

DESCRIPTION

TITLE OF THE INVENTION: RESIN SHEET FOR SEALING ELECTRONIC
DEVICE 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]

In order to give various pieces of information (for example, character information pieces such as a product number, and figure information pieces such as a two-dimensional code) to an electronic device package, laser marking is sometimes applied to the electronic device package. However, a thermosetting resin sheet generally contains a large proportion of a filler; thus, the proportion of colorants (such as carbon black and a dye) that are vaporized by irradiation with a laser is small therein. It is also difficult to engrave the thermosetting resin sheet deeply by the irradiation with the laser because of the highly-filled filler. For such reasons, it is difficult that the thermosetting resin sheet gains, therein, a high contrast, so that a mark excellent in visibility is not easily formed on the thermosetting resin sheet.

[0005]

An object of the present invention is to solve the problem to provide an electronic device sealing resin sheet that is capable of forming a mark excellent in visibility by laser marking, and a method for manufacturing an electronic device package.

MEANS FOR SOLVING THE PROBLEM

[0006]

The present invention relates to an electronic device sealing resin sheet including a first resin layer and a second resin layer, wherein between a marked region obtained after laser marking is applied to the first resin layer and a region other than the marked region, a contrast of 20% or more is shown.

[0007]

The electronic device sealing resin sheet of the present invention has the first resin layer in which between the marked region and the non-marked region the contrast is 20% or more. For this reason, the application of laser marking to the first resin layer makes it possible to form a mark excellent in visibility.

[0008]

In the electronic device sealing resin sheet of the present invention, it is unnecessary to heighten a contrast in the second resin layer, so that a filler can be filled into the second resin layer in a high proportion. Thus, the resin sheet makes it possible to decrease warpage of an electronic device package.

[0009]

It is preferred that the content of the filler in the first resin layer is 76% by volume or less. When the content is 76% by volume or less, the first resin layer can gain a high contrast.

[0010]

It is preferred that the first resin layer contains carbon

black, and the content of the carbon black in the first resin layer is from 0.1 to 2% by weight. When the content is in this range, the first resin layer can gain a good contrast.

[0011]

It is preferred that the first resin layer contains a dye, and the content of the dye in the first resin layer is from 0.1 to 2% by weight. When the content is in this range, the first resin layer can gain a good contrast.

[0012]

It is preferred that the second resin layer is obtained by kneading. This case makes it possible to produce the second resin layer without using any solvent, so that any surface of the resin sheet can be prevented from being deformed by the volatilization of the solvent.

[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.

[0014]

The method for manufacturing an electronic device package preferably includes the step of applying laser marking to the first resin layer after the electronic device is sealed.

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 an electronic device package is diced.

Fig. 5 is a drawing that schematically illustrates a situation that a chip-form electronic device package 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 a 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.

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]

In the first resin layer 1, a contrast of 20% or more is shown between a marked region obtained after laser marking is applied to this layer and any region other than the marked region. The lower limit of the contrast is preferably 25%, and is

preferably 30% or more. As the contrast is larger, a more preferred result is obtained. The upper limit is, for example, 60%, 100%, 150%, 200% or 250%. In the first resin layer 1, between the marked region obtained after the laser marking and the region other than the marked region, the contrast is 20% or more; thus, the first resin layer 1 has an excellent contrast so that various information pieces (such as character information pieces and figure information pieces) given to the layer by the laser marking are good in visibility.

[0019]

The contrast is obtained by using CV-5000 manufactured by Keyence Corporation to measure the brightness of the marked region of the first resin layer 1 and the brightness of a site (non-marked region) of this layer other than the marked region, and then making a calculation in accordance with the following calculation formula:

$$\left[\frac{(\text{"Brightness of the marked region"} - \text{"brightness of the non-marked region"})}{\text{"brightness of the marked region"}} \right] \times 100$$

(%)

[0020]

When the laser marking is performed, a known laser marking device is usable. The laser may be a laser that may be of various types, such as a gas laser, a solid laser and a liquid laser. Specifically, the gas laser is not particularly limited, and may be a known gas laser, preferred examples thereof including

carbon dioxide laser (CO₂ laser) and excimer lasers (such as ArF laser, KrF laser, XeCl laser, and XeF laser). The solid laser is not particularly limited, and may be a known solid laser, preferred examples thereof including YAG lasers (such as Nd:YAG laser) and YVO₄ laser.

