

DESCRIPTION

TITLE OF THE INVENTION: SHEET FOR ELECTRONIC DEVICE SEAL AND METHOD FOR MANUFACTURING ELECTRONIC DEVICE PACKAGE

TECHNICAL FIELD

[0001]

The present invention relates to a sheet for electric device seal and a method for manufacturing an electronic device package.

BACKGROUND ART

[0002]

A method of sealing an electronic device with a resin sheet has been known as a method for sealing an electronic device.

[0003]

For example, Patent Documents 1 and 2 disclose a method of arranging a resin sheet and a base such as a separator on electronic function elements (such as a SAW filter) mounted on a substrate; placing the electronic function elements mounted on the substrate, the resin sheet, and the base in a gas-barrier bag; sealing the electronic function elements in the bag with the resin sheet to form a sealed body; thermally curing a portion originated from the resin sheet of the sealed body to form a cured body; and dicing the cured body to manufacture a package. In this method, the base is arranged between the resin sheet and the bag to prevent the resin sheet from sticking to the bag.

PRIOR ART DOCUMENTS

PATENT DOCUMENTS

[0004]

Patent Document 1: WO 2005/071731 (or WO 05/071731 pamphlet)

Patent Document 2: Patent No. 5223657

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005]

In the method described in Patent Documents 1 and 2, a part of the base may be lifted (peeled) from the resin sheet. If the base is lifted from the resin sheet, air bubbles enter a space between the resin sheet and the base. As a result, an unintended pattern (such as polka dots) may be formed on the surface of the package. That is, the appearance of the package may become poor.

[0006]

The lifting of the base (peeling of the base) is a problem also in a method other than the methods described in Patent Documents 1 and 2. For example, also in a method of placing a sheet having a structure including a base and a resin layer laminated on the base on an electronic device so that the resin layer faces the electronic device mounted on the substrate to form a laminate and sandwiching the laminate with two heating plates (for example, a lower heating plate and an upper heating plate) to seal the electronic device, a part of the base may be lifted from the resin layer to make the appearance of the package poor.

[0007]

The present invention aims to solve the above-described problems,

and to provide a sheet for electronic device seal and a method for manufacturing an electronic device package that are capable of preventing lifting of the base.

MEANS FOR SOLVING THE PROBLEMS

[0008]

The present invention relates to a sheet for electronic device seal, including: a protective film having a structure including a base and a pressure-sensitive adhesive layer laminated thereon, and a thermally curable resin layer laminated on the pressure-sensitive adhesive layer.

[0009]

In the sheet of the present invention, the lifting of the base can be prevented because the pressure-sensitive adhesive layer is arranged between the thermally curable resin layer and the base. Therefore, poor appearance of the electronic device package can be prevented.

[0010]

The peeling strength when the protective film is peeled from the thermally curable resin layer under conditions of a temperature of 25°C, a tensile speed of 300 mm/sec, and a peeling angle of 180 degrees is preferably 0.03 N/20 mm or more. In this case, the lifting of the protective film from the thermally curable resin layer can be prevented well.

[0011]

The pressure-sensitive adhesive layer is preferably at least one

layer selected from the group consisting of an ultraviolet-ray curing-type pressure-sensitive adhesive layer, a thermally curable pressure-sensitive adhesive layer, and a thermally foamable pressure-sensitive adhesive layer. If the pressure-sensitive adhesive layer is of one of these types, the peeling strength when the protective film is peeled from the thermally curable resin layer can be reduced by heating and irradiation with radiation.

[0012]

The thermally curable resin layer preferably contains an inorganic filler, and the content of the inorganic filler in the thermally curable resin layer is preferably 70% by volume to 90% by volume. In this case, a hollow part can be easily maintained when a hollow electronic device such as a SAW filter is sealed with a resin. In addition, warpage of the package can be reduced.

[0013]

The present invention also relates to a method for manufacturing an electronic device package, including the steps of: preparing a sheet having a protective film having a structure including a base and a pressure-sensitive adhesive layer laminated thereon, and a thermally curable resin layer laminated on the pressure-sensitive adhesive layer, placing the sheet on the electronic device so that the thermally curable resin layer faces the electronic device, sealing the electronic device with the thermally curable resin layer to form a sealed body, curing a portion originated from the thermally curable resin layer of the sealed body to form a cured body, and peeling the protective film from the cured body.

[0014]

When the pressure-sensitive adhesive layer is an ultraviolet-ray curing-type pressure-sensitive adhesive layer, the method for manufacturing an electronic device package according to the present invention preferably further includes a step of curing the ultraviolet-ray curing-type pressure-sensitive adhesive layer before the step of peeling the protective film from the cured body.

[0015]

When the pressure-sensitive adhesive layer is a thermally curable pressure-sensitive adhesive layer, the method for manufacturing an electronic device package according to the present invention preferably further includes a step of curing the thermally curable pressure-sensitive adhesive layer before the step of peeling the protective film from the cured body.

[0016]

When the pressure-sensitive adhesive layer is a thermally foamable pressure-sensitive adhesive layer, the method for manufacturing an electronic device package according to the present invention preferably further includes a step of foaming the thermally foamable pressure-sensitive adhesive layer before the step of peeling the protective film from the cured body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a schematic cross-sectional view of a sheet of Embodiment 1.

Fig. 2 is a schematic cross-sectional view of an LTCC substrate on which SAW filters are mounted.

Fig. 3 is a drawing schematically showing a state in which the sheet is laminated on the SAW filters mounted on the LTCC substrate.

Fig. 4 is a drawing schematically showing a state in which the SAW filters mounted on the LTCC substrate and the sheet on the SAW filters are put in a vacuum packaging container.

Fig. 5 is a drawing schematically showing a state in which the vacuum packaging container is sealed.

Fig. 6 is a drawing schematically showing a state in which a cured body and a protective film laminated on the cured body are removed from the vacuum packaging container.

