DESCRIPTION

Title of Invention

SEALING FILM, SEALED STRUCTURE, AND METHOD FOR MANUFACTURING SEALED STRUCTURE

Technical Field

[0001] The present invention relates to a sealing film, a sealed structure, and a method for manufacturing the sealed structure.

Background Art

[0002] In recent years, with the development of electronic devices made with the premise of being portable, as represented by smartphones and the like, the miniaturization and thinning of semiconductor devices has progressed. Similarly, there is an increasing demand for the miniaturization and thinning of the electronic component devices used in such devices. Therefore, various techniques for packaging electronic components having movable parts, such as surface acoustic wave (SAW) devices, are being investigated. A SAW device is an electronic component in which a comb-like electrode having regularity is formed on a piezoelectric thin film or a piezoelectric substrate, and which is capable of extracting an electric signal of a specific frequency band using surface acoustic waves.

[0003] In a case of packaging an electronic component which has such movable parts, it is necessary to provide space for ensuring the mobility of the movable parts. For example, in SAW devices, the formation of a hollow structure is essential since it is not possible to obtain the desired frequency characteristics when another substance is attached to the surface on which the comb-like electrode is formed.

[0004] In the related art, in order to form a hollow structure, a sealing method is performed in which ribs or the like are formed on a piezoelectric substrate and then covered with a lid (for example, Patent Literature 1). However, there is a problem with this method in that it is difficult to thin the electronic component device since the number of steps increases and the height of the sealing portion is high.

[0005] Therefore, a method has been proposed in which a hollow structure, in which a chip on which a comb-like electrode is formed is flip-chip mounted on a substrate via a bump, is prepared and the chip is sealed in a state where a hollow region is provided between the substrate and the chip (for example, Patent Literature 2 and 3).

Citation List

Patent Literature

[0006]

[Patent Literature 1] Japanese Unexamined Patent Publication No. 2002-16466

[Patent Literature 2] Japanese Patent No.4989402

[Patent Literature 3] Japanese Unexamined Patent Publication No. 2016-175976

Summary of Invention

Technical Problem

[0007] In a case where an object to be sealed is sealed in a state in which a hollow region is provided between a substrate and the object to be sealed, it is difficult to sufficiently suppress the inflow of a sealing material (the resin composition which forms the sealing film) into the hollow region while securing excellent embeddability with respect to

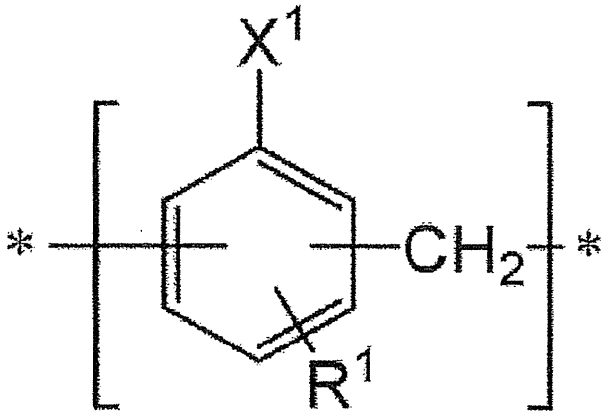
the object to be sealed. For example, in the techniques of Patent Literature 2 and 3, in a case of trying to ensure sufficient embeddability, the sealing material may enter into the hollow region between the base material and the object to be sealed.

[0008] Therefore, an object of the present invention is to provide a sealing film which is excellent in embeddability with respect to an object to be sealed and which is able to sufficiently suppress the inflow of a sealing material into a hollow region between a substrate and the object to be sealed, a sealed structure using the sealing film, and a method for manufacturing the sealed structure.

Solution to Problem

[0009] First, in consideration of adjusting the melt viscosity of a resin composition forming a sealing film to a desired range, the present inventors investigated adding an elastomer component to the resin composition, adjusting the blending amount of an inorganic filler, and the like. However, it was difficult to solve the problems described above simply by adjusting the melt viscosity to a desired range by these methods. The inventors of the present invention focused on the thermosetting resin and carried out further investigation and discovered that, by introducing a specific side chain group into the main skeleton of a specific thermosetting resin, control of the fluidity of the sealing film is made easy and it is possible to sufficiently suppress the inflow of a sealing material (resin composition which forms the sealing film) into the hollow region between a substrate and an object to be sealed while ensuring excellent embeddability with respect to the object to be sealed, thereby completing the present invention.

[0010] That is, one aspect of the present invention relates to a sealing film including a resin composition containing a thermosetting resin which has a structural unit represented by Formula (1), and an inorganic filler.



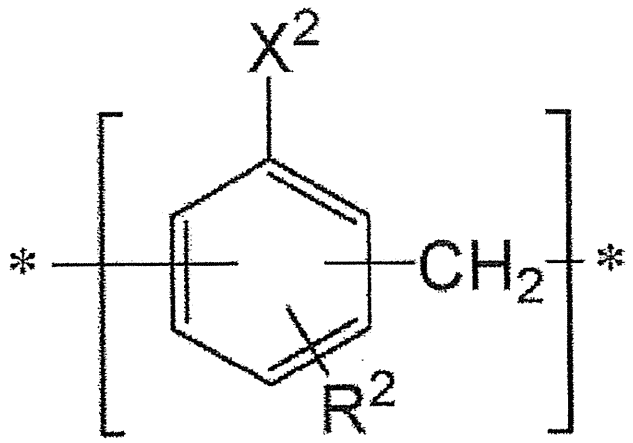
(1)

[In Formula (1), X^1 represents a reactive functional group and R^1 represents a hydrocarbon group having 2 to 25 carbon atoms.]

[0011] According to the sealing film described above, it is possible to sufficiently suppress the inflow of a sealing material into a hollow region between a substrate and an object to be sealed while securing excellent embeddability with respect to the object to be sealed. That is, according to the sealing film described above, it is possible to satisfy both embeddability and a hollow non-filling property. Furthermore, according to the sealing film described above, the glass transition temperature (Tg) after curing is easily made sufficient, and the reliability (heat reliability) of the sealed structure is easily improved.

[0012] The thermosetting resin described above may further have a structural unit represented by Formula (2). In such a case, it is possible to further improve the embeddability with respect to the object to be sealed while sufficiently maintaining the hollow non-filling

property.



(2)

[In Formula (2), X^2 represents a reactive functional group and R^2 represents a hydrogen atom or a phenyl group.]

[0013] X^1 described above may be a hydroxyl group. In such a case, the heat resistance and the flame retardance are excellent. In addition, it is possible to produce such a thermosetting resin at low cost.

[0014] The resin composition may further contain an epoxy resin. In such a case, the mechanical strength is excellent, the shrinkage during curing is small, and the dimensional stability is excellent. In addition, the heat resistance, water resistance, and chemical resistance are excellent, and the electrical insulation is excellent.

[0015] The content of the structural unit represented by Formula (1) in the thermosetting resin may be 20 mol% or more based on a total amount of the structural units forming the thermosetting resin. In such a case, it is possible to satisfy both embeddability and a hollow non-filling property at a higher level.

[0016] A weight average molecular weight of the thermosetting resin may be 500 or more. In such a case, it is possible to satisfy both

embeddability with respect to the object to be sealed and a hollow non-filling property at a higher level.

[0017] The film thickness of the sealing film may be 20 to 250 μm.

[0018] It is possible to favorably use the sealing film described above for uses which seal an object to be sealed, which is provided on a substrate via a bump.

[0019] One aspect of the present invention relates to a method for manufacturing a sealed structure including preparing a hollow structure including a substrate and an object to be sealed provided on the substrate via a bump, in which a hollow region is provided between the substrate and the object to be sealed; and sealing the object to be sealed with the sealing film of the present invention. According to this method, it is possible to obtain a sealed structure in which the object to be sealed is sufficiently embedded and the hollow region is sufficiently secured.

[0020] In the manufacturing method described above, the object to be sealed may be a SAW device having an electrode on the hollow region side. In the manufacturing method described above, it is possible to sufficiently embed the SAW device and to sufficiently suppress attachment of the sealing material to the surface having the electrode of the SAW device. Therefore, according to the manufacturing method, it is possible to improve the reliability of the SAW device. In addition, for the same reason, in the manufacturing method described above, it is possible to improve the yield in the manufacturing of a sealed structure (hollow sealed structure) provided with such an object to be sealed.

[0021] One aspect of the present invention relates to a sealed structure

including a substrate, an object to be sealed provided on the substrate via a bump, and a cured product of the sealing film of the present invention, which seals the object to be sealed, in which a hollow region is provided between the substrate and the object to be sealed. In this sealed structure, the object to be sealed is sufficiently embedded and the hollow region is sufficiently secured.

[0022] In the sealed structure, the object to be sealed may be a SAW device having an electrode on the hollow region side. In this sealed structure, the SAW device is sufficiently embedded and attachment of the sealing material to the surface having the electrode of the SAW device is sufficiently suppressed. Therefore, the reliability of the SAW device is excellent.

Advantageous Effects of Invention

[0023] According to the present invention, it is possible to provide a sealing film which is excellent in embeddability with respect to an object to be sealed and which is able to sufficiently suppress the inflow of a sealing material into a hollow region between a substrate and the object to be sealed, a sealed structure using the sealing film, and a method for manufacturing the sealed structure.

Brief Description of Drawings

[0024] FIG. 1 is a schematic cross-sectional view showing a sealing film with a support, which is provided with a sealing film of an embodiment.

FIG. 2 is a schematic cross-sectional view for illustrating an embodiment of a method for manufacturing a hollow sealed structure.

Description of Embodiments

[0025] In the present specification, a numerical value range indicated using "to" indicates a range including the numerical values described before and after "to" as the minimum value and the maximum value, respectively. The upper limit value or lower limit value of the numerical range of one step may be replaced with the upper limit value or lower limit value of the numerical range of another step, in the numerical ranges which are described for the steps in the present specification. In the numerical ranges described in the present specification, the upper limit value or the lower limit value of the numerical range may be replaced with values shown in Examples. "A or B" means that either A or B may be included, or both. The materials illustrated in the present specification may be used alone as one type or in a combination of two or more types, unless otherwise specified. In the present specification, in a case where there are a plurality of substances corresponding to each component in the composition, the content of each component in the composition means the total amount of the plurality of substances present in the composition unless otherwise specified.

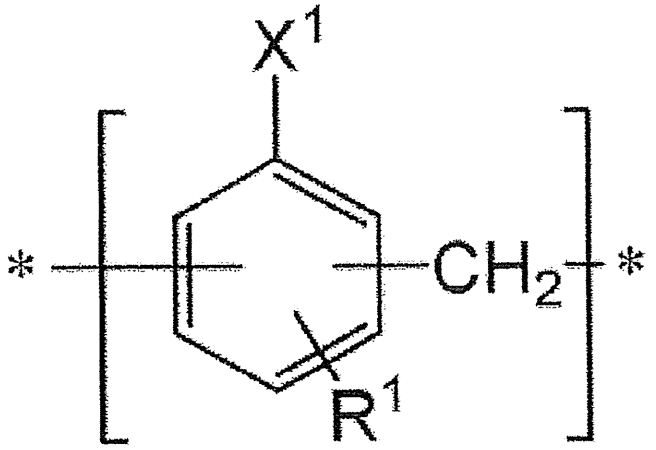
[0026] A description will be given below of favorable embodiments of the present invention with reference to the drawings.

[0027]

<Sealing Film>

The sealing film of the present embodiment is a film-like resin composition containing a thermosetting component and an inorganic filler. The sealing film of the present embodiment contains a thermosetting resin which has a structural unit represented by Formula

(1) as a thermosetting component.



(1)

[In Formula (1), X^1 represents a reactive functional group and R^1 represents a hydrocarbon group having 2 to 25 carbon atoms.]

[0028] The sealing film of the present embodiment is favorably used with respect to a hollow structure provided with a substrate, an object to be sealed (for example, an electronic component such as a SAW device) provided on the substrate, and a hollow region provided between the substrate and the object to be sealed. According to the sealing film of the present embodiment, it is possible to satisfy both embeddability with respect to the object to be sealed and a hollow non-filling property. The reason such an effect is obtained is not clear, but the present inventors speculate as follows. That is, in the sealing film of the present embodiment, the flow of the thermosetting resin in the sealing film is suppressed due to R_1 in the structural unit represented by Formula (1) becoming a steric hindrance and the flow of the resin composition into the hollow region is suppressed. On the other hand, since R_1 has an appropriate size and the steric hindrance is alleviated by the shear stress at the time of sealing, the embeddability with respect to

the object to be sealed is not inhibited. For this reason, it is speculated that the sealing film of the present embodiment obtains the effect described above.

