

DESCRIPTION

RELEASE FILM

Technical Field

[0001] The present invention relates to a release film.

Background Art

[0002] A semiconductor chip is usually encapsulated with a resin to be isolated and protected from the outside air, and is mounted on a substrate in the state of a molded article called "package". This molded article is usually molded such that a molded package as an individual chip is connected via a runner which is a flow path of the encapsulation resin with another package. In this case, a molded article can be released from a mold owing to the structure of the mold used for molding the molded article, addition of a release agent to an encapsulation resin, or the like.

[0003] Meanwhile, in response to the request for miniaturization, increase in pin number, etc. of the package, the demand for packages by a ball grid array (BGA) method, a quad flat non-lead (QFN) method, a wafer level chip size package (WL-CSP) method, or the like is increasing. A resin release film is used in the QFN method for securing adequate stand-off height and preventing generation of a burr of an encapsulation material at a terminal area, and in the BGA method or the WL-CSP method for improving the releasability of a package from a mold (see, for example, Patent Literature 1). The molding method using such a release film is referred to as "film assisted molding".

[0004] In the fields of the BGA method and the WL-CSP method, the molding method is being changed from the conventional transfer molding method to the compression molding method in order to increase the size of one shot and the efficiency.

[0005] Meanwhile, without relying on these molding methods, a molding process has been also proposed, in which a functional sheet having another function is previously mounted on a release film, and molding is performed at a molding step such that the functional sheet is arranged on the semiconductor package (see, for example, Patent Literature 2 and Patent Literature 3).

[0006]

[Patent Literature 1] Japanese Patent Application Laid-Open (JP-A) No. 2002-158242

[Patent Literature 2] JP-A No. 2007-287937

[Patent Literature 3] International Publication (WO) No. 2013/183671

SUMMARY OF INVENTION

Technical Problem

[0007] According to the methods described in Patent Literature 2 and Patent Literature 3, it is possible to place a functional sheet on a semiconductor package simultaneously in the step of molding the semiconductor package. Meanwhile, in the actual process step, a release film preferably satisfies both the property that a functional sheet is retained without being detached from a release layer in a step up to a molding step, and the property that a functional sheet can be released well from a mold in a molding step.

[0008] Currently, a release film widely used in the compression molding method is not provided with the property of retaining a functional sheet. Therefore, in order to mold a functional sheet on a semiconductor package in the molding step using such a release film, it is necessary to mount a functional sheet after the release film is placed in a mold. However, it is difficult to automate the process step of mounting a functional sheet on the release film placed in the mold which is heated and has a complicated shape. Meanwhile, a manual operation has drawbacks of low working efficiency and poor safety.

[0009] The present invention was made in view of the above circumstances, with an object to provide a release film having favorable properties of retaining a functional sheet up to a molding step and releasing the functional sheet from a mold in the molding step.

Solution to Problem

[0010] The means for achieving the object includes the following embodiments.

<1> A release film including a substrate and a release layer formed on the substrate, the release layer including a resin component and a filler,

wherein a ratio (A/B) of a volume average particle diameter A (μm) of the filler to a mass B (g/m^2) per 1 m^2 of the release layer is 1 or less.

<2> The release film according to <1>, wherein the volume average particle diameter A of the filler is from $1 \mu\text{m}$ to $50 \mu\text{m}$.

<3> The release film according to <1> or <2>, wherein the mass B per 1 m^2 of the release layer is from $0.1 \text{ g}/\text{m}^2$ to $100 \text{ g}/\text{m}^2$.

<4> The release film according to any one of <1> to <3>, wherein the resin component includes a thermosetting resin.

<5> The release film according to any one of <1> to <4>, wherein the release film further includes a crosslinking agent, and a content of the crosslinking agent with respect to 100 parts by mass of the resin component is from 1 part by mass to 10 parts by mass.

<6> The release film according to any one of <1> to <5>, wherein the substrate includes at least one selected from the group consisting of polyethylene terephthalate, polybutylene terephthalate, and polyethylene naphthalate.

Advantageous Effects of Invention

[0011] According to the present invention, there can be provided a release film having favorable properties of retaining a functional sheet up to a molding step and releasing the functional sheet from a mold in the molding step.

BRIEF DESCRIPTION OF DRAWINGS

[0012] FIG. 1 is a diagram schematically showing a cross section of a release film in a state of retaining a functional sheet.

FIG. 2 is a diagram schematically showing a cross section of equipment for molding by a transfer molding method using a release film.

FIG. 3 is a diagram schematically showing a cross section of equipment for molding by a transfer molding method using a release film.

FIG. 4 is a diagram schematically showing a cross section of equipment for molding by a transfer molding method using a release film.

DESCRIPTION OF EMBODIMENTS

[0013] Hereinbelow, specific embodiments for implementing the present invention are described in detail. However, the invention is not limited to these embodiments. In the embodiments below, the components (including element steps and the like) are not always indispensable unless otherwise expressly stated. The same applies to numerical values and ranges thereof, and the invention is not limited thereby.

[0014] The term "step" as used herein includes not only a separate step independent from another step but also a step that is not clearly distinguished from other steps as long as the intended object of the step can be attained therefrom.

As used herein, the notation "to" expressing a numerical range indicates a range including the numerical values before and after "to", as the minimum value and the maximum value, respectively.

Regarding numerical ranges described herein in a stepwise manner, an upper value or a lower value of one numerical range described in a stepwise manner may be replaced with an upper value or a lower value of the numerical range of another numerical range described in a stepwise manner. Further, regarding numerical ranges described herein, an upper value or a lower value of the numerical range may be replaced with a value shown in a working example.

Regarding a content or amount of a component in a composition, when plural kinds of substances corresponding to the same component exist in the composition, the content or

amount of the component in the composition refers to total content or amount of the plural kinds of substances in the composition unless otherwise specified.

Regarding a particle diameter of a component in a composition, when plural particles corresponding to the same component exist in the composition, the particle diameter of the component in the composition refers to a value obtained from the mixture of the plural particles exist in the composition unless otherwise specified.

The term "layer" or "film" as used herein includes not only a structure to cover an entire region but also a structure configured to cover a part of the region when the region where the layer or film exists is observed.

The term "layered" means herein to stacking of layers, where two or more layers may be bonded together or may be detachable from each other.

In the specification, the term "(meth)acryloyl group" refers to one or both of an acryloyl group or a methacryloyl group, the term "(meth)acryl" refers to one or both acryl and methacryl, and the term "(meth)acrylate" refers to one or both of acrylate and methacrylate.

[0015] <Release Film>

A release film according to the present embodiment includes a substrate and a release layer that is formed on the substrate and contains a resin component and a filler, in which the ratio (A/B) of a volume average particle diameter A (μm) of the filler to a mass B (g/m^2) per 1 m^2 of the release layer is 1 or less.

