DESCRIPTION

Title of Invention

RESIN PASTE FOR DIE BONDING, METHOD FOR PRODUCING SEMICONDUCTOR DEVICE, AND SEMICONDUCTOR DEVICE

Technical Field

[0001] The present invention relates to a die bonding resin paste, a method for producing a semiconductor device and a semiconductor device, and more specifically it relates to a die bonding resin paste which is used as a bonding material (die bonding material) for bonding of semiconductor elements such as ICs and LSIs, with supporting members such as lead frames and insulating support boards, and a method for producing a semiconductor device using the same and the semiconductor device.

Background Art

[0002] Au-Si eutectic alloys, solder silver paste or the like are conventionally known as bonding materials for bonding of ICs or LSIs with lead frames. In addition, adhesive films using specific polyimide resins, die bonding adhesive films comprising conductive fillers or inorganic fillers added to specific polyimide resins have already been proposed (see Patent Literatures 1 to 3).

Citation List

Patent Literature

[0003] Patent Literature 1: JP 07-228697 A

Patent Literature 2: JP 06-145639 A

Patent Literature 3: JP 06-264035 A

Summary of Invention

Technical Problem

[0004] The above Au-Si eutectic alloys have high heat resistance and high moisture resistance, but they have problems such that they tend to crack when they are applied to large chips because their elastic modulus are large. In addition, the Au-Si eutectic alloys have a bad trait of their high cost. Solder, on the other hand, is inexpensive yet with poor heat resistance, while its elastic modulus is also high like Au-Si eutectic alloys, complicating application of the solder to the large chips.

[0005] Silver pastes, on the other hand, are inexpensive, exhibit high moisture resistance and have lower elastic moduls than that of the Au-Si eutectic alloys or the solder, also exhibit heat resistance which allows them to be applied to 350°C thermocompression bonding wire bonders. Currently, therefore, the silver pastes are the mainstream of die bonding materials. However, in the course of progressing of higher integration of ICs and LSIs with growing chip sizes, it becomes difficult to evenly coat the silver pastes over the entire surfaces of chips when ICs or LSIs and lead frames are bonded by the silver pastes.

[0006] In addition, use of insulating support boards become to be expanded with downsizing and weight saving of packages. Furthermore, in order to reduce manufacturing costs, methods for supplying the die bonding materials using productive printing are attracting attention. Under these circumstances, in an attempt to efficiently supply and attach such an adhesive film as described in the above Patent Literatures 1 to 3 onto an insulating support board, it is necessary to pre-cut (or punch) it to the chip size and then attach it to the adhesive film.

[0007] In methods of cutting adhesive films into chip sizes and attaching it to boards, an applicator is necessary for increasing production efficiency. In addition, in methods of punching adhesive films and attaching it at one time for multiple chips, the adhesive film tends to be wasted. In addition, since the majority of the insulating support board has inner wiring formed inside the board, many irregularities are present on the surface to which the adhesive film is attached, resulting often in creation of gaps during attachment of the adhesive film and thus lowering the reliability.

[0008] In methods of forming a die bonding material on a board preliminary and attaching a semiconductor chip to it, the die bonding material coated onto the board is subjected to dry semi-curing (B-staging) before attaching the semiconductor chip, and then the semiconductor chip is contact bonded thereto and the die bonding material is cured for 1 hour in an oven at 180°C, for example, as postcuring. Typically, after the die bonding material is B-staged, the boards are put one by one in a rack or the like and are temporarily stored. However, recently, in the viewpoint of simplification of process control, there has been a demand for directly stacking and treating the boards after the die bonding material is B-staged. The stacked boards are temporarily stored under room temperature conditions, and are transported one by one by suction in a process of attaching the semiconductor chip. However, in the case of the die bonding material having tackiness (adhesion) after B-staging, when the boards are directly stacked and stored, weights of the boards are applied as a load to cause the attaching of the boards to preclude the

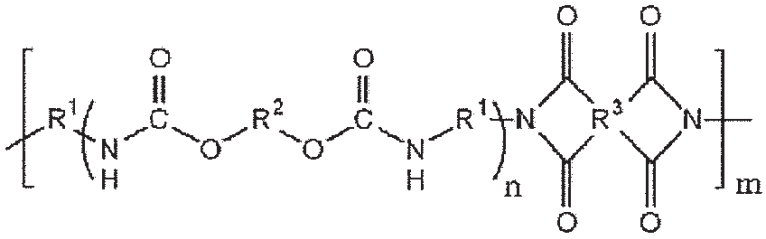
transportation of the boards one by one by suction. In addition, after the boards have been attached together, since the film thickness and surface roughness of the die bonding material may be changed when the boards are peeled off, reliability may be lowered. Therefore, in the case of the B-staged boards are directly stacked and treated, it is necessary to reduce tackiness so that the boards are not attached even if a fixed load is applied under room temperature conditions after B-staging.

[0009] The present invention has been accomplished in light of such circumstances, and it is an object of the present invention to provide a die bonding resin paste enabling boards to be easily peeled off even if the boards are directly stacked after the resin paste is B-staged, namely, having its sufficiently reduced tackiness in a B-stage state. It is another object of the present invention to provide a method for producing a semiconductor device, and a semiconductor device, which use the die bonding resin paste.