[0029] Here, it is also considered that adding an excessive amount of elastomer to the sealing film prevents the inflow of the sealing material (in particular, the thermosetting resin) into the hollow region; however, in this method, not only may the embeddability be lowered in some cases, but the Tg after curing may also be lowered in some cases, and it is difficult to ensure the reliability (thermal reliability) of the sealed structure. On the other hand, in the sealing film of the present embodiment, since it is not necessary to use an excessive amount of elastomer, and, in addition, there is a structural unit represented by Formula (1), it is possible to sufficiently secure the Tg after curing.

[0030]

(Thermosetting Component)

Examples of the thermosetting component include a thermosetting resin, a curing agent, a curing accelerator, and the like. The thermosetting component may include a thermosetting resin without including a curing agent and/or a curing accelerator. In addition, the thermosetting component contains at least a thermosetting resin having a structural unit represented by Formula (1) (also referred to below as a “first thermosetting resin”); however, the thermosetting component may further contain other thermosetting resins other than the first thermosetting resin (also referred to below as a "second thermosetting resin").

[0031]

[First Thermosetting Resin]

The first thermosetting resin has at least a structural unit represented by Formula (1).

[0032] The reactive functional group represented by X^1 may be a functional group capable of reacting with other reactive functional groups due to heat. In the present embodiment, for example, the reactive functional group of the first thermosetting resin reacts with another reactive functional group due to heat to form a tertiary crosslinked structure and cure the sealing film. Examples of the reactive functional group include a hydroxyl group, an epoxy group, a carboxyl group, an isocyanate group, and the like. Among these, the reactive functional group is preferably a hydroxyl group (phenolic hydroxyl group) from the viewpoint of making cheap production possible and the viewpoint of excellent heat resistance and flame retardance. In other words, the first thermosetting resin preferably includes a phenol resin. The other reactive functional group which reacts with the reactive functional group may be a reactive functional group of the first thermosetting resin, a reactive functional group of the second thermosetting resin, or a reactive functional group of the curing agent.

[0033] The hydrocarbon group represented by R^1 may be linear or branched. In addition, the hydrocarbon group may be either saturated or unsaturated. In a case where the hydrocarbon group is an unsaturated hydrocarbon group, the unsaturated hydrocarbon group may have two or more unsaturated bonds.

[0034] From the viewpoint that the hollow non-filling property is more

favorable, the number of carbon atoms of the hydrocarbon group is preferably 4 or more, more preferably 8 or more, even more preferably 10 or more, and particularly preferably 15 or more. In particular, in a case where the number of carbon atoms of the hydrocarbon group is 15 or more, it is possible to reduce the elastic modulus and to improve the splitting property and the warpage. From the viewpoint that the embeddability is more favorable, the number of carbon atoms of the hydrocarbon group may be 22 or less, 20 or less, or 18 or less. It is possible to arbitrarily combine the upper limit value and the lower limit value described above. Accordingly, the number of carbon atoms of the hydrocarbon group may be, for example, 4 to 22, 8 to 20, 10 to 18, or 15 to 18. Here, in similar descriptions below, it is possible to arbitrarily combine the upper limit values and the lower limit values described individually.

[0035] In the present embodiment, the longer the main chain of the hydrocarbon group is, the more favorable the hollow non-filling property tends to be and the more the Tg after curing tends to be sufficient. From such a viewpoint, in a case where the hydrocarbon group is branched, the number of carbon atoms of the main chain of the branched hydrocarbon group may be 2 or more, 4 or more, or 6 or more. From the viewpoint that the embeddability is more favorable, the number of carbon atoms of the main chain of the branched hydrocarbon group may be 22 or less, 20 or less, or 18 or less.

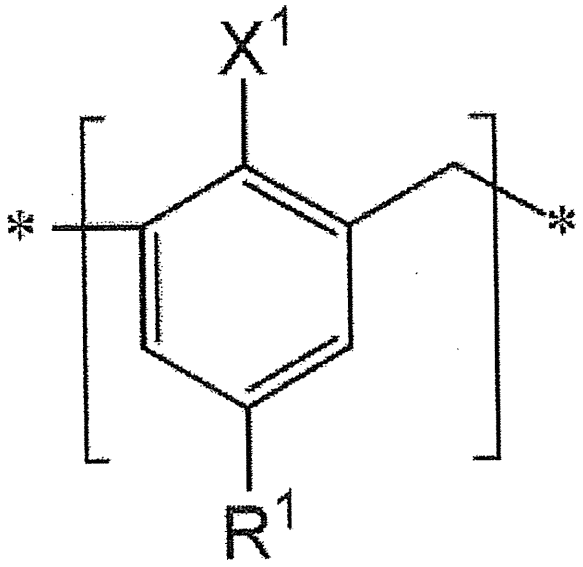
[0036] Examples of the linear hydrocarbon group include $-(CH_2)_{14}CH_3$, $-(CH_2)_7CH{=}CH(CH_2)_5CH_3$, $-(CH_2)_7CH{=}CHCH_2CH{=}CH(CH_2)_2CH_3$, $-(CH_2)_7CH{=}CHCH_2CH{=}CHCH{=}CHCH_3$,

$-(CH_2)_7CH{=}CHCH_2CH{=}CHCH_2CH{=}CH_2$, and the like.

[0037] Examples of branched hydrocarbon groups include $-C(CH_3)_2CH_3$, $-C(CH_3)_2CH_2C(CH_3)_2CH_3$, and the like.

[0038] The position of R^1 in Formula (1) may be any of an ortho position, a meta position, or a para position with respect to $-X^1$. From the viewpoint of being less likely to cause steric hindrance and excellent reactivity, the position of R^1 is preferably a para position with respect to the position of $-X^1$.

[0039] The position of the bond (-* and $-CH_2$-*) may be any of an ortho position, a meta position, or a para position with respect to $-X^1$. From the viewpoint of widening the range covered by R^1, the position of the bond is preferably an ortho position with respect to X^1. For example, the structural unit represented by Formula (1) may include the structural unit represented by Formula (1a).

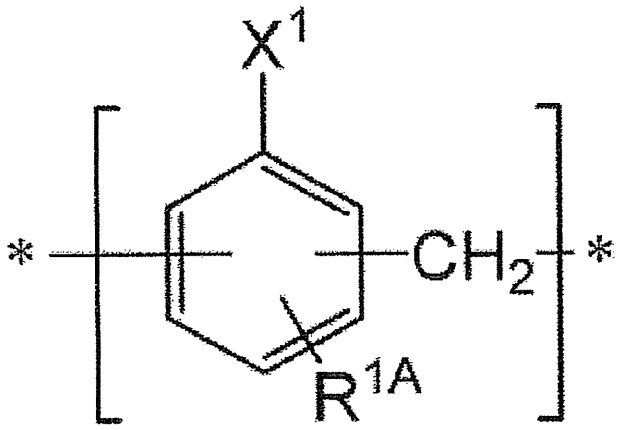


(1a)

[In Formula (1a), the same as X^1 in Formula (1) and R^1 is the same as R^1 in Formula (1).]

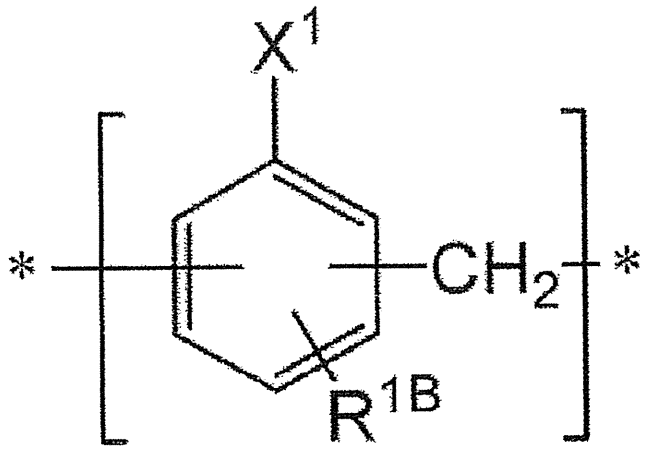
[0040] The first thermosetting resin may be formed only of the structural unit represented by Formula (1). In such a case, the structural unit represented by Formula (1) may be a plurality. In a case where the structural unit represented by Formula (1) is a plurality, a plurality of X^1 may be same or different, respectively, and a plurality of R^1 may be same or different, respectively. The first thermosetting resin may be, for example, a random copolymer formed of a plurality of different structural units or may be a block copolymer.

[0041] In a case where there are a plurality of structural units represented by Formula (1), the first thermosetting resin preferably includes a structural unit (1A), in which R^1 is a hydrocarbon group having 6 or more carbon atoms, and a structural unit (1B), in which R^1 is a hydrocarbon group having 5 or fewer carbon atoms.



(1A)

[In Formula (1A), X^1 is the same as X^1 in Formula (1) and R^{1A} represents a hydrocarbon group having 6 or more carbon atoms.]



(1B)

[In Formula (1B), X^1 is the same as X^1 in Formula (1) and R^{1B} represents a hydrocarbon group having 5 or less carbon atoms.]

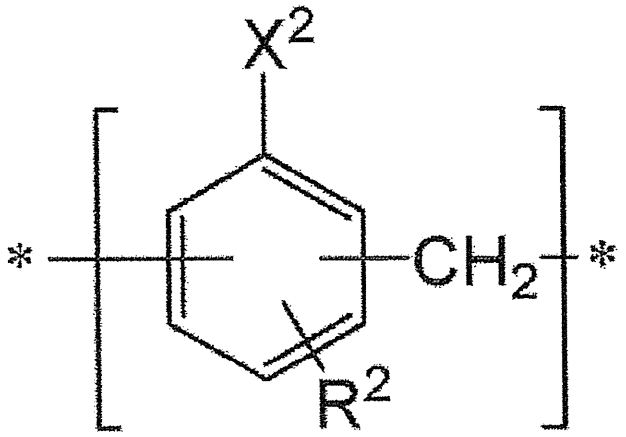
[0042] Among the structural units represented by Formula (1) in the first thermosetting resin, from the viewpoint that the hollow non-filling property is more favorable, the content of the structural unit (1A) may be 20 mol% or more, 30 mol% or more, or 40 mol% or more based on the total amount of structural units forming the thermosetting resin. From the viewpoint that the embeddability is more favorable, the content of the structural unit (1A) may be 100 mol% or less, 90 mol% or less, or 80 mol% or less based on the total amount of structural units forming the thermosetting resin. From these viewpoints, the content of the structural unit (1A) may be 20 to 100 mol%, 30 to 90 mol%, or 40 to 80 mol% based on the total amount of structural units forming the thermosetting resin.

[0043] Among the structural units represented by Formula (1) in the first thermosetting resin, from the viewpoint that the embeddability is more favorable, the content of the structural unit (1B) may be more than 0 mol%, 10 mol% or more, or 20 mol% or more based on the total

amount of structural units forming the thermosetting resin. From the viewpoint that the hollow non-filling property is more favorable, the content of the structural unit (1B) may be 80 mol% or less, 70 mol% or less, or 60 mol% or less based on the total amount of structural units forming the thermosetting resin. From these viewpoints, the content of the structural unit (1B) may be more than 0 mol% to 80 mol% or less, 10 to 70 mol%, or 20 to 60 mol% based on the total amount of structural units forming the thermosetting resin.

[0044] From the viewpoint of being able to satisfy both the embeddability with respect to the object to be sealed and the hollow non-filling property at a higher level, the molar ratio of the structural unit (1A) with respect to the structural unit (1B) may be 0.5 or more or may be 3.0 or less. Accordingly, the molar ratio of structural unit (1A) with respect to structural unit (1B) may be, for example, 0.5 to 3.0.

[0045] The first thermosetting resin may also have other structural units other than the structural unit represented by Formula (1). Examples of other structural units include the structural unit represented by following Formula (2).



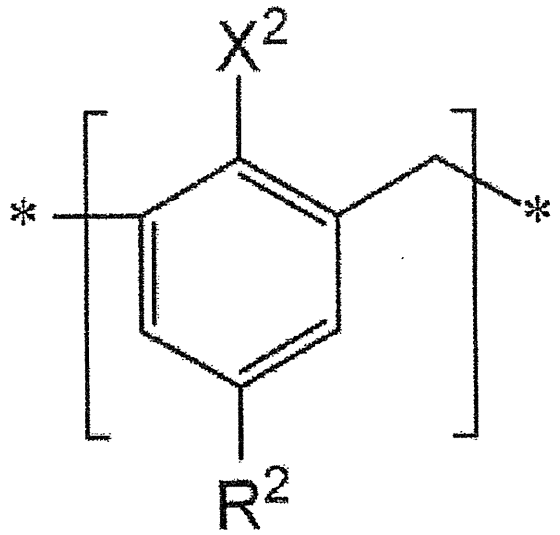
(2)

[In Formula (2), X^2 represents a reactive functional group and R^2 represents a hydrogen atom or a phenyl group. In a case where there is a plurality of the structural unit represented by Formula (2), a plurality of X^2 may be same or different, respectively, and a plurality of R^2 may be same or different, respectively.]