[0016] A release film according to the present embodiment has favorable properties of retaining a functional sheet up to a molding step and releasing a functional sheet from a mold in the molding step. Therefore, the release film can be suitably used, for example, in a method of placing a functional sheet on the surface of a semiconductor package during a molding step of the semiconductor package.

[0017] Although the reason why a release film according to the present embodiment has favorable properties of retaining a functional sheet up to a molding step and releasing the functional sheet from a mold in the molding step is not very clear, it is presumably attributable to moderate tackiness provided by the resin component contained in the release layer, and to moderate surface unevenness provided by the filler contained in the release layer.

[0018] From the viewpoint of the property of retaining a functional sheet, the ratio of the volume average particle diameter A (μm) of the filler contained in the release layer to a mass B (g/m^2) per 1 m^2 of the release layer is preferably 1.0 or less, more preferably 0.7 or less, and still more preferably 0.5 or less.

[0019] The lower limit value of A/B is not specifically limited. For example, in a case in which the pressure at the time of molding is desired to be raised depending on the type and

application of the semiconductor package, or in which the finish of the outermost surface of the semiconductor package is desired to be roughen, a higher A/B value is preferable from the viewpoint of imparting high releasability to a release film, or roughening the surface. For example, A/B is preferably 0.3 or more, and more preferably 0.5 or more.

[0020] [Release Layer]

A release layer includes a resin component and a filler, in which the ratio (A/B) of a volume average particle diameter A (μm) of the filler to a mass B (g/m^2) per 1 m^2 of the release layer is 1 or less.

[0021] In the present embodiment, the volume average particle diameter A (μm) of the filler is a value measured by the light diffraction/scattering method, and is defined as the particle diameter (D50), at which a cumulative volume from the smaller diameter side of the obtained particle size distribution in terms of mass reaches 50%.

[0022] The range of the mass B (g/m^2) per 1 m^2 of the release layer is not particularly limited, and may be selected considering the relationship with the average particle diameter of the filler. For example, the mass B per 1 m^2 of the release layer is preferably from $0.1\text{ g}/\text{m}^2$ to $100\text{ g}/\text{m}^2$, and more preferably from $1\text{ g}/\text{m}^2$ to $50\text{ g}/\text{m}^2$.

In a case in which the mass B per 1 m^2 of the release layer is $0.1\text{ g}/\text{m}^2$ or more, the release layer includes a sufficient amount of the resin component, and the favorable flexibility and stretchability required in the molding step can be obtained, whereby delamination or missing of the release layer from a substrate tends to be suppressed. In addition, favorable flexibility can be obtained, whereby the retention property of the functional sheet tends to be well maintained.

In a case in which the mass B per 1 m^2 of the release layer is $100\text{ g}/\text{m}^2$ or less, the phenomenon that the flatness of the release film is impaired by a thermal contraction stress at the time of thermal curing due to excessive thickness of the release layer tends to be suppressed. Further, the phenomenon that the release layer becomes excessively soft, and a mounted functional sheet is buried in the release layer and consequently not correctly positioned on a package surface tends to be suppressed.

[0023] In the present embodiment, the method for determining the mass B (g/m^2) per 1 m^2 of the release layer is not particularly limited. For example, the mass (g) of the release layer is calculated from the mass (g) of the release film cut out to have an area of 100 cm^2 (for example, in a size of $10\text{ cm} \times 10\text{ cm}$), and the mass (g) of the substrate obtained by removing the release layer from the release film using an organic solvent or the like. The mass (g/m^2) per 1 m^2 of the release layer can be obtained by multiplying the obtained value by a conversion factor of 100.

[0024] The thickness of the release layer is not particularly limited. For example, the thickness of the release layer is preferably from 0.1 μm to 100 μm . In a case in which the thickness of the release layer is 0.1 μm or more, the resin component can sufficiently retain the filler, so that a problem that the filler falls off and is incorporated into a package at the time of molding tends to be hardly caused, and semiconductor packages can be stably manufactured. In a case in which the thickness of the release layer is 100 μm or less, a raw material used for the release layer may be saved, which is preferable from the viewpoint of production cost.

[0025] In the present embodiment, the thickness of the release layer is a number average value of values measured at 5 arbitrary points. The thickness of the release layer can be measured, for example, using a general-purpose micrometer.

[0026] The release layer may have an uneven outer surface (the surface opposite to the side facing the substrate) depending on the application. In a case in which the release layer has the uneven outer surface, it is preferable from the viewpoint of uniformity in the appearance of the package surface, that the arithmetic average roughness (R_a) of the outer surface (the surface opposite to the side facing the substrate) of the release layer is from 0.5 μm to 5 μm . Further, the ten-point average roughness (R_z) of the outer surface is preferably from 5 μm to 50 μm .

[0027] In the present embodiment, the arithmetic average roughness (R_a) and the ten-point average roughness (R_z) of the outer surface of the release layer may be the value obtained through an analysis by the method according to JIS B0601 (2013), or ISO 4287 (1997) of the values measured, for example, by a surface roughness measuring instrument (for example, Model No. SE-3500, manufactured by Kosaka Laboratory Ltd.) under the conditions of: stylus tip radius of 2 μm , scan speed of 0.5 mm/s, and scan length of 8 mm.

[0028] The tackiness at 25°C of the release layer in the outer surface is preferably 1.0 gf or more. In a case in which the tackiness at 25°C in the outer surface is 1.0 gf or more, the property of retaining a functional sheet up to a molding step tends to be improved.

[0029] The tackiness at 170°C of the release layer in the outer surface is preferably 20.0 gf or less. In a case in which the tackiness at 170°C in the outer surface is 20.0 gf or less, the releasability of a functional sheet from a mold in the molding step tends to be improved.

[0030] In the present embodiment, the tackiness (gf) of the release layer in the outer surface may be a value measured, for example, using a tackiness tester (for example, one manufactured by Rhesca Co., Ltd.) with a probe having a diameter of 5 mm, under conditions of a load before measurement of 10 gf, a loading time before measurement of 1 sec, and an

lifting speed at measurement of 600 mm/min.

[0031] The content of the filler in the release layer is not particularly limited. For example, the content of the filler is preferably from 1.0% by mass to 50.0% by mass with respect to the total mass of the release layer. In a case in which the content of the filler is 1.0% by mass or more with respect to the total mass of the release layer, the surface of the semiconductor package after molding can be finished to have a uniform appearance owing to the surface roughness of the release layer. In a case in which the content of the filler is 50.0% by mass or less with respect to the total mass of the release layer, the resin component can sufficiently retain the filler component, so that a problem that the filler falls off and is incorporated into a package at the time of molding tends to be hardly caused, and the semiconductor packages can be stably manufactured.