Fig. 7 is a cross-sectional view of the cured body.

Fig. 8 is a cross-sectional view of a SAW filter package obtained by dividing the cured body.

MODE FOR CARRYING OUT THE INVENTION

[0018]

The present invention will be described in detail with reference to the embodiments below. However, the present invention is not limited to these embodiments.

[0019]

[Embodiment 1]

Fig. 1 is a cross-sectional view of a sheet 11 of Embodiment 1. The sheet 11 has a protective film 5 having a structure including a base 1 and a pressure-sensitive adhesive layer 2 laminated on the base 1,

and a thermally curable resin layer 3 laminated on the pressure-sensitive adhesive layer 2. That is, the sheet 11 has a structure in which the base 1, the pressure-sensitive adhesive layer 2, and the thermally curable resin layer 3 are laminated in this order. A support such as a polyethylene terephthalate (PET) film may be provided in the thermally curable resin layer 3 of the sheet 11. In order to facilitate peeling of the support from the sheet 11, the support may be subjected to a release treatment.

[0020]

Because the pressure-sensitive adhesive layer 2 is arranged between the thermally curable resin layer 3 and the base 1 in the sheet 11, lifting of the base 1 can be prevented. Therefore, poor appearance of the electronic device package can be prevented.

[0021]

The peeling strength when the protective film 5 is peeled from the thermally curable resin layer 3 under conditions of a temperature of 25°C, a tensile speed of 300 mm/sec, and a peeling angle of 180 degrees is preferably 0.03 N/20 mm or more. When the peeling strength is 0.03 N/20 mm or more, lifting of the protective film 5 from the thermally curable resin layer can be prevented well. The upper limit of the peeling strength is not particularly limited, and it is 1 N/20 mm or less, for example.

[0022]

The pressure-sensitive adhesive layer 2 is not particularly limited; however, an ultraviolet-ray curing-type pressure-sensitive adhesive layer, a thermally curable pressure-sensitive adhesive layer,

and a thermally foamable pressure-sensitive adhesive layer are preferable. If the pressure-sensitive adhesive layer 2 is of one of these types, the peeling strength when the protective film 5 is peeled from the thermally curable resin layer 3 can be reduced by heating and irradiation with radiation.

[0023]

A conventionally known pressure-sensitive adhesive layer can be used as the ultraviolet-ray curing-type pressure-sensitive adhesive layer, the thermally curable pressure-sensitive adhesive layer, or the thermally foamable pressure-sensitive adhesive layer. The thermally foamable pressure-sensitive adhesive layer is described in detail in JP-A-2012-117040, etc.

[0024]

Examples of the base 1 include plastic bases such as a plastic sheet; rubber bases such as a rubber sheet; foam bases such as a foam sheet; metal bases such as a metal foil and a metal plate; fiber bases such as cloth, non-woven fabric, felt, and net; paper bases such as paper; and laminates of these bases. Examples of the plastic materials include olefin resins such as polyethylene (PE), polypropylene (PP), and an ethylene-propylene copolymer; copolymers having ethylene as a monomer component, such as an ethylene-vinyl acetate copolymer (EVA), an ionomer resin, an ethylene-(meth)acrylic acid copolymer, and an ethylene-(meth)acrylic ester (random, alternate) copolymer; polyesters such as polyethylene terephthalate (PET), polyethylene naphthalate (PEN), and polybutylene terephthalate (PBT); acrylic resin; polyvinyl chloride (PVC); polyurethane; polycarbonate; polyphenylene sulfide

(PPS); amide resins such as polyamide (nylon) and wholly aromatic polyamide (aramid); polyetheretherketone (PEEK); polyimide; polyetherimide; polyvinylidene chloride; ABS (acrylonitrile-butadiene-styrene copolymer); cellulose resin; silicone resin; and fluororesin. Further, a base that transmits ultraviolet rays is suitable for the base 1.

[0025]

The thermally curable resin layer 3 is a layer for sealing an electronic device.

[0026]

The tensile storage modulus at 25°C of the thermally curable resin layer 3 is preferably 1 MPa or more. If the tensile storage modulus is 1 MPa or more, deformation of the thermally curable resin layer 3 caused by the contact between the sheet 11 and the inner surface of the vacuum packaging container, etc. can be prevented or suppressed. In addition, a hollow part can be easily maintained when a SAW filter is sealed with a resin in a packaging container. The tensile storage modulus at 25°C is preferably 1,000 MPa or less. If the tensile storage modulus is 1,000 MPa or less, good adhesion of the resin layer to an electronic device can be obtained.

The tensile storage modulus at 25°C can be measured by the method described in Examples.

[0027]

The thermally curable resin layer 3 preferably contains an epoxy resin.

[0028]

The epoxy resin is not particularly limited, and examples thereof include triphenyl methane 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, phenoxy resin, and other various epoxy resins. These epoxy resins may be used alone or in combination of two or more thereof.

[0029]

In order to secure reactivity, the epoxy resin is preferably a resin which has an epoxy equivalent of 150 to 250, and has a softening point or melting point of 50 to 130°C to be solid at room temperature. Out of species of the epoxy resin, more preferred are triphenylmethane type epoxy resin, cresol novolak type epoxy resin, and biphenyl type epoxy resin from the viewpoint of the reliability of the resin sheet.

[0030]

The thermally curable resin layer 3 preferably contains a phenol resin.

[0031]

The phenol resin is not particularly limited as long as it initiates a curing reaction with an epoxy resin. Examples thereof include a phenol novolak resin, a phenolaralkyl resin, a biphenylaralkyl resin, a dicyclopentadiene-type phenol resin, a cresol novolak resin, and a resol resin. These phenol resins may be used either alone or in combination of two or more thereof.

