

DESCRIPTION

Title of Invention

FILM-LIKE ADHESIVE, ADHESIVE SHEET AND SEMICONDUCTOR DEVICE

5 Technical Field

[0001] The present invention relates to a film-form adhesive, an adhesive sheet, and a semiconductor device.

Background Art

10 [0002] In recent years, stacked MCPs (Multi Chip Packages) in which semiconductor elements (semiconductor chips) are stacked in multiple stages have been popularly spread, and stacked MCPs are mounted as memory semiconductor packages for mobile telephones and mobile audio devices, and the like. Furthermore, along with multifunctioning of mobile telephones and the like, speed increase, density increase, high
15 integration, and the like of semiconductor packages have also been promoted. Concomitantly with this, attempts have been made to increase the speed by using copper as a wiring material for semiconductor chip circuits. Furthermore, from the viewpoints of enhancing the reliability of connection to complicated mounting boards and promoting
20 heat rejection from semiconductor packages, lead frames and the like that are composed of copper are in use.

[0003] However, since copper has a characteristic of being easily
corrodible, and the coating materials for securing insulation properties of circuit surfaces also tend to be simplified from the viewpoint of cost
25 reduction, it tends to become difficult to secure electrical characteristics of semiconductor packages. Particularly, in semiconductor packages

obtained by stacking semiconductor chips in multiple stages, there is a tendency that copper ions generated due to corrosion migrate through the inner part of adhesive, and a loss of electrical signals within a semiconductor chip or between a semiconductor chip and another semiconductor chip easily occurs.

[0004] Furthermore, from the viewpoint of improved functionality, semiconductor elements are connected to complicated mounting boards in many cases, and thus, lead frames composed of copper tend to be preferred in order to enhance the connection reliability. Even in such a case, a loss of electrical signals caused by copper ions generated from a lead frame may bring a problem.

[0005] In addition, with regard to semiconductor packages that use members composed of copper, there is a high possibility that copper ions may be generated from those members and cause electrical failure, and sufficient HAST resistance may not be obtained.

[0006] From the viewpoint of preventing a loss of electrical signals or the like, an investigation has been conducted on adhesives that scavenge copper ions generated inside a semiconductor package. For example, Patent Literature 1 discloses an adhesive sheet for semiconductor device production, the adhesive sheet having a thermoplastic resin that has an epoxy group but does not have a carboxyl group, and an organic complex-forming compound that has a heterocyclic compound containing a tertiary nitrogen atom as a ring atom and forms a complex with a cation.

Citation List

Patent Literature

[0007] Patent Literature 1: JP No. 2013-026566

Summary of Invention

Technical Problem

[0008] However, conventional adhesives are not satisfactory from the viewpoint of suppressing the inconvenience associated with the migration of copper ions within the adhesive, and there is still room for improvement.

[0009] Thus, a main object of the present invention is to provide a film-form adhesive in which the inconvenience associated with the migration of copper ions within the adhesive can be sufficiently suppressed.

Solution to Problem

[0010] The inventors of the present invention conducted a thorough investigation, and they found that permeation of copper ions within an adhesive can be sufficiently suppressed by using an acrylic rubber having a glass transition temperature (T_g) in a specific range, thus completing the present invention.

[0011] According to an aspect of the present invention, there is provided a film-form adhesive for adhering a semiconductor element to a support member for mounting the semiconductor element, the film-form adhesive containing an acrylic rubber, wherein the acrylic rubber satisfies either the following condition (i) or condition (ii):

condition (i): the acrylic rubber has a constituent unit derived from acrylonitrile and has a glass transition temperature (T_g) of higher than 12°C; and

condition (ii): the acrylic rubber does not have a constituent unit derived from acrylonitrile and has a glass transition temperature (T_g) of 0°C or higher.

[0012] The reason why the migration of copper ions within the adhesive can be sufficiently suppressed by using such an acrylic rubber, is not necessarily clearly known; however, the present inventors speculate that it is because as the glass transition temperature (T_g) of the acrylic rubber becomes higher, the molecular mobility tends to be lowered, and the probability of copper ions passing through the gaps between molecules is lowered.

[0013] According to another aspect of the present invention, there is provided an adhesive sheet comprising a base material and the above-mentioned film-form adhesive provided on one surface of the base material. The base material may be a dicing tape.