[0046] Examples of the reactive functional group represented by X^2 include the same examples as the examples of X^1 and the preferable examples thereof are also the same.

[0047] The position of R^2 in Formula (2) may be any of an ortho position, a meta position, or a para position with respect to $-X^2$. From the viewpoint of being less likely to cause steric hindrance and excellent reactivity, the position of R^2 is preferably a para position with respect to the position of $-X^2$.

[0048] The position of the bond (-* and $-CH_2-$*) may be an ortho position, a meta position, or a para position with respect to $-X^2$. From the viewpoint of reducing the volume of the thermosetting resin and improving the reactivity, the position of the bond is preferably in an ortho position with respect to $-X^2$. For example, the structural unit represented by Formula (2) may include the structural unit represented by Formula (2b).



(2b)

[In Formula (2b), X^2 is the same as X^2 in Formula (2) and R^2 is the same as R^2 in Formula (2).]

[0049] From the viewpoint that the hollow non-filling property is more favorable, the content of the structural unit represented by Formula (1) in the first thermosetting resin may be 20 mol% or more, 30 mol% or more, or 40 mol% or more based on the total amount of structural units forming the thermosetting resin. From the viewpoint that the embeddability is more favorable, the content of the structural unit represented by Formula (1) in the first thermosetting resin may be 100 mol% or less, 90 mol% or less, or 80 mol% or less based on the total amount of structural units forming the thermosetting resin. From these viewpoints, the content of the structural unit represented by Formula (1) in the first thermosetting resin may be 20 to 100 mol%, 30 to 90 mol%, or 40 to 80 mol% based on the total amount of structural units forming the thermosetting resin.

[0050] From the viewpoint that the embeddability is more favorable, the content of the structural unit represented by Formula (2) in the first

thermosetting resin may be more than 0 mol%, 10 mol% or more, or 20 mol% or more, based on the total amount of structural units forming the thermosetting resin. From the viewpoint that the hollow non-filling property is more favorable, the content of the structural unit represented by Formula (2) in the first thermosetting resin may be 80 mol% or less, 70 mol% or less, or 60 mol% or less based on the total amount of structural units forming the thermosetting resin. From these viewpoints, the content of the structural unit represented by Formula (2) in the first thermosetting resin may be more than 0 mol% to 80 mol% or less, 10 to 70 mol%, or 20 to 60 mol% based on the total amount of structural units forming the thermosetting resin.

[0051] From the viewpoint of being able to satisfy both the embeddability with respect to the object to be sealed and the hollow non-filling property at a higher level, the molar ratio of the structural unit represented by Formula (1) with respect to the structural unit represented by Formula (2) in the first thermosetting resin may be 0.5 or more or may be 3.0 or less. Accordingly, the molar ratio of the structural unit represented by Formula (1) with respect to the structural unit represented by Formula (2) may be, for example, 0.5 to 3.0.

[0052] From the viewpoint of being able to satisfy both the embeddability with respect to the object to be sealed and the hollow non-filling property at a higher level, the weight average molecular weight of the first thermosetting resin may be 500 to 1,000,000, 500 to 500,000, or 500 to 300,000. Here, the weight average molecular weight is a polystyrene conversion value using a calibration curve by standard polystyrene by a gel permeation chromatography method

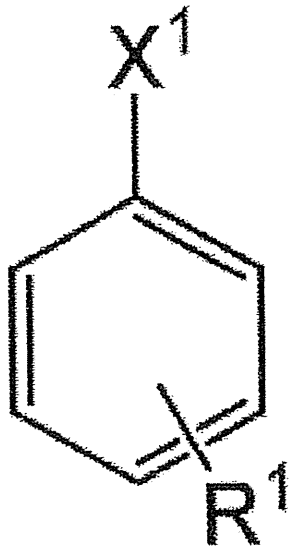
(GPC).

[0053] From the viewpoint of increasing a crosslinking point of the resin or increasing the Tg after curing, the reactive functional group equivalent of the first thermosetting resin may be 100 g/eq. or more, 110 g/eq. or more, 120 g/eq. or more, or 130 g/eq. or more, and, from the same viewpoint, 250 g/eq. or less, 240 g/eq. or less, 210 g/eq. or less, or 200 g/eq. or less. Accordingly, the reactive functional group equivalent of the first thermosetting resin may be, for example, 100 to 250 g/eq., 110 to 240 g/eq., 120 to 210 g/eq., or 130 to 200 g/eq. In addition, the "reactive functional group equivalent" means the mass (g/eq.) of the thermosetting resin per equivalent (1 eq.) of the reactive functional groups of the thermosetting resin. In a case where the reactive functional group is an epoxy group, the reactive functional group equivalent is, for example, measured by dissolving a thermosetting resin in chloroform, then adding acetic acid and tetraethyl ammonium bromide acetic acid solution to the obtained solution, carrying out potentiometric titration using a perchloric acid acetic acid standard solution, and detecting the end point at which all epoxy groups have reacted. In addition, in a case where the reactive functional group equivalent is a hydroxyl group, the measuring is carried out by adding an acetylation reagent to the thermosetting resin, carrying out heating in a glycerin bath, carrying out cooling, then adding a phenolphthalein solution as an indicator and carrying out titration with a potassium hydroxide ethanol solution.

[0054] From the viewpoint of easily suppressing the generation of splitting and cracks on the film surface, the first thermosetting resin may

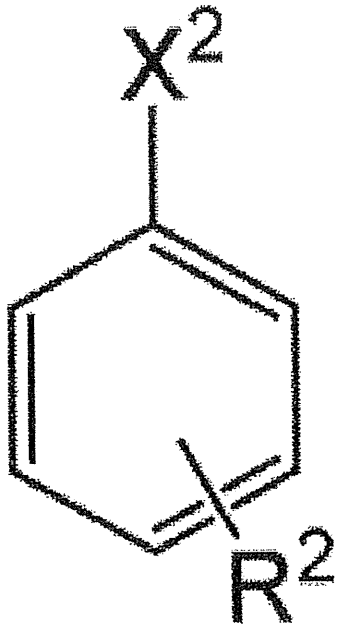
be a liquid at 25°C. "Liquid at 25°C" indicates that the viscosity at 25°C measured with an E-type viscometer is 400 Pa · s or less.

[0055] It is possible to obtain the resin having a structural unit represented by Formula (1), for example, by polymerizing a compound represented by Formula (3) by a method known in the related art. In addition, it is possible to obtain a resin having a structural unit represented by Formula (1) and a structural unit represented by Formula (2) by copolymerizing the compound represented by Formula (3) and the compound represented by Formula (4) by a method known in the related art.



(3)

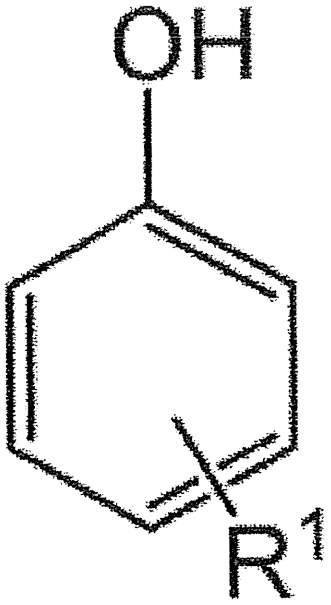
[In Formula (3), X^1 is the same as X^1 in Formula (1) and R^1 is the same as R^1 in Formula (1). The position of R^1 may be any of an ortho position, a meta position, or a para position with respect to $-X^1$.]



(4)

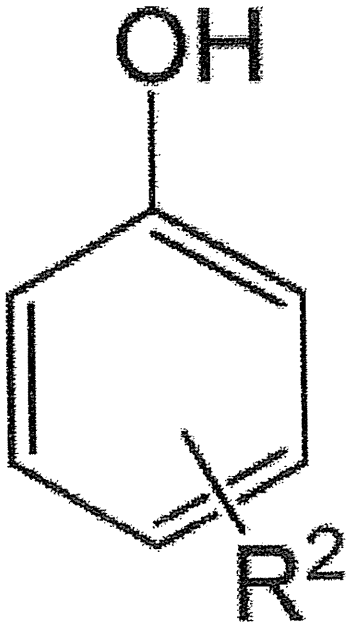
[In Formula (4), X^2 is the same as X^2 in Formula (2) and R^2 is the same as R^2 in Formula (2). The position of R^2 may be any of an ortho position, a meta position, or a para position with respect to $-X^2$.]

[0056] For example, in a case where X^1 is a hydroxyl group, it is possible to obtain the first thermosetting resin by reacting a substituent-containing phenol represented by Formula (3a), formaldehyde, and, in some cases, a substituent-containing phenol represented by Formula (4a). In the present embodiment, it is possible to adjust the content of each of the structural units of the first thermosetting resin by adjusting the usage amounts of the substituent-containing phenol represented by Formula (3a) and the substituent-containing phenol represented by Formula (4a), or the like.



(3a)

[In Formula (3a), R^1 is the same as R^1 in Formula (1). The position of R^1 may be any of an ortho position, a meta position, or a para position to -OH.]



(4a)

[In Formula (4a), R^2 is the same as R^2 in Formula (2). The position of

R^2 may be any of an ortho position, a meta position, or a para position to -OH.]

[0057] In addition, for example, in a case where X^1 is an epoxy group, it is possible to obtain the first thermosetting resin by reacting the substituent-containing phenol represented by Formula (3a) with epichlorohydrin in a 30% NaOH solution. In the present embodiment, it is possible to adjust the content of each of the structural units of the first thermosetting resin by adjusting the usage amounts of the substituent-containing phenol represented by Formula (3a) and the substituent-containing phenol represented by Formula (4a) or the like.

[0058] From the viewpoint that the hollow non-filling property is more favorable, the content of the first thermosetting resin may be 1% by mass or more, 3% by mass or more, or 5% by mass or more based on the total mass of the sealing film. From the viewpoint that the embeddability is more favorable, the content of the first thermosetting resin may be 50% by mass or less, 30% by mass or less, or 10% by mass or less based on the total mass of the sealing film. Accordingly, the content of the first thermosetting resin may be, for example, 1 to 50% by mass, 3 to 30% by mass, or 5 to 10% by mass based on the total mass of the sealing film.

[0059]

[Second Thermosetting Resin]

Examples of the second thermosetting resin include epoxy resin, phenol resin, phenoxy resin, cyanate resin, thermosetting polyimide, melamine resin, urea resin, unsaturated polyester, alkyd resin, polyurethane, and the like. The reactive functional group of the

second thermosetting resin is preferably a functional group which reacts with the reactive functional group of the first thermosetting resin due to heat. For example, in a case where the reactive functional group of the first thermosetting resin is a hydroxyl group (phenolic hydroxyl group), the reactive functional group of the second thermosetting resin is preferably an epoxy group. In other words, in a case where the first thermosetting resin is a phenol resin, the second thermosetting resin is preferably an epoxy resin. In such a case, the mechanical strength is excellent, the shrinkage during curing is small, and the dimensional stability is excellent. In addition, the heat resistance, water resistance, and chemical resistance are excellent, and the electrical insulation is excellent. The reactive functional group of the second thermosetting resin may be the same as the reactive functional group of the first thermosetting resin. For example, in a case where the reactive functional group of the first thermosetting resin is a hydroxyl group (phenolic hydroxyl group), the reactive functional group of the second thermosetting resin may be a hydroxyl group (phenolic hydroxyl group). In such a case, it is possible to use a curing agent as the thermosetting component.

[0060] As the epoxy resin, it is possible to use any resin having two or more epoxy groups in one molecule without particular limitation. Examples of the epoxy resin include bisphenol A type epoxy resin, bisphenol AP type epoxy resin, bisphenol AF type epoxy resin, bisphenol B type epoxy resin, bisphenol BP type epoxy resin, bisphenol C type epoxy resin, bisphenol E type epoxy resin, bisphenol F type epoxy resin, bisphenol G type epoxy resin, bisphenol M type epoxy

resin, bisphenol S type epoxy resin (hexanediol bisphenol S diglycidyl ether, and the like), bisphenol P type epoxy resin, bisphenol PH type epoxy resin, bisphenol TMC type epoxy resin, bisphenol Z type epoxy resin, phenol novolak epoxy resin, biphenyl type epoxy resin, naphthalene type epoxy resin, dicyclopentadiene type epoxy resin, bixylenol type epoxy resin (bixylenol diglycidyl ether, and the like), hydrogenated bisphenol A type epoxy resin (hydrogenated bisphenol A glycidyl ether, and the like), dibasic acid modified diglycidyl ether type epoxy resin of these resins, aliphatic epoxy resin, and the like. An epoxy resin may be used alone as one type or two or more types may be used in combination.