[0032] If necessary, in addition to the resin component and the filler, the release layer may further include other components, such as a solvent, an anchoring improver, a crosslinking accelerator, an antistatic agent, or a colorant.

[0033] (Resin Component)

The kind of the resin component contained in the release layer is not particularly limited. For example, the resin component may be a resin (thermosetting resin) which is cured through a crosslinking reaction by heating. Examples of a resin that can be used as the resin component include an acrylic resin, an olefin resin, a styrene resin, an acrylonitrile resin, a silicone resin, an epoxy resin, a cyanate ester resin, a maleimide resin, an allyl-nadi-imide resin, a phenol resin, a urea resin, a melamine resin, an alkyd resin, an unsaturated polyester resin, a diallyl phthalate resin, a resorcinol formaldehyde resin, a xylene resin, a furan resin, a urethane resin, a ketone resin, a triallyl cyanurate resin, an isocyanate resin, a resin including tris(2-hydroxyethyl) isocyanurate, a resin including triallyl trimellitate, a thermosetting resin synthesized from cyclopentadiene, and a thermosetting resin obtained by trimerization of an aromatic dicyanamide. The release layer may include single kind of resin component, or two or more kinds thereof.

[0034] From the viewpoint of releasability with respect to the semiconductor package, the release layer preferably contains at least one kind selected from the group consisting of an acrylic resin, an olefin resin, a styrene resin, and an acrylonitrile resin, as a resin component.

[0035] Examples of the acrylic resin include a homopolymer and a copolymer, including at least a (meth)acrylic monomer in a polymerization component. Specific examples thereof include poly((meth)acrylic acid), and poly(meth)acrylate.

[0036] Examples of a (meth)acrylic monomer constituting the acrylic resin include (meth)acrylic acid, methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate,

isopropyl (meth)acrylate, n-butyl (meth)acrylate, isobutyl (meth)acrylate, sec-butyl (meth)acrylate, t-butyl (meth)acrylate, pentyl (meth)acrylate, hexyl (meth)acrylate, heptyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, octyl (meth)acrylate, nonyl (meth)acrylate, decyl (meth)acrylate, dodecyl (meth)acrylate, tetradecyl (meth)acrylate, hexadecyl (meth)acrylate, octadecyl (meth)acrylate, eicosyl (meth)acrylate, docosyl (meth)acrylate, cyclopentyl (meth)acrylate, cyclohexyl (meth)acrylate, cycloheptyl (meth)acrylate, benzyl (meth)acrylate, phenyl (meth)acrylate, methoxyethyl (meth)acrylate, dimethylaminoethyl (meth)acrylate, diethylaminoethyl (meth)acrylate, dimethylaminopropyl (meth)acrylate, 2-chloroethyl (meth)acrylate, 2-fluoroethyl (meth)acrylate, and dicyclopentanyl (meth)acrylate.

[0037] Examples of a monomer constituting the acrylic resin other than a (meth)acrylic monomer include styrene, α -methylstyrene, cyclohexylmaleimide, vinyltoluene, vinyl chloride, vinyl acetate, N-vinylpyrrolidone, butadiene, isoprene, and chloroprene.

[0038] Examples of the olefin resin include a homopolymer of an olefin monomer, a homopolymer of an alkene monomer, and a copolymer including an olefin monomer or an alkene monomer as a polymerization component. Specific examples thereof include a polyolefin, such as polyethylene, polypropylene, or polymethylpentene.

[0039] Examples of the styrene resin include a homopolymer of styrene, a homopolymer of a styrene derivative, and a copolymer including styrene or a styrene derivative as a polymerization component. Examples of the styrene derivative include an alkyl-substituted styrene having an alkyl chain, such as α -methylstyrene, 4-methylstyrene, 2-methylstyrene, 3-methylstyrene, 2-ethylstyrene, 3-ethylstyrene, or 4-ethylstyrene; a halogen-substituted styrene, such as 2-chlorostyrene, 3-chlorostyrene, or 4-chlorostyrene; a fluorine-substituted styrene, such as 4-fluorostyrene or 2,5-difluorostyrene; and vinyl naphthalene.

[0040] Examples of the acrylonitrile resin include a homopolymer of a (meth)acrylonitrile monomer, and a copolymer including a (meth)acrylonitrile monomer as a polymerization component.

[0041] In a case in which a thermosetting resin is used as the resin component, a crosslinking agent may be used. In a case in which a crosslinking agent is used, the content of the crosslinking agent with respect to 100 parts by mass of the thermosetting resin is not particularly limited. For example, the content of the crosslinking agent may be from 1 part by mass to 10 parts by mass with respect to 100 parts by mass of the thermosetting resin.

[0042] The kind of crosslinking agent is not particularly limited, and may be selected appropriately according to the kind of thermosetting resin, a desired curing speed, or the like. For example, in a case in which an acrylic resin is used as the thermosetting resin, it may be selected from known crosslinking agents, such as an isocyanate compound, a melamine

compound, or an epoxy compound.

[0043] [Filler]

The volume average particle diameter of the filler is not particularly limited, as long as the condition that the ratio (A/B) of the volume average particle diameter A (μm) of the filler to the mass B (g/m^2) per 1 m^2 of the release layer is 1 or less is satisfied. For example, the volume average particle diameter of the filler is preferably from $1 \mu\text{m}$ to $50 \mu\text{m}$.

[0044] In a case in which the volume average particle diameter of the filler is $1 \mu\text{m}$ or more, sufficient unevenness tends to be provided with the outer surface of the release layer, and uniformity of the surface appearance of a molded semiconductor package tends to be improved, and generation of flow marks of an encapsulation material tends to be suppressed. In a case in which the volume average particle diameter of the filler is $50 \mu\text{m}$ or less, the thickness of the release layer required for suppressing falling-off of the filler from the release layer tends to be reduced.

[0045] The upper limit of the volume average particle diameter of the filler is preferably $50 \mu\text{m}$, and more preferably $20 \mu\text{m}$, from the viewpoint of the surface appearance of the semiconductor package. The lower limit of the volume average particle diameter of the filler is preferably $1 \mu\text{m}$ from the viewpoint of adjusting the surface roughness of the molded semiconductor package.

[0046] The shape of the filler contained in the release layer is not particularly limited. Examples thereof include spherical shape, elliptical shape, and indefinite shape.

[0047] The material of the filler is not particularly limited as long as the filler can maintain its shape in the release layer (that is, the filler is not easily soluble in an organic solvent used for forming the release layer, or a resin component contained in the release layer). The filler may be a filler made of an organic material, a filler made of an inorganic material, or a filler made of both an organic material and an inorganic material. The release layer may contain single kind of filler, or two or more kinds thereof.