[0014] According to another aspect of the present invention, there is provided a semiconductor device comprising a semiconductor element; a support member for mounting the semiconductor element; and an adhesive member provided between the semiconductor element and the support member, and adhering the semiconductor element to the support member, wherein the adhesive member is the above-mentioned film-form adhesive or a cured product thereof.

Advantageous Effects of Invention

[0015] According to the present invention, a film-form adhesive capable of sufficiently suppressing the inconvenience associated with the migration of copper ions within the adhesive is provided. Furthermore, according to the present invention, an adhesive sheet and a semiconductor device, both of which use such a film-form adhesive, are provided.

Brief Description of Drawings

[0016] FIG. 1 is a schematic cross-sectional view illustrating an

embodiment of a film-form adhesive.

FIG. 2 is a schematic cross-sectional view illustrating an embodiment of an adhesive sheet.

FIG. 3 is a schematic cross-sectional view illustrating another embodiment of the adhesive sheet.

FIG. 4 is a schematic cross-sectional view illustrating another embodiment of the adhesive sheet.

FIG. 5 is a schematic cross-sectional view illustrating another embodiment of the adhesive sheet.

FIG. 6 is a schematic cross-sectional view illustrating an embodiment of a semiconductor device.

FIG. 7 is a schematic cross-sectional view illustrating another embodiment of the semiconductor device.

Description of Embodiments

[0017] Hereinafter, embodiments of the present invention will be described with appropriate reference to the drawings. However, the present invention is not limited to the following embodiments. In the following embodiments, constituent elements of the embodiments (also including steps and the like) are not essential unless particularly stated otherwise. The sizes of the constituent elements in each of the drawings are conceptual, and the relative relationship between the sizes of the constituent elements is not limited to the relationship as illustrated in each drawing.

[0018] The same also applies to the numerical values and ranges thereof in the present specification, and the present invention is not intended to be limited. A numerical value range expressed using the term "to" in

the present specification represents a range including the numerical values described before and after the term "to" as the minimum value and the maximum value, respectively. With regard to the numerical value range described stepwise in the present specification, the upper limit value or the lower limit value described in one numerical value range may be replaced with the upper limit value or the lower limit value of another stepwise numerical value range described. Furthermore, with regard to a numerical value ranges described in the present specification, the upper limit value or the lower limit value of the numerical value range may be replaced with the values described in Examples.

[0019] According to the present specification, a (meth)acrylic acid ester means an acrylic acid ester or a methacrylic acid ester corresponding thereto.

[0020] The film-form adhesive according to an embodiment is a film-form adhesive for adhering a semiconductor element to a support member for mounting the semiconductor element, and the film-form adhesive contains an acrylic rubber (hereinafter, may be referred to as "component (A)").

[0021] The film-form adhesive can be obtained by molding an adhesive composition containing the component (A) into a film shape. The film-form adhesive and the adhesive composition may be in a semi-cured (stage B) state.

[0022] The component (A) is a rubber having a constituent unit derived from a (meth)acrylic acid ester as a main component. The content of the constituent unit derived from a (meth)acrylic acid ester in the component (A) may be, for example, 70% by mass or more, 80% by mass

or more, or 90% by mass or more, based on the total amount of the constituent units. The component (A) may be a component including a constituent unit derived from a (meth)acrylic acid ester having a crosslinkable functional group such as an epoxy group, an alcoholic or phenolic hydroxyl group, or a carboxyl group.

[0023] The component (A) satisfies either the following condition (i) or condition (ii).

Condition (i): The component (A) has a constituent unit derived from acrylonitrile and has a glass transition temperature (T_g) of higher than 12°C.

Condition (ii): The component (A) does not have a constituent unit derived from acrylonitrile and has a glass transition temperature (T_g) of 0°C or higher.

[0024] With regard to the condition (i), in a case where the component (A) has a constituent unit derived from acrylonitrile, the glass transition temperature (T_g) of the component (A) may be higher than 12°C and 55°C or lower, 15°C or higher and 30°C or lower, or 19°C or higher and 25°C or lower. With regard to the condition (ii), in a case where the component (A) does not have a constituent unit derived from acrylonitrile, the glass transition temperature (T_g) may be 0°C or higher and 50°C or lower, 10°C or higher and 30°C or lower, or 15°C or higher and 25°C or lower. When the T_g of the component (A) is equal to or higher than the lower limit of each of the conditions, there is a tendency that the pliability of the adhesive composition can be prevented from becoming too high. As a result, the film-form adhesive can be easily cut during wafer dicing, and the occurrence of burring can be prevented.