Solution to Problem

[0010] In order to achieve the above object, the present invention provides a die bonding resin paste comprising a polyurethaneimide resin represented by the following formula (I), a thermosetting resin, a filler and a printing solvent, wherein a content of the thermosetting resin is 250 to 500 parts by mass with respect to 100 parts by mass of the polyurethaneimide resin:

[Chemical Formula 1]



(I)

[in the formula, R^1 represents a divalent organic group containing an aromatic ring or an aliphatic ring; R^2 represents a divalent organic group with a molecular weight of 100 to 10,000; R^3 represents a tetravalent organic group containing 4 or more carbon atoms; and n and m each independently represent an integer of 1-100.].

[0011] The die bonding resin paste contains the polyurethaneimide resin represented by the above formula (I), together with the thermosetting resin, the filler and the printing solvent, a predetermined range of the thermosetting resin is contained, so that its tackiness is sufficiently reduced in a B-stage state, and after the boards are directly stacked and stored, the boards can be easily peeled off and used for subsequent steps. In addition, the die bonding resin paste having the above construction can be easily supplied and coated by a printing process onto the boards which require attachment of semiconductor chips at relatively low temperature.

[0012] In the die bonding resin paste of the present invention, the filler preferably contains spherical silica fine particles. Thereby, the tackiness in the B-stage state can be further reduced.

[0013] The present invention further provides a method for producing a semiconductor device comprising a coating step of coating the die bonding resin paste of the present invention onto a board to form a

coated film, and a semiconductor chip mounting step of mounting a semiconductor chip onto the coated film.

[0014] Since the method for producing a semiconductor device uses the die bonding resin paste according to the present invention, it is possible to attach the semiconductor chip onto the board at relatively low temperature, to obtain a semiconductor device with excellent heat resistance and chip adhesion.

[0015] The method for producing a semiconductor device according to the present invention further comprises a drying step of drying the coated film for B-staging after the coating step, and preferably the semiconductor chip is mounted on the B-staged coated film in the semiconductor chip mounting step.

[0016] Since the die bonding resin paste of the present invention can have satisfactory heat resistance and chip adhesion in the B-stage state, the semiconductor device exhibiting more excellent reliability can be obtained by including the drying step.

[0017] The present invention still further provides a semiconductor device obtained by the method for producing a semiconductor device according to the present invention. Since the semiconductor device has a semiconductor chip attached to a board using the die bonding resin paste according to the present invention, excellent heat resistance and chip adhesion can be obtained.

Advantageous Effects of Invention

[0018] According to the present invention, it is possible to provide a die bonding resin paste which can be easily supplied and coated by a printing process onto boards which require attaching of semiconductor

chips at relatively low temperature. In addition, the die bonding resin paste of the present invention has heat resistant, manageable, excellent low-stress properties and excellent low-temperature adhesion. Furthermore, since the tackiness in the B-stage state is sufficiently reduced, it is possible to directly stack and store the boards after B-staging, thus aiding in simplification of process control for assembly of semiconductor devices. The die bonding resin paste of the present invention may be suitably used for die bonding of insulating support boards such as organic boards, and copper lead frames, as well as for 42-alloy lead frames. Furthermore, according to the present invention, it is also possible to provide a method for producing a semiconductor device using the die bonding resin paste of the present invention, and a semiconductor device produced by the producing method.

Brief Description of Drawings

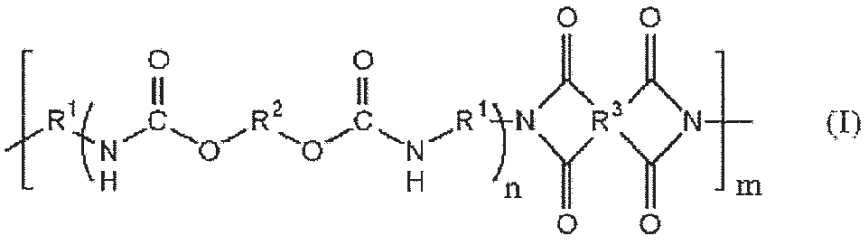
[0019] Figure 1 is a schematic cross-sectional view showing an embodiment of a semiconductor device according to the present invention.

Description of Embodiments

[0020] Hereinafter, preferred embodiments of the present invention will be described in detail.

[0021] A die bonding resin paste according to the present invention (hereinafter, also referred to merely as a "resin paste") comprises (A) a polyurethaneimide resin represented by the following formula (I) (hereinafter, also referred to as a "component (A)"):

[Chemical Formula 2]



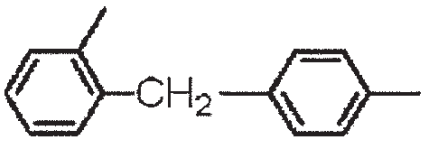
(I)

[in the formula, R^1 represents a divalent organic group containing an aromatic ring or an aliphatic ring; R^2 represents a divalent organic group with a molecular weight of 100 to 10,000; R^3 represents a tetravalent organic group containing 4 or more carbon atoms; and n and m each independently represent an integer of 1 to 100.].

[0022] The resin paste of the present invention also comprises, in addition to the above component (A), (B) a thermosetting resin (hereinafter, also referred to as a "component (B)"), (C) a filler (hereinafter, also referred to as "component (C)") and (D) a printing solvent (hereinafter, also referred to as a "component (D)"). Hereinafter, each of the components will now be described in detail.