[0048] Examples of the inorganic substance which is used as a material for the filler include a metal such as silver, gold, or copper, silica, alumina, titania, and an iron oxide. The inorganic substance may have electric conductivity, or may not necessarily have electric conductivity.

[0049] In a case in which the filler made of an inorganic substance is used, an inorganic ion exchanger may be used in combination. As the inorganic ion exchanger, one having a recognizable scavenging action on an ion (Na^+ , K^+ , Cl^- , F^- , RCOO^- , Br^- , etc., wherein R is an alkyl group, an aryl group, or the like) extracted into an aqueous solution, when the release layer is extracted in hot water, is effective. Examples of such an inorganic ion exchanger

include a natural mineral, such as naturally produced zeolite, a zeolite group, acid clay, dolomite, or hydrotalcite, and artificially synthesized synthetic zeolite.

[0050] Examples of the organic substance which is use as a material for the filler include an acrylic resin, an imide resin, an amide resin, an amide-imide resin, an olefin resin, a styrene resin, a carbonate resin, a silicone resin, and an ABS resin. These resins are preferably in a state cured by a crosslinking reaction.

[0051] Among the above-mentioned fillers, a filler containing an acrylic resin which is in a state cured by a crosslinking reaction (hereinafter also referred to as a "crosslinked acrylic resin") is preferable, because such a filler exhibits favorable dispersibility in a resin component, and the characteristics of the filler, such as shape, particle diameter, or heat resistance can be easily adjusted by selecting the kind of monomer to be used as a polymerization component.

[0052] As the crosslinked acrylic resin, a (meth)acrylic copolymer obtained by copolymerizing a (meth)acrylic monomer having no a functional group, such as butyl (meth)acrylate, ethyl (meth)acrylate, or 2-ethylhexyl (meth)acrylate, with a (meth)acrylic monomer having a functional group, such as (meth)acrylic acid, hydroxyethyl (meth)acrylate, (meth)acrylamide, or (meth)acrylonitrile, or with another monomer is preferable.

[0053] Examples of the (meth)acrylic monomer used as a polymerization component of the crosslinked acrylic resin include: (1) a (meth)acrylic monomer having a chain-like alkyl group, (2) a (meth)acrylic monomer having an alicyclic skeleton, (3) a polyfunctional (meth)acrylic monomer, and (4) a (meth)acrylic monomer having a functional group. Each (meth)acrylic monomer is described below.

[0054] (1) (Meth)acrylic Monomer Having Chain-like Alkyl Group

Examples of the (meth)acrylic monomer having a chain-like hydrocarbon group include a (meth)acrylic acid ester having a chain-like hydrocarbon group in the ester moiety thereof (hereinafter the (meth)acrylic acid ester is sometimes referred to as "(meth)acrylate").

[0055] Examples of the (meth)acrylic acid ester having a chain-like hydrocarbon group include a (meth)acrylic acid ester having a chain-like hydrocarbon group having 1 to 20 carbon atoms. In a case in which the number of carbon atoms of the hydrocarbon group is 20 or less, the elastic modulus tends to be low. From the viewpoint of the solubility of the acrylic polymer, the number of carbon atoms is preferably from 2 to 18, and from the viewpoint of heat resistance in a molding step, the carbon number is more preferably from 4 to 18. The chain-like hydrocarbon group is preferably an alkyl group having 1 to 20 carbon atoms.

[0056] The chain-like hydrocarbon group may be linear or branched. In a case in which

the chain-like hydrocarbon group is branched, it preferably has no tertiary carbon atom. In a case in which the chain-like hydrocarbon group does not have no tertiary carbon atom, mass reduction due to thermal decomposition at a low temperature hardly occurs, which is advantageous from the viewpoint of heat resistance.

[0057] Specific examples of the (meth)acrylic ester having a chain-like hydrocarbon group having 1 to 20 carbon atoms include methyl (meth)acrylate, ethyl (meth)acrylate, n-propyl (meth)acrylate, isopropyl (meth)acrylate, n-butyl (meth)acrylate, isobutyl (meth)acrylate, sec-butyl (meth)acrylate, pentyl (meth)acrylate, n-hexyl (meth)acrylate, n-octyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, decyl (meth)acrylate, 1-dodecyl (meth)acrylate, and isostearyl (meth)acrylate.

[0058] (2) (Meth)acrylic Monomer Having Alicyclic Skeleton

Examples of the (meth)acrylic monomer having an alicyclic skeleton include a (meth)acrylic acid ester having an alicyclic skeleton. Examples of the alicyclic skeleton include a cycloalkane skeleton, a bicycloalkane skeleton, a norbornyl skeleton, and an isobornyl skeleton. Among them, from the viewpoint of improving the transparency, a bicycloalkane skeleton and a norbornyl skeleton are preferable.

[0059] Specific examples of the (meth)acrylic monomer having an alicyclic skeleton include cyclopentyl (meth)acrylate, cyclopentanyl (meth)acrylate, cyclohexyl (meth)acrylate, methylcyclohexyl (meth)acrylate, trimethylcyclohexyl (meth)acrylate, norbornyl (meth)acrylate, norbornylmethyl (meth)acrylate, phenylnorbornyl (meth)acrylate, cyanonorbornyl (meth)acrylate, isobornyl (meth)acrylate, bornyl (meth)acrylate, menthyl (meth)acrylate, fenchyl (meth)acrylate, adamantyl (meth)acrylate, dimethyladamantyl (meth)acrylate, tricyclo[5.2.1.0^{2,6}]dec-8-yl (meth)acrylate, tricyclo[5.2.1.0^{2,6}]deca-4-methyl (meth)acrylate, and cyclodecyl (meth)acrylate.

[0060] From the viewpoint of heat resistance, preferable examples include cyclopentanyl acrylate, cyclohexyl acrylate, isobornyl acrylate, norbornyl acrylate, norbornylmethyl acrylate, tricyclo[5.2.1.0^{2,6}]dec-8-yl acrylate, tricyclo[5.2.1.0^{2,6}]deca-4-methyl acrylate, adamantyl acrylate, cyclopentyl methacrylate, cyclohexyl methacrylate, methylcyclohexyl methacrylate, trimethylcyclohexyl methacrylate, norbornyl methacrylate, norbornylmethyl methacrylate, isobornyl methacrylate, bornyl methacrylate, menthyl methacrylate, fenchyl methacrylate, adamantyl methacrylate, dimethyladamantyl methacrylate, tricyclo[5.2.1.0^{2,6}]dec-8-yl methacrylate, tricyclo[5.2.1.0^{2,6}]deca-4-methyl methacrylate, cyclodecyl methacrylate, and phenyl norbornyl methacrylate.