When the Tg of the component (A) is equal to or lower than the upper limit of each of the conditions, there is a tendency that a decrease in pliability of the adhesive composition can be suppressed. As a result, when the film-form adhesive is stuck to a wafer, voids tend to be easily embedded sufficiently. Furthermore, it is possible to prevent chipping at the time of dicing, which is caused by a decrease in the adhesiveness of the wafer. Here, the glass transition temperature (Tg) means the value measured using a DSC (thermal differential scanning calorimeter) (for example, manufactured by Rigaku Corporation, Thermo Plus 2).

[0025] The glass transition temperature (Tg) of the component (A) can be adjusted to a predetermined range by, for example, adjusting the proportions of a (meth)acrylic acid ester having a high Tg and a (meth)acrylic acid ester having a low Tg.

[0026] Examples of a commercially available product of the component (A) having a constituent unit derived from acrylonitrile include SG-P3, SG-80H, and HTR-860P-3CSP (all manufactured by Nagase ChemteX Corporation). Examples of a commercially available product of the component (A) that does not have a constituent unit derived from acrylonitrile include KH-CT-865 (manufactured by Hitachi Chemical Co., Ltd.).

[0027] The film-form adhesive (adhesive composition) may be composed of the component (A); however, the film-form adhesive may further contain other components. Examples of the other components include a pigment, an ion trapping agent, and an oxidation inhibitor.

[0028] The content of the other components may be 0 to 30 parts by mass with respect to 100 parts by mass of the total mass of the component (A).

[0029] FIG. 1 is a schematic cross-sectional view illustrating an embodiment of the film-form adhesive. A film-form adhesive 1 (adhesive film) illustrated in FIG. 1 is a product obtained by molding the adhesive composition into a film shape. The film-form adhesive 1 may be in a semi-cured (stage B) state. Such a film-form adhesive 1 can be formed by applying the adhesive composition on a support film. In the case of using a varnish of the adhesive composition (adhesive varnish), the component (A) and other components that are added as necessary are mixed in a solvent, the mixed liquid is mixed or kneaded to prepare an adhesive varnish, the adhesive varnish is applied on a support film, the solvent is removed by heating and drying the adhesive varnish, and thereby the film-form adhesive 1 can be formed.

[0030] The support film is not particularly limited as long as it can withstand the above-described heating and drying; however, for example, a polyester film, a polypropylene film, a polyethylene terephthalate film, a polyimide film, a polyetherimide film, a polyether naphthalate film, a polymethylpentene film, or the like may be used. The support film may be a multilayer film combining two or more kinds or may be a film having the surface treated with a mold release agent such as a silicone-based agent or a silica-based agent. The thickness of the support film may be, for example, 1 to 200 μm or 5 to 170 μm .

[0031] Mixing or kneading can be carried out using conventional dispersing machines such as a stirrer, a Raikai mixer, a three-roll mill, and a ball mill, by appropriately combining these.

[0032] The solvent to be used for the preparation of the adhesive varnish is not limited so long as the solvent can uniformly dissolve, knead, or

disperse various components, and conventionally known solvents can be used. Examples of such a solvent include ketone-based solvents such as acetone, methyl ethyl ketone, methyl isobutyl ketone, and cyclohexanone; dimethylformamide, dimethylacetamide, N-methyl-2-pyrrolidone, toluene, and xylene. The solvent may be methyl ethyl ketone, cyclohexanone, or the like from the viewpoints of having a high drying speed and being inexpensive.

[0033] Regarding the method of applying the adhesive varnish on a support film, any known method can be used, and examples include a knife coating method, a roll coating method, a spray coating method, a gravure coating method, a bar coating method, and a curtain coating method. The conditions for heating and drying are not particularly limited so long as they are conditions in which the solvent used is sufficiently volatilized; however, heating and drying can be carried out by heating at 50°C to 150°C for 1 to 30 minutes.

[0034] The thickness of the film-form adhesive may be 50 μm or less. When the thickness of the film-form adhesive is 50 μm or less, since the distance between a semiconductor element and a support member for mounting the semiconductor element is shortened, inconvenience caused by copper ions tends to occur easily. With regard to the film-form adhesive according to the present embodiment, since it is possible to sufficiently suppress migration (permeation) of copper ions within the adhesive, the thickness of the film-form adhesive can be adjusted to 50 μm or less. The thickness of the film-form adhesive 1 may be 40 μm or less, 30 μm or less, 20 μm or less, or 10 μm or less. The lower limit of the thickness of the film-form adhesive 1 is not particularly limited;

however, the lower limit can be adjusted to, for example, 1 μm or more.

