

S P E C I F I C A T I O N

TITLE OF INVENTION: Thermally Curable Composition and Sheet/Device
Manufacturing Method

TECHNICAL FIELD

[0001] The present invention relates to a thermally curable composition, a sheet, and a device manufacturing method.

BACKGROUND ART

[0002] A device may be manufactured by a method comprising an operation in which a sheet-like thermally curable composition is arranged over an electronic component, an operation in which softening of the thermally curable composition is made to occur and the electronic component is covered with the thermally curable composition, and an operation in which heating of the composite body formed by the operation in which the electronic component was covered with the thermally curable composition causes curing of the thermally curable composition to occur.

PRIOR ART REFERENCES

PATENT REFERENCES

[0003] PATENT REFERENCE NO. 1: Japanese Patent Application Publication Kokai No. 2006-19714

SUMMARY OF INVENTION

PROBLEM TO BE SOLVED BY INVENTION

[0004] Gas sometimes becomes trapped between the electronic component and the thermally curable composition when the electronic component is covered with the thermally curable composition. The gas sometimes migrates and causes occurrence of pinholes and/or unevenness in the surface of the post-curing thermally curable composition.

[0005] It is also true that flow marks sometimes appear on the surface of the post-curing thermally curable composition.

[0006] It is an object of the present invention to provide a thermally curable composition that will solve the foregoing problems, that is capable of reducing gas trapped between an electronic component and a thermally curable composition, and that can suppress occurrence of flow marks. It is also an object of the present

invention to provide a sheet that is capable of reducing gas trapped between an electronic component and a thermally curable composition, and that can suppress occurrence of flow marks. It is also an object of the present invention to provide a method for manufacturing a device for which the amount of internal voids, unevenness, pinholes, and flow marks is small.

MEANS FOR SOLVING PROBLEM

[0007] The present invention relates to a sheet-like thermally curable composition comprising a phenolic resin, an inorganic filler, and silicone-type particles. A thermally curable composition in accordance with the present invention may make it possible to reduce gas trapped between an electronic component and a thermally curable composition. It is thought that this may be due to the fact that viscosity of the thermally curable composition is high at the time that the electronic component is covered with the thermally curable composition. A thermally curable composition in accordance with the present invention may make it possible to suppress occurrence of flow marks. It is thought that this may be due to the fact that silicone-type particles suppress glossiness that might otherwise occur at the package surface.

[0008] It is preferred that the silicone-type particles have epoxy group(s). This is so as to permit increase in the strength of the post-curing thermally curable composition. This is thought to occur due to the fact that phenolic resin bonds with silicone-type particles, constraining the silicone rubber particles.

[0009] The present invention also relates to a sheet comprising a thermally curable composition. The two faces of the thermally curable composition may be defined such that there is a first face and a second face opposite the first face. A sheet in accordance with the present invention further comprises a first separator which is provided over the first face, and a second separator which is provided over the second face.

[0010] The present invention also relates to a device manufacturing method. A device manufacturing method in accordance with the present invention comprises an operation in which the thermally curable composition is arranged over an electronic component, and an operation in which a composite body is formed. The composite body comprises the electronic component and the thermally curable

composition which covers the electronic component. The operation in which the composite body is formed comprises a step in which softening of the thermally curable composition is made to occur. A device manufacturing method in accordance with the present invention further comprises an operation in which heating of the composite body causes curing of the thermally curable composition to occur.

BRIEF DESCRIPTION OF DRAWINGS

- [0011] [FIG. 1] Schematic sectional diagram of a sheet associated with a first embodiment.
- [FIG. 2] Schematic sectional diagram showing an operation for manufacturing a device.
- [FIG. 3] Schematic sectional diagram showing an operation for manufacturing a device.
- [FIG. 4] Schematic sectional diagram showing an operation for manufacturing a device.
- [FIG. 5] Schematic sectional diagram showing an operation in the context of a first example of manufacture of a semiconductor device.
- [FIG. 6] Schematic sectional diagram showing an operation in the context of a first example of manufacture of a semiconductor device.
- [FIG. 7] Schematic sectional diagram showing an operation in the context of a first example of manufacture of a semiconductor device.
- [FIG. 8] Schematic sectional diagram showing an operation in the context of a second example of manufacture of a semiconductor device.
- [FIG. 9] Schematic sectional diagram showing an operation in the context of a second example of manufacture of a semiconductor device.
- [FIG. 10] Schematic sectional diagram showing an operation in the context of a second example of manufacture of a semiconductor device.
- [FIG. 11] Schematic sectional diagram showing an operation in the context of a second example of manufacture of a semiconductor device.

