

DESCRIPTION

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

TECHNICAL FIELD

[0001]

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

BACKGROUND ART

[0002]

As a method for manufacturing an electronic device package, the following method has been hitherto known: a method in which one or more electronic devices fixed to, for example, a substrate are sealed with a sealing resin. As such a sealing resin, for example, a thermosetting resin sheet is known (see, for example, Patent Document 1).

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0003]

Patent Document 1: JP-A-2006-19714

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004]

Electronic devices used in smartphones and others operate at a high speed, so that the electronic devices and the periphery thereof easily become high in temperature (hot spots are easily generated). When the electronic devices become high in temperature, the devices may turn unstable in operation or may be deteriorated in properties.

[0005]

However, in Patent Document 1, no investigations are made about a solution to the hot spots, so that a thermosetting resin sheet described in Patent Document 1 cannot eliminate the hot spots.

[0006]

An object of the present invention is to solve the problem to provide an electronic device sealing resin sheet which makes it possible to release heat from the electronic device to the substrate, and a method for manufacturing an electronic device package.

MEANS FOR SOLVING THE PROBLEM

[0007]

The present invention relates to an electronic device sealing resin sheet, including a first resin layer and a second

resin layer, wherein the first resin layer has a thermal conductivity of 1 W/mK or more.

[0008]

By sealing an electronic device with the electronic device sealing resin sheet of the present invention, heat from the electronic device can be released through the first resin layer, which is high in thermal conductivity, to the substrate, so that the heat can be released to the housing. Consequently, hot spots can be eliminated.

[0009]

In the electronic device sealing resin sheet of the present invention, the first resin layer, which is high in thermal conductivity, takes charge of releasing heat from the electronic device to the substrate. Thus, the second resin layer does not need to be heightened in thermal conductivity. In other words, it is unnecessary to blend thermally conductive particles of alumina or the like, which cause the abrasion of a dicing blade, in the whole of the resin sheet. Thus, the abrasion of the dicing blade can be decreased. Moreover, costs can be decreased.

[0010]

It is preferred that the first resin layer contains thermally conductive particles, and the content of the thermally conductive particles in the first resin layer is from 60 to 85% by volume. When the content of the thermally

conductive particles is in the range, the resin sheet can gain good wettability and good adhesion to the electronic device and the substrate while the thermal conductivity of the first resin layer can be heightened.

[0011]

It is preferred that the thermally conductive particles are alumina and/or boron nitride. In this case, the first resin layer can gain good thermal conductivity and good fluidity.

[0012]

It is preferred that a resin layer is formed in a region of the first resin layer which is to be diced, and this resin layer is a layer in which the content of the thermally conductive particles is 30% by volume or less. The thermally conductive particles (particularly, alumina) are very hard to cause abrasion of the dicing blade. However, the abrasion of the dicing blade can be decreased by laying the resin layer, in which the content of the thermally conductive particles is small or zero, in the region of the first resin layer which is to be diced.

[0013]

The present invention also relates to a method for manufacturing an electronic device package, including the step of sealing an electronic device with the above-mentioned electronic device sealing resin sheet to bring the first resin layer into contact with the electronic device.

[0014]

In the electronic device package obtained by this method, the first resin layer, which is high in thermal conductivity, contacts the electronic device, so that heat generated in the electronic device can be released to the substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a schematic sectional view of a resin sheet of Embodiment 1.

Fig. 2 is a schematic sectional view of a substrate on which electronic devices are mounted.

Fig. 3 is a drawing that schematically illustrates a situation that the electronic devices are sealed with the resin sheet of Embodiment 1.

Fig. 4 is a drawing that schematically illustrates a situation that a package of the electronic devices is diced.

Fig. 5 is a drawing that schematically illustrates a situation that any one of the electronic device packages, which is in a chip form, is mounted on a substrate.

Fig. 6 is a drawing that schematically illustrates a situation that electronic devices are fixed to a pressure-sensitive adhesive sheet.

Fig. 7 is a drawing that schematically illustrates a situation that the electronic devices are sealed with a resin sheet.

Fig. 8 is a drawing that schematically illustrates a situation that the pressure-sensitive adhesive sheet is peeled off from the sealed body.

Fig. 9 is a drawing that schematically illustrates a cross section of the sealed body after the sealed body is ground.

Fig. 10 is a drawing that schematically illustrates a situation that re-interconnections and bumps are formed on the sealed body.

Fig. 11 is a drawing that schematically illustrates a situation that the sealed body is diced.

Fig. 12(a) is a schematic sectional view of a resin sheet of Embodiment 2, and Fig. 12(b) is a schematic bottom view thereof.

MODE FOR CARRYING OUT THE INVENTION

[0016]

Hereinafter, the present invention will be described in detail by way of embodiments thereof. However, the invention is not limited only to these embodiments.

[0017]

[Embodiment 1]

Fig. 1 is a schematic sectional view of a resin sheet 11 of Embodiment 1. The resin sheet 11 has a structure in which a first resin layer 1 and a second resin layer 2 are laminated on each other. Supports, such as polyethylene terephthalate

(PET) films, may be laid on both surfaces of the resin sheet 11, respectively. Release treatment may be applied to the supports in order that the supports can easily be peeled off from the resin sheet 11.

[0018]

The first resin layer 1 has a thermal conductivity of 1 W/mK or more. Since the thermal conductivity is 1 W/mK or more, heat from the electronic device can be released through the first resin layer, which is high in thermal conductivity, to the substrate. The thermal conductivity of the first resin layer 1 is preferably 3 W/mK or more. The upper limit of the thermal conductivity of the first resin layer 1 is not particularly limited, and is, for example, 15 W/mK or less.

[0019]

The first resin layer 1 is preferably an electric insulating layer.

[0020]

The first resin layer 1 preferably contains thermally conductive particles. In this case, the first resin layer 1 can be designed to have a thermal conductivity of 1 W/mK or more.