[0061] From the viewpoint of easily suppressing the generation of splitting and cracks on the film surface, the epoxy resin may be an epoxy resin (liquid epoxy resin) which is liquid at 25°C. Examples of liquid epoxy resins include bisphenol A type glycidyl ether, bisphenol AD type glycidyl ether, bisphenol S type glycidyl ether, bisphenol F type glycidyl ether, water-added bisphenol A type glycidyl ether, ethylene oxide adduct bisphenol A type glycidyl ether, propylene oxide adduct bisphenol A type glycidyl ether, glycidyl ether of naphthalene resin, trifunctional or tetrafunctional glycidyl amine, and the like.

[0062] Examples of commercially available epoxy resins include trade name "jER 825" manufactured by Mitsubishi Chemical Co., Ltd., (bisphenol A type epoxy resin, epoxy equivalent: 175 g/eq.), trade name "jER 806" manufactured by Mitsubishi Chemical Co., Ltd. (bisphenol F type epoxy resin, epoxy equivalent: 160 g/eq.), trade name "HP-4032D" manufactured by DIC Corporation (naphthalene type epoxy resin, epoxy

equivalent: 141 g/eq.), soft tough epoxy resins such as trade name "EXA-4850" manufactured by DIC Corporation, trade name "HP-4700" (tetrafunctional naphthalene type epoxy resin), trade name "HP-4750" (trifunctional naphthalene type epoxy resin), trade name " HP-4710 (tetrafunctional naphthalene type epoxy resin), trade name "Epiclon N-770" (phenol novolak epoxy resin), trade name "Epiclon N-660 (cresol novolak epoxy resin), and trade name "Epiclon HP-7200H" (dicyclopentadiene type epoxy resin) manufactured by DIC Corporation, trade name "EPPN-502H" (trisphenylmethane type epoxy resin) and trade name "NC-3000" (biphenyl aralkyl type epoxy resin) manufactured by Nippon Kayaku Co., Ltd., trade name "ESN-355" (naphthalene type epoxy resin) manufactured by Nippon Steel Sumikin Chemical Co., Ltd., trade name "YX-8800" (anthracene type epoxy resin) manufactured by Mitsubishi Chemical Co., Ltd., trade name "ESCN-190-2" (o-cresol novolak epoxy resin) manufactured by Sumitomo Chemical Co., Ltd., and the like. These epoxy resins may each be used alone or in a combination of two or more types.

[0063] As a phenol resin, it is possible to use any known phenol resins having two or more phenolic hydroxyl groups in one molecule without particular limitation. Examples of phenol resins include a resin obtained by condensation or co-condensation of a phenol and/or a naphthol with an aldehyde under an acidic catalyst, a biphenyl skeleton type phenol resin, a paraxylene modified phenol resin, a metaxylylene paraxylene modified phenol resin, a melamine modified phenol resin, a terpene modified phenol resin, a dicyclopentadiene modified phenol resin, a cyclopentadiene modified phenol resin, a polycyclic aromatic

ring modified phenol resin, a xylylene modified naphthol resin, and the like. Examples of phenols include phenol, cresol, xylenol, resorcinol, catechol, bisphenol A, bisphenol F, and the like. Examples of naphthols include α-naphthol, β-naphthol, dihydroxy naphthalene, and the like. Examples of aldehydes include formaldehyde, acetaldehyde, propionaldehyde, benzaldehyde, salicylaldehyde, and the like.

[0064] Examples of commercially available phenol resins include trade name "PAPS-PN2" (novolak phenol resin) manufactured by Asahi Organic Chemicals Industry Co., Ltd., trade name "SK resin HE200C-7" (biphenyl aralkyl type phenol resin) and trade name "HE 910-10" (trisphenylmethane type phenol resin) manufactured by Air Water Inc., trade name "MEH-7000", "DL-92", "H-4", and "HF-1M" manufactured by Meiwa Plastic Industries. Ltd., trade name "LVR-8210DL", "ELP" series, and "NC" series manufactured by Gun Ei Chemical Industry Co., Ltd., trade name "SN-100, SN-300, SN-395, and SN-400" (naphthalene phenol resins) manufactured by Nippon Steel Sumikin Chemical Co., Ltd., and trade name "HP-850N" (novolak phenol resin) manufactured by Hitachi Chemical Co., Ltd., and the like.

[0065] From the viewpoint of being able to improve the warpage and cracking by reducing the crosslinking point between the resins and reducing the cure shrinkage, the reactive functional group equivalent of the second thermosetting resin may be 100 g/eq. or more, 120 g/eq. or more, or 140 g/eq. or more, and, from the same viewpoint, 500 g/eq. or less, 400 g/eq. or less, or 300 g/eq. or less. Accordingly, the reactive functional group equivalent of the second thermosetting resin may be, for example, 100 to 500 g/eq., 120 to 400 g/eq., or 140 to 300 g/eq.

[0066] In a case where the second thermosetting resin includes an epoxy resin, from the viewpoint that the embeddability is more favorable, the content of the epoxy resin may be 1% by mass or more, 3% by mass or more, or 5% by mass or more based on the total mass of the sealing film. From the viewpoint that the hollow non-filling property is more favorable, the content of the epoxy resin may be 50% by mass or less, 30% by mass or less, or 10% by mass or less based on the total mass of the sealing film. Accordingly, the content of the epoxy resin may be, for example, 1 to 50% by mass, 3 to 30% by mass, or 5 to 10% by mass, based on the total mass of the sealing film.

[0067] In a case where the second thermosetting resin includes a liquid epoxy resin, from the viewpoint of easily suppressing the generation of splitting and cracks on the film surface, the content of the liquid epoxy resin is preferably 0.5% by mass or more, more preferably 1% by mass or more, even more preferably 3% by mass or more, particularly preferably 5% by mass or more, still more preferably 7% by mass or more, and extremely preferably 9% by mass or more based on the total mass of the sealing film. From the viewpoint of easily suppressing excessive increases in the tackiness of the film and the viewpoint of easily suppressing edge fusion, the content of the liquid epoxy resin is preferably 20% by mass or less, more preferably 15% by mass or less, and even more preferably 13% by mass or less based on the total mass of the sealing film. From these viewpoints, the content of the liquid epoxy resin is preferably 0.5 to 20% by mass, more preferably 1 to 20% by mass, even more preferably 3 to 20% by mass, particularly preferably 5 to 20% by mass, still more preferably 7 to 15% by mass,

and extremely preferably 9 to 13% by mass based on the total mass of the sealing film.

[0068] From the viewpoint of easily suppressing the generation of splitting and cracks on the film surface, the content of the liquid epoxy resin is preferably 20% by mass or more, more preferably 30% by mass or more, and even more preferably 50% by mass or more based on the total mass of the second thermosetting resin. From the viewpoint of easily suppressing excessive increases in the tackiness of the film and from the viewpoint of easily suppressing edge fusion, the content of the liquid epoxy resin is preferably 95% by mass or less, more preferably 90% by mass or less, and even more preferably 80% by mass or less based on the total mass of the second thermosetting resin. From these viewpoints, the content of the liquid epoxy resin is preferably 20 to 95% by mass, more preferably 30 to 90% by mass, and even more preferably 50 to 80% by mass, based on the total mass of the second thermosetting resin. The content of the liquid epoxy resin may be 100% by mass based on the total mass of the second thermosetting resin.

[0069] In a case where the second thermosetting resin includes a phenol resin, from the viewpoint that the embeddability is more favorable, the content of the phenol resin may be 1% by mass or more, 3% by mass or more, or 5% by mass or more based on the total mass of the sealing film. From the viewpoint that the hollow non-filling property is more favorable, the content of the phenol resin may be 50% by mass or less, 30% by mass or less, or 10% by mass or less based on the total mass of the sealing film. Accordingly, the content of the phenol resin may be, for example, 1 to 50% by mass, 3 to 30% by mass,

or 5 to 10% by mass, based on the total mass of the sealing film.

[0070] In the present embodiment, from the viewpoint of being able to satisfy both the embeddability with respect to the object to be sealed and the hollow non-filling property at a higher level, the thermosetting component preferably includes an epoxy resin and a phenol resin, the first thermosetting resin preferably includes a phenol resin and the second thermosetting resin preferably includes an epoxy resin. In such a case, it is possible to set the contents of all the epoxy resin and the contents of the phenol resin included in the resin composition based on the ratio of the number of moles M2 of epoxy groups with respect to the number of moles M1 of phenolic hydroxyl groups in the resin composition.

[0071] The ratio (M2/M1) of the number of moles M2 of epoxy groups with respect to the number of moles M1 of phenolic hydroxyl groups in the resin composition may be 0.7 or more, 0.8 or more, or 0.9 or more and may be 2.0 or less, 1.8 or less, or 1.7 or less. Accordingly, the ratio (M2/M1) may be, for example, 0.7 to 2.0, 0.8 to 1.8, or 0.9 to 1.7.

[0072]

[Curing Agent]

The curing agent (excluding components corresponding to the thermosetting resin) is not particularly limited; however, examples thereof include a phenol-based curing agent, an acid anhydride-based curing agent, an active ester-based curing agent, a cyanate ester-based curing agent, and the like. A curing agent may be used alone as one type or two or more types may be used in combination.

[0073] From the viewpoint of excellent curing of the thermosetting resin, the content of the curing agent may be 1 to 20% by mass, 2 to 15% by mass, or 3 to 10% by mass based on the total mass of the sealing film.

[0074]

[Curing Accelerator]

It is possible to use a curing accelerator without particular limitation; however, at least one type selected from the group formed of an amine-based curing accelerator and a phosphorus-based curing accelerator is preferable. From the viewpoint that it is possible to easily obtain a cured product having excellent thermal conductivity, that derivatives thereof are abundant, and that it is possible to easily obtain a desired activation temperature, as a curing accelerator, an amine-based curing accelerator is particularly preferable, at least one type selected from the group formed of imidazole compounds, aliphatic amines, and alicyclic amines is more preferable, and imidazole compounds are even more preferable. Examples of the imidazole compound include 2-phenyl-4-methylimidazole, 1-benzyl-2-methylimidazole, and the like. A curing accelerator may be used alone as one type or two or more types may be used in combination. Examples of commercial curing accelerator products include "2P4MZ", "1B2MZ", and the like manufactured by Shikoku Chemicals Corporation.

[0075] The content of the curing accelerator is preferably in the range below based on the total amount of the thermosetting resin. From the viewpoint that a sufficient curing acceleration effect is easily obtained, the content of the curing accelerator is preferably 0.01% by mass or

more, more preferably 0.1% by mass or more, and even more preferably 0.3% by mass or more. From the viewpoint that the curing does not easily proceed during the steps (for example, coating and drying) for manufacturing the sealing film or during storage of the sealing film and that cracking of the sealing film and molding defects accompanying an increase in melt viscosity are easily prevented, the content of the curing accelerator is preferably 5% by mass or less, more preferably 3% by mass or less, and even more preferably 1.5% by mass or less. From these viewpoints, the content of the curing accelerator is preferably 0.01 to 5% by mass, more preferably 0.1 to 3% by mass, and even more preferably 0.3 to 1.5% by mass.

[0076]

(Inorganic filler)

As the inorganic filler, it is possible to use inorganic fillers known in the related art without particular limitation. Examples of constituent materials of the inorganic filler include silicas (amorphous silica, crystalline silica, fused silica, spherical silica, synthetic silica, hollow silica, and the like), barium sulfate, barium titanate, talc, clay, mica powder, magnesium carbonate, calcium carbonate, aluminum oxide (alumina), aluminum hydroxide, magnesium oxide, magnesium hydroxide, silicon nitride, aluminum nitride, aluminum borate, boron nitride, barium titanate, strontium titanate, calcium titanate, magnesium titanate, bismuth titanate, titanium oxide, barium zirconate, calcium zirconate, and the like. From the viewpoint that it is possible to easily obtain an effect of improving the dispersibility in the resin composition and the sedimentation suppression effect in the varnish by surface

modification (for example, surface treatment with a silane compound) or the like and from the viewpoint that it is possible to easily obtain the desired cured film characteristics due to the relatively small thermal expansion coefficient, inorganic fillers including silicas are preferable. From the viewpoint of obtaining high thermal conductivity, an inorganic filler containing aluminum oxide is preferable. The inorganic filler may be used alone or in a combination of two or more types.