[0061] From the viewpoint of high heat resistance, more preferable examples include cyclopentanyl acrylate, cyclohexyl acrylate, isobornyl acrylate, norbornyl acrylate,

norbornylmethyl acrylate, tricyclo[5.2.1.0^{2,6}]dec-8-yl acrylate, tricyclo[5.2.1.0^{2,6}]deca-4-methyl acrylate, and adamantyl acrylate.

[0062] (3) Polyfunctional (Meth)acrylic Monomer

The polyfunctional (meth)acrylic monomer is not particularly limited as long as it has two or more (meth)acryloyl groups. Examples of the polyfunctional (meth)acrylic monomer include a (meth)acrylic monomer having two or more (meth)acryloyl groups and an alicyclic skeleton, a (meth)acrylic monomer having two or more (meth)acryloyl groups and an aliphatic skeleton, a (meth)acrylic monomer having two or more (meth)acryloyl groups and a dioxane glycol skeleton, and a (meth)acrylic monomer having two or more (meth)acryloyl groups and a functional group, which (4) the (meth)acrylic monomer having a functional group described below may possess.

[0063] Specific examples of the polyfunctional (meth)acrylic monomer include cyclohexane-1,4-dimethanol di(meth)acrylate, cyclohexane-1,3-dimethanol di(meth)acrylate, tricyclodecanedimethylol di(meth)acrylate, (for example, KAYARAD R-684, tricyclodecanedimethylol diacrylate, produced by Nippon Kayaku Co., Ltd.), tricyclodecanedimethanol di(meth)acrylate (for example, A-DCP, tricyclodecanedimethanol diacrylate, produced by Shin-Nakamura Chemical Co., Ltd.), dioxane glycol di(meth)acrylate (for example, KAYARAD R-604, dioxane glycol diacrylate, produced by Nippon Kayaku Co., Ltd.), neopentyl glycol di(meth)acrylate, dicyclopentanyl di(meth)acrylate, 1,6-hexanediol di(meth)acrylate, ethylene oxide-modified 1,6-hexanediol di(meth)acrylate, neopentyl glycol di(meth)acrylate, poly(ethylene oxide)-modified neopentyl glycol di(meth)acrylate, hydroxypivalic acid neopentyl glycol di(meth)acrylate, poly(ethylene glycol) di(meth)acrylate, poly(propylene glycol) di(meth)acrylate, ethylene oxide-modified bisphenol A di(meth)acrylate (preferably poly(ethylene oxide)-modified bisphenol A di(meth)acrylate, more preferably (5 to 15 mol)-ethylene oxide-modified bisphenol A di(meth)acrylate), and poly(ethylene oxide)-modified phosphoric acid di(meth)acrylate.

[0064] (4) (Meth)acrylic Monomer Having Functional Group

Examples of the (meth)acrylic monomer having a functional group include a (meth)acrylic monomer having in the molecule thereof at least one functional group selected from the group consisting of a carboxy group, a hydroxy group, an acid anhydride group, an amino group, an amide group, and an epoxy group.

[0065] Examples of the (meth)acrylic monomer having a carboxy group as a functional group include (meth)acrylic acid, 2-(meth)acryloyloxyethyl succinic acid, 2-(meth)acryloyloxyethyl phthalic acid, 2-(meth)acryloyloxyethyl hexahydrophthalic acid, and 2-(meth)acryloyloxypropyl hexahydrophthalic acid.

[0066] Examples of the (meth)acrylic monomer having a hydroxy group as a functional group include hydroxyethyl (meth)acrylate, hydroxypropyl (meth)acrylate, hydroxybutyl (meth)acrylate, cyclohexanedimethanol mono(meth)acrylate, and N-methylol (meth)acrylamide.

[0067] Examples of the (meth)acrylic monomer having an acid anhydride group as a functional group include (meth)acryloyloxyethyl trimellitic anhydride and (meth)acryloyloxyethyl cyclohexanetricarboxylic anhydride.

[0068] Examples of the (meth)acrylic monomer having an amino group as a functional group include diethylaminoethyl (meth)acrylate, 2,2,6,6-tetramethylpiperidinyl (meth)acrylate, and (meth)acrylamide.

[0069] Examples of the (meth)acrylic monomer having an amide group as a functional group include N-(meth)acryloylglycinamide.

[0070] Examples of the (meth)acrylic monomer having an epoxy group as a functional group include glycidyl (meth)acrylate, glycidyl α -ethyl (meth)acrylate, glycidyl α -n-propyl (meth)acrylate, 2-(2,3-epoxypropoxy)ethyl (meth)acrylate, 3-(2,3-epoxypropoxy)propyl (meth)acrylate, 4-(2,3-epoxypropoxy)butyl (meth)acrylate, 5-(2,3-epoxypropoxy)pentyl (meth)acrylate, 6-(2,3-epoxypropoxy)hexyl (meth)acrylate, 3,4-epoxybutyl (meth)acrylate, 4,5-epoxypentyl (meth)acrylate, 6,7-epoxyheptyl (meth)acrylate, 6,7-epoxyheptyl α -ethyl(meth)acrylate, 3-methyl-3,4-epoxybutyl (meth)acrylate, 4-methyl-4,5-epoxypentyl (meth)acrylate, 5-methyl-5,6-epoxyhexyl (meth)acrylate, β -methylglycidyl (meth)acrylate, β -methylglycidyl α -ethyl(meth)acrylate, 3-methyl-3,4-epoxybutyl (meth)acrylate, 4-methyl-4,5-epoxypentyl (meth)acrylate, and 5-methyl-5,6-epoxyhexyl (meth)acrylate.

[0071] Among the (meth)acrylic monomers having a functional group, an acrylic resin obtained by polymerizing a (meth)acrylic monomer having an epoxy group as a functional group (preferably, glycidyl methacrylate) is preferable from the viewpoint of improving the antifouling property of the release film, because the resin has favorable airtightness.

[0072] (Other Monomers)

The crosslinked acrylic resin may include a monomer (other monomer) other than the above-described (meth)acrylic monomers as a polymerization component. Examples of other monomer include a (meth)acrylic monomer having a benzene ring or a heterocyclic ring, an aromatic vinyl compound, a vinyl cyanide compound, an unsaturated dicarboxylic anhydride, and a N-substituted maleimide.

[0073] Examples of the (meth)acrylic monomer having a benzene ring or a heterocyclic ring include phenyl (meth)acrylate, benzyl (meth)acrylate, phenoxyethyl (meth)acrylate, naphthyl (meth)acrylate, and tetrahydrofurfuryl (meth)acrylate.