[0023] The (A) polyurethaneimide resin is represented by the above formula (I). Here, in the above formula (I), the divalent organic group containing an aromatic ring or an aliphatic ring represented by R^1 is preferably a diisocyanate residue, and more preferably, the divalent organic group contains a structure represented by the following formula (II):

[Chemical Formula 3]

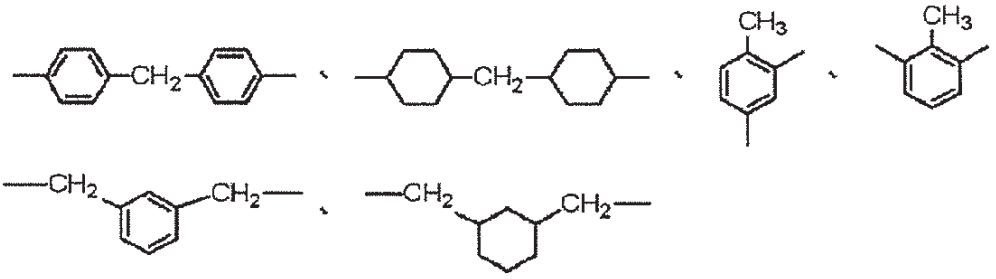


(II)

at 10 to 100 mol%.

[0024] Examples of other diisocyanate residues include the following formulas:

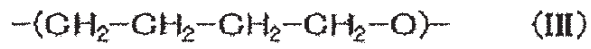
[Chemical Formula 4]



These may be used alone or in combinations of two or more types.

[0025] The divalent organic group with a molecular weight of 100 to 10,000 represented by R^2 in the above formula (I) is preferably a diol residue. The diol residue is, for example, a group derived from diols such as polybutadiene diol, polyisoprene diol, polycarbonate diol, polyether diol, polyester diol, polycaprolactone diol, and silicone diol. R^2 is more preferably containing a structure with a repeating unit represented by the following formula (III) as the diol residue:

[Chemical Formula 5]



(III)

at 10 to 100 mol%.

[0026] Examples of other diol residues include ones having repeating units represented by the following formulas:

[Chemical Formula 6]

$-(CH_2-CH(CH_3)-O)-$、

$-(CH_2-CH_2-O)-$、

$-(CH_2-CH_2-CH_2-CH_2-O)-$、

$-(CH_2-CH(CH_3)-O)a-(CH_2-CH_2-O)b-$ (Copolymer of a/b = 9 to 1/1 to 9 mol%)

$-[CO-(CH_2)_4-CO-O-(CH_2)_2-O]-$、

$-[CO-(CH_2)_4-CO-O-(CH_2)_2-O-(CH_2)_2-O]-$、

$-[CO-(CH_2)_4-CO-O-CH_2-CH(CH_3)-O]-$、

$-[CO-(CH_2)_4-CO-O-(CH_2)_4-O]-$、

$-[CO-(CH_2)_4-CO-O-(CH_2)_6-O]-$、

$-[CO-(CH_2)_4-CO-O-CH_2-C(CH_3)_2-CH_2-O]-$、

$-[CO-(CH_2)_8-CO-O-(CH_2)_6-O]-$、

$-[CO-(CH_2)_5-O]-$、

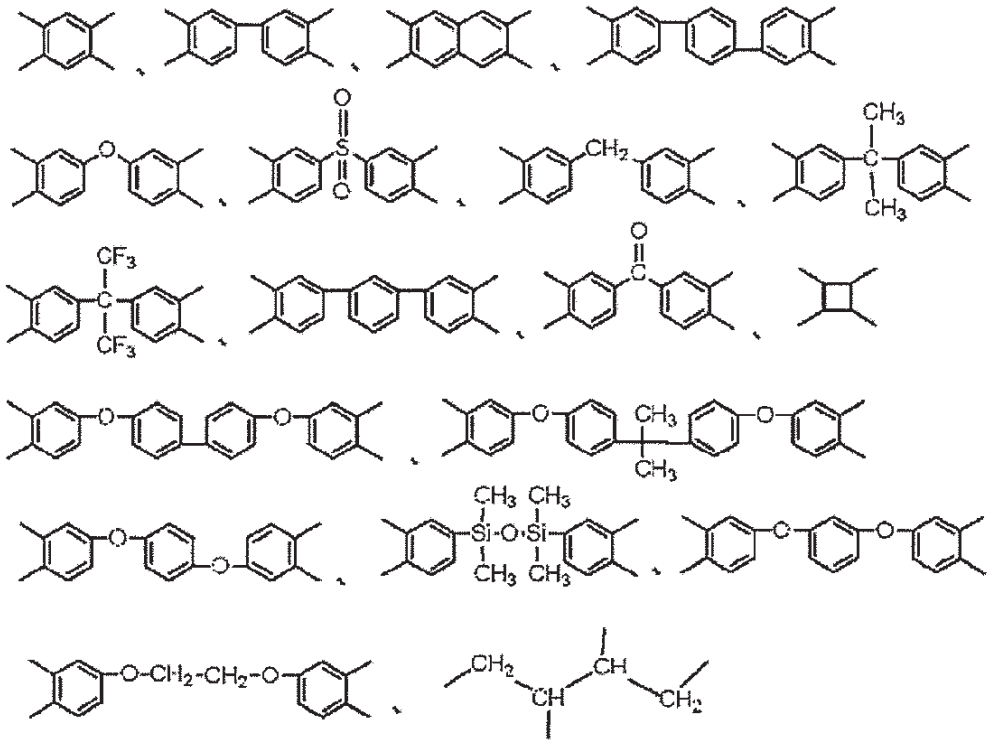
$-[CO-O-(CH_2)_6-O]-$、

$-R^4-(Si(CH_3)_2-O)-R^4-$ (R^4 is a C1 to C10 organic group)

These may be used alone or in combinations of two or more types. These weight-average molecular weight are preferably 100 to 10,000, and more preferably 500 to 5,000.