[0032]

A phenol resin having a hydroxyl equivalent of 70 to 250 and a softening point of 50°C to 110°C is preferably used from the viewpoint of reactivity with the epoxy resin. Among these phenol resins, a phenol novolak resin can be preferably used from the viewpoint of its high curing reactivity. Further, a phenol resin having low moisture absorption such as a phenolaralkyl resin and a biphenylaralkyl resin can also be suitably used from the viewpoint of its reliability.

[0033]

The total content of the epoxy resin and the phenol resin in the thermally curable resin layer 3 is preferably 5% by weight or more. If the total content is 5% by weight or more, good adhering strength of the thermally curable resin layer 3 to an electronic device, a substrate, etc. can be obtained. The total content of the epoxy resin and the phenol resin in the thermally curable resin layer 3 is preferably 20% by weight or less. If the total content thereof is 20% by weight or less, moisture absorption can be suppressed low.

[0034]

From the viewpoint of curing reactivity, the compounding ratio of the epoxy resin to the phenol resin is preferably set so that the total amount of the hydroxy groups in the phenol resin is 0.7 equivalent to 1.5 equivalents, and more preferably 0.9 equivalent to 1.2 equivalents per one equivalent of the epoxy groups in the epoxy resin.

[0035]

The thermally curable resin layer 3 preferably contains a curing accelerator.

[0036]

The curing accelerator is not particularly limited as long as it promotes curing of the epoxy resin and the phenol resin. Examples thereof include imidazole-based curing accelerators such as 2-methylimidazole (trade name; 2MZ), 2-undecylimidazole (trade name; C11-Z), 2-heptadecylimidazole (trade name; C17Z), 1,2-dimethylimidazole (trade name; 1.2DMZ), 2-ethyl-4-methylimidazole (trade name; 2E4MZ), 2-phenylimidazole (trade name; 2PZ), 2-phenyl-4-methylimidazole (trade name; 2P4MZ), 1-benzyl-2-methylimidazole (trade name; 1B2MZ), 1-benzyl-2-phenylimidazole (trade name; 1B2PZ), 1-cyanoethyl-2-methylimidazole (trade name; 2MZ-CN), 1-cyanoethyl-2-undecylimidazole (trade name; C11Z-CN), 1-cyanoethyl-2-phenylimidazolium trimellitate (trade name; 2PZCNS-PW), 2,4-diamino-6-[2'-methylimidazolyl-(1')]-ethyl-s-triazine (trade name; 2MZ-A), 2,4-diamino-6-[2'-undecylimidazolyl-(1')]-ethyl-s-triazine (trade name; C11Z-A), 2,4-diamino-6-[2'-ethyl-4'-methylimidazolyl-(1')]-ethyl-s-triazine (trade name; 2E4MZ-A), 2,4-diamino-6-[2'-methylimidazolyl-(1')]-ethyl-s-triazine isocyanuric acid adduct (trade name; 2MA-OK), 2-phenyl-4,5-dihydroxymethylimidazole (trade name; 2PHZ-PW), and 2-phenyl-4-methyl-5-hydroxymethylimidazole (trade name; 2P4MZ-PW) (all of these compounds are manufactured by Shikoku Chemicals Corporation).

[0037]

The content of the curing accelerator is preferably 0.1 part by

weight or more, and more preferably 1 part by weight or more to 100 parts by weight in total of the epoxy resin and the phenol resin. The content of the curing accelerator is preferably 15 parts by weight or less, and more preferably 10 parts by weight or less.

[0038]

The thermally curable resin layer 3 preferably contains a thermoplastic resin (elastomer).

[0039]

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

[0040]

The content of the thermoplastic resin in the thermally curable resin layer 3 is preferably 1% by weight or more. If the content is 1% by weight or more, the tensile storage modulus at 25°C can be easily adjusted to be in the above-described range. The content of the thermoplastic resin in the thermally curable resin layer 3 is preferably 30% by weight or less, and more preferably 15% by weight or less. If

the content is 30% by weight or less, good adhering strength of the thermally curable resin layer 3 to an electronic device, etc. can be obtained.

[0041]

The thermally curable resin layer 3 preferably contains an inorganic filler. The inorganic filler can reduce the thermal expansion coefficient.

[0042]

Examples of the inorganic filler include quartz glass, talc, silica (fused silica, crystalline silica, etc.), alumina, aluminum nitride, silicon nitride, and boron nitride. Among these inorganic fillers, silica and alumina are preferable, and silica is more preferable because the thermal expansion coefficient can be reduced well. Silica is preferably fused silica and more preferably spherical fused silica because of its excellent fluidity.

[0043]

The average particle size of the inorganic filler is preferably 5 μm or more. If the average particle size is 5 μm or more, the flexibility and softness of the thermally curable resin layer 3 can be easily obtained. The average particle size of the inorganic filler is preferably 50 μm or less, and more preferably 30 μm or less. If the average particle size is 50 μm or less, a high filling rate of the inorganic filler can be easily obtained.

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

population.

[0044]

The inorganic filler is preferably treated (pretreated) with a silane coupling agent. By this treatment, wettability of the inorganic filler to the resin can be improved, and dispersibility of the inorganic filler can be enhanced.

[0045]

The silane coupling agent is a compound having a hydrolyzable group and an organic functional group in a molecule.

[0046]

Examples of the hydrolyzable group include alkoxy groups having 1 to 6 carbon atoms such as a methoxy group and an ethoxy group, an acetoxy group, and a 2-methoxyethoxy group. Among these, a methoxy group is preferable because it is easy to remove a volatile component such as an alcohol generated by hydrolysis.

[0047]

Examples of the organic functional group include a vinyl group, an epoxy group, a styryl group, a methacrylic group, an acrylic group, an amino group, a ureido group, a mercapto group, a sulfide group, an isocyanate group. Among these, an epoxy group is preferable because the epoxy group can easily react with an epoxy resin and a phenol resin.