[0021]

When the laser marking is performed, conditions for radiating the laser may be appropriately set, considering the contrast between the marked region and the region other than the marked region, the worked depth of the first resin layer, and others. In the case of using, for example, a laser marking device (trade name "MD-S9900") manufactured by Keyence Corporation, the conditions may be set in the following scope.

Laser Radiating Conditions:

Wavelength: 532 nm

Intensity: 1.0 W

Scanning speed: 700 mm/sec

Q switch frequency: 64 kHz

[0022]

The etching proportion (engraved depth of the marked region) of the first resin layer 1 is preferably 80% or more, more preferably 100% or more. When the proportion is 80% or more, a clear difference in brightness is generated between the marked region and the non-marked region so that the layer can gain a good contrast. The etching proportion of the first resin

layer 1 is preferably 1000% or less, more preferably 800% or less. When the proportion is 1000% or less, the marked region becomes minute and fine so that the first resin layer can gain a good contrast.

The etching proportion is measurable by a method described in the item "EXAMPLES."

[0023]

The first resin layer 1 may contain a filler, but does not have to contain a filler.

[0024]

The filler is not particularly limited, and is preferably an inorganic filler. Examples of the inorganic filler include quartz glass, talc, silica (such as fused silica or crystalline silica), alumina, aluminum nitride, silicon nitride, and boron nitride. Out of these examples, silica and alumina are preferred and silica is more preferred since these fillers make it possible to decrease the first resin layer 1 satisfactorily in linear expansion coefficient. The silica is preferably fused silica, more preferably spherical fused silica.

[0025]

The average particle diameter of the filler is preferably 0.1 μm or more, more preferably 0.4 μm or more. When the average particle diameter is 0.1 μm or more, the resin sheet can easily gain flexibility and softness. The average particle diameter of the filler is preferably 40 μm or less, more preferably 30

μm or less.

The average particle diameter of particles can be derived, for example, by using a sample extracted at will from a population thereof, and measuring the sample by use of a laser diffraction scattering type particle size distribution measuring instrument.

[0026]

In order to heighten the contrast, it is more preferred that the content of the filler in the first resin layer 1 is smaller. The filler content in the first resin layer 1 is preferably 76% by volume or less, more preferably 70% by volume or less. When the content is 76% by volume or less, the first resin layer 1 can gain a high contrast. The filler content in the first resin layer 1 is more preferably 0% by volume. When the content is 0% by volume, through holes can easily be made in the first resin layer 1 by the laser.

[0027]

The filler content can also be described using, as a unit thereof, the unit "% by weight." Typically, the silica content will be described using, as a unit thereof, the unit "% by weight."

Silica usually has a specific gravity of 2.2 g/cm³; thus, a preferred range of the silica content (% by weight) is, for example, as follows.

The silica content in the first resin layer 1 is

preferably 86% by weight or less, more preferably 83% by weight or less.

[0028]

The first resin layer 1 preferably contains carbon black. This case makes it possible to heighten the contrast.

[0029]

The content of the carbon black in the first resin layer 1 is preferably 0.1% by weight or more. When the content is 0.1% by weight or more, the first resin layer 1 can gain a good contrast. The carbon black content in the first resin layer 1 is preferably 2% by weight or less. When the content is 2% by weight or less, the composition for the first resin layer 1 is good in fluidity to be easily molded.

[0030]

The first resin layer 1 preferably contains a dye. This case makes it possible to heighten the contrast.

[0031]

Examples of the dye include black dyes, cyan dyes, magenta dyes, and yellow dyes.

[0032]

Examples of the black dyes include C.I. Solvent Blacks 3, 7, 22, 27, 29, 34, 43, and 70; C.I. Direct Blacks 17, 19, 22, 32, 38, 51, and 71; C.I. Acid Blacks 1, 2, 24, 26, 31, 48, 52, 107, 109, 110, 119, and 154; and C.I. Disperse Blacks 1, 3, 10, and 24. Examples of the cyan dyes include C.I. Solvent