[0077] The inorganic filler may be surface-modified. The method of surface modification is not particularly limited. From the viewpoint of a simple process, abundant types of functional groups, and easily imparting desired properties, surface modification using a silane coupling agent is preferable.

[0078] Examples of the silane coupling agent include alkylsilanes, alkoxysilanes, vinylsilanes, epoxysilanes, aminosilanes, acrylsilanes, methacrylsilanes, mercaptosilanes, sulfide silanes, isocyanate silanes, sulfasilanes, styrylsilanes, alkylchlorosilanes, and the like.

[0079] Specific examples of the silane coupling agent include methyltrimethoxysilane, dimethyldimethoxysilane, trimethylmethoxysilane, methyltriethoxysilane, methyltriphenoxysilane, ethyltrimethoxysilane, n-propyltrimethoxysilane, diisopropyldimethoxysilane, isobutyltrimethoxysilane, diisobutyldimethoxysilane, isobutyltriethoxysilane, n-hexyltrimethoxysilane, n-hexyltriethoxysilane, cyclohexylmethyldimethoxysilane, n-octyltriethoxysilane, n-dodecylmethoxysilane, phenyltrimethoxysilane, diphenyldimethoxysilane, triphenylsilanol, methyltrichlorosilane,

dimethyldichlorosilane, trimethylchlorosilane, n-octyldimethylchlorosilane, tetraethoxysilane, 3-aminopropyltrimethoxysilane, 3-aminopropyltriethoxysilane, 3-(2-aminoethyl)aminopropyltrimethoxysilane, 3-(2-aminoethyl)aminopropylmethyl dimethoxysilane, 3-phenylaminopropyltrimethoxysilane, 3-glycidoxypropyltrimethoxysilane, 3-glycidoxypropylmethyldimethoxysilane, 3-glycidoxypropyltriethoxysilane, 3-glycidoxypropylmethyldiethoxysilane, bis(3-(triethoxysilyl)propyl)disulfide, bis(3-(triethoxysilyl)propyl)tetrasulfide, vinyltriacetoxysilane, vinyltrimethoxysilane, vinyltriethoxysilane, vinyltriisopropoxysilane, allyltrimethoxysilane, diallyldimethylsilane, 3-methacryloxypropyltrimethoxysilane, 3-methacryloxypropylmethyldimethoxysilane, 3-methacryloxypropyltriethoxysilane, 3-mercaptopropyltrimethoxysilane, 3-mercaptopropylmethyldimethoxysilane, 3-mercaptopropyltriethoxysilane, N-(1,3-dimethylbutylidene)-3-aminopropyltriethoxysilane, aminosilane (phenylaminosilane and the like) and the like. A silane coupling agent may be used alone as one type or in a combination of two or more types.

[0080] From the viewpoint of easily suppressing aggregation of the inorganic filler and easily dispersing the inorganic filler, the average particle diameter of the inorganic filler is preferably 0.01 μm or more,

more preferably 0.1 μm or more, even more preferably 0.3 μm or more, and yet more preferably 0.5 μm or more. From the viewpoint that it is easy to suppress the inorganic filler from becoming sediment in the varnish and easy to produce a uniform sealing film, the average particle diameter of the inorganic filler is preferably 25 μm or less, more preferably 10 μm or less, and even more preferably 5 μm or less. From these viewpoints, the average particle diameter of the inorganic filler is preferably 0.01 to 25 μm, more preferably 0.01 to 10 μm, even more preferably 0.1 to 10 μm, particularly preferably 0.3 to 5 μm, and extremely preferably 0.5 to 5 μm. The average particle diameter of the inorganic filler may be 10 to 18 μm.

[0081] From the viewpoint of excellent fluidity of the resin composition, it is preferable to use a combination of a plurality of inorganic fillers each having different average particle diameters. Among the combinations of inorganic fillers, a combination in which the average particle diameter of the inorganic filler having the largest average particle diameter is 15 to 25 μm is preferable. It is preferable to use a combination of an inorganic filler having an average particle diameter of 15 to 25 μm, an inorganic filler having an average particle diameter of 0.5 to 2.5 μm, and an inorganic filler having an average particle diameter of 0.1 to 1.0 μm.

[0082] The "average particle diameter" is the particle diameter of a point corresponding to 50% of the volume when the cumulative frequency distribution curve according to particle diameter is determined with the total volume of the particles as 100% and it is possible to carry out measurement using a particle diameter distribution

measurement device or the like using the laser diffraction scattering method. It is possible to confirm the average particle diameter of each combined inorganic filler from the average particle diameter of each inorganic filler at the time of mixing, and by measuring the particle diameter distribution.

[0083] Examples of commercially available inorganic fillers include "DAW 20" manufactured by Denka Co., Ltd., and trade names "SC550O-SXE", "SC 2050-KC", and the like manufactured by Admatechs Co., Ltd..

[0084] From the viewpoint of improving the thermal conductivity and from the viewpoint of easily suppressing increasing warpage of the sealed structure (for example, an electronic component device such as a semiconductor device) due to the difference in the coefficient of thermal expansion with the object to be sealed, the content of the inorganic filler may be 70% by mass or more, 75% by mass or more, 80% by mass or more, or 84% by mass or more, based on the total mass of the sealing film. From the viewpoint of easily suppressing breaking of the sealing film in the drying step in the production of the sealing film and from the viewpoint of suppressing decreases in the fluidity due to increases in the melt viscosity of the sealing film and of easily sufficiently sealing the object to be sealed (electronic components and the like), the content of the inorganic filler may be 93% by mass or less, 91% by mass or less, or 88% by mass or less based on the total mass of the sealing film. From these viewpoints, the content of the inorganic filler may be 70 to 93% by mass, 75 to 91% by mass, 80 to 91% by mass, 84 to 91% by mass, 84 to 88% by mass based on the total mass of the sealing film. In

addition, the content described above is the content of the inorganic filler except for the amount of the surface treating agent.

[0085]

(Elastomer)

The sealing film of the present embodiment may contain an elastomer (flexibilizer), as necessary. From the viewpoint of excellent dispersibility and solubility, the elastomer is preferably at least one type selected from the group consisting of polybutadiene particles, styrene butadiene particles, acrylic elastomers, silicone powders, silicone oils, and silicone oligomers. An elastomer may be used alone as one type or in a combination of two or more types.

[0086] In a case where the elastomer is in the form of particles, the average particle diameter of the elastomer is not particularly limited. Since it is necessary to carry out embedding between semiconductor elements in an Embedded Wafer-Level Ball Grid Array (eWLB) application, in a case of using a sealing film for an eWLB application, the average particle diameter of the elastomer is preferably 50 μm or less. The average particle diameter of the elastomer is preferably 0.1 μm or more from the viewpoint of excellent dispersibility of the elastomer.

[0087] Examples of commercially available elastomers include "SG-280 EK23", "SG-70L", "WS-023 EK30", and the like, which are acrylic elastomers manufactured by Nagase ChemteX corporation. In addition, among commercially available elastomer components, there are components which are dispersed in advance in a liquid resin (for example, liquid epoxy resin) instead of an elastomer alone; however,

use thereof is possible without problems. Such commercial products include "MX-136", "MX-965", and the like manufactured by Kaneka Corporation.

[0088] From the viewpoint that the hollow non-filling property is more favorable, the content of the elastomer may be 1% by mass or more, 5% by mass or more, or 10% by mass or more based on the total amount of the thermosetting component and the elastomer. From the viewpoint that the embeddability is more favorable and from the viewpoint of easily obtaining a sufficient Tg after curing and easily improving the reliability (heat reliability) of the sealed structure, the content of the elastomer may be 30% by mass or less, 25% by mass or less, or 20% by mass or less, based on the total amount of the thermosetting component and the elastomer. From the above, the content of the elastomer may be 1 to 30% by mass, 5 to 25% by mass, or 10 to 20% by mass, based on the total amount of the thermosetting component and the elastomer.

[0089]

(Other Components)

It is possible for the sealing film of the present embodiment to further contain other additives. Specific examples of such additives include pigments, dyes, mold release agents, antioxidants, surface tension adjusting agents, and the like.

[0090] In addition, the sealing film of the present embodiment may contain a solvent (for example, the solvent used for manufacturing the sealing film). The solvent may be an organic solvent known in the related art. The organic solvent may be a solvent capable of dissolving the components other than the inorganic filler and examples thereof

include aliphatic hydrocarbons, aromatic hydrocarbons, terpenes, halogens, esters, ketones, alcohols, aldehydes, and the like. The solvents may be used alone as one type or in a combination of two or more types.

[0091] From the viewpoint of a small environmental load and the viewpoint of easily dissolving the thermosetting component, the solvent may be at least one type selected from the group consisting of esters, ketones, and alcohols. Among the above, in a case where the solvent is a ketone, the thermosetting component is particularly easily dissolved. From the viewpoint of low volatilization at room temperature (25°C) and easy removal during drying, the solvent may be at least one type selected from the group consisting of acetone, methyl ethyl ketone, and methyl isobutyl ketone.

[0092] The content of the solvent (organic solvent and the like) included in the sealing film is preferably in the following range based on the total mass of the sealing film. From the viewpoint of easily suppressing the generation of defects such as the sealing film becoming brittle and cracking of the sealing film as well as increases in the minimum melt viscosity and decreases in the embeddability, the content of the solvent may be 0.2% by mass or more, 0.3% by mass or more, 0.5% by mass or more, 0.6% by mass or more, or 0.7% by mass or more. From the viewpoint of easily suppressing defects in which the adhesiveness of the sealing film becomes too strong and the handleability decreases and defects such as foaming due to the volatilization of the solvent (organic solvent and the like) at the time of heat curing of the sealing film, the content of the solvent may be 1.5%

by mass or less or 1% by mass or less. From these viewpoints, the content of the solvent may be 0.2 to 1.5% by mass, 0.3 to 1% by mass, 0.5 to 1% by mass, 0.6 to 1% by mass, or 0.7 to 1% by mass.

[0093] From the viewpoint of easily suppressing variation in thickness in the surface at the time of coating, the thickness (film thickness) of the sealing film may be 20 μm or more, 30 μm or more, 50 μm or more, or 100 μm or more. From the viewpoint of easily obtaining a certain drying property in the depth direction at the time of coating, the thickness of the sealing film may be 250 μm or less, 200 μm or less, or 150 μm or less. From these viewpoints, the thickness of the sealing film may be 20 to 250 μm, 30 to 250 μm, 50 to 200 μm, or 100 to 150 μm. In addition, it is also possible to laminate a plurality of sealing films to produce a sealing film having a thickness of more than 250 μm.

[0094] From the viewpoint of the reliability (heat reliability) of the obtained sealed structure, the glass transition temperature Tg of the sealing film after curing may be 80 to 180°C, 80 to 165°C, or 80 to 150°C. It is possible to adjust the glass transition temperature Tg of the sealing film after curing according to the type and content of the thermosetting component, the type and content of the elastomer component, and the like. It is possible to measure the glass transition temperature Tg by the method described in the Examples.

[0095] From the viewpoint that the embeddability is more favorable, the lowest value (minimum melt viscosity) of the melt viscosity of the sealing film at 35 to 200°C may be 100 to 10,000 Pa · s, 250 to 8,500 Pa · s, or 500 to 7,000 Pa · s. From the viewpoint that the hollow non-filling property is more favorable, the maximum value of the melt

viscosity (maximum melt viscosity) of the sealing film at 70 to 90°C may be 500 to 25,000 Pa · s, 4,000 to 20,000 Pa · s, or 6,000 to 15,000 Pa · s. It is possible to determine the minimum melt viscosity and maximum melt viscosity by measuring the melt viscosity of the sealing film using the method as described in the Examples.

[0096] As described above, the sealing film of the present embodiment is favorably used to seal the object to be sealed in the hollow structure, but the structure to be sealed may not have a hollow structure. It is also possible to use the sealing film of the present embodiment, for example, for sealing a semiconductor device, embedding an electronic component arranged on a printed wiring board, and the like.

[0097] It is also possible to use the sealing film of the present embodiment as a sealing film with a support, for example. A sealing film 10 with a support shown in FIG. 1 is provided with a support 1 and a sealing film 2 provided on the support 1.