[0048]

Examples of the silane coupling agent include vinyl group-containing silane coupling agents such as vinyltrimethoxysilane and vinyltriethoxysilane; epoxy group-containing silane coupling agents such as 2-(3,4-epoxycyclohexyl)ethyltrimethoxysilane and

3-glycidoxypropyl methyldimethoxysilane, 3-glycidoxypropyl trimethoxysilane, 3-glycidoxypropyl methyldiethoxysilane, and 3-glycidoxypropyl triethoxysilane; styryl group-containing silane coupling agents such as p-styryltrimethoxysilane; methacrylic group-containing silane coupling agents such as 3-methacryloxypropylmethyldimethoxysilane, 3-methacryloxypropyltrimethoxysilane, 3-methacryloxypropylmethyldiethoxysilane, and 3-methacryloxypropyltriethoxysilane; acrylic group-containing silane coupling agents such as 3-acryloxypropyltrimethoxysilane; amino group-containing silane coupling agents such as N-2-(aminoethyl)-3-aminopropylmethyldimethoxysilane, N-2-(aminoethyl)-3-aminopropyltrimethoxysilane, 3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, 3-triethoxysilyl-N-(1,3-dimethyl-butylidene)propylamine, N-phenyl-3-aminopropyltrimethoxysilane, and N-(vinylbenzyl)-2-aminoethyl-3-aminopropyltrimethoxysilane; ureido group-containing silane coupling agents such as 3-ureidopropyltriethoxysilane; mercapto group-containing silane coupling agents such as 3-mercaptopropylmethyldimethoxysilane and 3-mercaptopropyltrimethoxysilane; sulfide group-containing silane coupling agents such as bis(triethoxysilylpropyl)tetrasulfide; and isocyanate group-containing silane coupling agents such as 3-isocyanatepropyltriethoxysilane.

[0049]

A method of treating the inorganic filler with the silane coupling

agent is not especially limited, and examples thereof include a wet method of mixing the inorganic filler and the silane coupling agent in a solvent and a dry method of treating the inorganic filler with the silane coupling agent in a gas phase.

[0050]

The amount of the silane coupling agent to be used for the treatment is not especially limited; however, 0.1 to 1 part by weight of the silane coupling agent is preferably used for the treatment to 100 parts by weight of the non-treated inorganic filler.

[0051]

The content of the inorganic filler in the thermally curable resin layer 3 is preferably 70% by volume or more, and more preferably 74% by volume or more. If the content is 70% by volume or more, the tensile storage modulus at 25°C can be easily adjusted to be in the above-described range. In addition, the thermal expansion coefficient and the water absorption rate can be made small. On the other hand, the content of the inorganic filler is preferably 90% by volume or less, and more preferably 85% by volume or less. If the content is 90% by volume or less, good softness, fluidity, and adhesion can be obtained.

[0052]

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

The specific gravity of silica is normally 2.2 g/cm³. Therefore, a preferred range of the content (% by weight) of silica is as follows.

The content of silica in the thermally curable resin layer 3 is

preferably 81% by weight or more, and more preferably 84% by weight or more. The content of silica in the thermally curable resin layer 3 is preferably 94% by weight or less, and more preferably 91% by weight or less.

[0053]

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

The content of alumina in the thermally curable resin layer 3 is preferably 88% by weight or more, and more preferably 90% by weight or more. The content of alumina in the thermally curable resin layer 3 is preferably 97% by weight or less, and more preferably 95% by weight or less.

[0054]

Besides the components described above, the thermally curable resin layer 3 may contain, as needed, other compounding agents generally used in manufacture of a sealing resin, such as a flame retardant component, and a pigment.

[0055]

Examples of the flame retardant component include various types of metal hydroxides such as aluminum hydroxide, magnesium hydroxide, iron hydroxide, calcium hydroxide, tin hydroxide, and complex metal hydroxides; and a phosphazene compound. Among these flame retardant components, a phosphazene compound is preferable because of its excellent flame retardancy and strength after curing.

[0056]

The pigment is not particularly limited, and an example thereof

is carbon black.

[0057]

A method for manufacturing the thermally curable resin layer 3 is not particularly limited; however, it is preferable to employ a method of performing plastic working on a kneaded product obtained by kneading components described above (for example, the epoxy resin, the phenol resin, the curing accelerator, the thermoplastic resin, the inorganic filler, etc.) to form a sheet. By this working, the thermally curable resin layer 3 can be highly filled with the inorganic filler.

[0058]

Specifically, the epoxy resin, the phenol resin, the curing accelerator, the thermoplastic resin, the inorganic filler, etc. are melted and kneaded using a known kneader such as a mixing roll, a pressurizing kneader, and an extruder to prepare a kneaded product, and the obtained kneaded product is subjected to plastic working to form a sheet. As kneading conditions, the upper limit of the temperature is preferably 140°C or lower, and more preferably 130°C or lower. The lower limit of the temperature is preferably higher than or equal to the softening point of components described above, and is 30°C or higher, and preferably 50°C or higher, for example. The kneading time is preferably 1 to 30 minutes. The kneading is preferably performed under a reduced pressure condition (under a reduced pressure atmosphere), and the pressure under the reduced pressure condition is 1×10^{-4} to 0.1 kg/cm², for example.

[0059]

It is preferred to apply the plastic working to the kneaded product

after the melt kneading in the state that the kneaded product keeps a high temperature without being cooled. The method for the plastic working is not particularly limited, and examples thereof include flat plate pressing, T-die extrusion, screw die extrusion, rolling, roll kneading, inflation extrusion, co-extrusion, and calendering methods. The plastic working temperature is preferably not lower than the respective softening points of the above-mentioned individual components, and is, for example, from 40 to 150°C, preferably from 50 to 140°C, more preferably from 70 to 120°C, considering the thermosetting property and the moldability of the epoxy resin.