Blues 25, 36, 60, 70, 93, and 95; and C.I. Acid Blues 6 and 45. Examples of the magenta dyes include C.I. Solvent Reds 1, 3, 8, 23, 24, 25, 27, 30, 49, 52, 58, 63, 81, 82, 83, 84, 100, 109, 111, 121, and 122; C.I. Disperse Red 9; C.I. Solvent Violets 8, 13, 14, 21, and 27; C.I. Disperse Violet 1; C.I. Basic Reds 1, 2, 9, 12, 13, 14, 15, 17, 18, 22, 23, 24, 27, 29, 32, 34, 35, 36, 37, 38, 39, and 40; and C.I. Basic Violets 1, 3, 7, 10, 14, 15, 21, 25, 26, 27, and 28. Examples of the yellow dyes include C.I. Solvent Yellows 19, 44, 77, 79, 81, 82, 93, 98, 103, 104, 112, and 162.

[0033]

The content of the dye in the first resin layer 1 is preferably 0.1% by weight or more. When the content is 0.1% by weight or more, the first resin layer 1 can gain a good contrast. The dye content in the first resin layer 1 is preferably 2% by weight or less. When the content is 2% by weight or less, the dye-containing composition is good in fluidity to be easily molded.

[0034]

The first resin layer 1 preferably contains an epoxy resin.

[0035]

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.

[0036]

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.

[0037]

The first resin layer 1 preferably contains a phenolic resin.

[0038]

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.

[0039]

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.

[0040]

The total content of the epoxy resin and the phenolic resin in the first resin layer 1 is preferably 9% by weight or more. When the content is 9% by weight or more, the resultant cured product can gain a good strength. The total content of the epoxy resin and the phenolic resin in the first resin layer 1 is preferably 90% by weight or less. When the content is 90% by weight or less, the hygroscopicity of this layer can be controlled to a low level.

[0041]

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.

[0042]

The first resin layer 1 preferably contains a thermoplastic resin.

[0043]

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.

[0044]

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, softness and flexibility can be given to this layer. The content of the thermoplastic resin in the first resin layer 1 is preferably 16% by weight or less. When the content is 16% by weight or less, this layer becomes good in adhesion when cured, so that the resultant electronic device package is to be improved in reliability.

[0045]

The first resin layer 1 preferably contains a curing accelerator.

[0046]

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.

[0047]

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.

[0048]

The first resin layer 1 may appropriately contain, besides the above-mentioned components, one or more compounding agents that are generally used to produce a sealing resin.

[0049]

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.

[0050]

Since the second resin layer 2 can be increased in thickness, it is more preferred that the thickness of the first resin layer 1 is smaller. The thickness of the first resin layer 1 is preferably 100 μm or less, more preferably 30 μm or less. When the thickness is 30 μm or less, through holes can easily be made in this layer by a low power, so that the layer can gain a good contrast. The lower limit of the thickness of the first resin layer 1 is not particularly limited, and is, for example, 5 μm or more.

[0051]

The etching proportion of the second resin layer 2 is preferably 2% or more. When the proportion is 2% or more, through holes can be made in the resin sheet down to the second resin layer 2 even when the interface between the first resin layer 1 and the second resin layer 2 has irregularities, so that the resin sheet can gain a good contrast.

The etching proportion of the second resin layer 2 is preferably 20% or less, more preferably 10% or less. When the proportion is 20% or less, the marking becomes fine and minute so that the resin sheet can gain a good contrast.

[0052]

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.

[0053]

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.

[0054]

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. When the content is 20% by weight or less, the cured product can be made small in linear expansion coefficient and hygroscopicity.

[0055]

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.

[0056]

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.

[0057]

The content of the thermoplastic resin in the second resin layer 2 is preferably 0.5% 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 2 is preferably 20% by weight or less. When the content is 20% by weight or less, the second resin layer gains good fluidity.

[0058]

The second resin layer 2 preferably contains a filler. The filler is preferably any one of the fillers described about the first resin layer 1. Out of the fillers, silica is preferred since silica can give white color to the second resin layer 2. The white second resin layer 2 makes it easy to perceive a mark obtained when a through hole is made in the first resin layer 1 by a laser.

[0059]

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.

[0060]

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

[0061]

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.

[0062]

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

[0063]

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.

[0064]

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.

[0065]

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.

[0066]

The content of the filler in the second resin layer 2 is preferably 55% by volume or more, and more preferably 60% by volume or more. If the content is 55% 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.