[0035] The time for copper ion permeation of the film-form adhesive in a semi-cured (stage B) state may be longer than 250 minutes and may also be 300 minutes or longer, 350 minutes or longer, or 400 minutes or longer. As the time for copper ion permeation is longer than 250 minutes, even in a case where defects such as insufficient curing occur during the production of a semiconductor device, it is expected that inconvenience caused by copper ions is less likely to occur.

[0036] FIG. 2 is a schematic cross-sectional view illustrating an embodiment of an adhesive sheet. An adhesive sheet 100 illustrated in FIG. 2 comprises a base material 2 and a film-form adhesive 1 provided on the base material 2. FIG. 3 is a schematic cross-sectional view illustrating another embodiment of the adhesive sheet. An adhesive sheet 110 illustrated in FIG. 3 comprises a base material 2; a film-form adhesive 1 provided on the base material 2; and a cover film 3 provided on a surface of the film-form adhesive 1, the surface being on the opposite side of the base material 2.

[0037] The base material 2 is not particularly limited; however, the base material 2 may be a base material film. The base material film may be a film similar to the above-mentioned support film.

[0038] The cover film 3 is used to prevent any damage or contamination of the film-form adhesive and may be, for example, a polyethylene film, a polypropylene film, or a surface peeling agent-treated film. The thickness of the cover film 3 may be, for example, 15 to 200 μm or 70 to 170 μm .

[0039] The adhesive sheets 100 and 110 can be formed by applying an

adhesive composition on a base material film, in the same manner as in the above-mentioned method for forming a film-form adhesive. The method of applying an adhesive composition on the base material 2 may be similar to the above-mentioned method of applying an adhesive composition on a support film.

[0040] The adhesive sheet 110 can be obtained by further laminating the cover film 3 on the film-form adhesive 1.

[0041] The adhesive sheets 100 and 110 may also be formed using a film-form adhesive that has been produced in advance. In this case, the adhesive sheet 100 can be formed by performing lamination under predetermined conditions (for example, room temperature (20°C) or a heated state) using a roll laminator, a vacuum laminator, or the like. From the viewpoint that the adhesive sheet can be continuously produced, and that the efficiency is excellent, the adhesive sheet 100 may also be formed using a roll laminator in a heated state.

[0042] Another embodiment of the adhesive sheet is a dicing-die bonding integrated adhesive sheet, in which the base material 2 is a dicing tape. When a dicing-die bonding integrated adhesive sheet is used, since the process of lamination on a semiconductor wafer is carried out only once, efficient implementation of operation is enabled.

[0043] Examples of the dicing tape include plastic films such as a polytetrafluoroethylene film, a polyethylene terephthalate film, a polyethylene film, a polypropylene film, a polymethylpentene film, and a polyimide film. Furthermore, the dicing tape may have been subjected to a surface treatment such as primer coating, a UV treatment, a corona discharge treatment, a polishing treatment, or an etching treatment, as

necessary. The dicing tape may have tacky adhesiveness. Such a dicing tape may be a product obtained by imparting tacky adhesiveness to the above-mentioned plastic film and may be a product obtained by providing a tacky adhesive layer on one surface of the above-mentioned plastic film. The tacky adhesive layer may be either a pressure-sensitive type layer or a radiation-curable type layer and is not particularly limited so long as the tacky adhesive layer has sufficient tacky adhesive force that does not allow scattering of semiconductor elements during dicing and has low tacky adhesive force to the extent that semiconductor elements are not damaged during a subsequent pickup process for semiconductor elements, and any conventionally known tacky adhesive layer can be used.

[0044] The thickness of the dicing tape may be 60 to 150 μm or 70 to 130 μm , from the viewpoints of economic efficiency and film handleability.

[0045] Examples of such a dicing-die bonding integrated adhesive sheet include an adhesive sheet having the configuration illustrated in FIG. 4 and an adhesive sheet having the configuration illustrated in FIG. 5. FIG. 4 is a schematic cross-sectional view illustrating another embodiment of the adhesive sheet. FIG. 5 is a schematic cross-sectional view illustrating another embodiment of the adhesive sheet. An adhesive sheet 120 illustrated in FIG. 4 comprises a dicing tape 7, a tacky adhesive layer 6, and a film-form adhesive 1 in this order. An adhesive sheet 130 illustrated in FIG. 5 comprises a dicing tape 7 and a film-form adhesive 1 provided on the dicing tape 7.