[0098] As the support 1, it is possible to use a polymer film, a metal foil, or the like. Examples of the polymer film include polyolefin films such as polyethylene films and polypropylene films; vinyl films such as polyvinyl chloride films; polyester films such as polyethylene terephthalate films; polycarbonate films; acetyl cellulose films; tetrafluoroethylene films, and the like. Examples of metal foil include copper foil, aluminum foil, and the like.

[0099] The thickness of the support 1 is not particularly limited, but may be 2 to 200 μm from the viewpoint of the workability and drying property being excellent. In a case where the thickness of the support 1 is 2 μm or more, it is easy to suppress defects such as breakage of the

support at the time of coating, defects due to the support bending due to the weight of the varnish, or the like. In a case where the thickness of the support 1 is 200 μm or less, in the drying step, in a case where hot air is blown from both sides of the coated surface and the back surface, it is easy to suppress defects in which the solvent drying is prevented in the varnish.

[0100] In the present embodiment, the support 1 may not be used. In addition, a protective layer for the purpose of protection of the sealing film may be arranged on the opposite side to the support 1 of the sealing film 2. Forming the protective layer on the sealing film 2 improves the handleability and makes it possible to avoid defects in which the sealing film adheres to the back surface of the support in a case of being wound up.

[0101] It is possible to use a polymer film, metal foil, or the like as a protective layer. Examples of polymer films include polyolefin films such as polyethylene films and polypropylene films; vinyl films such as polyvinyl chloride films; polyester films such as polyethylene terephthalate films; polycarbonate films; acetyl cellulose films; tetrafluoroethylene films, and the like. Examples of metal foils include a copper foil, an aluminum foil, and the like.

[0102]

<Method for Manufacturing Sealing Film>

Specifically, it is possible to produce the sealing film of the present embodiment as follows.

[0103] First, a varnish (varnish-like resin composition) is produced by mixing the components of the resin composition of the present

embodiment (thermosetting resin, curing agent, curing accelerator, inorganic filler, solvent, and the like). The mixing method is not particularly limited and it is possible to use a mill, a mixer, and a stirring blade. It is possible to use a solvent (such as an organic solvent) to prepare a varnish by dissolving and dispersing the components of the resin composition which is a material of a sealing film, or to assist in preparing a varnish. It is possible to remove most of the solvent in the drying step after coating.

[0104] It is possible to produce a sealing film by coating the varnish produced in this manner on a support (a film-like support or the like) and then heating and drying by blowing with hot air or the like. Although the coating method is not particularly limited; however, for example, it is possible to use coating devices such as a comma coater, a bar coater, a kiss coater, a roll coater, a gravure coater, and a die coater.

[0105]

<Sealed structure and Manufacturing Method Thereof>

The sealed structure according to the present embodiment is provided with an object to be sealed and a sealing portion which seals the object to be sealed. The sealing portion is a cured product of the sealing film of the present embodiment, and includes the cured product of the resin composition of the present embodiment. The sealed structure may be a hollow sealed structure having a hollow structure. The hollow sealed structure is provided with, for example, a substrate, an object to be sealed provided on the substrate, a hollow region provided between the substrate and the object to be sealed, and a sealing portion for sealing the object to be sealed. The sealed structure of the

present embodiment may be provided with a plurality of objects to be sealed. The plurality of objects to be sealed may be the same type as each other or may be different types from each other.

[0106] The sealed structure is, for example, an electronic component device. The electronic component device is provided with an electronic component as an object to be sealed. Examples of the electronic components include semiconductor elements, semiconductor wafers, integrated circuits, semiconductor devices, filters such as SAW filters, passive components such as sensors, and the like. A semiconductor element obtained by dividing up a semiconductor wafer may be used. The electronic component device may be a semiconductor device provided with a semiconductor element or a semiconductor wafer as an electronic component; a printed wiring board, or the like. In a case where the electronic component device has a hollow structure, that is, in a case where the electronic component device is a hollow sealed structure, the object to be sealed is, for example, provided on the substrate via a bump to have a movable part on the surface of the hollow region side (substrate side). Examples of such an object to be sealed include electronic components, such as SAW devices, such as a SAW filter. In a case where the object to be sealed is a SAW filter, on the surface of the piezoelectric substrate, the surface on the side on which the electrodes (for example, Inter Digital Transducers (IDT) as a pair of comb-like electrodes) are attached is a movable part.

[0107] Next, a description will be given of the method for manufacturing a hollow sealed structure using the sealing film of the

present embodiment. Here, a description will be given of a case where the hollow sealed structure is an electronic component device and the object to be sealed is a SAW device.

[0108] FIG. 2 is a schematic cross-sectional view for illustrating an embodiment of a method for manufacturing a semiconductor device which is an electronic component device as an embodiment of a method for manufacturing a hollow sealed structure. In the manufacturing method of the present embodiment, first, a hollow structure provided with a substrate 30 and a plurality of SAW devices 20 arranged side by side via bumps 40 on the substrate 30, as objects to be sealed (objects to be embedded) is prepared and then a surface of the substrate 30 on the SAW device 20 side and a surface of the sealing film 10 with a support on the sealing film 2 side are opposed to each other ((a) of FIG. 2). Here, a hollow structure 60 has a hollow region 50, and the SAW device 20 has a movable part on the surface 20a on the hollow region 50 side (the substrate 30 side).

[0109] Next, the sealing film 2 is pressed (laminated) under heating on the SAW device 20 to embed the SAW device 20 in the sealing film 2 and then the sealing film 2 in which the SAW device 20 is embedded is cured to obtain a cured product (a sealed portion including the cured product of the resin composition) 2a of the sealing film ((b) of FIG. 2). Due to this, it is possible to obtain an electronic component device 100.

[0110] The laminator used for lamination is not particularly limited; however, examples thereof include laminators, such as a roll type and a balloon type. From the viewpoint of excellent embeddability, the laminator may be a balloon type capable of vacuum and pressure.

[0111] Lamination is usually performed at the softening point or lower of the support. The laminating temperature (sealing temperature) is preferably in the vicinity of the minimum melt viscosity of the sealing film. The laminating temperature is, for example, 60 to 140°C. The pressure at the time of lamination varies depending on the size, density, and the like of the object to be sealed (for example, an electronic component such as a semiconductor element) to be embedded. The pressure during lamination may be, for example, in the range of 0.2 to 1.5 MPa, or in the range of 0.3 to 1.0 MPa. The laminating time is not particularly limited, but may be 20 to 600 seconds, 30 to 300 seconds, or 40 to 120 seconds.

[0112] It is possible to perform the curing of the sealing film, for example, in the air or in an inert gas. The curing temperature (heating temperature) is not particularly limited and may be 80 to 280°C, 100 to 240°C, or 120 to 200°C. When the curing temperature is 80°C or higher, the curing of the sealing film proceeds sufficiently, and it is possible to suppress the generation of defects. In a case where the curing temperature is 280°C or lower, there is a tendency to be able to suppress heat damage to other materials. The curing time (heating time) is not particularly limited and may be 30 to 600 minutes, 45 to 300 minutes, or 60 to 240 minutes. In a case where the curing time is in these ranges, the curing of the sealing film proceeds sufficiently and more favorable production efficiency is obtained. In addition, the curing conditions may be a combination of a plurality of conditions.

[0113] In the present embodiment, a plurality of electronic component devices 200 may be obtained by further dividing the electronic

component devices 100 using a dicing cutter or the like ((c) of FIG. 2).

[0114] In the method for manufacturing a hollow sealed structure of the present embodiment, it is possible to sufficiently suppress inflow of the sealing material into the hollow region 50 between the substrate 30 and the object to be sealed while securing excellent embeddability with respect to the object to be sealed (for example, the SAW device 20).

[0115] In the present embodiment, after sealing the SAW device 20 with the sealing film 2 by the laminating method, a hollow sealed structure (electronic component device) provided with the SAW device 20 embedded in the cured product 2a by thermosetting the sealing film 2 is obtained; however, the sealed structure may be obtained by compression molding using a compression molding device or the sealed structure may be obtained by press molding using a hydraulic press. The temperature (sealing temperature) when sealing the object to be sealed by the compression mold and the hydraulic press may be the same as the laminating temperature described above.

[0116] A description was given of favorable embodiments of the present invention, however, the present invention is not necessarily limited to the embodiments described above and appropriate changes may be made thereto in a range which does not deviate from the gist thereof.

[Examples]

[0117] A more detailed description will be given below of the present invention using Examples, but the present invention is not limited to any of these Examples.

[0118] The following materials were used in the Examples and

Comparative Examples.

[0119]

(Thermosetting Resin)

A1: Bisphenol F-type epoxy resin (manufactured by Mitsubishi Chemical Co., Ltd., trade name "jER806", epoxy group equivalent: 160 g/eq.)

B1: Hydrocarbon group-containing phenol resin (phenolic hydroxyl group equivalent: 140 g/eq., weight average molecular weight: 120,000)

B2: Hydrocarbon group-containing phenol resin (phenolic hydroxyl group equivalent: 185 g/eq., weight average molecular weight: 120,000)

B3: Hydrocarbon group-containing phenol resin (phenolic hydroxyl group equivalent: 243 g/eq., weight average molecular weight: 120,000)

B4: Hydrocarbon group-containing phenol resin (phenolic hydroxyl group equivalent: 205 g/eq., weight average molecular weight: 120,000)

B5: Novolak phenol resin (manufactured by Meiwa Plastic Industries. Ltd., trade name "DL-92", phenolic hydroxyl group equivalent: 103 g/eq., weight average molecular weight: 50,000)

[0120]

(Curing Accelerator)

C1: Imidazole (manufactured by Shikoku Chemicals Corporation, trade name "2P4MZ")

[0121]

(Elastomer)

D1: Acrylic acid ester polymer (manufactured by Nagase ChemteX corporation, trade name "SG-280 EK23", molecular weight 900,000)

[0122]

(Inorganic Filler)

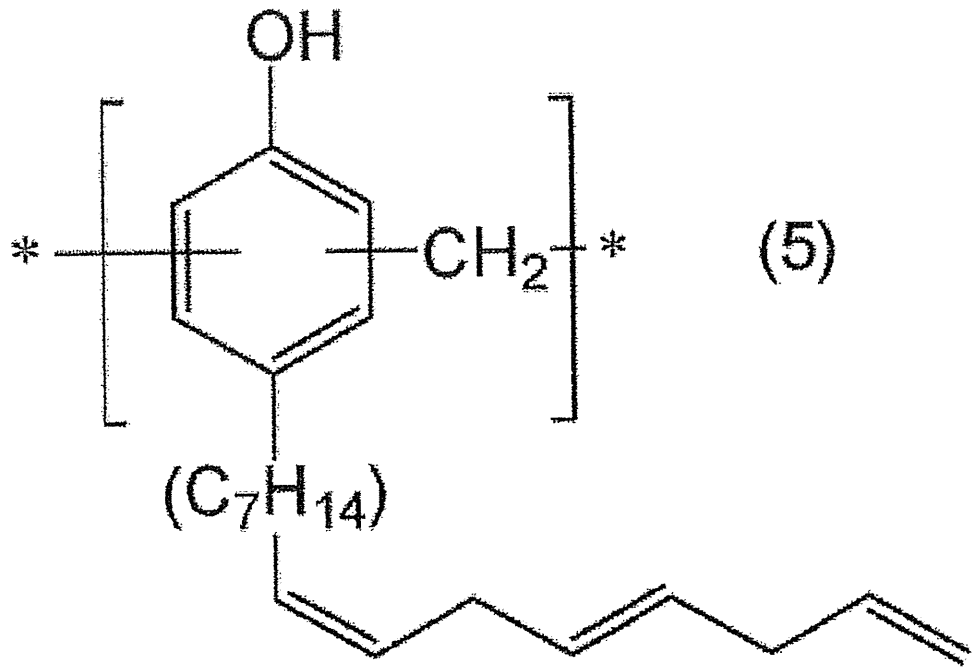
E1: Silica (manufactured by Admatechs Co., Ltd., trade name "5 μm SX-E2, treated with phenylaminosilane, average particle diameter: 5.8 μm)

[0123] B1 to B4 were prepared according to the method described in Japanese Unexamined Patent Publication No. 2015-89949. Specifically, B1 to B4 were prepared by the following method.

[0124]

(Synthesis Example 1)

First, cardanol, methanol, and a 50% aqueous formaldehyde solution were mixed to obtain a mixed solution. Next, 30% aqueous sodium hydroxide solution was added dropwise to the obtained mixed solution to cause a reaction, then 35% hydrochloric acid was added to the obtained reaction solution to neutralize the sodium hydroxide. Next, after adding phenol to the reaction solution, oxalic acid was further added thereto. Next, after washing the reaction solution with water, excess phenol was distilled off. Due to this, a resin B1 was obtained which was formed of 40 mol% of structural units represented by Formula (5) and 60 mol% of structural units represented by Formula (6).