[0074] Examples of the aromatic vinyl compound include 4-vinylpyridine, 2-vinylpyridine, α -methylstyrene, α -ethylstyrene, α -fluorostyrene, α -chlorostyrene, α -bromostyrene, fluorostyrene, chlorostyrene, bromostyrene, methylstyrene, methoxystyrene, (o-, m-, p-)hydroxystyrene, and styrene.

[0075] Examples of the vinyl cyanide compound include acrylonitrile and methacrylonitrile.

[0076] Examples of the unsaturated dicarboxylic anhydride include maleic anhydride.

[0077] Examples of the N-substituted maleimide include N-methylmaleimide, N-ethylmaleimide, N-propylmaleimide, N-isopropylmaleimide, N-butylmaleimide, N-isobutylmaleimide, N-t-butylmaleimide, N-laurylmaleimide, N-cyclohexylmaleimide, N-benzylmaleimide, and N-phenylmaleimide.

[0078] (Crosslinking Agent)

The kind of crosslinking agent used for causing a crosslinking reaction for forming a crosslinked acrylic resin is not particularly limited. Examples thereof include known crosslinking agents, such as an isocyanate compound, a melamine compound, and an epoxy compound. In order to form a mildly spread network structure in the crosslinked acrylic resin, it is preferable to use a polyfunctional crosslinking agent. "Polyfunctional" means herein trifunctional or higher functional.

[0079] [Substrate]

The kind of substrate is not particularly limited. It is preferable that the substrate has both heat resistance enough to withstand the heating of a mold at the time of molding for a predetermined time period, and has flexibility sufficient to follow the structure of a mold. Examples of the substrate having such characteristics include a substrate containing a resin having heat resistance. In a case in which the substrate includes a resin, the substrate may include single kind of resin, or in combination of two or more kinds thereof.

[0080] Considering that the molding of an encapsulation material is carried out at a high temperature (usually approximately from 100°C to 200°C), a substrate has desirably heat resistance enough to withstand this temperature for a predetermined period of time. Further, in order to suppress occurrence of wrinkles of an encapsulation resin flowing in a mold, or breakage of the release film, at the time of placement of the release film in the mold and at the time of molding, it is important to select a substrate taking into account the elastic modulus, elongation, or the like at high temperature.

[0081] From the viewpoints of heat resistance and elastic modulus at high temperature, it is preferable that the substrate contains polyester as a resin. Examples of the polyester include polyethylene terephthalate, polybutylene terephthalate, polyethylene naphthalate, a resin containing two or more of these polyester polymerization components as a polymerization

component, and a resin obtained by modifying any of these polyesters. Among them, it is preferable that the substrate contains at least one kind selected from the group consisting of polyethylene terephthalate, polybutylene terephthalate, and polyethylene naphthalate.

[0082] The substrate is preferably in the form of a sheet. Specific examples thereof include a resin formed into a sheet. From the viewpoint of followability to a mold, a biaxially stretched resin sheet (film) is preferable.

[0083] The thickness of the substrate is not particularly limited, and preferably from 1 μm to 100 μm , and more preferably from 3 μm to 20 μm . In a case in which the thickness of the substrate is 1 μm or more, the release film has favorable handling property, and wrinkling tends to be suppressed. In a case in which the thickness is 100 μm or less, the followability to a mold at the time of molding is excellent, and generation of wrinkles or the like in a molded semiconductor package tends to be suppressed.

[0084] The thickness of the substrate in the present embodiment is a number average value of values measured at 5 arbitrary positions. The thickness of the substrate can be measured, for example, using a general-purpose micrometer.

[0085] Since the substrate comes into contact with the surface of a mold, a strong peel force is sometimes necessary to release the release film from the mold depending on its material. In a case in which the substrate is hardly peeled off from a mold, it is preferable to adjust the substrate such that it can be release more easily from the mold.

[0086] Examples of the method for adjusting the substrate so as to facilitate release from a mold include a method of imparting unevenness, such as satin finishing, to the surface on the side of the substrate opposite to the side of the release layer (surface in contact with the mold), and a method of applying another release layer (second release layer) on the substrate.

[0087] In a case in which the second release layer is provided on the substrate, the material for the second release layer is not particularly limited. For example, the second release layer may be formed using the same material as the above-mentioned material used for the release layer. The thickness of the second release layer is not particularly limited, and is preferably from 0.1 μm to 100 μm . The thickness of the second release layer is defined in the same manner as the thickness of the release layer described above.

[0088] [Other Members]

If necessary, the release film may include a member other than the release layer and the substrate. For example, a member such as an anchoring enhancement layer for the release layer or the second release layer, an antistatic layer, or a colored layer may be provided between the release layer and the substrate, between the substrate and the second release layer, or the like. Further, a protective layer may be provided to protect the surface

of the release film.

[0089] <Method of Producing Release Film>

The method of producing the release film is not particularly limited. The release film can be produced, for example, by preparing a composition for forming the release layer, applying the composition to one side of the substrate, and if necessary by removing a volatile component in the composition by drying to form the release layer on the substrate. In this case, by adjusting the amount of the composition to be applied on to the substrate and the amount of the filler used, the ratio (A/B) of the volume average particle diameter A (μm) of the filler contained in the release layer to be formed to the mass B (g/m^2) per 1 m^2 of the release layer is controlled to 1 or less.

[0090] The method for preparing the composition for forming the release layer is not particularly limited. For example, the composition may be prepared by mixing the resin component, the filler, and a solvent. From the viewpoint of forming the release layer with suppressed unevenness in the thickness on the substrate, it is preferable to use an organic solvent capable of dissolving the resin component as the solvent. Examples of the organic solvent include toluene, methyl ethyl ketone, and ethyl acetate.

[0091] The method of applying the composition to a substrate is not particularly limited. For example, it may be applied by a known coating method, such as a roll coating method, a bar coating method, and a kiss coating method. In a case in which the composition for forming the release layer is applied to the substrate, it is preferably applied such that the thickness of the formed release layer is in a range of from $0.1 \mu\text{m}$ to $100 \mu\text{m}$.

[0092] If necessary, the composition applied to the substrate may be dried to remove a volatile component such as a solvent in the composition. The method for drying is not particularly limited, and may be performed by a known method. Drying may be carried out, for example, in a range of from 50°C to 150°C for from 0.1 to 60 min.

[0093] [Method of Using Release Film]

An example of the method of using the release film according to the present embodiment is described below with reference to the drawings. In this regard, the sizes of the members in each drawing are conceptual, and the relative relationship among the sizes of the members is not limited thereto.

[0094] FIG. 1 schematically shows a cross section of a release film in a state of retaining a functional sheet. In FIG. 1, a release film 10 includes a substrate 1 and a release layer 2, and a functional sheet 3 is placed on the release layer 2.