[0046] The adhesive sheet 120 can be obtained by, for example,

providing a tacky adhesive layer 6 on a dicing tape 7 and further laminating a film-form adhesive 1 on the tacky adhesive layer 6. The adhesive sheet 130 can be obtained by, for example, sticking a dicing tape 7 and a film-form adhesive 1 together.

5 [0047] The film-form adhesive and the adhesive sheet may be a film-form adhesive and an adhesive sheet that are used for the production of a semiconductor device, and may be the ones that are used for the production of a semiconductor device, the production including a step of sticking a film-form adhesive and a dicing tape together at 0°C to 90°C
10 to a semiconductor wafer or to semiconductor elements (semiconductor chips) that have been already singulated, subsequently obtaining film-form adhesive-attached semiconductor elements by dividing the assembly with a rotating blade, a laser, or by stretching, and then adhering one of the film-form adhesive-attached semiconductor elements onto an
15 organic substrate, a lead frame, or another semiconductor element.

[0048] Examples of the semiconductor wafer include single crystal silicon, polycrystalline silicon, various ceramics, and compound semiconductors such as gallium arsenide.

20 [0049] The film-form adhesive and the adhesive sheet can be used as adhesives for die bonding for sticking together a semiconductor element such as IC or LSI with a lead frame such as an alloy 42 lead frame or a copper lead frame; a plastic film of a polyimide resin or an epoxy resin; a product obtained by impregnating a base material such as a nonwoven glass fabric with a plastic such as a polyimide resin or an epoxy resin and
25 curing the resultant; a support member for semiconductor mounting, formed from a ceramic such as alumina; or the like.

[0050] The film-form adhesive and the adhesive sheet are suitably used also as adhesives for adhering a semiconductor element to another semiconductor element in a Stacked-PKG having a structure in which a plurality of semiconductor elements are stacked. In this case, one of the semiconductor elements serves as a support member for mounting a semiconductor element.

[0051] The film-form adhesive and the adhesive sheet can also be used as, for example, protective sheets for protecting the back surface of semiconductor elements in a flip-chip type semiconductor device, sealing sheets for sealing between the surface of semiconductor elements of a flip-chip type semiconductor device and an adherend, or the like.

[0052] A semiconductor device produced using a film-form adhesive will be specifically described using the drawings. In recent years, semiconductor devices having various structures have been proposed, and it should be noted that the use application of the film-form adhesive according to the present embodiment is not limited to the semiconductor device having the structure described below.

[0053] FIG. 6 is a schematic cross-sectional view illustrating an embodiment of a semiconductor device. A semiconductor device 200 illustrated in FIG. 6 comprises a semiconductor element 9; a support member 10 for mounting the semiconductor element 9; and an adhesive member 1c (film-form adhesive or a cured product thereof) provided between the semiconductor element 9 and the support member 10 and adhering the semiconductor element 9 to the support member 10. The adhesive member 1c is a film-form adhesive or a cured product thereof. A connection terminal (not illustrated in the drawing) of the

semiconductor element 9 is electrically connected to an external connection terminal (not illustrated in the drawing) through a wire 11 and is sealed by a sealing material 12.

[0054] FIG. 7 is a schematic cross-sectional view illustrating another embodiment of the semiconductor device. In a semiconductor device 210 illustrated in FIG. 7, a semiconductor element 9a of a first stage is adhered, by an adhesive member 1c, to a support member 10 having a terminal 13 formed thereon, and a semiconductor element 9b of a second stage is further adhered onto the semiconductor element 9a of the first stage by the adhesive member 1c. The connection terminals (not illustrated in the drawing) of the semiconductor element 9a of the first stage and the semiconductor element 9b of the second stage are electrically connected to external connection terminals through a wire 11 and are sealed by a sealing material 12. The adhesive member 1c is a film-form adhesive or a cured product thereof. As such, the film-form adhesive according to the present embodiment can also be suitably used in a semiconductor device having a structure in which a plurality of semiconductor elements are stacked.