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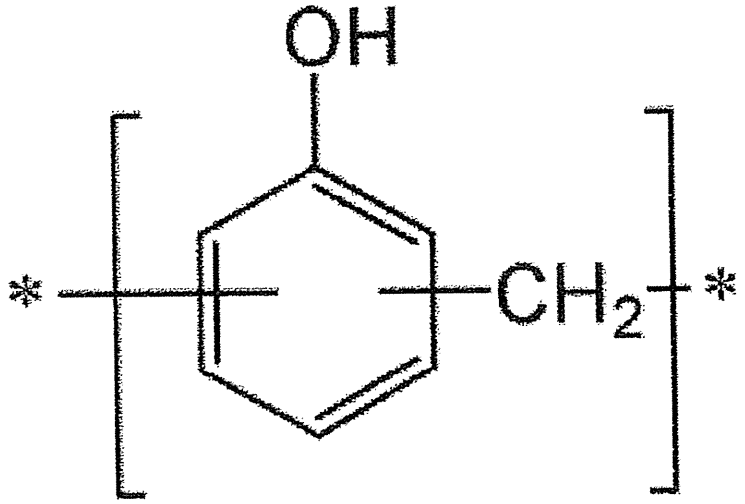

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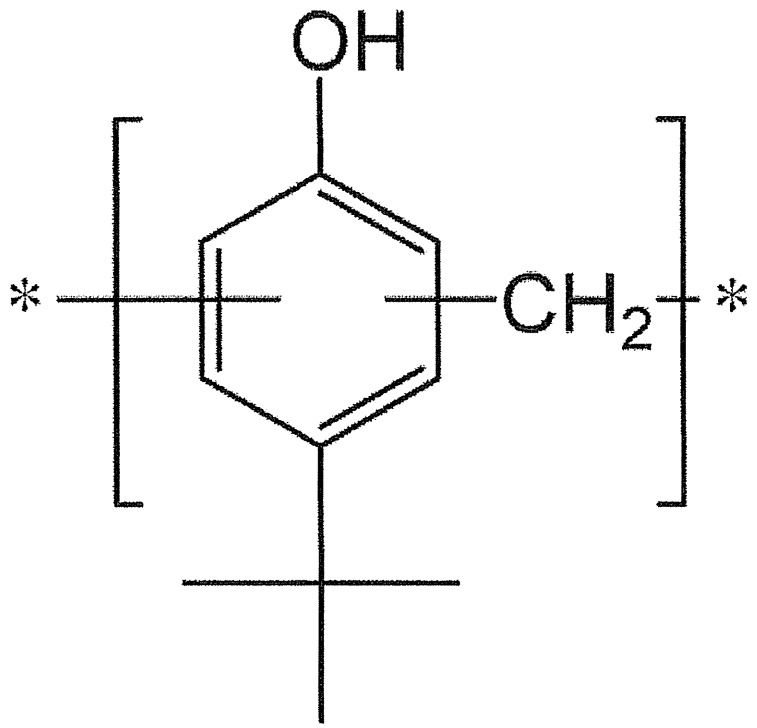
[0125]

(Synthesis Example 2)

First, 4-tert-butylphenol, methanol, and a 50% aqueous formaldehyde solution were mixed to obtain a mixed solution. Next, a 30% aqueous sodium hydroxide solution was added dropwise to the

obtained mixed solution to cause a reaction, and then 35% hydrochloric acid was added to the obtained reaction solution to neutralize the sodium hydroxide. Next, 4-phenylphenol was added to the reaction solution and then oxalic acid was further added thereto. Next, the reaction solution was washed with water and then excess 4-phenylphenol was distilled off. Due to this, a resin B2 was obtained which was formed of 50 mol% of structural units represented by Formula (7), and 50 mol% of structural units represented by Formula (8).



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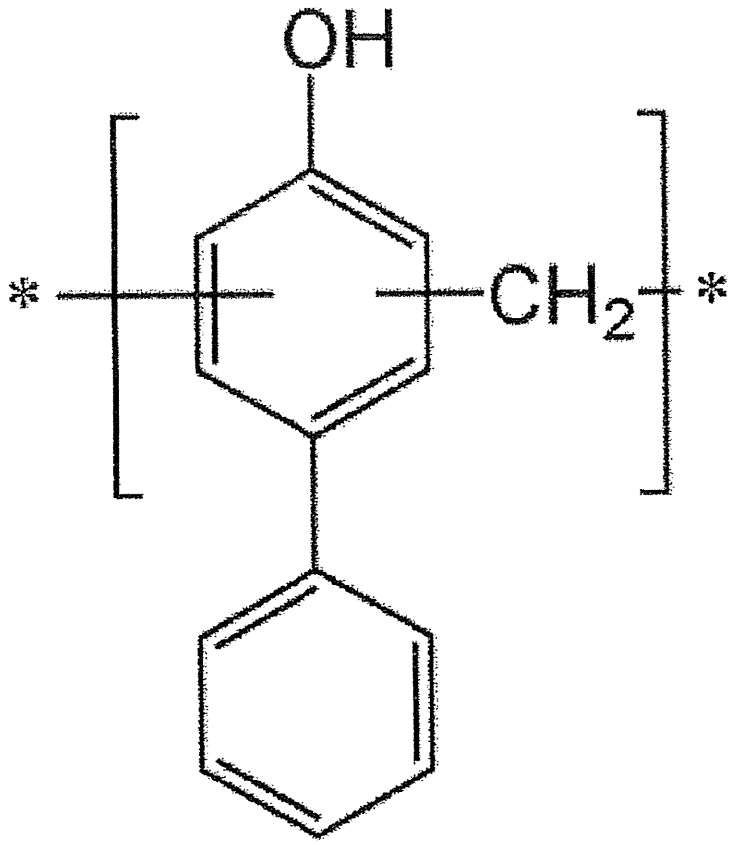

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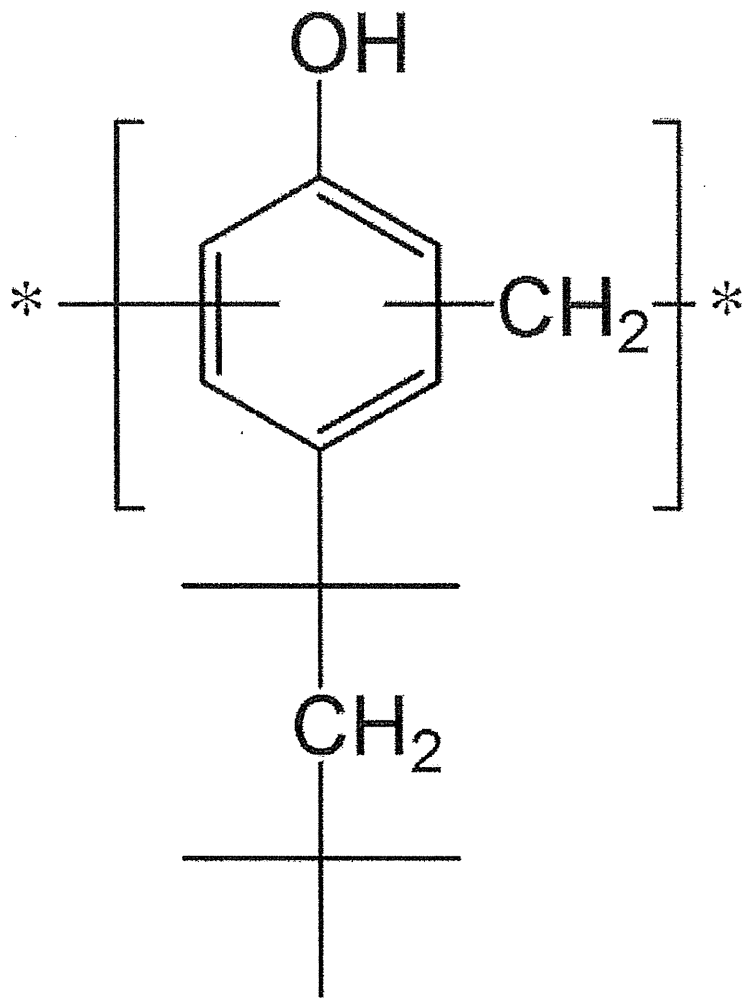
[0126]

(Synthesis Example 3)

First, 4-(1,1,3,3-tetramethylbutyl)phenol, methanol and a 50% aqueous formaldehyde solution were mixed to obtain a mixed solution. Next, a 30% aqueous sodium hydroxide solution was added dropwise to the obtained mixed solution to cause a reaction. Due to this, a resin B3 which is formed of a structural unit represented by Formula (9) was obtained.



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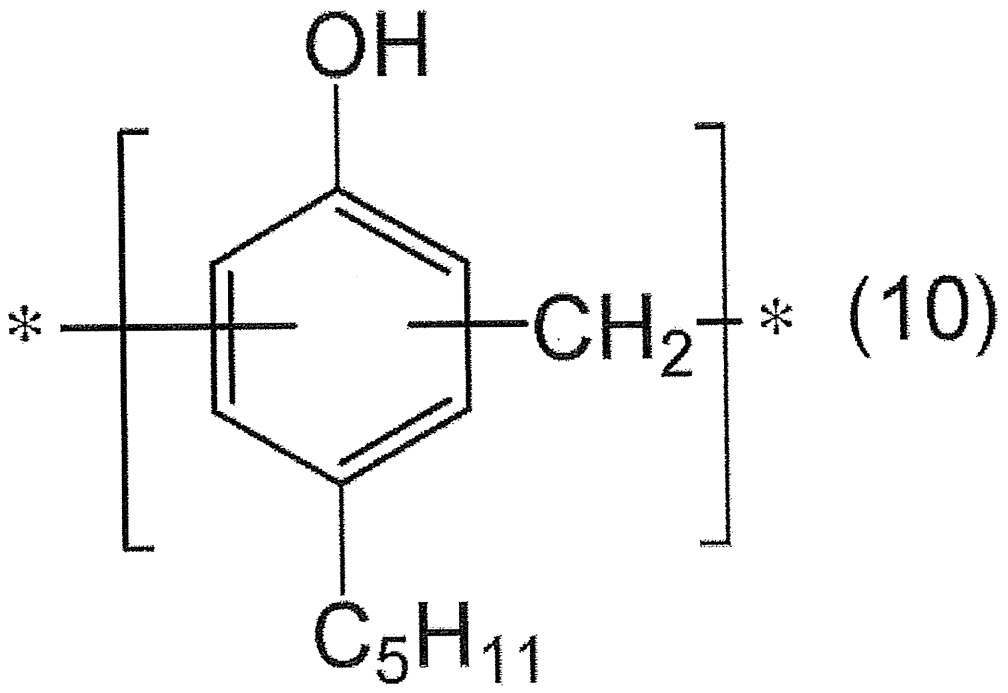
[0127]

(Synthesis Example 4)

First, cardanol, methanol, and a 50% aqueous formaldehyde solution were mixed to obtain a mixed solution. Next, 30% aqueous sodium hydroxide solution was added dropwise to the obtained mixed solution to cause a reaction and then 35% hydrochloric acid was added to the obtained reaction solution to neutralize sodium hydroxide. Next, pentyl phenol was added to the reaction solution, and then oxalic acid was further added thereto. Next, after washing the reaction solution

with water, excess pentylphenol was distilled off. Due to this, a resin B4 was obtained which was formed of 75 mol% of structural units represented by Formula (5) and 25 mol% of structural units represented by Formula (10).



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[0128]

<Production of sealing film (film-like epoxy resin composition)>

(Example 1)

A1, B1, D1, and E1 were added in the amounts (parts by mass) shown in Table 1 to a 0.5 L polyethylene container and the mixed solution was stirred with a stirring blade to disperse the inorganic filler E1. Then, C1 was added thereto in the amount (parts by mass) shown in Table 1 and stirring was carried out for a further 30 minutes. The obtained mixed solution was filtered through a #150 mesh made of nylon (opening 106 μm) to collect a filtrate. Due to this, a varnish-like

epoxy resin composition was obtained. The varnish-like epoxy resin composition was coated onto a PET film using a coating machine under the following conditions. Due to this, a sealing film with a thickness of 110 μm was produced on a support (PET film).

- Coating head method: comma
- Coating and drying speed: 1 m/min
- Drying conditions (temperature/oven length): 80°C/1.5m, 100°C/1.5m
- Support: PET film with a thickness of 38 μm

[0129] The surface of the sealing film was protected by arranging a protective layer (a polyethylene terephthalate film with a thickness of 50 μm) on the side of the sealing film opposite to the support. In addition, in each of the following evaluations, evaluation was performed after peeling a support and a protective layer. The same applies to the following Examples and Comparative Examples.