[0095] FIG. 2 schematically shows a cross section of equipment in which a release film 10 unwound from a roll is supplied and molded using molding equipment based on a transfer

molding method. In FIG. 2, the reference number 4 denotes a mold, and the reference number 5 denotes a plunger for injecting an encapsulation resin into the cavity in the mold. The reference number 6 denotes a support member for a semiconductor package, and in the case of a BGA package configuration, an electric circuit is often provided inside the support member. The reference number 7 denotes a semiconductor chip, and a circuit on the semiconductor chip is generally connected with the circuit in the support member by a metal wire such as gold or copper (not illustrated).

[0096] As shown in FIG. 2, the release film 10 is unwound from a roll 8A and placed in a concave portion of the mold 4. Simultaneously, the functional sheet 3 mounted on the release film 10 is also placed in the concave portion of the mold 4. Further, the mold 4 is heated (for example, at about 170°C) such that an encapsulation resin to be injected at a later step will be melted.

[0097] FIG. 3 schematically shows a state in which the upper and lower parts of the mold 4 are brought into contact, and the encapsulation resin 9 is injected into the cavity in the mold 4 using the plunger 5.

[0098] FIG. 4 schematically shows a state in which the upper and lower parts of the mold 4 are separated after completion of molding. As shown in FIG. 4, the functional sheet 3 having been mounted on the release film 10 is left from the release film 10 and placed on the semiconductor package. The release film 10 after use is wound up by a roll 8B for collection.

[0099] Since the release film according to the present embodiment has a favorable property of retaining a functional sheet up to the molding step, it is possible to place the functional sheet in the mold without causing the functional sheet to fall off from the release film. In addition, since the release film according to the present embodiment has a favorable property of releasing the functional sheet from the mold in the molding step, when the upper and lower parts of the mold are separated after completion of molding, the functional sheet is released from the release sheet and placed on the semiconductor package.

EXAMPLES

[0100] Hereinbelow, the invention is described more specifically by way of examples. However, the invention is not limited to these examples.

[0101] <Examples 1 to 10 and Comparative Examples 1 to 7>

(Preparation of Composition for Forming Release Layer)

An acrylic resin as a resin component, a crosslinking agent, and a filler were mixed with toluene such that each material had the nonvolatile content (parts by mass) set forth in

Table 1 or 2, whereby a composition for forming the release layer was prepared as a toluene solution with the solid content of 15% by mass.

[0102] As the acrylic resin, a 24% by mass toluene solution of an acrylic ester copolymer, ethyl acetate, and n-butyl acrylate (trade name "S-43", manufactured by Soken Chemical & Engineering Co., Ltd.) was used.

As the crosslinking agent, a 75% by mass toluene solution of an isocyanate compound (trade name "CORONATE L", manufactured by Tosoh Corporation), or a polyisocyanate based on hexamethylene diisocyanate adduct (trade name "DURANATE AE710-100", manufactured by Asahi Kasei Corporation) was used.

As the filler, a particle of a crosslinked acrylic resin which is a copolymer with a methacrylic acid ester (trade names "MX-150" (volume average particle diameter: 1.5 μm), "MX-300" (volume average particle diameter: 3.0 μm), or "MX-1000" (volume average particle diameter: 10.0 μm), manufactured by Soken Chemical & Engineering Co., Ltd.), or a silica particle (trade name "SYLOSPHERE C-0809", volume average particle diameter: 5.0 μm , manufactured by Fuji Silysia Chemical Ltd.) was used.

[0103] (Preparation of Release Film)

The prepared composition for forming the release layer was applied to one side of a substrate using a roll coater at a speed in a range of from 0.5 m/min to 3 m/min, and then directly dried at 100°C in a 3 m-long drying oven to form the release layer on the substrate, thereby obtaining a release film. In this process, the roll gap in coating was adjusted such that the coating amount (g) per 1 m² of the dried composition (the mass of the release layer) was the value set forth in Table 1 or Table 2.

[0104] As the substrate, a biaxially stretched polyethylene terephthalate (PET) film (trade name "FT 3-25", manufactured by Teijin DuPont Films Japan Limited), or a biaxially stretched polybutylene terephthalate (PBT) film (manufactured by Okura Industrial Co., Ltd.), either of which had a thickness of 25 μm and was subjected to a corona treatment, was used.

[0105] (Measurement of Mass of Release Layer)

The prepared release film was cut into a size of 10 cm $\times$ 10 cm and the mass thereof was measured. Thereafter, the release layer was removed using methyl ethyl ketone, and the mass was measured again after air drying. The mass of the release layer was calculated from the difference between the masses before and after the treatment. The obtained value was multiplied by 100 to calculate the mass (g/m²) of the release layer per 1 m². The results are shown in Table 1 or Table 2.

[0106] (Measurement of Tackiness)

The prepared release film was set on a tackiness tester (trade name "TAC-II",

manufactured by Rhesca Co., Ltd.) so that a measurement probe touched the release layer at the time of measurement. Then, a tackiness (gf) was measured using a probe having a diameter of 5 mm under the conditions of a probe descending speed of 120 mm/min, a load before measurement of 10 gf, and an lifting speed at measurement of 600 mm/min. The measurements of tackiness were carried out at a supposed room temperature (25°C), and at a supposed molding step temperature (170°C), respectively. The results are shown in Table 1 or Table 2.

[0107] (Evaluation of Retention Property)

In order to evaluate the ability of the release film to retain a functional sheet, the following test was conducted.

The prepared release film was cut into a size of 15 cm × 30 cm, and a dust-free paper in a size of 50 cm × 100 cm was bonded on the release layer of the cut out release film using a silicone rubber roll. Then, in the environment at 25°C, the laminate was placed on a stand such that the dust-free paper faced downward, and edges of the release film were gripped and lifted up 50 cm to 100 cm to the angle of 90°, to observe whether or not the bonded dust-free paper was delaminated. In a case in which the dust-free paper was not delaminated, it was rated as "OK", and in a case in which the dust-free paper was delaminated, it was rated as "NG". The results are shown in Table 1 or Table 2.

[0108] (Evaluation of Surface Roughness)

The arithmetic average roughness (Ra) and the ten-point average roughness (Rz) of the outer surface of the release layer were measured using a surface roughness measuring instrument (model No. SE-3500, manufactured by Kosaka Laboratory Ltd.) under the conditions of a stylus tip radius of 2 μm, scan speed of 0.5 mm/s, and scan length of 8 mm, based on the analyses according to JIS B0601 (2013) or ISO 4287 (1997). The results are shown in Table 1 or Table 2.