[0021]

The thermally conductive particles are not particularly limited, and are electric insulating particles of, for example, alumina (aluminum oxide), zinc oxide, magnesium oxide, boron nitride, magnesium hydroxide, aluminum nitride, or silicon

carbide. These materials may be used singly, or in any combination of two or more thereof. Alumina or boron nitride is particularly preferred since the material is high in thermal conductivity so that the first resin layer can gain good fluidity.

[0022]

The thermal conductivity of the thermally conductive particles is not particularly limited as far as the particles can give thermal conductivity to the first resin layer 1. The thermal conductivity is preferably 12 W/mK or more, more preferably 15 W/mK or more, even more preferably 25 W/mK or more. When the thermal conductivity is 12 W/mK or more, a thermal conductivity of 1 W/mK or more can easily be given to the first resin layer 1. The thermal conductivity of the thermally conductive particles is, for example, 200 W/mK or less.

[0023]

The particle shape of the thermally conductive particles is not particularly limited. Examples thereof include spherical, elliptically spherical, flat, acicular, fibrous, flake, spike and coil shapes. Out of these shapes, a spherical shape is preferred since the shape makes the particles excellent in dispersibility and better in filling factor.

[0024]

The content of the thermally conductive particles in the first resin layer 1 is preferably 55% by volume or more, more

preferably 60% by volume or more. When the content is 55% by volume or more, the first resin layer 1 can be heightened in thermal conductivity. In the meantime, the content of the thermally conductive particles is preferably 83% by volume or less, more preferably 70% by volume or less. When the content is 83% by volume or less, an adhesive component in the first resin layer 1 can be prevented from being relatively decreased, so that the resin sheet can secure wettability and adhesion to the electronic device and the substrate.

[0025]

The content of the thermally conductive particles can also be described using, as a unit thereof, the unit "% by weight." Typically, the content of alumina will be described using, as a unit thereof, the unit "% by weight."

Alumina usually has a specific gravity of 3.9 g/cm^3 ; thus, a preferred range of the content (% by weight) of alumina is, for example, as follows.

The content of alumina in the first resin layer 1 is preferably 83% by weight or more, more preferably 86% by weight or more. The content of alumina in the first resin layer 1 is preferably 95% by weight or less, more preferably 90% by weight or less.

[0026]

In the first resin layer 1, the particle size distribution preferably satisfies a relationship described below, this

distribution being obtained by measuring the thermally conductive particles by a laser diffraction scattering method when the total amount of the thermally conductive particles is set to 100% by volume.

More than 100 μm : 1% by volume or less

10 μm or less: 30% by volume or more and 70% by volume or less

1 μm or less: 10% by volume or more

[0027]

In the particle size distribution, the proportion of the particles having a particle diameter more than 100 μm is 1% by volume or less, preferably 0.5% by volume or less, more preferably 0.3% by volume or less. The lower limit of the proportion of the particles having a particle diameter more than 100 μm is preferably 0.01% by volume or more. The proportion of the particles having a particle diameter of 10 μm or less is from 30% by volume to 70% by volume (both inclusive), preferably from 35% by volume to 65% by volume (both inclusive), more preferably from 40% by volume to 60% by volume (both inclusive). Furthermore, the proportion of the particles having a particle diameter of 1 μm or less is 10% by volume or more, preferably 13% by volume or more, more preferably 15% by volume or more. The upper limit of the proportion of the particles having a particle diameter of 1 μm or less is preferably 40% by volume or less. When the particle size

distribution has the above-mentioned specific relationship, the particles can give a dilatancy-like effect to the resin in the vicinity of a hollow structure to restrain the resin appropriately from invading the hollow structure when the electronic device is sealed with the resin sheet. The particle size distribution can be derived by using a sample extracted at will from a population of the particles, and measuring the sample by use of a laser diffraction scattering type particle size distribution measuring instrument.

[0028]

The first resin layer 1 preferably contains an epoxy resin.

[0029]

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.

[0030]

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.

[0031]

The first resin layer 1 preferably contains a phenolic resin.

[0032]

The phenolic resin is not particularly limited as far as the resin causes a curing reaction with the epoxy resin. Examples thereof include phenol novolak resin, phenol aralkyl resin, biphenyl aralkyl resin, dicyclopentadiene type phenolic resin, cresol novolak resin, and resol resin. These phenolic resins may be used alone or in combination of two or more thereof.

[0033]

The phenolic resin is preferably a resin having a hydroxyl equivalent of 70 to 250 and a softening point of 50°C to 110°C from the viewpoint of the reactivity thereof with the epoxy resin. The phenolic resin is in particular preferably phenol novolak resin because the resin is high in curing reactivity. Moreover, from the viewpoint of the reliability, the phenolic resin is a low-hygroscopicity phenolic resin such as phenol aralkyl resin, or biphenyl aralkyl resin can be preferably used.

[0034]

The total content of the epoxy resin and the phenolic resin in the first resin layer 1 is preferably 5% by weight or more. When the content is 5% by weight or more, the resin sheet can gain a good adhering strength to an electronic device, a substrate and others. The total content of the epoxy resin and the phenolic resin in the first resin layer 1 is preferably 20% by weight or less. When the content is 20% by weight or less, the hygroscopicity of the resin sheet can be controlled to a low level.

[0035]

About the blend ratio between the epoxy resin and the phenolic resin, it is preferred from the viewpoint of curing reactivity that the blending is attained to set the total amount of the hydroxyl groups in the phenolic resin in the range of 0.7 to 1.5 equivalents per equivalent of the epoxy groups in the epoxy resin. The total amount is more preferably from 0.9 to 1.2 equivalents.

[0036]

The first resin layer 1 preferably contains a thermoplastic resin.

[0037]

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 block copolymer, and a methylmethacrylate-butadiene-styrene copolymer (MBS resin). These thermoplastic resins may be used alone or in combination of two or more thereof.

[0038]

The content of the thermoplastic resin in the first resin layer 1 is preferably 1% by weight or more. When the content is 1% by weight or more, the resin can give softness and flexibility thereto. The content of the thermoplastic resin in the first resin layer 1 is preferably 10% by weight or less. When the content is 10% by weight or less, the resin sheet satisfactorily gains an adhering strength to an electronic device, a substrate and others.