[0060]

The thickness of the thermally curable resin layer 3 is not particularly limited; however, it is preferably 100 μm or more, and more preferably 150 μm or more. The thickness of the thermally curable resin layer 3 is preferably 2,000 μm or less, and more preferably 1,000 μm or less. If the thickness is within the above-described range, the electronic device can be sealed well.

[0061]

Fig. 1 shows a case in which the thermally curable resin layer 3 is composed of a single layer; however, the thermally curable resin layer 3 is not limited to be composed of a single layer and may have a multilayer structure. Similarly, the pressure-sensitive adhesive layer 2 may have a multilayer structure. The base 1 may have a multilayer structure.

[0062]

The sheet 11 is used for sealing an electronic device. Examples

of the electronic device include electronic devices having a follow structure (hollow electronic devices) such as a sensor, MEMS (Micro Electro Mechanical Systems), and a SAW (Surface Acoustic Wave) filter; semiconductor elements such as a semiconductor chip, IC (integrated circuit), and a transistor; capacitors; and resistors. Among these electronic devices, a SAW filter can be particularly preferably used. The hollow structure refers to a hollow part formed between an electronic device and a substrate when the electronic device is mounted on a substrate. The substrate is not particularly limited, and examples thereof include a printed wiring board, an LTCC (Low Temperature Co-fired Ceramics) substrate, a ceramic substrate, a silicon substrate, and a metal substrate.

[0063]

The sheet 11 can be preferably used for sealing an electronic device arranged in the vacuum packaging container.

[0064]

A typical example of the method for sealing an electronic device with the sheet 11 is a method of embedding the electronic device in the thermally curable resin layer 3. More specifically, the sheet 11 is placed on the electronic device so that the thermally curable resin layer 3 faces the electronic device, and the electronic device is embedded in the thermally curable resin layer 3 to seal the electronic device.

[0065]

The thermally curable resin layer 3 can function as a sealing resin for protecting the electronic device and other associated components from the external environment.

[0066]

[Method for manufacturing electronic device package]

An example of the method for manufacturing an electronic device package will be explained, in which SAW filters 13 mounted on an LTCC substrate 12 are sealed with the sheet 11 to manufacture a SAW filter package 16.

[0067]

(Step of preparing SAW filter mounting substrate)

In the step of preparing a SAW filter mounting substrate, the LTCC substrate 12 on which a plurality of the SAW filters 13 are mounted is prepared (see Fig. 2). A piezoelectric crystal in which prescribed interdigital electrodes are formed is diced into individual pieces by a known method to form the SAW filters 13. A known apparatus such as a flip-chip bonder and a die bonder is used to mount the SAW filter 13 to the LTCC substrate 12. The SAW filter 13 and the LTCC substrate 12 are electrically connected with each other through a bump electrode 13a such as a bump. A hollow part 14 is maintained between the SAW filter 13 and the LTCC substrate 12 so that the transmission of surface acoustic wave is not inhibited on the surface of the SAW filter. The distance between the SAW filter 13 and the LTCC substrate 12 can be appropriately set, and it is generally about 15 μm to 50 μm .

[0068]

(Arranging step)

The sheet 11 is placed on the SAW filters 13 so that the thermally curable resin layer 3 faces the SAW filters 13 (see Fig. 3).

[0069]

(Inserting step)

Then, the SAW filters 13 mounted on the LTCC substrate 12 and the sheet 11 on the SAW filters 13 are placed in a vacuum packaging container 21 (see Fig. 4).

[0070]

The vacuum packaging container 21 is not particularly limited, and a gas-barrier bag, etc. can be used, for example. The vacuum packaging container 21 preferably has heat resistance, specifically resistance sufficient for enduring a temperature during thermal curing. In addition, the vacuum packaging container 21 preferably has softness and a heat sealing property.

[0071]

A specific example of the vacuum packaging container 21 is a vacuum packaging container having a multilayer structure with a polyester film as an outer layer and a polyethylene film having a heat sealing property as an inner layer (sealant layer). A polypropylene film can also be suitably used as the inner layer. A polyimide film, a polyamide film, etc. can also be suitably used as the outer layer. An intermediate layer may exist between the outer layer and the inner layer. The intermediate layer preferably has a high gas-barrier property, and a preferable example thereof is an aluminum layer.

[0072]

(Vacuum packaging step)

Then, the pressure inside of the vacuum packaging container 21 is reduced (for example, 500 Pa or less) and then the vacuum packaging container 21 is sealed (see Fig. 5).

[0073]

Specifically, the vacuum packaging container 21 containing the LTCC substrate 12, the SAW filters 13, and the sheet 11 is placed in an airtight container, and the airtight container is degassed with a vacuum pump to reduce the pressure inside the airtight container. Then, the vicinity of the opening of the vacuum packaging container 21 is heat-sealed from both sides with a heater for heat sealing (heat sealer) to seal the vacuum packaging container 21 (see Fig. 5). This process is shown in Fig. 3 of WO 2005/071731. The opening of the vacuum packaging container 21 can also be closed with a clip, etc.

[0074]

When the airtight vacuum packaging container 21 is taken out to the atmosphere from the airtight container, the vacuum packaging container 21 is adhered to the LTCC substrate 12 and the sheet 11 due to a pressure difference between the inside and the outside of the vacuum packaging container 21.

[0075]

An example of the method of reducing pressure inside the vacuum packaging container 21 also includes a method of airtightly inserting a metal pipe connected to a vacuum pump into the opening of the vacuum packaging container 21 and degassing the inside of the vacuum packaging container 21.

[0076]

(Heating step)

In the heating step, the thermally curable resin layer 3 is heated with the vacuum packaging container 21 to soften the thermally curable

resin layer 3. The heating temperature is normally less than the curing temperature of the thermally curable resin layer 3, and it is 100°C to 140°C, for example.