[0109] <Comparative Example 8>

On an ETFT (Ethylene Tetra Fluoro Ethylene) film (trade name: "AFLEX 50 HK", manufactured by Asahi Glass Co., Ltd.), which was widely used mainly as a release film for compression molding, the evaluation was carried out s Examples. The results are shown in Table 2. Since the AFLEX 50 HK has no resin layer (release layer), the mass of the release layer was not measured.

[0110] Table 1

Item		Unit	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8	Example 9	Example 10
Release layer	Resin component	S-43	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Crosslinking agent	CORONATE L	2.5	-	-	-	-	2.5	2.5	5.0	10.0	10.0
		AE710-100	-	2.5	2.5	2.0	1.5	-	-	-	-	-
	Filler	MX-1000	-	-	7.5	7.5	7.5	7.5	7.5	7.5	-	-
		MX-300	2.5	-	-	-	-	-	-	-	-	-
		MX-150	-	5.0	-	-	-	-	-	-	-	-
		SYLOSPHERE	-	-	-	-	-	-	-	-	5.0	2.5
	Volume average particle diameter A		3.0	1.5	10.0	10.0	10.0	10.0	10.0	10.0	5.0	5.0
	Mass B per 1 m ²		3.0	3.0	10.0	10.0	10.0	10.0	15.0	15.0	10.0	10.0
	A/B		1.0	0.5	1.0	1.0	1.0	1.0	0.7	0.7	0.5	0.5
	Ra		0.2	0.4	1.1	1.1	1.1	1.3	1.4	1.2	1.3	0.8
	Rz		3.3	3.8	11.6	11.2	12.6	13.5	12.7	12.2	12.5	10.6
	Substrate		PET	PBT	PBT	PBT	PBT	PET	PET	PET	PET	PET
	Tackiness (25□)		2.6	2.5	9.2	15.2	17.8	7.3	21.7	6.2	1.2	2.8
	Tackiness (170□)		1.9	2.0	6.6	12.2	13.3	2.7	5.2	0.8	0.4	0.8
	Evaluation of retention property		OK	OK	OK	OK	OK	OK	OK	OK	OK	OK

[0111] Table 2

Item		Unit	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4	Comparative Example 5	Comparative Example 6	Comparative Example 7	Comparative Example 8
Release layer	Resin component	parts by mass	100.0	100.0	100.0	100.0	100.0	100.0	100.0	AFLEX 50HK
	Crosslinking agent	parts by mass	2.5	-	-	-	-	2.5	5.0	
		parts by mass	-	2.5	2.5	2.0	1.5	-	-	
	Filler	parts by mass	5.0	20.0	7.5	7.5	7.5	7.5	7.5	
		parts by mass	-	-	-	-	-	-	-	
		parts by mass	-	-	-	-	-	-	-	
		parts by mass	-	-	-	-	-	-	-	
		parts by mass	-	-	-	-	-	-	-	
	SYLOSPHERE		-	-	-	-	-	-	-	
	Volume average particle diameter		10.0	10.0	10.0	10.0	10.0	10.0	10.0	
	Mass B per 1 m ²		3.0	3.0	6.0	6.0	6.0	6.0	6.0	
	A/B		3.3	3.3	1.7	1.7	1.7	1.7	1.7	
	Ra		0.2	0.7	0.7	0.7	0.6	0.8	1.0	
	Rz		6.3	10.0	10.9	10.9	9.6	11.5	11.0	
Substrate		-	PET	PET	PBT	PBT	PBT	PET	PET	1.5
Tackiness (25°C)		gf	0.6	0.2	0.4	0.3	0.6	0.6	0.4	0.0
Tackiness (170°C)		gf	0.7	0.2	0.4	0.3	0.5	0.4	0.5	0.0
Evaluation of retention property		-	NG	NG	NG	NG	NG	NG	NG	NG

[0112] As shown in Table 1, with respect to the release film of each of Examples 1 to 10, in which the ratio (A/B) of the volume average particle diameter A (μm) of the filler to the mass B (g/m^2) per 1 m^2 of the release layer was 1 or less, the tackiness at 25°C was high, and delamination of the dust-free paper was not observed in the evaluation test of retention property, which indicates favorable retention property. On the other hand, it was found that the release film of each of Examples 1 to 10 had low tackiness at 170°C , which indicates favorable release property in the molding step. Further, favorable results were obtained even when the surface roughness was changed by adjusting the kind and content of the filler contained in the release layer, which indicates application to various combinations of the release film material and a package while maintaining desired characteristics.

[0113] With respect to the mold release film of each of Comparative Examples 1 to 7, in which the ratio (A/B) of the volume average particle diameter A (μm) of the filler to the mass B (g/m^2) per 1 m^2 of the release layer exceeded 1, the tackiness at 25°C was significantly low, and delamination of the dust-free paper was observed in the evaluation test of retention property, which indicates that the retention property was inferior to Examples.

[0114] AFLEX 50HK used as the release film in Comparative Example 8 gave low tackiness both at 25°C and 170°C , and therefore the releasability from the mold was excellent. However, delamination of the dust-free paper was observed in the evaluation test of retention property, which indicates that the retention property was inferior to Examples.

[0115] From the above results, it has been confirmed that the release film according to the present embodiment has favorable property of retaining a functional sheet up to the molding step and releasing the functional sheet from the mold in the molding step.

[0116] The disclosure of Japanese Patent Application No. 2016-101820 is incorporated herein by reference in its entirety. All documents, patent applications, and technical standards described in the present specification are also incorporated by the reference to the same extent as if each individual documents, patent applications, and technical standards were specifically and individually incorporated by reference.

CLAIMS

1. A release film comprising a substrate and a release layer formed on the substrate, the release layer comprising a resin component and a filler,
wherein a ratio (A/B) of a volume average particle diameter A (μm) of the filler to a mass B (g/m^2) per 1 m^2 of the release layer is 1 or less.
2. The release film according to claim 1, wherein the volume average particle diameter A of the filler is from $1 \mu\text{m}$ to $50 \mu\text{m}$.
3. The release film according to claim 1 or 2, wherein the mass B per 1 m^2 of the release layer is from $0.1 \text{ g}/\text{m}^2$ to $100 \text{ g}/\text{m}^2$.
4. The release film according to any one of claims 1 to 3, wherein the resin component comprises a thermosetting resin.
5. The release film according to any one of claims 1 to 4, wherein the release film further comprises a crosslinking agent, and a content of the crosslinking agent with respect to 100 parts by mass of the resin component is from 1 part by mass to 10 parts by mass.
6. The release film according to any one of claims 1 to 5, wherein the substrate comprises at least one selected from the group consisting of polyethylene terephthalate, polybutylene terephthalate, and polyethylene naphthalate.