[0039]

The first resin layer 1 preferably contains a curing accelerator.

[0040]

The curing accelerator is not particularly limited as far as the accelerator advances the curing of the epoxy resin and the phenolic resin. Examples thereof include organic phosphorus compounds such as triphenylphosphine and

tetraphenylphosphonium tetraphenylborate; and imidazole compounds such as 2-phenyl-4,5-dihydroxymethylimidazole and 2-phenyl-4-methyl-5-hydroxymethylimidazole.

[0041]

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

[0042]

The first resin layer 1 may appropriately contain compounding agents that are other than the above-mentioned components and are generally used to produce a sealing resin. This layer may contain, for example, silica.

[0043]

The first resin layer 1 can be produced by an ordinary production method. For example, the above-mentioned individual components are dissolved or dispersed in a solvent (such as methyl ethyl ketone or ethyl acetate) to prepare a coating liquid, and the coating liquid is applied to a substrate separator. Thereafter, the coating film is dried. In this way, the first resin layer 1 can be produced.

[0044]

The thickness of the first resin layer 1 is preferably 200 μm or less, more preferably 100 μm or less. When the thickness is 100 μm or less, the abrasion of the dicing blade can be decreased. Moreover, the thickness of the first resin

layer 1 is preferably 40 μm or more, more preferably 50 μm or more. When the thickness is 40 μm or more, a thermal circuit (thermally conductive path) can be formed which is arranged in parallel with bumps or any other electric wiring.

[0045]

The thermal conductivity of the second resin layer 2 is not particularly limited, and is preferably lower than that of the first resin layer 1. This case makes it easy to release heat from the electronic device to the substrate.

[0046]

The thermal conductivity of the second resin layer 2 is preferably 3 W/mK or less, more preferably 1 W/mK or less. The lower limit of the thermal conductivity of the second resin layer 2 is not particularly limited, and is, for example, 0.5 W/mK or more.

[0047]

The second resin layer 2 may have electrical insulating property but does not have to have electrical insulating property, and preferably has electrical insulating property.

[0048]

The second resin layer 2 preferably contains an epoxy resin. The epoxy resin is preferably any one of the epoxy resins described about the first resin layer 1.

[0049]

The second resin layer 2 preferably contains a phenolic

resin. The phenolic resin is preferably any one of the phenolic resins described about the first resin layer 1.

[0050]

The total content of the epoxy resin and the phenolic resin in the second resin layer 2 is preferably 2% by weight or more. When the content is 2% by weight or more, the resultant cured product can gain a sufficient strength. The total content of the epoxy resin and the phenolic resin in the second resin layer 2 is preferably 20% by weight or less, more preferably 10% by weight or less. When the content is 20% by weight or less, the cured product can be made small in linear expansion coefficient and hygroscopicity.

[0051]

About the blend ratio between the epoxy resin and the phenolic resin, it is preferred from the viewpoint of curing reactivity that the blending is attained to set the total amount of the hydroxyl groups in the phenolic resin in the range of 0.7 to 1.5 equivalents per equivalent of the epoxy groups in the epoxy resin. The total amount is more preferably from 0.9 to 1.2 equivalents.

[0052]

The second resin layer 2 preferably contains a thermoplastic resin. The thermoplastic resin is preferably any one of the thermoplastic resins described about the first resin layer 1.

[0053]

The content of the thermoplastic resin in the second resin layer 2 is preferably 0.5% by weight or more, more preferably 1% by weight or more. When the content is 0.5% by weight or more, the second resin layer gains good flexibility. The content of the thermoplastic resin in the second resin layer is preferably 3.5% by weight or less. When the content is 3.5% by weight or less, the second resin layer gains good fluidity.

[0054]

The second resin layer 2 preferably contains a filler.

[0055]

The filler is not especially limited; however, an inorganic filler is preferable. 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, silica and alumina are preferable, and silica is more preferable because the linear expansion coefficient can be satisfactorily decreased. As silica, fused silica is preferable, and spherical fused silica is more preferable because of excellent fluidity.

[0056]

The filler has an average particle size of preferably 1 μm or more, and more preferably 5 μm or more. If the average particle size is 1 μm or more, the flexibility of the resin sheet can be easily achieved. The filler has an average particle size

of preferably 40 μm or less, and more preferably 30 μm or less. If the average particle size is 40 μm or less, the filler can be easily filled at a high rate.

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

[0057]

The filler is preferably a filler treated (pretreated) with a silane coupling agent. This case makes it possible to improve the filler in wettability with the resin to heighten the dispersibility of the filler.

[0058]

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

[0059]

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.

[0060]

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 phenolic resin

[0061]

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.

[0062]

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

[0063]

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 filler.

[0064]

The content of the filler in the second resin layer 2 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 linear expansion coefficient can be designed to be low. On the other hand, the content of the 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, flexibility, fluidity, and adhesion can be suitably obtained.

[0065]

The content of the filler can be also explained by using "% by weight" as a unit. The content of silica is explained typically by using "% by weight" as a unit.

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

That is, the content of silica in the second resin layer 2 is preferably 81% by weight or more, and more preferably 84% by weight or more. The content of silica in the second resin layer 2 is preferably 94% by weight or less, and more preferably 91% by weight or less.

[0066]

Alumina normally has a specific gravity of 3.9 g/cm³. Therefore, the preferred range of the content (% by weight) of alumina is as follows.

That is, the content of alumina in the second resin layer

2 is preferably 88% by weight or more, and more preferably 90% by weight or more. The content of alumina in the second resin layer 2 is preferably 97% by weight or less, and more preferably 95% by weight or less.

[0067]

The second resin layer 2 preferably contains a curing accelerator. The curing accelerator is preferably any one of the curing accelerators described about the first resin layer 1.

[0068]

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

[0069]

The second resin layer 2 may appropriately contain compounding agents that are other than the above-mentioned components and are generally used to produce a sealing resin. This layer may appropriately contain, for example, a flame retardant component, a pigment and/or a silane coupling agent.