[0077]

By the heating, the softened thermally curable resin layer 3 enters into a space between the SAW filters 13 mounted on the LTCC substrate 12. As a result, the SAW filters 13 are covered with the thermally curable resin layer 3. That is, the thermally curable resin layer 3 is heated with the vacuum packaging container 21 to form a sealed body 15.

[0078]

In the heating step, the vacuum packaging container 21 can be heated under a pressure higher than that inside of the vacuum packaging container 21 (for example, under the atmosphere). Accordingly, the pressure difference between the inside and the outside of the vacuum packaging container 21 is used to make the softened thermally curable resin 3 enter into a space between the SAW filters 13 mounted on the LTCC substrate 12. The sealed body 15 obtained in the heating step has the LTCC substrate 12, the SAW filters 13 mounted on the LTCC substrate 12, and a portion 4 that covers the SAW filters 13 (a portion 4 originated from the thermally curable resin layer 3).

[0079]

As shown in Figs. 8 and 9 of WO 2005/071731, Fig. 8 of Patent No. 5223657, etc., the vacuum packaging container 21 may be heated and pressurized using a heating and pressurizing roller, a press, etc. to make the softened thermally curable resin 3 enter into a space between the SAW filters 13 mounted on the LTCC substrate 12.

[0080]

(Thermal curing step)

Then, the sealed body 15 is heated with the vacuum packaging container 21, and the portion 4 originated from the thermally curable resin layer 3 of the sealed body 15 is cured to form a cured body 16 (see Fig. 6). The cured body 16 has the LTCC substrate 12, the SAW filters 13 mounted on the LTCC substrate 12, and the portion 4 that covers the SAW filters 13 (the portion 4 originated from the thermally curable resin layer 3). The portion 4 of the cured body 16 is made of the cured resin.

The protective film 5 is laminated on the cured body 16.

[0081]

An example of the specific method is a method of placing the sealed vacuum packaging container 21 in an airtight container and heating the vacuum packaging container 21 while applying a pressure to the vacuum packaging container 21 using a pressure medium that fills the airtight container to thermally cure the portion 4 originated from the thermally curable resin layer 3 of the sealed body 15. Because the vacuum packaging container 21 can be pressurized and heated through the pressure medium in this method, the shape and the size of the hollow part 14 can be easily controlled. Examples of the pressure medium include air, water, and oil. This process is shown in Fig. 4 of WO 2005/071731.

[0082]

The heating temperature is 60°C to 150°C, for example.

[0083]

Other preferable examples of the specific method include a method of heat-pressing the vacuum packaging container 21 using a press to

thermally cure the portion 4 originated from the thermally curable resin layer 3 of the sealed body 15 and a method of heating the vacuum packaging container 21 under a pressure higher than that inside of the vacuum packaging container 21 (for example, under the atmospheric pressure) to thermally cure the portion 4 originated from the thermally curable resin layer 3 of the sealed body 15. This process is shown in Figs. 8 and 9 of Patent No. 5223657.

[0084]

(Taking-out step)

The vacuum packaging container 21 is unsealed to take out the cured body 16 and the protective film 5 laminated on the cured body 16 from the vacuum packaging container 21.

[0085]

(Step of reducing peeling strength)

Then, the pressure-sensitive adhesive layer 2 is preferably irradiated with ultraviolet rays to cure the pressure-sensitive adhesive layer 2 when the pressure-sensitive adhesive layer 2 is an ultraviolet-ray curing-type pressure-sensitive adhesive layer. By this curing, the peeling strength can be reduced when the protective film 5 is peeled from the thermally curable resin layer 3. The method of radiating ultraviolet rays is not particularly limited, and an example thereof is a method of radiating ultraviolet rays from above the base 1 to the pressure-sensitive adhesive layer 2.

[0086]

When the pressure-sensitive adhesive layer 2 is a thermally curable pressure-sensitive adhesive layer, the cured body 16 and the protective

film 5 laminated on the cured body 16 are preferably heated to cure the pressure-sensitive adhesive layer 2. When the pressure-sensitive adhesive layer 2 is a thermally foamable pressure-sensitive adhesive layer, the cured body 16 and the protective film 5 laminated on the cured body 16 are preferably heated to foam the pressure-sensitive adhesive layer 2.

[0087]

Then, the protective film 5 is peeled from the cured body 16 (see Fig. 7).

[0088]

The cured body 16 is divided into SAW filters 13 (see Fig. 8). By this division, SAW filter packages 17 can be obtained. Examples of the dividing method include dicing, and cutting and breaking.

[0089]

The method described above as an example has advantages such that the generation of voids can be suppressed because the SAW filter can be sealed under a reduced pressure, and that the method can be performed using a simple pressure reducing apparatus.

[0090]

When a semiconductor chip is used instead of the SAW filter in the above-described example, a space between the semiconductor chip and the substrate may be filled with an underfill material. This process is shown in Fig. 7 of WO 2005/071731.

[0091]

In the above-described example, a method of sealing the vacuum packaging container 21 and heating the container is shown. However, it

is also suitable to employ a method of heating the vacuum packaging container 21 containing the LTCC substrate 12, the SAW filters 13, and the sheet 11 at a temperature less than the curing temperature of the sheet 11 in an airtight container under a reduced pressure, and sealing the vacuum packaging container 21. By employing this method, when a solvent exists in the sheet 11, the solvent can be volatilized. This process is shown in Fig. 3 of Patent No. 5223657.

[0092]

In the above-described examples, methods in which the heating step and the thermal curing step are performed in two stages are shown. However, a method in which these steps are combined and performed in one step is also suitable.