[0055] The semiconductor devices (semiconductor packages) illustrated in FIG. 6 and FIG. 7 are obtained by, for example, interposing a film-form adhesive between a semiconductor element and a support member or between a semiconductor element and another semiconductor element, adhering the two by subjecting these to heating and pressure-bonding, and subsequently performing a wire bonding step, a sealing step using a sealing material, a heating and melting step including reflow soldering, and the like, as necessary. The heating temperature for the heating and

pressure-bonding step is usually 20°C to 250°C, the load is usually 0.1 to 200 N, and the heating time is usually 0.1 to 300 seconds.

[0056] Regarding the method of interposing the film-form adhesive between a semiconductor element and a support member or between a semiconductor element and another semiconductor element, as described above, the method may be a method for producing a film-form adhesive-attached semiconductor element in advance and then sticking the semiconductor element to a support member or another semiconductor element.

[0057] The support member may include a member composed of copper. In the semiconductor device according to the present embodiment, since a semiconductor element and a support member are adhered by a film-form adhesive or a cured product thereof, even in a case where a member composed of copper is used as a constituent member of the semiconductor device, the influence of the copper ions generated from the member can be reduced, and the occurrence of any electrical inconvenience caused by copper ions can be sufficiently suppressed.

[0058] Here, examples of the member composed of copper include a lead frame, a wiring, a wire, and a heat-dissipating material; however, in all cases where copper is used for any of the members, the influence of copper ions can be reduced.

[0059] Next, an embodiment of the method for producing a semiconductor device in the case of using the dicing-die bonding integrated adhesive sheet illustrated in FIG. 4 will be described. It should be noted that the method for producing a semiconductor device using a dicing-die bonding integrated adhesive sheet is not limited to the

method for producing a semiconductor device that will be described below.

[0060] First, a semiconductor wafer is pressure-bonded to a film-form adhesive 1 in an adhesive sheet 120 (dicing-die bonding integrated adhesive sheet), and this is adhered and held to be fixed (mounting step). The present step may also be carried out by pressing the assembly by a pressing member such as a pressure-bonding roll.

[0061] Next, dicing of the semiconductor wafer is performed. Thereby, the semiconductor wafer is cut out into a predetermined size to produce a plurality of singulated film-form adhesive-attached semiconductor elements (semiconductor chips). Dicing can be carried out by, for example, a conventional method from the circuit surface side of the semiconductor wafer. Furthermore, in the present step, for example, a cutting method called full-cut, by which incision up to the dicing tape is performed; a cutting method of dividing the semiconductor wafer by inserting a half-cut incision into the semiconductor wafer and pulling the semiconductor wafer under cooling; a cutting method of using a laser; and the like can be employed. The dicing device used for the present step is not particularly limited, and any conventionally known device can be used.

[0062] In order to detach the semiconductor element adhered and fixed to the dicing-die bonding integrated adhesive sheet, picking up of the semiconductor element is performed. The method for picking up is not particularly limited, and various conventionally known methods can be employed. For example, a method of pushing up individual semiconductor elements using a needle through the dicing-die bonding

integrated adhesive sheet side and picking up the pushed semiconductor elements by a pick-up device, and the like may be mentioned.

[0063] Here, picking up is carried out, in a case where the tacky adhesive layer is a radiation (for example, ultraviolet radiation)-curable type, after the tacky adhesive layer is irradiated with radiation. Thereby, the tacky adhesive force of the tacky adhesive layer to the film-form adhesive is decreased, and detachment of the semiconductor element is made easy. As a result, picking up is made possible without damaging the semiconductor element.

[0064] Next, the film-form adhesive-attached semiconductor element formed by dicing is adhered to a support member for mounting a semiconductor element, by means of the film-form adhesive. Adhesion may be carried out by pressure-bonding. The conditions for die bonding are not particularly limited and can be appropriately set according to necessity. Specifically, for example, die bonding can be carried out at a die bonding temperature of 80°C to 160°C, a bonding load of 5 to 15 N, and a bonding time in the range of 1 to 10 seconds.

[0065] If necessary, a step of thermally curing the film-form adhesive may be provided. By thermally curing the film-form adhesive that adheres the support member and the semiconductor element by the above-described adhesion step, adhesive fixing can be achieved more strongly. In the case of performing thermal curing, curing may also be achieved by applying pressure at the same time. The heating temperature for the present step can be appropriately changed depending on the constituent component of the film-form adhesive. The heating temperature may be, for example, 60°C to 200°C. Meanwhile, the step

may be carried out while changing the temperature or pressure stepwise.