[0070]

Examples of the flame retardant component include various kinds of metal hydroxides such as aluminum hydroxide, magnesium hydroxide, iron hydroxide, calcium hydroxide, tin hydroxide, and composite metal hydroxide; and a phosphazene compound. Among these, a phosphazene compound is preferable because it

has excellent flame retardance and excellent strength after curing.

[0071]

The pigment is not especially limited, and an example thereof includes carbon black.

[0072]

The method for producing the second resin layer 2 is not particularly limited, and is preferably a method of kneading the above-mentioned individual components (for example, the epoxy resin, the phenolic resin, the thermoplastic resin, the filler and the curing accelerator), and working the resultant kneaded product plastically into a sheet form. This method makes it possible to fill the filler into the layer at a high proportion and design the layer to have a low linear expansion coefficient.

[0073]

Specifically, the epoxy resin, the phenolic resin, the thermoplastic resin, the filler and the curing accelerator are melt-kneaded in a known kneading machine such as a mixing roller, a pressurizing kneader or an extruder to prepare a kneaded product, and the resultant kneaded product is plastically worked into a sheet form. About conditions for the kneading, the upper limit of the temperature is preferably 140°C or lower, more preferably 130°C or lower. The lower limit of the temperature is preferably not lower than the respective

softening points of the individual components and is, for example, 30°C or higher, preferably 50°C or higher. The kneading period is preferably from 1 to 30 minutes. The kneading is preferably performed under a reduced pressure condition (in a reduced pressure atmosphere). The pressure under the reduced pressure condition is, for example, from 1×10^{-4} to 0.1 kg/cm².

[0074]

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.

[0075]

The thickness of the second resin layer 2 is not particularly limited, and is preferably 20 μm or more, more preferably 50 μm or more. The thickness of the second resin

layer 2 is preferably 2000 μm or less, more preferably 1000 μm or less. When the thickness is in the range, the resin sheet makes it possible to seal an electronic device satisfactorily.

[0076]

The value of "thermal conductivity of the first resin layer 1"/"thermal conductivity of the second resin layer 2" (the ratio of thermal conductivity of the first resin layer 1 to thermal conductivity of the second resin layer 2) is preferably 2 or more, more preferably 3 or more. When the ratio is 2 or more, heat from the electronic device can be effectively released to the substrate. The upper limit of the value of "thermal conductivity of the first resin layer 1"/"thermal conductivity of the second resin layer 2" is not particularly limited, and is, for example, 10 or less.

[0077]

The value of "thickness of the first resin layer 1"/"thickness of the second resin layer 2" (the ratio of thickness of the first resin layer 1 to thickness of the second resin layer 2) is preferably 10 or less, more preferably 5 or less. When the value is 10 or less, the abrasion of the dicing blade can be decreased while heat from the electronic device can be effectively released to the substrate. The value of "thickness of the first resin layer 1"/"thickness of the second resin layer 2" is preferably 1 or more. When the value is 1 or more, warpage of the electronic device package can be

decreased.

[0078]

In Fig. 1, a case has been illustrated in which the first resin layer 1 has a monolayered structure. However, the first resin layer 1 is not limited to this case. Thus, the first resin layer 1 may have a multilayered structure. In Fig. 1, a case has been illustrated in which the second resin layer 2 has a monolayered structure. However, the second resin layer 2 is not limited to this case. Thus, the second resin layer 2 may have a multilayered structure.

[0079]

The resin sheet 11 is used to seal an electronic device. Examples of the electronic device include electronic devices each having a hollow structure (hollow electronic device packages), such as sensors, MEMS (micro electro mechanical systems) and SAW (surface acoustic wave) filters; semiconductor elements such as semiconductor chips, ICs (integrated circuits) and transistors; capacitors; and resistors. The hollow structure denotes a structure having a hollow between an electronic device and a substrate when the electronic device is mounted on the substrate.

[0080]

The method for the sealing is not particularly limited, and is, for example, a method of covering the electronic device mounted on a substrate with the resin sheet 11, or a method of

covering the electronic device mounted on a pressure-sensitive adhesive sheet with the resin sheet 11. The substrate is not particularly limited, and is, for example, a printed wiring board, a ceramic substrate, a silicon substrate, a metal substrate or a semiconductor wafer.

[0081]

In order to secure the thermally conductive path, it is important to bring the first resin layer 1 into contact with the electronic device.

[0082]

[Method for Manufacturing Electronic Device Package]

An electronic device package can be obtained by performing, for example, a process described below. The process is generally called a chip-on-wafer (COW) process.

[0083]

Electronic-Device-Mounted Substrate Providing Step:

In an electronic-device-mounted substrate providing step, a substrate 12 is provided on which a plurality of electronic devices 13 are mounted (see Fig. 2). In order to mount the electronic devices 13 on the substrate 12, a known apparatus such as a flip-chip bonder or a die bonder is usable. Usually, the electronic devices 13 are electrically connected to the substrate 12. In Fig. 2, an example is illustrated in which the electronic devices 13 are electrically connected to the substrate 12 through projected electrodes 13a such as bumps.

[0084]

When the electronic devices 13 are each a hollow electronic device such as a SAW filter, hollow regions (hollow structures) 14 are kept between the electronic devices 13 and the substrate 12. In this case, the distance between each of the electronic devices 13 and the substrate 12 is generally from about 15 to 50 μm .

[0085]

Sealing Step:

In a sealing step, the resin sheet 11 is laminated on the substrate 12 to bring the first resin layer 1 into contact with the substrate 12 and the electronic devices 13 to seal the electronic devices 13 with the resin sheet 11 (see Fig. 3). In this way, an electronic device package 15 is obtained in which the electronic devices 13 are sealed with the resin.

[0086]

The method for laminating the resin sheet 11 on the substrate 12 is not particularly limited, and the lamination can be attained by a known means, such as hot pressing or a laminator. About conditions for the hot pressing, the temperature is, for example, from 40 to 100°C, preferably from 50 to 90°C, the pressure is, for example, from 0.1 to 10 MPa, preferably from 0.5 to 8 MPa, and the period is, for example, from 0.3 to 10 minutes, preferably from 0.5 to 5 minutes. The pressing is preferably performed under a reduced pressure (of,

(
for example, 0.1 to 5 kPa), considering an improvement in the tackiness of the resin sheet 11 to the electronic devices 13 and the substrate 12 and the performance of the resin sheet 11 that the sheet 11 follows these members 12 and 13.