[0067]

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 73% by weight or more, and more preferably 76% by weight or more. The content of silica in the second resin layer 2 is preferably 95% by weight or less, and more preferably 93% by weight or less.

[0068]

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

That is, the content of alumina in the second resin layer 2 is preferably 82% by weight or more, and more preferably 85% 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.

[0069]

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.

[0070]

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.

[0071]

The second resin layer 2 may appropriately contain, besides the above-mentioned components, one or more compounding agents that are generally used to produce a sealing resin, examples of the agent(s) including a flame retardant component, a silane coupling agent, carbon black, and dyes.

[0072]

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.

[0073]

As the total content of the carbon black and the dye in the second resin layer 2 is smaller, a more preferred result is obtained. Specifically, the total content is preferably 0% by weight.

[0074]

The method for producing the second resin layer 2 is not particularly limited. However, in the case of producing the second resin layer 2 by coating with a solvent, the solvent remaining in the second resin layer 2 vaporizes when the resin sheet 11 is thermally cured. Thus, the resultant gas enters

a gap between the second resin layer 2 and the first resin layer 1 so that the thickness of the resin sheet 11 is lowered in evenness or the front surface of the resin sheet 11 is slightly deformed. Consequently, it may become difficult to perceive the mark.

[0075]

Thus, the method for producing the second resin layer 2 is preferably a method of kneading the above-mentioned individual components (such as 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 produce the second resin layer 2 without using any solvent, so that the above-mentioned problems can be solved. A gas may be produced from the first resin layer 1. However, the first resin layer 1 is usually thinner than the second resin layer 2, so that the gas from the first resin layer 1 causes no problem.

[0076]

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.

[0077]

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.

[0078]

The thickness of the second resin layer 2 is not

particularly limited, and is preferably 100 μm or more, more preferably 150 μm or more, even more preferably 200 μm or more. When the thickness is 200 μm or more, a bad effect of the laser on the electronic device can be decreased. The thickness of the second resin layer 2 is not particularly limited, and further the thickness is preferably 1000 μm or less, more preferably 800 μm or less. When the thickness is 1000 μm or less, any ordinary electronic device can be satisfactorily sealed with the resin sheet.

[0079]

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 1/4 or less, more preferably 1/6 or less. When the value is 1/4 or less, a bad effect of the laser on the electronic device can be decreased. The lower limit of the value of "thickness of the first resin layer 1"/"thickness of the second resin layer 2" is not particularly limited, and is, for example, 1/40 or more.

[0080]

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.

[0081]

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 devices), 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.

[0082]

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 metallic substrate or a semiconductor wafer.

[0083]

[Method for Manufacturing Electronic Device Package]

An electronic device package can be obtained by performing, for example, a process described below.

[0084]

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 bump electrodes 13a such as bumps.

[0085]

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 .

[0086]

Sealing Step:

In a sealing step, the resin sheet 11 is laminated on the substrate 12 to bring the second resin layer 2 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.

[0087]

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.

[0088]

Thermal Curing Step:

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

[0089]

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.

[0090]

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.

[0091]

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.

[0092]

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.

[0093]

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).

[0094]

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.

[0095]

The laser marking is applied to regions of the first resin layer 1 of the electronic device package 15 or each of the electronic device packages 16.

[0096]

The electronic device package 15 and the electronic device package 16 each have the first resin layer 1, which is

high in contrast; thus, a mark excellent in visibility can be formed therein by the laser marking.

[0097]

In each of Figs. 2 to 5, an example is shown in which each electronic device package 16 has a first resin layer 1. However, the method for manufacturing an electronic device package is not limited thereto. For example, the first resin layer 1 may be removed through a grinding step.

[0098]

[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).

[0099]

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.

[0100]

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

[0101]

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.

[0102]

Sealing Step:

In a sealing step, the resin sheet 11 is laminated on the pressure-sensitive adhesive sheet 41 to bring the second resin layer 2 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.

[0103]

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.

[0104]

Thermal Curing Step:

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

[0105]

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.

[0106]

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.

[0107]

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).

[0108]

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.

[0109]

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.

[0110]

Dicing Step:

The sealed body 51 may be diced, which is composed of the electronic devices 13, the second resin layer 2, 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.

[0111]

Mounting-to-substrate Step:

As required, the electronic device packages 61 are each

mounted on a substrate.

[0112]

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.