[0027] The tetravalent organic group containing 4 or more carbon atoms represented by R^3 in the above formula (I) is preferably a tetracarboxylic anhydride residue, and examples thereof include groups each represented by the following formulas:

[Chemical Formula 7]



These may be used alone or in combinations of two or more types. R^3 is more preferably a tetracarboxylic anhydride residue containing 4 to 27 carbon atoms, still more preferably a tetracarboxylic anhydride residue containing 4 to 20 carbon atoms, and particularly preferably a tetracarboxylic anhydride residue containing 6 to 18 carbon atoms.

[0028] The n and m in the above formula (I) must each independently be an integer of 1 to 100, and more preferably an integer of 1 to 50.

[0029] The (A) polyurethaneimide resin may be synthesized by a conventional method such as solution polymerization. For example, in the case of the solution polymerization, diisocyanate and diol are dissolved in a solvent in which the polyurethaneimide resin to be produced will dissolve, such as N-methyl-2-pyrrolidone (NMP), and reacted at 70°C to 180°C for 1 to 5 hours to synthesize a urethane

oligomer. Next, tetracarboxylic dianhydride may be added and reacted at 70°C to 180°C for 1 to 10 hours to obtain an NMP solution of the polyurethaneimide resin. After that, in some cases, a monovalent alcohol, oxime, amine, isocyanate, acid anhydride or the like may be further added to continue the reaction for end modification of the polyurethaneimide resin. In addition, during the synthesis, water, an alcohol, a tertiary amine or the like may be also used as a catalyst.

[0030] The obtained polyurethaneimide resin solution may be subjected to reprecipitation or the like with water, depending on the purpose, for separation of the polyurethaneimide resin. The compositional ratio of the diisocyanate and diol in the urethane oligomer is preferably 0.1 to 1.0 mol of diol component to 1.0 mol of the diisocyanate. The compositional ratio of the polyurethane oligomer and tetracarboxylic dianhydride making up the polyurethaneimide resin is preferably 0.1 to 2.0 mol of the tetracarboxylic dianhydride to 1.0 mol of the polyurethane oligomer.

[0031] The (A) polyurethaneimide resin according to the present invention preferably has a weight-average molecular weight based on polystyrene which is measured by gel permeation chromatography using tetrahydrofuran as the solvent of 5,000 to 500,000 and more preferably 10,000 to 100,000. A weight-average molecular weight of less than 5,000 will tend to lower the strength of the resin, while greater than 500,000 will tend to result in inferior solubility of the resin.

[0032] The content of the component (A) in the resin paste is preferably 10 to 50 mass% based on the total solid mass of the resin paste. A content of greater than 50 mass% will tend to lower the curability, while

a content of less than 10 mass% will tend to lower the chip adhesion in the B-stage state.

[0033] Preferred examples of the thermosetting resins for the component (B) include epoxy resins. As the component (B), there may be used a resin mixture comprising an epoxy resin, a phenol resin or a compound with a phenolic hydroxyl group in the molecule, and a curing accelerator. By including the (B) thermosetting resin, the resin paste can exhibit high reliability after simultaneous curing with sealing materials.

[0034] The epoxy resin contains at least two epoxy groups in the molecule, and from the viewpoint of curability and cured product properties, it is preferably a phenol glycidyl ether-type epoxy resin. Examples of such resins include condensation products of bisphenol A, bisphenol AD, bisphenol S, bisphenol F or halogenated bisphenol A with epichlorohydrin, phenol-novolac resin glycidyl ether, cresol-novolac resin glycidyl ether and bisphenol A-novolac resin glycidyl ether. These may be used alone or in combinations of two or more types.

[0035] The phenol resin has at least two phenolic hydroxyl groups in the molecule, and examples include a phenol-novolac resin, a cresol-novolac resin, a bisphenol A-novolac resin, poly-p-vinylphenol and a phenol aralkyl resin. These may be used alone or in combinations of two or more types.

[0036] In the resin paste of the present invention, from the viewpoint of curability and reliability of a cured film, the (B) thermosetting resin preferably used combination of an epoxy resin, and a phenol resin or a

compound containing a phenolic hydroxyl group within the molecule.

[0037] In the component (B), the content of the phenol resin or the compound with a phenolic hydroxyl group in the molecule is preferably 1 to 150 parts by mass, more preferably 20 to 120 parts by mass and still more preferably 50 to 100 parts by mass with respect to 100 parts by mass of the epoxy resin.

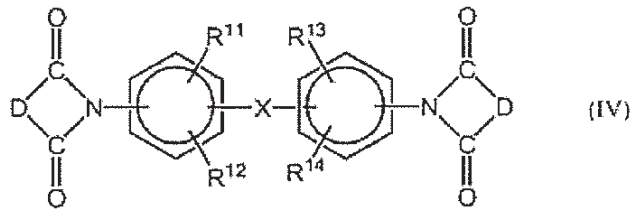
[0038] From the viewpoint of being capable of further improving the curability of the epoxy resin, the resin paste of the present invention may contain a curing accelerator with the epoxy resin. The curing accelerator is not particularly restricted so long as it can be used for curing of the epoxy resin. Examples of such curing accelerators include imidazoles, dicyandiamide derivatives, dicarboxylic dihydrazide, triphenylphosphine, tetraphenylphosphonium tetraphenyl borate, 2-ethyl-4-methylimidazole-tetraphenyl borate, and 1,8-diazabicyclo(5,4,0)undecene-7-tetraphenyl borate. These may be used alone or in combinations of two or more types.