[0087]

Thermal Curing Step:

As required, the resin sheet 11 for the electronic device package 15 is thermally cured.

[0088]

About conditions for the thermal curing treatment, the heating temperature is preferably 100°C or higher, more preferably 120°C or higher. The upper limit of the heating temperature is preferably 200°C or lower, more preferably 180°C or lower. 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 or shorter, more preferably 120 minutes or shorter. As required, the resin sheet 11 may be pressured. The pressure is preferably 0.1 MPa or more, more preferably 0.5 MPa or more. The upper limit thereof is preferably 10 MPa or less, more preferably 5 MPa or less.

[0089]

Grinding Step:

As required, the resin sheet 11 of the electronic device package 15 is ground. The method for the grinding is, for example, a grinding method using a grinding stone rotatable at

a high speed.

[0090]

Wiring Layer Forming Step:

As required, the substrate 12 of the electronic device package 15 is ground. The method for the grinding is, for example, a grinding method using a grinding stone rotatable at a high speed. Next, vias are formed in the electronic device package 15 as required. Next, re-interconnections are formed on the electronic device package 15 as required. Next, bumps are formed on the re-interconnections as required.

[0091]

Dicing Step:

As required, the electronic device package 15 is diced (see Fig. 4). In this way, electronic device packages 16 that are each in a chip form can be obtained.

[0092]

Mounting-to-substrate Step:

As required, re-interconnections and bumps 17 are formed on the electronic device package 15, or each of the electronic device packages 16. The resultant is mounted on a substrate 18 (see Fig. 5).

[0093]

Laser Marking Step:

Laser marking may be applied to the electronic device package 15 or each of the electronic device packages 16 at any

timing. For example, laser marking may be applied to the electronic device package 15 before the thermal curing or may be applied to the electronic device package 15 after the thermal curing. Laser marking may be applied to the electronic device package 16.

[0094]

In the electronic device package 15 or the electronic device package 16, the first resin layer 1, which is high in thermal conductivity, contacts the electronic device(s) 13 so that heat generated in the electronic device(s) 13 can be released to the substrate 12 and others (for example, the substrate 12, the substrate 18 and a housing). Accordingly, hot spots can be eliminated.

[0095]

[Method for Manufacturing Electronic Device Package]

An electronic device package can be obtained also by performing, for example, a process described below. The process is suitable for manufacturing a Fan-out wafer level package (WLP).

[0096]

Step of Fixing Electronic Devices to Pressure-sensitive Adhesive Sheet:

A plurality of electronic devices 13 are initially fixed to a pressure-sensitive adhesive sheet 41 (see Fig. 6). At this time, as required, the electronic devices 13 are arranged and

fixed to cause a surface of each of the electronic devices 13 on which a circuit is to be formed to face the pressure-sensitive adhesive sheet 41. For the fixing of the electronic devices 13, a known apparatus such as a flip-chip bonder or a die bonder is usable.

[0097]

The pressure-sensitive adhesive sheet 41 usually has a support 42 and a pressure-sensitive adhesive layer 43 laminated on the support 42.

[0098]

The pressure-sensitive adhesive layer 43 is not particularly limited, and may be usually a thermally peelable pressure-sensitive adhesive layer, a radiation curable pressure-sensitive adhesive layer or some other since the layer can easily be peeled off. The material of the support 42 is not particularly limited. Examples thereof include metal materials such as SUS, and plastic materials such as polyimide, polyamideimide, polyetheretherketone and polyethersulfone.

[0099]

Sealing Step:

In a sealing step, the resin sheet 11 is laminated on the pressure-sensitive adhesive sheet 41 to bring the first resin layer 1 into contact with the pressure-sensitive adhesive sheet 41 and the electronic devices 13 to seal the electronic devices 13 with the resin sheet 11 (see Fig. 7). In this way, a sealed

body 51 is obtained in which the electronic devices 13 are sealed with the resin.

[0100]

The method for laminating the resin sheet 11 on the pressure-sensitive adhesive sheet 41 is not particularly limited, and the lamination can be attained by a known means, such as hot pressing or a laminator.

[0101]

Thermal Curing Step:

As required, the sealed body 51 is thermally cured (the resin sheet 11 of the sealed body 51 is thermally cured).

[0102]

Peeling-off Step:

Next, the pressure-sensitive adhesive sheet 41 is peeled off from the sealed body 51 (see Fig. 8). The method for the peeling is not particularly limited. It is preferred to lower the adhesive strength of the pressure-sensitive adhesive layer 43 and subsequently peel off the pressure-sensitive adhesive sheet 41. When the pressure-sensitive adhesive layer 43 is, for example, a thermally peelable pressure-sensitive adhesive layer, the pressure-sensitive adhesive sheet 41 is peeled off after the pressure-sensitive adhesive layer 43 is heated to be lowered in adhesive strength.

[0103]

Grinding Step:

As required, next, the resin sheet 11 of the sealed body 51 is ground (see Fig. 9). The method for the grinding is, for example, a grinding method using a grinding stone rotatable at a high speed.

[0104]

Wiring Layer Forming Step:

Next, re-interconnections 52 are formed on the sealed body 51 using, e.g., a semi-additive method (see Fig. 10).

[0105]

Subsequently, an electric insulating layer made of, e.g., polyimide or polybenzoxazole (PBO) is formed on the re-interconnection-52-formed surface of the sealed body 51. The electric insulating layer can be formed, for example, by laminating a film such as a dry film resist on the surface.

[0106]

Next, bumping is performed in which bumps 53 are formed on the re-interconnections 52. The bumping can be attained by a known means such as solder balls or solder plating.

[0107]

Dicing Step:

The sealed body 51 may be diced, which is composed of the electronic devices 13, the first resin layer 1, the re-interconnections 52 and others (see Fig. 11). The steps described hereinbefore can give electronic device packages 61 in each of which one or more of the interconnections are led

to the outside of a chip region. The sealed body 51 may be used, as it is, as an electronic device package without being diced.