[0093]

In the above-described examples, a case is shown in which the cured body 16 and the protective film 5 laminated on the cured body 16 are taken out of the vacuum packaging container 21 and these components are heated to cure or foam the pressure-sensitive adhesive layer 2. However, the method for manufacturing an electronic device package is not limited to this case, and a method of heating the cured body 16 and the protective film 5 laminated on the cured body 16 with the vacuum packaging container 21 to cure or foam the pressure-sensitive adhesive layer 2, and taking these components out of the vacuum packaging container 21 is also suitable. This method can simplify the process.

[0094]

In the above-described examples, a case is shown in which the SAW filters 13 in the vacuum packaging container 21 are sealed. However,

the method for manufacturing an electronic device package is not limited to this by all means, and the vacuum packaging container does not have to be used. A preferable example of the method for manufacturing an electronic device package without using the vacuum packaging container is a method of placing the sheet 11 on the SAW filters 13 to form a laminate so that the thermally curable resin layer 3 faces the SAW filters 13 and sandwiching the laminate between two heating plates (for example, a lower heating plate and an upper heating plate) to form a sealed body.

[0095]

As described above, an electronic device package can be suitably manufactured by the method including the steps of: preparing the sheet 11 having the protective film 5 having a structure including the base 1 and the pressure-sensitive adhesive layer 2 laminated on the base 1, and the thermally curable resin layer 3 laminated on the pressure-sensitive adhesive layer 2, placing the sheet 11 on the electronic device so that the thermally curable resin layer 3 faces the electronic device, sealing the electronic device with the thermally curable resin layer 3 to form a sealed body, curing a portion originated from the thermally curable resin layer 3 of the sealed body to form a cured body, and peeling the protective film 5 from the cured body.

[0096]

When the pressure-sensitive adhesive layer 2 is an ultraviolet-ray curing-type pressure-sensitive adhesive layer, the method for manufacturing an electronic device package preferably further includes a step of curing the ultraviolet-ray curing-type pressure-sensitive adhesive layer before the step of peeling the protective film 5 from

the cured body.

[0097]

When the pressure-sensitive adhesive layer 2 is a thermally curable pressure-sensitive adhesive layer, the method for manufacturing an electronic device package preferably further includes a step of curing the thermally curable pressure-sensitive adhesive layer before the step of peeling the protective film 5 from the cured body.

[0098]

When the pressure-sensitive adhesive layer 2 is a thermally foamable pressure-sensitive adhesive layer, the method for manufacturing an electronic device package preferably further includes a step of foaming the thermally foamable pressure-sensitive adhesive layer before the step of peeling the protective film 5 from the cured body.

[0099]

The method for manufacturing an electronic device package may further include a step of preparing the electronic device mounted on the substrate and a step of placing the electronic device mounted on the substrate and the sheet in a vacuum packaging container.

EXAMPLES

[0100]

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

in a limitative manner.

[0101]

The components used in the working examples will be described.

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

Phenol resin: "MEH-7851-SS" manufactured by Meiwa Kasei Industries, Ltd. (phenol resin having a biphenylaralkyl skeleton, hydroxyl equivalent 203 g/eq, softening point 67°C)

Thermoplastic resin: "Metablen C-132E" manufactured by Mitsubishi Rayon Co., Ltd. (MBS resin, average particle size 120 μm)

Inorganic filler: "FB-9454FC" manufactured by Denka Co., Ltd. (spherical fused silica, average particle size 20 μm)

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

Carbon black: "#20" manufactured by Mitsubishi Chemical Corporation

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

Base: "MRF75" manufactured by Mitsubishi Chemical Corporation (material: PET)

Protective film: each protective film having a polyethylene terephthalate film and ultraviolet-ray curing-type pressure-sensitive adhesive layer laminated on the polyethylene terephthalate film. A production example is described below.

[0102]

(Production Example)

In a reactor having a cooling tube, a nitrogen gas introducing tube, a thermometer, and a stirrer, 86.4 parts of 2-ethylhexyl acrylate (referred to as "2EHA" below), 13.6 parts of 2-hydroxyethyl acrylate (referred to as "HEA" below), 0.2 part of benzoyl peroxide, and 65 parts of toluene were placed, and polymerization was performed in a nitrogen gas flow at 61°C for 6 hours to obtain an acrylic polymer A.

[0103]

To the acrylic polymer A, 14.6 parts of 2-methacryloyloxyethyl isocyanate (referred to as "MOI" below) was added, and an addition reaction was performed in an air flow at 50°C for 48 hours to obtain an acrylic polymer A'.

[0104]

Then, 8 parts of a polyisocyanate compound (trade name "Coronate L" manufactured by Nippon Polyurethane Industry Co., Ltd.) and 5 parts of a photopolymerization initiator (trade name "Irgacure 651" manufactured by Chiba Specialty Chemicals Inc.) were added to 100 parts of the acrylic polymer A' to obtain a pressure-sensitive adhesive composition solution A.

[0105]

The pressure-sensitive adhesive composition solution A was applied to a release-treated polyethylene terephthalate film having a thickness of 50 μm ("MRF75" manufactured by Mitsubishi Chemical Corporation) and dried to form an ultraviolet-ray curing-type pressure-sensitive adhesive layer. By this procedure, a protective film having a polyethylene terephthalate film and an ultraviolet-ray

curing-type pressure-sensitive adhesive layer laminated on the polyethylene terephthalate film was obtained.

[0106]

[Examples]

According to the compounding ratio described in Table 1, components were blended, and melted and kneaded at 60°C to 120°C for 10 minutes under a reduced pressure condition (0.01 kg/cm²) using a roll kneader to prepare a kneaded product. The obtained kneaded product was formed into a sheet in a parallel plate manner to produce a sheet-shaped thermally curable resin composition.

The sheet-shaped thermally curable resin composition was laminated on the ultraviolet-ray curing-type pressure-sensitive adhesive layer of the protective film to produce a sheet having a structure in which a base (thickness: 75 μm), an ultraviolet-ray curing-type pressure-sensitive adhesive layer (thickness: 20 μm), and a thermally curable resin layer (thickness: 200 μm) are laminated in this order.