[0039] In the component (B), the content of the curing accelerator is preferably 0.5 to 50 parts by mass, and more preferably 1 to 10 parts by mass with respect to 100 parts by mass of the epoxy resin. If the content is greater than 50 parts by mass, the storage stability of the resin paste may be lowered.

[0040] As the (B) thermosetting resin, an imide compound with at least two thermosetting imide groups in each molecule may be also used. Examples of such compounds include orthobismaleimidebenzene, metabismaleimidebenzene, parabismaleimidebenzene, 1,4-bis(p-maleimidecumyl)benzene,

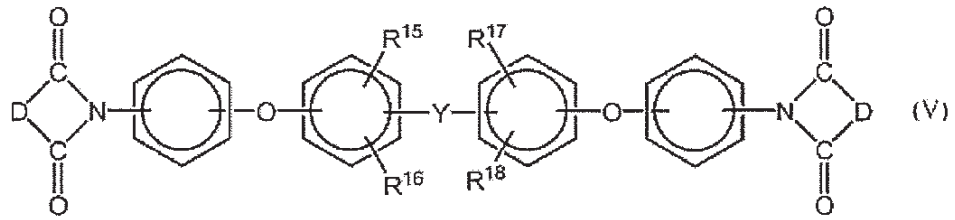
1,4-bis(m-maleimidecumyl)benzene and the like. These may be used alone or in combinations of two or more types. Furthermore, as the imide compounds, there are also preferably used imide compounds represented by the following formulas (IV) to (VI).

[0041] [Chemical Formula 8]



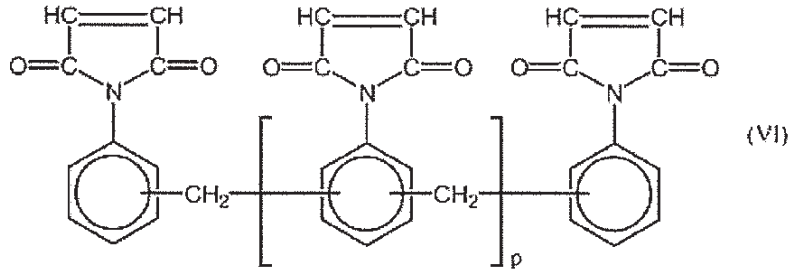
(IV)

[0042] [Chemical Formula 9]



(V)

[0043] [Chemical Formula 10]



(VI)

[0044] In the above formulas (IV) to (VI), X and Y each independently represent -O-, $-CH_2-$, $-CF_2-$, $-SO_2-$, -S-, -CO-, $-C(CH_3)_2-$ or $-C(CF_3)_2-$; R^{11}, R^{12}, R^{13}, R^{14}, R^{15}, R^{16}, R^{17} and R^{18} each independently represent a hydrogen atom, a lower alkyl group, a lower alkoxy group, a fluorine atom, a chlorine atom or a bromine atom; D represents a dicarboxylic acid residue with an ethylenic unsaturated double bond,; and p

represents an integer of 0 to 4.

[0045] The content of the (B) thermosetting resin must be 250 to 500 parts by mass, preferably 260 to 450 parts by mass, and more preferably 260 to 370 parts by mass with respect to 100 parts by mass of the component (A). In case that the content is in the range of 250 to 500 parts by mass, it is able to be excellent plasticity, to sufficiently reduce tackiness in the B-stage state, and also to improve hot die shear strength.

[0046] Examples of the fillers for the component (C) include conductive (metal) fillers such as silver powder, gold powder and copper powder, and inorganic substance fillers such as silica, alumina, titania, glass, iron oxide, and ceramic. Including the (C) filler can impart to the resin paste thixotropic properties required for printing.

[0047] In the fillers, conductive (metal) fillers such as silver powder, gold powder and copper powder are added to impart conductivity, heat conductive properties or thixotropic properties to the adhesives. In addition, inorganic substance fillers such as silica, alumina, titania, glass, iron oxide and ceramics are added to impart low thermal expansion properties, low moisture absorption coefficient and thixotropic properties to adhesives. These may be used alone or in combinations of two or more types.

[0048] As fillers to enhance the electrical reliability of the semiconductor device, inorganic ion exchangers may be added. In inorganic ion exchangers, in case that the paste cured product is extracted in hot water, ion extracted into an aqueous solution, for example, those known to have ion sequestering effects on ions such as Na^+, K^+, Cl^-, F^-, $RCOO^-$ or Br^- are effective. Examples of such ion

exchangers include natural minerals such as naturally produced zeolite, boiling stone, acidic white clay, dolomite and hydrotalcites, artificially synthesized synthetic zeolites and the like.

[0049] These conductive fillers and inorganic fillers may be used alone or in combinations of two or more types. Also, within a scope which does not impair the physical properties, one or more conductive fillers may be combined with one or more inorganic fillers.

[0050] From the viewpoint of improving printability and further reducing tack, the resin paste of the present invention, preferably contains spherical silica fine particles as the component (C).