[0108]

Mounting-to-substrate Step:

As required, the electronic device packages 61 are each mounted on a substrate.

[0109]

Laser Marking Step:

Laser marking may be applied to the sealed body 51 or each of the electronic device packages 61 at any timing. For example, laser marking may be applied to the sealed body 51 before the thermal curing, or may be applied to the sealed body 51 after the thermal curing. Laser marking may be applied to the electronic device package 61.

[0110]

In the electronic device package 61, the first resin layer 1, which is high in thermal conductivity, contacts the electronic device(s) 13 so that heat generated in the electronic device(s) 13 can be released to the substrate and others (for example, the substrate and a housing). Accordingly, hot spots can be eliminated. The heat generated in the electronic device 13 can be transmitted through the first resin layer 1, the re-interconnections 52, the bumps 53 and others to the substrate.

[0111]

The electronic device package 61 is favorably applicable to mounting methods such as package-on-package (PoP), system-in-package (SiP), and multichip-package (MCP). In the package-on-package (PoP), heat can be satisfactorily released using through mold vias (TMVs).

Modified Examples:

In Embodiment 1, the resin sheet 11 has been described, which has the first resin layer 1 and the second resin layer 2 laid on the first resin layer 1. In Modified Example 1, a resin sheet has a first resin layer 1, a third layer laid on the first resin layer 1, and a second resin layer 2 laid on the third layer. In Modified Example 2, a resin sheet has a first resin layer 1, a second resin layer 2 laid on the first resin layer 1, and a third layer laid on the second resin layer 2. The third layer is preferably, for example, a resin-containing layer or a metallic layer. The third layer may have a monolayered or multilayered structure.

[0112]

[Embodiment 2]

Fig. 12(a) is a schematic sectional view of a resin sheet 101 of Embodiment 2. Fig. 12(b) is a schematic bottom view thereof. The resin sheet 101 is identical with the resin sheet 11 in Embodiment 1 except that a resin layer 31 in which the content of thermally conductive particles is small or zero is formed in a region of the first resin layer 1 which is to be

diced (region to be diced).

[0113]

The thermally conductive particles (particularly, alumina) are very hard to cause abrasion of the dicing blade. However, the resin sheet 101 has the resin layer 31 in the region to be diced so that the abrasion of the dicing blade can be decreased. Additionally, in the first resin layer 1, any region other than the resin layer 31 is high in thermal conductivity so that the region can release heat from the electronic device to the substrate.

[0114]

The content of the thermally conductive particles in the resin layer 31 is 30% by volume or less, preferably 0% by volume. When the content is 30% by volume or less, the abrasion of the dicing blade can be decreased.

[0115]

The resin layer 31 preferably contains an epoxy resin. The epoxy resin is preferably any one of the epoxy resins described about the first resin layer 1.

[0116]

The resin layer 31 preferably contains a phenolic resin. The phenolic resin is preferably any one of the phenolic resins described about the first resin layer 1.

[0117]

About the blend ratio between the epoxy resin and the

phenolic resin, it is preferred from the viewpoint of curing reactivity that the blending is attained to set the total amount of the hydroxyl groups in the phenolic resin in the range of 0.7 to 1.5 equivalents per equivalent of the epoxy groups in the epoxy resin. The total amount is more preferably from 0.9 to 1.2 equivalents.

[0118]

The resin layer 31 preferably contains a thermoplastic resin. The thermoplastic resin is preferably any one of the thermoplastic resins described about the first resin layer 1.

[0119]

The resin layer 31 preferably contains a filler. The filler is preferably any one of the fillers described about the second resin layer 2.

[0120]

The resin layer 31 preferably contains a curing accelerator. The curing accelerator is preferably any one of the curing accelerators described about the first resin layer 1.

[0121]

The method for forming the resin layer 31 in the region to be diced of the first resin layer 1 is not particularly limited. The resin layer 31 can be formed, for example, by removing the resin layer in the region to be diced from the first resin layer 1 to form a space, filling the space with a solution for forming

the resin layer 31, and then drying the solution.

Modified Examples:

In Embodiment 2, the resin sheet 101 has been described, which has the first resin layer 1 and the second resin layer 2 laid on the first resin layer 1. In Modified Example 1, a resin sheet has a first resin layer 1, a third layer laid on the first resin layer 1, and a second resin layer 2 laid on the third layer. In Modified Example 2, a resin sheet has a first resin layer 1, a second resin layer 2 laid on the first resin layer 1, and a third layer laid on the second resin layer 2. The third layer is preferably, for example, a resin-containing layer or a metallic layer. The third layer may have a monolayered or multilayered structure.

EXAMPLES

[0122]

Hereinafter, preferred examples of this invention will be illustratively described in detail. However, about materials, blended amounts and others that are described in the examples, the scope of this invention is not limited only to these described matters unless the specification especially includes a restrictive description thereabout.

[0123]

A description is firstly made about components used in the examples.

[0124]

Components used to produce a first resin layer are described in the following:

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

Phenolic resin: MEH-7851-SS (phenolic resin having a biphenylaralkyl skeleton; hydroxyl equivalent: 203 g/eq., and softening point: 67°C) manufactured by Meiwa Plastic Industries, Ltd.

Thermoplastic resin: METABLEN C-132E (MBS resin; average particle diameter: 120 μm) manufactured by Mitsubishi Rayon Co., Ltd.

Thermally conductive particles: DAB-45SI (alumina; d50: 19.9 μm , and thermal conductivity: 30 W/mK) manufactured by Denka Co., Ltd.

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

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

[0125]

Components used to produce a second resin layer are described in the following:

Epoxy resin: YSLV-80XY (bisphenol F type epoxy resin;

epoxy equivalent: 200 g/eq., and softening point: 80°C)
manufactured by Nippon Steel Chemical Co., Ltd.

Phenolic resin: MEH-7851-SS (phenolic resin having a biphenylaralkyl skeleton; hydroxyl equivalent: 203 g/eq., and softening point: 67°C) manufactured by Meiwa Plastic Industries, Ltd.