EMBODIMENTS FOR CARRYING OUT INVENTION

[0012] Although the present invention is described in detail below in terms of embodiments, it should be understood that the present invention is not limited only to these embodiments.

[0013] Embodiment 1

—Sheet 1—

As shown in FIG. 1, sheet 1 comprises sheet-like thermally curable composition 11. The two faces of thermally curable composition 11 may be defined such that there is a first face and a second face opposite the first face. Sheet 1 further comprises first separator 12 provided over the first face. As first separator 12, polyethylene terephthalate (PET) film and the like may be cited as examples. Sheet 1 further comprises second separator 13 provided over the second face. As second separator 13, polyethylene terephthalate (PET) film and the like may be cited as examples.

[0014] As the lower limit of the range in values for the thickness of thermally curable composition 11, 100 μm , 200 μm , and so forth may be cited as examples. Examples of the upper limit of the range in values for the thickness of thermally curable composition 11 include 2000 μm , 1500 μm , and so forth.

[0015] Minimum melt viscosity of thermally curable composition 11 is preferably 100 Pa·s to 10000 Pa·s. At 100 Pa·s and higher, there tends to be little gas trapped between thermally curable composition 11 and electronic component(s). At 10000 Pa·s and lower, there tends to be no space, i.e., unfilled region(s), between thermally curable composition 11 and electronic component(s) during molding.

[0016] Thermally curable composition 11 comprises silicone-type particles. The silicone-type particles are preferably silicone elastomer particles.

[0017] It is preferred that the silicone-type particles have a group that reacts with at least one of phenolic resin and epoxy resin. As the group that reacts with at least one of phenolic resin and epoxy resin, epoxy group and so forth may be cited as examples.

[0018] It is preferred that the shape of the silicone-type particles be spherical. It is preferred that average particle diameter of the silicone-type particles be not greater than 20 μm , and more preferred that this be not greater than 10 μm . As the

lower limit of the range in values for the average particle diameter of the silicone-type particles, 0.5 μm , 1 μm , and so forth may be cited as examples.

[0019] Taking the weight of thermally curable composition 11 less the total weight of inorganic filler to be 100%, it is preferred that total weight of silicone-type particles be not less than 0.5%, and more preferred that this be not less than 1%. Taking the weight of thermally curable composition 11 less the total weight of inorganic filler to be 100%, it is preferred that total weight of silicone-type particles be not greater than 50%, and more preferred that this be not greater than 45%. Above 50%, it may be that space, i.e., unfilled region(s), will remain between thermally curable composition 11 and electronic component(s).

[0020] Thermally curable composition 11 comprises an epoxy resin that is liquid at 25° C and an epoxy resin that is solid at 25° C. Causing an epoxy resin that is liquid at 25° C to be blended therein will make it possible to manufacture thermally curable composition 11 through kneaded extrusion using a roll kneader or the like.

[0021] It is preferred that the epoxy equivalent of the epoxy resin that is liquid at 25° C be not less than 100 g/eq, and more preferred that this be not less than 120 g/eq. It is preferred that the epoxy equivalent of the epoxy resin that is liquid at 25° C be not greater than 500 g/eq, and more preferred that this be not greater than 300 g/eq. Epoxy equivalent may be measured in accordance with the method set forth at JIS K 7236-2009. As epoxy resin that is liquid at 25° C, bisphenol-A-type epoxy resin and so forth may be cited as examples.

[0022] As epoxy resin that is solid at 25° C, epoxy resin having an epoxy equivalent that is 100 g/eq to 180 g/eq, epoxy resin having an epoxy equivalent that is not less than 200 g/eq, and so forth may be cited as examples. It is preferred that thermally curable composition 11 comprise epoxy resin having an epoxy equivalent that is 100 g/eq to 180 g/eq and epoxy resin having an epoxy equivalent that is not less than 200 g/eq. Causing an epoxy resin having an epoxy equivalent that is 100 g/eq to 180 g/eq to be blended therein will make it possible to increase the glass transition temperature of post-thermal-curing thermally curable composition 11. As epoxy resin having an epoxy equivalent that is not less

than 200 g/eq, dicyclopentadiene-type epoxy resins and so forth may be cited as examples.

[0023] Taking the weight of thermally curable composition 11 less the total weight of inorganic filler to be 100%, it is preferred that total weight of epoxy resin be not less than 20%. Taking the weight of thermally curable composition 11 less the total weight of inorganic filler to be 100%, it is preferred that total weight of epoxy resin be not greater than 80%.