[0107]

[Comparative Example]

According to the compounding ratio described in Table 1, components were blended, and melted and kneaded at 60°C to 120°C for 10 minutes under a reduced pressure condition (0.01 kg/cm²) using a roll kneader to prepare a kneaded product. The obtained kneaded product was formed into a sheet in a parallel plate manner to produce a sheet having a thickness of 200 μm. A polyethylene terephthalate film ("MRF75" manufactured by Mitsubishi Chemical Corporation) was laminated on the obtained sheet.

[0108]

[Table 1]

(Thermally Curable Resin Layer)

		Example 1	Example 2	Example 3	Comparative Example 1
Compounding ratio (part by weight)	Epoxy Resin	3.5	4.4	4.8	3.5
	Phenol Resin	3.8	4.8	5.2	3.8
	Thermoplastic Resin	4.0	5.0	7.2	4.0
	Inorganic Filler	88.0	85.0	82.0	88.0
	Silane Coupling Agent	0.3	0.3	0.3	0.3
	Carbon Black	0.3	0.3	0.3	0.3
	Curing Accelerator	0.1	0.2	0.2	0.1
Total		100.0	100.0	100.0	100.0
Content (% by volume) of Inorganic Filler in Thermally Curable Resin Layer		80.0	75.6	71.3	80.0

[0109]

[Evaluations]

The obtained sheets were used to perform the following evaluations.
The results are shown in Table 2.

[0110]

(Lifting of base)

The sheet was cut from the base side (polyethylene terephthalate film side) using a razor blade under an atmosphere of 25°C and the lifting of the protective layer was visually observed.

[0111]

(Appearance)

A resin sheet (size: 65 mm square, thickness: 200 μ m) was placed on SAW filters mounted on an alumina substrate (size: 70 mm square, thickness: 0.25 mm). The alumina substrate, the SAW filters, and the resin sheet were placed in a vacuum packaging container (three-way

alumina retort bag, color: white, HA-1013H, size: 100 mm × 130 mm) to be vacuum-packaged at 90°C in a condition of 1 torr. The alumina substrate, the SAW filters, and the resin sheet were heated with the vacuum packaging container at 150°C for 1 hour, and the SAW filters were covered with the thermally curable resin layer of the resin sheet to obtain a sealed body. The sealed body was further heated to cure the portion originated from the thermally curable resin layer of the sealed body. The protective film was peeled from the cured product of the sealed body, and the contamination level of the appearance of the cured product was visually evaluated.

[0112]

[Table 2]

(Sheet)

		Example 1	Example 2	Example 3	Comparative Example 1
Presence of Protective Film		Yes	Yes	Yes	No
Evaluations	Lifting of Base	Good	Good	Good	-
	Appearance	Good	Good	Good	Poor

DESCRIPTION OF REFERENCE SIGNS

[0113]

- 1 Base
- 2 Pressure-sensitive adhesive layer
- 3 Thermally curable resin layer
- 4 Portion originated from thermally curable resin layer
- 5 Protective film
- 11 Sheet
- 12 LTCC substrate

- 13 SAW filter
- 13a Bump electrode
- 14 Hollow part
- 15 Sealed body
- 16 Cured body
- 17 Electronic device package
- 21 Vacuum packaging container

CLAIMS

1. A sheet for electronic device seal, comprising:
a protective film having a structure including a base and a pressure-sensitive adhesive layer laminated thereon, and
a thermally curable resin layer laminated on the pressure-sensitive adhesive layer.
2. The sheet for electronic device seal according to claim 1, wherein peeling strength when the protective film is peeled from the thermally curable resin layer under conditions of a temperature of 25°C, a tensile speed of 300 mm/sec, and a peeling angle of 180 degrees is 0.03 N/20 mm or more.
3. The sheet for electronic device seal according to claim 1 or 2, wherein the pressure-sensitive adhesive layer is at least one layer selected from the group consisting of an ultraviolet-ray curing-type pressure-sensitive adhesive layer, a thermally curable pressure-sensitive adhesive layer, and a thermally foamable pressure-sensitive adhesive layer.
4. The sheet for electronic device seal according to any of claims 1 to 3, wherein the thermally curable resin layer contains an inorganic filler,

wherein the content of the inorganic filler in the thermally curable resin layer is 70% by volume to 90% by volume.

5. A method for manufacturing an electronic device package, comprising the steps of:

preparing a sheet having a protective film having a structure including a base and a pressure-sensitive adhesive layer laminated thereon, and a thermally curable resin layer laminated on the pressure-sensitive adhesive layer;

placing the sheet on the electronic device so that the thermally curable resin layer faces the electronic device;

sealing the electronic device with the thermally curable resin layer to form a sealed body;

curing a portion originated from the thermally curable resin layer of the sealed body to form a cured body; and

peeling the protective film from the cured body.

6. The method for manufacturing an electronic device package according to claim 5,

wherein the pressure-sensitive adhesive layer is an ultraviolet-ray curing-type pressure-sensitive adhesive layer, and

the method further comprises the step of curing the ultraviolet-ray curing-type pressure-sensitive adhesive layer before the step of peeling the protective film from the cured body.

7. The method for manufacturing an electronic device package

according to claim 5,

wherein the pressure-sensitive adhesive layer is a thermally curable pressure-sensitive adhesive layer, and

the method further comprises the step of curing the thermally curable pressure-sensitive adhesive layer before the step of peeling the protective film from the cured body.

8. The method for manufacturing an electronic device package according to claim 5,

wherein the pressure-sensitive adhesive layer is a thermally foamable pressure-sensitive adhesive layer, and

the method further comprises the step of foaming the thermally foamable pressure-sensitive adhesive layer before the step of peeling the protective film from the cured body.