Thermoplastic resin: METABLEN C-132E (MBS resin; average particle diameter: 120 μ m) manufactured by Mitsubishi Rayon Co., Ltd.

Filler: FB-9454FC (spherical fused silica; average particle diameter: 20 μ m) manufactured by Denka Co., Ltd.

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

Silane coupling agent-treated filler: treated filler obtained by treating the filler FB-9454FC (spherical fused silica; average primary particle diameter: 20 μ m) manufactured by Denka Co., Ltd. with the agent KBM-403 (3-glydoxypropyltrimethoxysilane) manufactured by Shin-Etsu Chemical Co., Ltd. (the treatment was conducted in a proportion of 0.5 part by weight of the agent KBM-403 for 87.9 parts by weight of the filler FB-9454FC)

Carbon black: #20 manufactured by Mitsubishi Chemical Corporation

Flame retardant: FP-100 (phosphazene compound)

manufactured by FUSHIMI Pharmaceutical Co., Ltd.

Curing accelerator: 2PHZ-PW

(2-phenyl-4,5-dihydroxymethylimidazole) manufactured by
Shikoku Chemicals Corporation

[0126]

[Examples, Reference Examples, and Comparative Example]

Production of Each First Resin Layer:

In each of the examples, individual components were blended with one another in accordance with blend proportions described in Table 1. To this blend was added methyl ethyl ketone in an amount equal to the total amount of the individual components to prepare a varnish. A comma coater was used to apply the resultant varnish to a release-treated surface of a 50 μm -thick polyester film A (MRF-50, manufactured by Mitsubishi Polyester Film, Inc.), and then the resultant was dried. Next, a release-treated surface of a 38 μm -thick polyester film B (MRF-38, manufactured by Mitsubishi Polyester Film, Inc.) was bonded to the dried varnish to produce a first resin layer (first resin layer thickness: 70 μm).

[0127]

The same varnish as used for each of the first resin layers was prepared except that a thermally conductive particle content described in Table 3 was used. From the first resin layer, the resin layer in its region to be diced was removed to form a space, and then the varnish was filled into the space.

The resultant was dried to form a resin layer in the region to be diced of the first resin layer.

[0128]

In other words, in the first resin layer, the resin layer in the region to be diced was different only in thermally conductive particle content from the resin layer in regions other than the region to be diced.

[0129]

[Table 1]

(First resin layer)

	Example 1	Example 2	Example 3	Example 4	Reference Example 1	Reference Example 2	Reference Example 3	Comparative Example 1
Blend proportions (part(s) by weight)	Epoxy resin	7.9	3.5	4.0	2.5	4.0	1.4	13.0
	Phenolic resin	7.9	3.5	4.0	2.5	4.0	1.4	13.0
	Thermoplastic resin	1.0	9.8	5.8	4.9	5.8	1.0	3.8
	Thermally conductive particles (alumina)	83.0	83.0	86.0	90.0	86.0	96.0	70.0
	Flame retardant	0.10	0.10	0.10	0.06	0.10	0.10	0.10
Total	Curing accelerator	0.10	0.10	0.10	0.06	0.10	0.10	0.10
		100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Content (% by volume) of thermally conductive particles in first resin layer	55%	55%	61%	69%	61%	86%	37%

[0130]

Production of Each Second Resin Layer:

Individual components were blended with one another in accordance with blend proportions described in Table 2. A roll kneader was used to melt-knead the blend at 60 to 120°C under a reduced pressure (0.01 kg/cm^2) for 10 minutes to prepare a kneaded product. Next, the resultant kneaded product was shaped into a sheet form by a flat plate pressing method to produce a second resin layer (second resin layer thickness: $130 \mu\text{m}$).

[0131]

[Table 2]

(Second resin layer)

	Example 1	Example 2	Example 3	Example 4	Reference Example 1	Reference Example 2	Reference Example 3	Comparative Example 1
Blend proportions (part(s) by weight)								
Epoxy resin	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Phenolic resin	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Thermoplastic resin	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Filler	0.0	0.0	0.0	0.0	94.7	0.0	0.0	0.0
Silane coupling agent-treated filler	94.7	94.7	94.7	94.7	0.0	94.7	94.7	94.7
Carbon black	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Flame retardant	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Curing accelerator	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Content (% by volume) of filler in second resin layer	89%	89%	89%	89%	95%	89%	89%	89%

[0132]

Production of Each Resin Sheet:

The polyester film A of the first resin layer was peeled off, and then a roll laminator was used to laminate the first resin layer on the second resin layer. In this way, a resin sheet was produced in which the first resin layer was laminated on the second resin layer.

[0133]

[Evaluations]

About the first resin layer, the second resin layer and the resin sheet of each of the examples, evaluations described below were made. The results are shown in Table 3.

[0134]

Thermal conductivity:

Samples (which were the first resin layer and the second resin layer) were each put in a drying machine and thermally treated at 175°C for 1 hour to be thermally cured. Thereafter, the thermal diffusivity α (m²/s) of the sample was measured by a TWA method (temperature wave analysis method; measuring instrument: ai-Phase Mobile, manufactured by ai-Phase Co., Ltd.). Next, the specific heat C_p (J/g·°C) of the sample was measured by a DSC method. The measurement of the specific heat was made at a heating rate of 10°C/minute and temperatures of 20 to 300°C using an instrument DSC6220 manufactured by SII NanoTechnology. On the basis of the resultant experimental

data, the specific heat was calculated in accordance with a JIS handbook (specific heat capacity measuring method K-7123). Furthermore, the specific gravity of the sample was measured.

[0135]

On the basis of the thermal diffusivity α , the specific heat C_p , and the specific gravity, the thermal conductivity of the sample was calculated in accordance with the following expression.