[0113]

The laser marking is preferably applied to regions of the first resin layer 1 of the sealed body 51 or each of the electronic device packages 61.

[0114]

The sealed body 51 or the electronic device package 61 has the first resin layer 1, which is high in contrast; thus, a mark excellent in visibility can be formed therein by the laser marking.

[0115]

In each of Figs. 6 to 11, a case has been shown in which the first resin layer 1 is removed by grinding the sealed body 51. However, the method for manufacturing an electronic device package is not limited thereto. Thus, the first resin layer 1 may remain.

[0116]

In the method for manufacturing an electronic device package, the laser marked depth is preferably 80% or more of the thickness of the first resin layer 1. When the depth is 80% or more, the first resin layer 1 can gain a high contrast. The laser marked depth is more preferably 100%. When the laser marked depth is set to 100%, that is, a through hole is made in the first resin layer 1 by the laser, the second resin layer 2 is made naked so that the resultant mark is heightened in visibility.

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 layer laid on the first resin layer 1, and a second resin layer 2 laid on the layer. The layer is preferably, for example, a resin-containing layer or a metallic layer. The layer may have a monolayered or multilayered structure. 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 layer laid on the second resin layer 2. In Modified Example 2, the layer is preferably, for example, a resin-containing layer or a metallic layer, more preferably a resin-containing layer. In Modified Example 2, the layer may have a monolayered or multilayered structure.

EXAMPLES

[0117]

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.

[0118]

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

[0119]

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.

Filler: FB-9454FC (spherical fused silica; average

particle diameter: 20 μm) manufactured by Denka Co., Ltd.

Carbon black: #20 manufactured by Mitsubishi Chemical Corporation

Dye: OIL BLACK BS manufactured by Orient Chemical Industries Co., Ltd.

Curing accelerator: 2PHZ-PW
(2-phenyl-4,5-dihydroxymethylimidazole) manufactured by
Shikoku Chemicals Corporation
[0120]

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 μm) manufactured by Mitsubishi Rayon Co., Ltd.

Silane coupling agent-treated filler: treated filler obtained by treating a filler FB-9454FC (spherical fused silica; average primary particle diameter: 20 μm) manufactured by Denka Co., Ltd. with an agent KBM-403

(3-glycidoxypropyltrimethoxysilane) manufactured by Shin-Etsu Chemical Co., Ltd. (the treatment was conducted in a proportion of 0.5 part by weight of KBM-403 for 87.9 parts by weight of FB-9454FC)

Curing accelerator: 2PHZ-PW

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

[0121]

[Examples and Comparative Examples]

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.

[0122]

[Table 1]

(First resin layer)

		Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2
Blend proportions (part(s) by weight)	Epoxy resin	41.64	41.64	41.64	5.64	41.66	4.01
	Phenolic resin	42.26	42.26	42.26	5.72	42.29	4.07
	Thermoplastic resin	15.00	15.00	15.00	2.10	15.00	1.80
	Filler	-	-	-	86.00	-	88.00
	Carbon black	0.10	0.10	-	0.40	0.05	0.50
	Dye	-	-	0.10	-	-	-
	Curing accelerator	1.00	1.00	1.00	0.14	1.00	0.12
Total		100.0	100.0	100.0	100.0	100.0	98.5
Filler content (% by volume) in first resin layer		0	0	0	76	0	80

[0123]

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.

[0124]

[Table 2]

(Second resin layer)

		Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2
Blend proportions (part(s) by weight)	Epoxy resin	7.91	2.05	7.91	7.91	7.91	7.91
	Phenolic resin	8.02	2.08	8.02	8.02	8.02	8.02
	Thermoplastic resin	10.80	2.80	10.80	10.80	10.80	10.80
	Silane coupling agent-treated filler	73.00	93.00	73.00	73.00	73.00	73.00
	Curing accelerator	0.27	0.07	0.27	0.27	0.27	0.27
Total		100.0	100.0	100.0	100.0	100.0	100.0
Filler content (% by volume) in second resin layer		55	85	55	55	55	55

[0125]

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.

[0126]

Laser Marking:

Laser marking was applied to the first resin layer of the resin sheet to give characters and a two-dimensional code.

Conditions for the laser marking were as follows.