[0051] The average particle diameter of the spherical silica fine particles is preferably 50 nm to 2000 nm, more preferably 100 nm to 1000 nm, and still more preferably 200 nm to 800 nm.

[0052] The content of the (C) filler is preferably 1 to 200 parts by mass, more preferably 30 to 170 parts by mass, and particularly preferably 60 to 140 parts by mass with respect to 100 parts by mass of the component (A). From the viewpoint of imparting satisfactory thixotropic properties (for example, a thixotropy index of 1.5 or greater) to the resin paste, the filler content is preferably at least 1 part by mass. Furthermore, from the viewpoint of printability and adhesion, the filler content is preferably no greater than 200 parts by mass. If a content is exceeding 200 parts by mass, the elastic modulus of the cured product increases, in the result, in lower the stress relaxation of the die bonding material decreases and the mounting reliability of the semiconductor device possibly degrades.

[0053] Mixing and kneading of the (C) filler are accomplished using

appropriate combinations of dispersers such as an ordinary stirrer, automatic agate mortar, triple roll and ball mill.

[0054] The printing solvent as the component (D) is preferably selected from among solvents which can uniformly knead and disperse the (C) filler. From the viewpoint of preventing volatilization of the solvent during printing, the solvent having a boiling point of 100°C or higher is preferably selected. The viscosity of the resin paste can be adjusted using the (D) printing solvent.

[0055] Examples of the above printing solvents include N-methyl-2-pyrrolidinone, diethyleneglycol dimethyl ether (also referred to as diglyme), triethyleneglycol dimethyl ether (also referred to as triglyme), diethyleneglycol diethyl ether, 2-(2-methoxyethoxy)ethanol, γ-butyrolactone, isophorone, carbitol, carbitol acetate, 1,3-dimethyl-2-imidazolidinone, 2-(2-butoxyethoxy)ethyl acetate, ethylcellosolve, ethylcellosolve acetate, butylcellosolve, dioxane, cyclohexanone and anisole, as well as solvents which is based mainly on petroleum distillation products used as solvents for printing inks. These may be used alone or in mixtures of two or more types.

[0056] The content of the (D) printing solvent is so that the resin paste solid content is preferably 30 to 90 mass%, more preferably 35 to 75 mass%, and particularly preferably 40 to 60 mass%. The above solid content of at least 30 mass% is preferred from the viewpoint of suppressing morphological changes based on volume reduction after paste drying, while the solid content of no greater than 90 mass% is preferred from the viewpoint of improving the flow property and

printing workability of the paste.

[0057] When the generations of bubbles and voids are notable during printing of the resin paste, it is effective to add additives such as defoaming agents, foam breakers and foam inhibitors to the (D) printing solvent. From the viewpoint of exhibiting a foam-inhibiting effect, these additive amount are preferably at least 0.01 mass% based on the total mass of the (D) printing solvent and additives, and from the viewpoint of adhesion and paste viscosity stability, they are preferably no greater than 10 mass%.

[0058] In order to enhance an adhesive force, in the resin paste, butadiene homopolymers or copolymers having a carboxylic acid terminal group, silane coupling agents, titanium-based coupling agents, nonionic surfactants, fluorine-based surfactants, silicone-based additives or the like may be appropriately added.

[0059] Examples of the butadiene homopolymer or copolymer having a carboxylic acid terminal group include low molecular weight liquid polybutadienes in which an acrylonitrile is introduced into the principal chain and which have carboxylic acid groups at the terminals, such as "Hycer CTBN-2009×162", "CTBN-1300×31", "CTBN-1300×8", "CTBN-1300×13", and "CTBNX-1300×9" (all of which are manufactured by Ube Industries, Ltd.), and low molecular weight liquid polybutadienes having a carboxylic acid group, such as "NISSO-PB-C-2000" (manufactured by Nippon Soda Co., Ltd.). These may be used alone or in combinations of two or more types.

[0060] The thixotropy index of the resin paste is preferably 1.0 to 8.0. If the thixotropy index of the resin paste is at least 1.0, it tends to be

possible to suppress running of the paste supplied and coated in the printing process, and maintain a more satisfactory printed form. In addition, if the thixotropy index of the resin paste is no greater than 8.0, it tends to be possible to suppress "chipping" and thinning or the like of the paste supplied and coated in the printing process.

[0061] The viscosity (25°C) of the resin paste is preferably 1 to 1000 Pa·s. The resin paste viscosity of 1 to 1000 Pa·s is suitable from the viewpoint of printing workability. Furthermore, the viscosity of the resin paste is preferably adjusted appropriately according to the type of printing process, for example, when a mesh is spread across a mask opening, such as in the case of a screen mesh board, it is preferably adjusted within a range of 1 to 100 Pa·s for proper passage through the mesh section, or in the case of a stencil board or the like, within a range of 20 to 500 Pa·s. When numerous voids are found remaining in the dried paste, it is effective to adjust the viscosity to no greater than 150 Pa·s.

[0062] The above viscosity is a value measured using an E-type rotating viscometer under conditions of 25°C and a revolution of 0.5 rpm. The thixotropy index is defined as the ratio between a value measured with an E-type rotating viscometer under conditions of 25°C and a revolution of 1 rpm, and a value measured under conditions of 25°C and a revolution of 10 rpm (thixotropy index = (viscosity at 1 rpm)/(viscosity at 10 rpm)).