[0066] Next, a wire bonding step of electrically connecting the tip of a terminal part (inner lead) of the support member with an electrode pad on the semiconductor element using a bonding wire is carried out. As the

5 bonding wire, for example, a gold wire, an aluminum wire, a copper wire, or the like is used. The temperature at the time of performing wire bonding may be in the range of 80°C to 250°C or 80°C to 220°C. The heating time may be several seconds to several minutes. Connecting the wire may also be carried out in a state of being heated in the above-described temperature range, by using vibration energy induced by ultrasonic waves and pressure-bonding energy induced by applied pressure in combination.

[0067] Next, a sealing step of sealing the semiconductor element using a sealing resin is carried out. The present step is carried out in order to protect the semiconductor element mounted on the support member or the bonding wire. The present step is carried out by molding a resin for sealing in a mold. The sealing resin may be, for example, an epoxy-based resin. The substrate and residue are embedded by heat and pressure at the time of sealing, and detachment at the adhesion interface caused by gas bubbles can be prevented.

[0068] Next, in the post-curing step, the sealing resin that has been insufficiently cured in the sealing step is completely cured. Even in a case where the film-form adhesive is not thermally cured in the sealing step, adhesive fixing is enabled by thermally curing the film-form adhesive together with curing of the sealing resin in the present step. The heating temperature in the present step can be appropriately set

according to the type of the sealing resin, and for example, the heating temperature may be in the range of 165°C to 185°C, while the heating time may be about 0.5 to 8 hours.

[0069] Next, the film-form adhesive-attached semiconductor element adhered to the support member is heated using a reflow furnace. In the present step, the resin-sealed semiconductor device may be surface-mounted on the support member. Regarding the method for surface mounting, for example, reflow soldering of supplying solder in advance on a printed wiring board, subsequently heating and melting the solder by warm air or the like, and performing soldering, and the like may be mentioned. Examples of the heating method include hot air reflow and infrared reflow. Furthermore, the heating method may be heating the entirety or may be heating a local site. The heating temperature may be, for example, in the range of 240°C to 280°C.

[0070] In a case where semiconductor elements are stacked in multiple layers, the thermal history of the wire bonding step and the like increases, and the influence of gas bubbles present at the interface between the film-form adhesive and the semiconductor elements on detachment may become serious. However, since the film-form adhesive according to the present embodiment uses a specific acrylic rubber, the cohesive force is decreased, and embeddability tends to be enhanced. Therefore, gas bubbles are not easily entrained into the semiconductor device, gas bubbles can be easily diffused in the sealing step, and detachment caused by gas bubbles at the adhesion interface can be prevented.

Examples

[0071] Hereinafter, the present invention will be specifically described

based on Examples and Comparative Examples; however, the present invention is not intended to be limited to these.

[0072] (Examples 1 and 2 and Comparative Example 1)

[Production of film-form adhesive]

<Preparation of adhesive varnish>

An acrylic rubber solution shown in Table 1 was used as an adhesive varnish. Incidentally, the numerical values shown in Table 1 mean the parts by mass of the solid content in the acrylic rubber solution.

[0073] Component (A): Acrylic rubber

(A1) Acrylic rubber A: SG-P3 solvent-changed product (product obtained by changing the solvent of SG-P3 (trade name, manufactured by Nagase ChemteX Corporation, methyl ethyl ketone solution of acrylic rubber)), constituent unit derived from acrylonitrile: present, weight average molecular weight: 700000, actually measured Tg: 12°C, solvent: cyclohexanone

(A2) Acrylic rubber B: constituent unit derived from acrylonitrile: present, weight average molecular weight: 700000, actually measured Tg: 22°C, solvent: cyclohexanone

(A3) Acrylic rubber C: constituent unit derived from acrylonitrile: absent, weight average molecular weight: 500000, actually measured Tg: 20°C, solvent: cyclohexanone

[0074] <Production of film-form adhesive>

Each of the adhesive varnishes thus produced was filtered through a 100-mesh filter and was subjected to vacuum defoaming. As a base material film, a polyethylene terephthalate (PET) film having a thickness of 38 μm that had been subjected to a mold release treatment was

prepared, and the adhesive varnish after vacuum defoaming was applied on the PET film. The applied adhesive varnish was heated and dried in two stages for 5 minutes at 90°C and subsequently for 5 minutes at 130°C, and film-form adhesives of Examples 1 and 2 and Comparative Example 1 in the stage B state were obtained. With regard to the film-form adhesive, the thickness was adjusted to 20 µm by adjusting the coating amount of the adhesive varnish.

