°C is 0.3 or more and 0.8
or less;

a storage modulus at 50 to 90°C is 1.0×10^5 or less;

loss tangent $\tan \delta$ at 150°C is 0.35 or less; and

a storage modulus at 150°C is 1.0×10^6 or less.

2. A method for producing a hollow electronic device
package, the method comprising the steps of:

preparing a laminated body having an adherend and an
electronic device fixed on the adherend with a bump interposed
therebetween;

preparing the sheet for sealing a hollow electronic device
according to claim 1;

disposing the sheet for sealing a hollow electronic device
on the electronic device of the laminated body;

embedding the electronic device into the sheet for sealing
a hollow electronic device by heat pressing; and

thermally curing the sheet for sealing a hollow electronic
device after the embedding step to obtain a sealed body.