[0063] The obtained die bonding resin paste may be supplied and coated onto lead frames such as 42-alloy lead frames or copper lead frames; or, plastic films such as polyimide resins, epoxy resins,

polyimide-based resins; in addition, plastics such as polyimide resins, epoxy resins, polyimide-based resins impregnated and cured in base materials such as nonwoven glass fabrics; or ceramic supporting members such as alumina, by a printing process for B-staging. Thereby, a B-stage adhesive equipped support board can be obtained. A semiconductor element (chip) such as an IC or LSI is attached to the B-stage adhesive equipped support board, and heated to bond the chip to the support board. Then, in a subsequent step of postcuring the resin paste, the chip is mounted onto the support board. So long as this does not pose a problem in the mounting and assembling steps, the postcuring of the resin paste may be combined with a postcuring step of the sealing material.

[0064] The method for producing a semiconductor device according to the present invention comprises at least a coating step of coating the resin paste onto a board to form a coated film and a semiconductor chip mounting step of mounting a semiconductor chip on the coated film, preferably it further comprises a drying step of drying the coated film after the coating step for B-staging, more specifically it comprises each of the steps described above. A semiconductor device according to the present invention is produced by a producing method comprising the aforementioned steps.

[0065] The die bonding resin paste contains a solvent, however, in the case of using in the method for producing a semiconductor device, by B-staging in the drying step, the majority of the solvent is volatilize. Therefore it is possible to assemble a semiconductor device having minimal voids in the die bonding layer and satisfactory mounting

reliability.

[0066] On the other hand, after supplying and coating the resin paste by a printing process, so long as this does not affect the package reliability, it is possible to attach the semiconductor element without dry semi-curing, and subsequently heat to bond the chip to the support board.

[0067] Thus, the method for producing a semiconductor device according to another aspect of the present invention comprises steps of coating a predetermined amount of the die bonding resin paste onto a board and mounting a semiconductor chip on the resin paste, and the semiconductor device according to another aspect of the present invention is produced by a producing method comprising the aforementioned steps.

[0068] Here, figure 1 is a schematic cross-sectional view showing an embodiment of a semiconductor device (board of a memory BOC configuration) according to the present invention. In a semiconductor device 100 shown in Figure 1, a semiconductor chip 2 such as an IC chip is bonded to a board 6 having solder balls 8 via an adhesive 4 consisting of a die bonding resin paste according to the present invention. Here, the solder balls 8 are formed on a circuit layer 14 formed on the surface of the board 6. A resist layer 16 is also formed on the circuit layer 14. And the semiconductor device 100 has a construction wherein the connection terminals of the semiconductor chip 2 are electrically connected to the board 6 via wires 10 such as gold wires, and then sealed with a sealing resin 12.

[0069] As described above, the preferred embodiments of the present

invention are described, but the present invention is not restricted thereto.

Example 1

[0070] Hereinafter, the present invention will be described more specifically based on examples and comparative examples.

[0071] (Examples 1 to 3 and Comparative Examples 1 to 3)

After reacting diphenylmethane-4,4'-diisocyanate (1.0 mol), diphenylmethane-2,4'-diisocyanate (1.0 mol) and polytetramethylene glycol having a weight-average molecular weight of 1,000 (0.8 mol) in 1-methyl-2-pyrrolidone (hereinafter, referred to as "NMP") under a nitrogen atmosphere at 100°C for 1 hour, 4,4'-oxydiphthalic anhydride (1.0 mol) and NMP (60.0 mol) were added thereto and the mixture was stirred at 100°C for 3 hours. Benzyl alcohol (0.49 mol) was then added, the mixture was stirred at 100°C for 1 hour, and the reaction was terminated. The obtained solution was placed in vigorously stirred water, and the formed precipitate was separated out by filteration and dried in a vacuum at 80°C for 8 hours to obtain a polyurethaneimide resin. As a result of measuring the obtained polyurethaneimide resin using GPC, Mw is 93,700 and Mn is 38,800 based on polystyrene. In addition, The obtained polyurethaneimide resin was dissolved in carbitol acetate (CA) to a solid concentration of 40 mass% to obtain a polyurethaneimide resin solution.

[0072] There was also prepared a carbitol acetate (36 parts by mass) solution containing 14.1 parts by mass of a cresol-novolac-type epoxy resin (trade name: YDCN-702S, manufactured by Tohto Kasei Co., Ltd., epoxy equivalents: 200) and 9.9 parts by mass of a bisphenol A-novolac

resin (trade name: VH-4170, manufactured by Dainippon Ink and Chemicals, Inc., OH equivalents: 118). Furthermore, there were each prepared tetraphenylphosphonium tetraphenylborate (trade name: TPPK, manufactured by Tokyo Kasei Kogyo Co., Ltd.), AEROSIL (trade name: AEROSIL 380, manufactured by Nippon Aerosil Co., Ltd., lumpy silica fine particles), and silica (trade name: SO-C2, manufactured by Admatechs, spherical silica fine particles, average particle diameter: 500 nm).

[0073] The materials were placed in a automatic agate mortar in the proportions listed in the following Table 1 as solid mass ratio, after kneading, they were subjected to defoaming and kneading at 5 Torr or less for 1 hour to obtain die bonding resin pastes of Examples 1 to 3 and Comparative Examples 1 to 3. The contents of carbitol acetate (CA) in Table 1 are the amounts of carbitol acetate included as solvent in the polyurethaneimide resin solution and in the epoxy resin and phenol resin carbitol acetate solutions.