[0075] [Measurement of copper ion permeation time]

<Preparation of liquid A>

2.0 g of anhydrous copper(II) sulfate was dissolved in 1020 g of distilled water, the solution was stirred until copper sulfate completely dissolved, and an aqueous solution of copper sulfate in which the copper ion concentration was a concentration of 500 mg/kg in terms of Cu element was prepared. The aqueous solution of copper sulfate thus obtained was designated as liquid A.

[0076] <Preparation of liquid B>

1.0 g of anhydrous sodium sulfate was dissolved in 1000 g of distilled water, and the solution was stirred until sodium sulfate completely dissolved. To this, 1000 g of N-methyl-2-pyrrolidone (NMP) was further added, and the mixture was stirred. Subsequently, the mixture was air-cooled to room temperature, and an aqueous solution of sodium sulfate was obtained. The solution thus obtained was designated as liquid B.

[0077] <Measurement of copper ion permeation time>

Each of the film-form adhesives (thickness: 20 µm) of Examples 1 and 2 and Comparative Example 1 produced as described above was

cut out into a circular shape having a diameter of about 3 cm. Next, two sheets of silicon packing sheets having a thickness of 1.5 mm, an outer diameter of about 3 cm, and an inner diameter of 1.8 cm were prepared. The film-form adhesive cut out into a circular shape was interposed between two sheets of silicon packing sheets, and this was interposed between the flange parts of two glass cells having a volume of 50 mL and fixed with a rubber band.

[0078] Next, 50 g of liquid A was poured into one of the glass cells, and 50 g of liquid B was poured into the other glass cell. Mars Carbon (manufactured by STAEDTLER Mars GmbH & Co. KG, ϕ 2 mm/130 mm) as a carbon electrode was inserted into each of the cells. The liquid A side was designated as an anode, the liquid B side was designated as a cathode, and the anode was connected to a direct current power supply (manufactured by A&D Company, Limited, direct current power supply device AD-9723D). Furthermore, the cathode and the direct current power supply were connected in series through an ammeter (manufactured by Sanwa Electric Instrument Co., Ltd., Digital multimeter PC-720M). At room temperature, voltage was applied at an applied voltage of 24.0 V, and measurement of the current value was initiated after the application. The measurement time was set to 500 minutes, and the time point at which the current value started to rise was designated as the copper ion permeation time. In the present evaluation, it can be said that as the time at which the current value starts to rise is late, copper ion permeation is suppressed. The results are presented in Table 1.

[0079] Table 1

		Comp. Exam. 1	Exam. 1	Exam. 2
Component (A)	(A1)	100	-	-
	(A2)	-	100	-
	(A3)	-	-	100
Copper ion permeation time (minutes)		250	420	More than 500

[0080] As described above, it was verified that the film-form adhesive of the present invention can have copper ion permeation within the adhesive sufficiently suppressed.

5 **Reference Signs List**

[0081] 1: film-form adhesive, 1c: adhesive member, 2: base material, 3: cover film, 6: tacky adhesive layer, 7: dicing tape, 9, 9a, 9b: semiconductor element, 10: support member, 11: wire, 12: sealing material, 13: terminal, 100, 110, 120, 130: adhesive sheet, 200, 210: semiconductor device.

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CLAIMS

1. A film-form adhesive for adhering a semiconductor element to a support member for mounting the semiconductor element,

the film-form adhesive comprising an acrylic rubber,

5 wherein the acrylic rubber satisfies either the following condition (i) or condition (ii):

condition (i): the acrylic rubber has a constituent unit derived from acrylonitrile and has a glass transition temperature (T_g) of higher than 12°C; and

10 condition (ii): the acrylic rubber does not have a constituent unit derived from acrylonitrile and has a glass transition temperature (T_g) of 0°C or higher.

2. An adhesive sheet comprising:

a base material; and

15 the film-form adhesive according to claim 1 provided on one surface of the base material.

3. The adhesive sheet according to claim 2, wherein the base material is a dicing tape.

4. A semiconductor device comprising:

20 a semiconductor element;

a support member for mounting the semiconductor element; and

an adhesive member provided between the semiconductor element and the support member, and adhering the semiconductor element to the support member,

25 wherein the adhesive member is the film-form adhesive according to claim 1 or a cured product thereof.