Laser marking device: trade name "MD-S9900" manufactured by Keyence Corporation

Wavelength: 532 nm

Intensity: 1.0 W

Scanning speed: 700 mm/sec

Q switch frequency: 64 kHz

The two-dimensional code obtained by the working was a code having a total size of about 4 mm × about 4 mm in which individual cells each had a size of 0.08 mm × 0.24 mm. The characters were produced without any especial limitation.

[0127]

[Evaluations]

About the laser-marked resin sheets of each of the

examples, evaluations described below were made. The results are shown in Table 3.

[0128]

Contrast:

An image processor (trade name "CV-5000" manufactured by Keyence Corporation) was used to measure the brightness of the marked region in any one of the resin sheets and the brightness of the non-marked region therein under a condition of a light quantity of 30%. The contrast was calculated in accordance with the following formula.

$$[(\text{"Brightness of the marked region"} - \text{"brightness of the non-marked region"}) / \text{brightness of the marked region}] \times 100 (\%)$$

[0129]

Visibility:

When each of the resin sheets was a resin sheet in which the characters formed by the laser marking were visually perceptible (visual distance: about 40 cm), and further the two-dimensional code was readable through a two-dimensional code reader (product name: "SR-600" manufactured by Keyence Corporation, the distance between the two-dimensional code and the two-dimensional code reader when the code was read: 10 cm or less), the resin sheet was judged to be O; or when the resin sheet was a resin sheet in which characters formed by the laser marking were not visually perceptible or the code was unreadable through the two-dimensional code reader, the resin sheet was

judged to be $\times$. The number of the resin sheets about which the evaluation was made was 10. The number of the resin sheets judged to be $\bigcirc$ was counted.

[0130]

Etching proportion:

Under the above-mentioned laser marking conditions, laser marking was applied to the first resin layer of any one of the resin sheets, and then a length-measuring microscope (STM6 manufactured by Olympus Corporation) was used to measure the engraved depth of the laser-marked region. The etching proportion obtained when a through hole is made by laser marking is regarded as 100%; under this presupposition, the etching proportion of the first resin layer was calculated.

Accordingly, when the first resin layer having a thickness of $20\text{ }\mu\text{m}$ has, for example, an engraved depth of $10\text{ }\mu\text{m}$, the etching proportion of the laser-marked region is 50%.

About the second resin layer too, the etching proportion was measured in the same way.

[0131]

[Table 3]

		Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2
Thickness (μm) of first resin layer		20	20	20	20	20	20
Thickness (μm) of second resin layer		180	180	180	180	180	180
Value of "first resin layer thickness"/"second resin layer thickness"		1/6	1/6	1/6	1/6	1/6	1/6
Evaluations	Contrast of first resin layer (%)	30	30	27	25	10	15
	Visibility (ratio of number of readable marks to number of total marks)	10/10	10/10	10/10	9/10	1/10	3/10
	Etching proportion of first resin layer (%)	100	100	100	80	100	50
	Etching proportion of second resin layer (%)	12	7	12	0	12	0

DESCRIPTION OF REFERENCE SINGS

[0132]

- 1: First resin layer
- 2: Second resin layer
- 11: Resin sheet
- 12: Substrate
- 13: Electronic device
- 13a: bump 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

CLAIMS

1. An electronic device sealing resin sheet, comprising a first resin layer and a second resin layer,

wherein between a marked region obtained after laser marking is applied to the first resin layer and a region other than the marked region, a contrast of 20% or more is shown.

2. The electronic device sealing resin sheet according to claim 1, wherein the content of the filler in the first resin layer is 76% by volume or less.

3. The electronic device sealing resin sheet according to claim 1 or 2, wherein the first resin layer comprises carbon black, and

the content of the carbon black in the first resin layer is from 0.1 to 2% by weight.

4. The electronic device sealing resin sheet according to any one of claims 1 to 3, wherein the first resin layer comprises a dye, and

the content of the dye in the first resin layer is from 0.1 to 2% by weight.

5. The electronic device sealing resin sheet according

to any one of claims 1 to 4, wherein the second resin layer is obtained by kneading.

6. A method for manufacturing an electronic device package, comprising the step of sealing an electronic device with the electronic device sealing resin sheet recited in any one of claims 1 to 5.

7. The method for manufacturing an electronic device package according to claim 6, comprising the step of applying laser marking to the first resin layer after the electronic device is sealed.