[0130]

(Examples 2 to 4 and Comparative Examples 1 to 2)

Varnish-like epoxy resin compositions of Examples 2 to 4 and Comparative Examples 1 and 2 were obtained in the same manner as Example 1, except that the types and blending amounts of the used materials (A1, B1, C1, D1, and E1) were changed as shown in Table 1. Next, sealing films (thickness 110 μm) of Examples 2 to 4 and Comparative Examples 1 and 2 were obtained in the same manner as Example 1, except that the varnish-like epoxy resin compositions of Examples 2 to 4 and Comparative Examples 1 and 2 were used respectively instead of the varnish-like epoxy resin of Example 1.

[0131]

<Evaluation Method>

The melt viscosity, embeddability, and hollow non-filling property of the sealing film as well as the elastic modulus and the glass transition temperature of the sealing film after curing were evaluated by the following methods.

[0132] (1) Evaluation A: Melt viscosity of Sealing Film (Film-Like Epoxy Resin Composition)

0.6 g of the sealing film was weighed and formed into a tablet having a diameter of 2 cm by a compression molding machine. The obtained molded product was used as a sample for evaluation and the melt viscosity of the sealing film was measured under the following conditions. The measurement was performed by heating from 40°C to 200°C.

Measuring device: Rheometer, trade name: ARES-G2 manufactured by TA Instruments Japan Inc.

Measurement mode: Dynamic Temperature Ramp

Frequency: 1.0 Hz

Temperature range: 40°C to 200°C

Heating rate: 5°C/min

[0133]

(2) Evaluation B: Embeddability and hollow non-filling property at sealing temperature of 70°C

The embeddability and the hollow non-filling property of the sealing film were evaluated at a sealing temperature of 70°C by the following method. First, a substrate (5 cm × 5 cm) provided with a through hole (diameter 1 mm) in the center of the main surface was

prepared. Next, a double-sided tape was made to adhere to a position 2 cm separated from the edge of the through hole on one main surface of the substrate and a glass plate was attached to the substrate via the double-sided tape. The obtained laminate was arranged with the surface on the glass plate side down and a sealing film with a size of 1 cm square was arranged on the surface of the substrate opposite to the glass plate to block the through hole. Next, a 100 g weight was placed on the sealing film and then heated for 1 hour in a 70°C oven (manufactured by Espec Corp., trade name "SAFETY OVEN SPH-201").

[0134] After heating, the presence or absence of the resin flowing from the through holes to the glass plate side by melting the sealing film and the inflow amount of the resin (inflow area) were visually observed, and the embeddability and the hollow non-filling property were evaluated based on the following criteria.

[Embeddability]

A: Resin reaches the glass substrate

B: Resin does not reach the glass substrate

[Hollow non-filling property]

A: Inflow area ≤ 2.5 mm^2

B: Inflow area ≤ 5 mm^2, > 2.5 mm^2

C: Inflow area > 5 mm^2

[0135]

(3) Evaluation C: Embeddability and hollow non-filling property at melt viscosity of 7000 Pa · s

Based on the measurement results of the melt viscosity in

evaluation A, the embeddability and hollow non-filling property were evaluated by the same method as evaluation B except that sealing was performed at a temperature at which the melt viscosity of the sealing film was 7000 Pa · s.

[0136]

(4) Evaluation D: Elastic modulus and glass transition temperature Tg of the sealing film after curing

The sealing films of Examples and Comparative Examples were laminated on a copper foil under the following conditions to obtain sealing films with copper foil.

- Laminator device: vacuum and pressure laminator MVLP-500 manufactured by Meiki Co., Ltd.
- Laminating temperature: 110°C
- Laminating pressure: 0.5MPa
- Vacuum suction time: 30 seconds
- Laminating time: 40 seconds

[0137] A sealing film with a copper foil was made to adhere to a SUS plate, the sealing film was cured under the following conditions, and a cured product of the sealing film with a copper foil (epoxy resin cured product with a copper foil) was obtained.

- Oven: SAFETY OVEN SPH-201 manufactured by Espec Corp.
- Oven temperature: 140°C
- Time: 120 minutes

[0138] After peeling the copper foil from the cured product of the sealing film with a copper foil, the cured product of the sealing film was cut to be 4 mm x 30 mm and test pieces were produced. The elastic

modulus and the glass transition temperature of the produced test pieces were measured under the following conditions.

- Measurement device: DVE (DVE-V4 manufactured by Rheology Co., Ltd.)
- Measurement temperature: 25-300°C
- Heating rate: 5°C/min

[0139] In a case where the elastic modulus is high, warpage and cracking easily occur in the sealed structure, thus, the elastic modulus was evaluated according to the following judgment criteria.

A: Elastic modulus (30°C) ≤15 GPa

B: Elastic modulus (30°C) >15 GPa

[0140] In a case where the glass transition temperature Tg is low, the thermal reliability of the sealed structure is deteriorated, thus, the glass transition temperature was evaluated according to the following judgment criteria.

A: Glass transition temperature (°C) ≥100

B: Glass transition temperature (°C) <100

[0141]

<Evaluation Results>

The results are shown in Table 1. Here, the blending amounts of each component in Table 1 are solid amounts (the amounts excluding the amount of the solvent).

[0142]

[Table1]

			Example 1	Example 2	Example 3	Example 4	Comparative Example 1	Comparative Example 2
Thermosetting resin	Epoxy resin	A1	6.45	4.80	5.61	5.30	7.24	4.77
	Phenol resin	B1	5.64	0	0	0	0	0
		B2	0	0	6.48	0	0	0
		B3	0	7.29	0	0	0	0
		B4	0	0	0	6.79	0	0
		B5	0	0	0	0	4.84	3.19
Curing accelerator		C1	0.03	0.02	0.03	0.03	0.04	0.02
Elastomer		D1	1.21	1.21	1.21	1.21	1.21	0.8
Inorganic filler		E1	86.67	86.67	86.67	86.67	86.67	91.22
Evaluation B	Sealing temperature		70	70	70	70	70	70
	Embeddability		A	A	A	A	A	B
	Hollow non-filling property		A	B	B	A	C	A
Evaluation C	Sealing temperature		70	80	80	60	50	40
	Embeddability		A	A	A	A	A	C
	Hollow non-filling property		B	B	B	B	C	-
Evaluation D	Tg (°C)		120	130	130	110	130	130
	Tg Evaluation		A	A	A	A	A	A
	Elastic modulus (Mpa)		14	15	15	14	16	18
	Elastic modulus evaluation		A	A	A	A	B	B

[0143] As shown in Table 1, in the Examples, it was possible to satisfy both the embeddability and the hollow non-filling property at a sealing temperature of 70°C. In addition, even in a case where sealing was performed at a temperature at which the melt viscosity is 7000 Pa · s, it was possible to satisfy both the embeddability and the hollow non-filling property. On the other hand, in Comparative Example 1, the desired embeddability was not obtained at the sealing temperature of 70°C and the desired hollow non-filling property was not obtained even at a temperature at which the melt viscosity was 7000 Pa · s. In addition, in Comparative Example 2, the desired hollow non-filling property was not obtained in either of evaluation A (sealing temperature of 70°C) or evaluation B (melt viscosity of 7000 Pa · s).

Reference Signs List

[0144]

1 SUPPORT

2 SEALING FILM

2a CURED PRODUCT OF SEALING FILM (SEALING PORTION)

10 SEALING FILM WITH SUPPORT

20 SAW DEVICE (OBJECT TO BE SEALED)

30 SUBSTRATE

40 BUMP

50 HOLLOW REGION

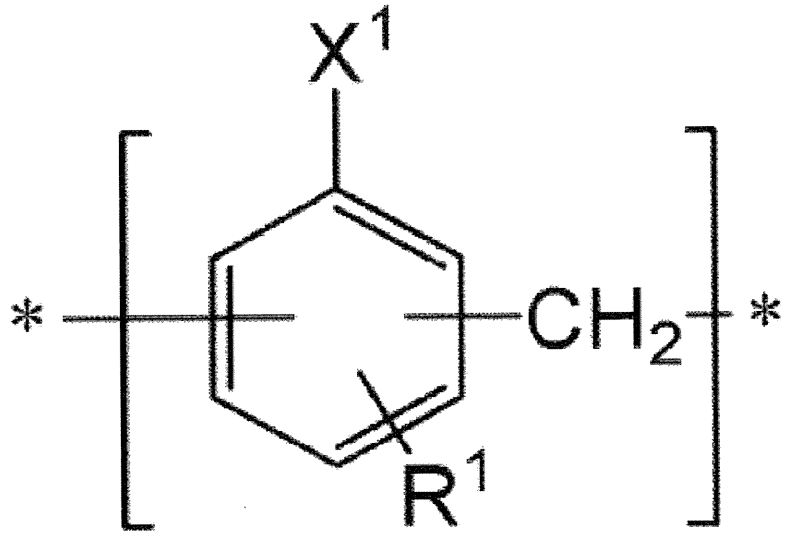
60 HOLLOW STRUCTURE

100, 200 HOLLOW SEALED STRUCTURE (SEALED STRUCTURE).

CLAIMS

1. A sealing film comprising:

a resin composition comprising a thermosetting resin which comprises a structural unit represented by Formula (1), and an inorganic filler,



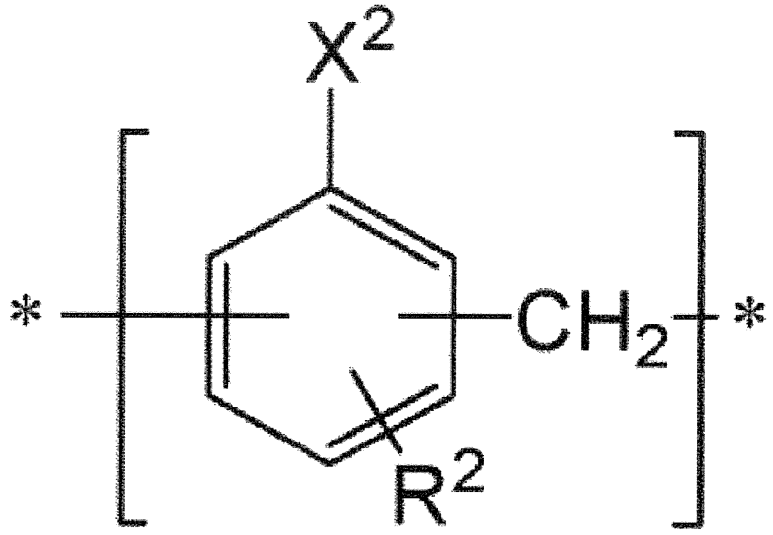
(1)

in Formula (1), X^1 represents a reactive functional group and R^1 represents a hydrocarbon group having 2 to 25 carbon atoms,

wherein the sealing film is used to seal an object to be sealed provided on a substrate via a bump.

2. The sealing film according to claim 1,

wherein the thermosetting resin further comprises a structural unit represented by Formula (2)



(2)

in Formula (2), X^2 represents a reactive functional group and R^2 represents a hydrogen atom or a phenyl group.

3. The sealing film according to claim 1 or 2,

wherein X^1 is a hydroxyl group.

4. The sealing film according to any one of claims 1 to 3,

wherein the resin composition further comprises an epoxy resin.

5. The sealing film according to any one of claims 1 to 4,

wherein a content of the structural unit represented by Formula (1) in the thermosetting resin is 20 mol% or more based on a total amount of structural units forming the thermosetting resin.

6. The sealing film according to any one of claims 1 to 5,

wherein a weight average molecular weight of the

thermosetting resin is 500 or more.

7. The sealing film according to any one of claims 1 to 6,

wherein a film thickness is 20 to 250 μm.

8. A method for manufacturing a sealed structure, the method comprising:

preparing a hollow structure comprising a substrate and an object to be sealed provided on the substrate via a bump, in which a hollow region is provided between the substrate and the object to be sealed; and

sealing the object to be sealed with the sealing film according to any one of claims 1 to 7.

9. The method for manufacturing a sealed structure according to claim 8,

wherein the object to be sealed is a SAW device comprising an electrode on the hollow region side.

10. A sealed structure comprising:

a substrate;

an object to be sealed provided on the substrate via a bump; and

a cured product of the sealing film according to any one of claims 1 to 7, which seals the object to be sealed,

wherein a hollow region is provided between the substrate and

the object to be sealed.

11. The sealed structure according to claim 10,

wherein the object to be sealed is a SAW device comprising an electrode on the hollow region side.