[0074] In addition, as a property of the resin paste, stickiness (tackiness) after contact bonding a resist coated board in a B-stage state was evaluated . A method for evaluating the stickiness is as follow. Each of the resin pastes produced in Examples and Comparative Examples was coated onto an evaluating board, and heated and dried in an oven at 110°C for 1 hour to form a B-staged coated film (die bonding layer). Here, the evaluating board is that a solder resist AUS-308 (manufactured by Dainippon Ink And Chemicals, Incorporated) was coated onto an MCL-E679F board (manufactured by Hitachi Chemical Co., Ltd.). Next, a 10 mm × 12 mm evaluating board was contact

bonded onto the die bonding layer by applying load of 5 kgf on a heating plate at 30°C for 60 seconds. This was inverted upside down after contact bonding, and it was observed whether the contact bonded board dropped. The results are shown in Table 1. In Table 1, "A" represents the dropping of the board without being attached after contact bonding, and "B" represents a state where the board is still attached after contact bonding.

[0075] In addition, as a property of the resin paste, the hot die shear strength at 250°C after contact bonding of the semiconductor chip and paste postcuring was examined. A method for measuring the hot die shear strength is as follow. Each of the resin pastes produced in examples and comparative examples was printed onto a 42-alloy lead frame and dried in an oven at 110°C for 60 minutes. Next, a 5 mm × 5 mm silicon chip (0.5 mm thickness) was contact bonded onto the resin paste by applying load of 5 kgf on a heating plate at 200°C for 1 second, and was heated and cured in an oven at 180°C for 60 minutes. An automatic adhesive force tester (trade name: Serie-4000, manufactured by Dage, Ltd.) was used to measure the shear strength (kgf/chip) at 250°C. The results are shown in Table 1.

[0076] [Table 1]

			Ex. 1	Ex. 2	Ex. 3	Comp. Ex. 1	Comp. Ex. 2	Comp. Ex. 3
(A)	Polyurethaneimideresin		64	64	64	64	64	64
(B)	Epoxy resin	YDCN-702S	100	140	160	200	60	80
	Phenol resin	VH-4170	67	93	109	133	40	53
	Curing accelerator	TPPK	2	2	2	2	2	2
	Content with respect to 100 parts by mass of (A) (parts by mass)		264	367	420	159	520	211
(C)	Filler	Aerosil 380	15	15	15	15	15	15
		SO-C2	60	60	60	60	60	60
(D)	Printing solvent	CA	370	460	650	800	270	320
Stickiness			A	A	A	B	B	A
Hot die shear strength (kgf/chip)			11.8	11.8	10.9	9.6	11	-*

*After B-staging, although tack was reduced, cracks were generated to preclude contact bonding.

[0077] As shown in Table 1, it was found that the resin pastes of the present invention (Examples 1 to 3) have tackiness sufficiently reduced under room temperature conditions after B-staging, and in comparison with the conventional resin pastes (Comparative Examples 1 to 3), the boards can be conveyed in a state where the boards were directly stacked. It was found that the resin pastes of the present invention have higher hot shear strength at 250°C after the contact bonding and postcuring of the chips than that of the conventional resin pastes, and have high chip adhesive force and heat resistance.

Reference Signs List

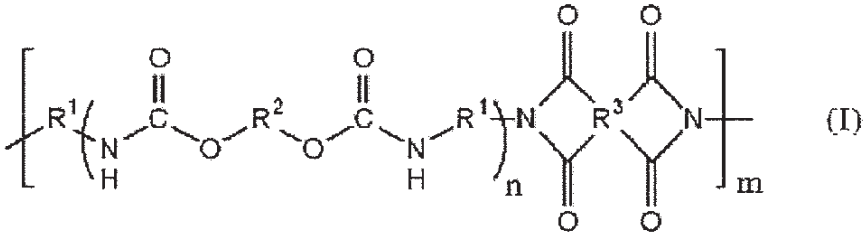
[0078] 2 ··· semiconductor chip, 4 ··· adhesive, 6 ··· board, 8 ··· solder ball, 10 ··· wire, 12 ··· sealing resin, 100 ··· semiconductor device.

CLAIMS

1. A die bonding resin paste comprising a polyurethaneimide resin represented by the following formula (I), a thermosetting resin, a filler and a printing solvent,

wherein a content of the thermosetting resin is 250 to 500 parts by mass with respect to 100 parts by mass of the polyurethaneimide resin:

[Chemical Formula 1]



(I)

[in the formula, R^1 represents a divalent organic group containing an aromatic ring or an aliphatic ring; R^2 represents a divalent organic group with a molecular weight of 100 to 10,000; R^3 represents a tetravalent organic group containing 4 or more carbon atoms; and n and m each independently represent an integer of 1 to 100.].

2. The die bonding resin paste according to claim 1, wherein the filler contains spherical silica fine particles.

3. A method for producing a semiconductor device comprising:

a coating step of coating the die bonding resin paste according to claim 1 or 2 onto a board to form a coated film, and

a semiconductor chip mounting step of mounting a semiconductor chip onto the coated film.

4. The method for producing a semiconductor device according to

claim 3, further comprising a drying step of drying the coated film for B-staging after the coating step,

wherein the semiconductor chip is mounted on the B-staged coated film in the semiconductor chip mounting step.

5. A semiconductor device obtained by the method for producing a semiconductor device according to claim 3 or 4.