[Math. 1]

Thermal conductivity (W/m·K) = "thermal diffusivity (m^2/s)" $\times$ "specific heat ($\text{J/g}\cdot^\circ\text{C}$)" $\times$ "specific gravity (g/cm^3)"

[0136]

[Abrasion Lifespan of Dicing Blade]

The resin sheet was laminated on a ceramic substrate on which SAW filters (chip thickness: 200 μm , and bump height: 20 μm) were arranged in a matrix form, and the laminate was vacuum-pressed (ultimate vacuum: 6.65×10^2 Pa) at a temperature of 100°C and a pressure of 300 kPa for 1 minute. The laminate was then exposed to the atmosphere, and then the SAW filter package was allowed to stand in an oven of 130°C for 3 hours to cure the resin sheet. Thereafter, a dicing machine was used to divide the SAW filter package into individual packages. After the dicing, a contact type blade positioning function of the dicing machine (DFD6361, manufactured by DISCO Corporation) was used to measure and gain the abrasion amount of the dicing

blade. When the abrasion amount was less than 30 μm , the resin sheet was judged to be O; or when the amount was 30 μm or more, the resin sheet was judged to be x.

[0137]

[Softness/Flexibility]

The resin sheet was wound around a pipe made of stainless steel and having a diameter of 30 mm at a temperature of 25°C. In this case, when the resin sheet was cracked, the resin sheet was judged to be x; or when the resin sheet was not cracked, the resin sheet was judged to be O.

[0138]

[Thermal Diffusing Property (Hot Spot Area)]

The resin sheet was laminated on a ceramic substrate on which SAW filters (chip thickness: 200 μm , and bump height: 20 μm) were arranged in a matrix form, and the laminate was vacuum-pressed (ultimate vacuum: 6.65×10^2 Pa) at a temperature of 100°C and a pressure of 300 kPa for 1 minute. The laminate was then exposed to the atmosphere, and then the SAW filter package was allowed to stand in an oven of 130°C for 3 hours to cure the resin sheet. Thereafter, a dicing machine was used to divide the SAW filter package into individual packages.

A SAW filter tester was used to make a driving test of any one of the individual SAW filters. An infrared thermography was used to measure the temperature distribution (one or more hot spots) of the front surface of the SAW filter which was being

driven. When the temperature of the hot spot(s) was higher than the temperature of a lowest temperature region of the front surface of the package by a temperature less than 10°C, the resin sheet was judged to be O; or when the area of the hot spot(s) was higher by a temperature of 10°C or more, the resin sheet was judged to be x.

[0139]

[Adhesion to Element and Substrate]

Elements were cut into individual pieces of 5 mm × 5 mm, and any one of the resultant individual pieces was arranged on the front surface of the resin sheet. The resultant was vacuum-pressed (ultimate vacuum: 6.65×10^2 Pa) at a temperature of 100°C and a pressure of 300 kPa for 1 minute. Thereafter, the resultant was put in an oven of 130°C for 3 hours to cure the resin sheet. After the curing, a universal bond tester (Dage 4000) manufactured by Dage was used to measure the shear adhering strength of the element.

A substrate was cut into individual pieces of 5 mm × 5 mm, and any one of the resultant individual pieces was arranged on the front surface of the resin sheet. The resultant was vacuum-pressed (ultimate vacuum: 6.65×10^2 Pa) at a temperature of 100°C and a pressure of 300 kPa for 1 minute. Thereafter, the resultant was put in an oven of 130°C for 3 hours to cure the resin sheet. After the curing, the universal bond tester (Dage 4000) manufactured by Dage was used to measure the shear

adhering strength of the substrate.

When the shear adhering strength of the element was 8 MPa or more and the shear adhering strength of the substrate was 8 MPa or more, the resin sheet was judged to be O; or when the shear adhering strength of the element or the shear adhering strength of the substrate was less than 8 MPa, the resin sheet was judged to be x.

[0140]

[Table 3]

	Evaluations							
	Example 1	Example 2	Example 3	Example 4	Reference Example 1	Reference Example 2	Reference Example 3	Comparative Example 1
Content (% by volume) of thermally conductive particles in region to be diced	0	10	15	30	15	35	15	0
Thermal conductivity (W/mK) of first resin layer	1.5	1.5	2.0	3.2	2.0	2.0	4.0	0.9
Thermal conductivity (W/mK) of second resin layer	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Value of "thermal conductivity of first resin layer"/"thermal conductivity of second resin layer"	1.9	1.9	2.5	4.0	2.5	2.5	5.0	1.1
Abrasion lifespan of dicing blade	○	○	○	○	○	×	○	○
Softness/flexibility	○	○	○	○	×	○	○	○
Thermal diffusivity (temperature difference of hot spot(s))	○	○	○	○	○	○	○	×
Adhesion to element and substrate	○	○	○	○	○	○	×	○

DESCRIPTION OF REFERENCE SIGNS

[0141]

- 1: First resin layer
- 2: Second resin layer
- 11: Resin sheet
- 12: Substrate
- 13: Electronic device
- 13a: Projected electrode
- 14: Hollow region
- 15, 16: Electronic device package
- 17: Bump
- 18: Substrate
- 41: Pressure-sensitive adhesive sheet
- 42: Support
- 43: Pressure-sensitive adhesive layer
- 51: Sealed body
- 52: Re-interconnection
- 53: Bump
- 61: Electronic device package
- 101: Resin sheet

CLAIMS

1. An electronic device sealing resin sheet,
comprising a first resin layer and a second resin layer,
5 wherein the first resin layer has a thermal
conductivity of 1 W/mK or more; and
wherein in a region of the first resin layer which is
to be diced, a resin layer is formed, the resin layer being
a layer in which the content of the thermally conductive
10 particles is 30% by volume or less.
2. The electronic device sealing resin sheet
according to claim 1,
wherein the first resin layer comprises thermally
15 conductive particles, and
the content of the thermally conductive particles in
the first resin layer is from 55 to 83% by volume.
3. The electronic device sealing resin sheet
20 according to claim 1 or 2, wherein the thermally conductive
particles are alumina and/or boron nitride.
4. A method for manufacturing an electronic device
package, comprising the step of sealing an electronic
25 device with the electronic device sealing resin sheet
recited in any one of claims 1 to 3 to bring the first
resin layer into contact with the electronic device.