[0024] Thermally curable composition 11 comprises phenolic resin. As phenolic resin, phenol novolac resins, phenol aralkyl resins, biphenyl aralkyl resins, dicyclopentadiene-type phenolic resins, cresol novolac resins, cresol resins, and so forth may be cited as examples. Any one of these phenolic resins may be used alone or two or more species chosen from thereamong may be used in combination. It is preferred that hydroxyl group equivalent of the phenolic resin be 70 to 250. It is preferred that softening point of the phenolic resin be 50° C to 110° C.

[0025] From the standpoint of curing reaction characteristics, it is preferred that blending ratio of epoxy resin and phenolic resin be such that there are 0.7 to 1.5, and more preferred that there are 0.9 to 1.2, total hydroxyl group equivalents attributable to phenolic resin blended therewithin per epoxy group equivalent attributable to epoxy resin.

[0026] Taking the weight of thermally curable composition 11 less the total weight of inorganic filler to be 100%, it is preferred that total weight of phenolic resin be not less than 5%, and more preferred that this be not less than 10%. Taking the weight of thermally curable composition 11 less the total weight of inorganic filler to be 100%, it is preferred that total weight of phenolic resin be not greater than 60%, and more preferred that this be not greater than 40%.

[0027] Thermally curable composition 11 comprises inorganic filler. As inorganic filler, quartz glass, talc, silica, alumina, boron nitride, aluminum nitride, silicon carbide, and the like may be cited as examples. Of these, because it may satisfactorily permit reduction in coefficient of thermal expansion, silica is preferred. Because of its/their excellent flow characteristics, fused silica is preferred, and spherical fused silica is more preferred. Because of their high

thermal conductivities, alumina, boron nitride, and aluminum nitride are preferred. Thermally curable composition 11 may comprise a single species of inorganic filler. Or it may comprise two or more species of inorganic filler.

[0028] It is preferred that average particle diameter of the inorganic filler be not less than 0.5 μm , and more preferred that this be not less than 1 μm . It is preferred that average particle diameter of the filler be not greater than 30 μm . Average particle diameter may be deduced for example by using an arbitrarily extracted sample from the population, and using a laser diffraction/scattering particle size distribution measuring device to carry out measurements.

[0029] It is preferred that inorganic filler be present within thermally curable composition 11 in an amount that is not less than 55 vol%, more preferred that this be not less than 60 vol%, and still more preferred that this be not less than 70 vol%. Increasing the amount of inorganic filler present therewithin will make it possible to cause the coefficient of linear expansion of post-curing thermally curable composition 11 to approach the coefficient of linear expansion of the substrate and/or the like. It is preferred that inorganic filler be present within thermally curable composition 11 in an amount that is not greater than 85 vol%, and more preferred that this be not greater than 80 vol%. When this is 85 vol% or less, this will facilitate molding in the form of a sheet.

[0030] Inorganic filler content may also be described in terms of units measured in "wt%". Silica content is typically described in terms of the "wt%" thereof. It is preferred that silica be present within thermally curable composition 11 in an amount that is not less than 60 wt%, more preferred that this be not less than 70 wt%, still more preferred that this be not less than 80 wt%, and still more preferred that this be not less than 85 wt%. The upper limit of the range in values for the amount of silica present within thermally curable composition 11 might, for example, be 95 wt%.

[0031] Alumina content is also described in terms of the "wt%" thereof. It is preferred that alumina be present within thermally curable composition 11 in an amount that is not less than 72 wt%, more preferred that this be not less than 80 wt%, and still more preferred that this be not less than 87 wt%. It is preferred that alumina be

present within thermally curable composition 11 in an amount that is not greater than 95 wt%, and more preferred that this be not greater than 93 wt%.

[0032] Thermally curable composition 11 comprises silane coupling agent. As silane coupling agent, 3-glycidoxypolytrimethoxysilane and so forth may be cited as examples.

[0033] Thermally curable composition 11 comprises curing accelerator. As curing accelerator, while there is no particular limitation so long as it promotes curing of epoxy resin and phenolic resin, 2-methylimidazole (product name: 2MZ), 2-undecylimidazole (product name: C11-Z), 2-heptadecylimidazole (product name: C17Z), 1,2-dimethylimidazole (product name: 1,2DMZ), 2-ethyl-4-methylimidazole (product name: 2E4MZ), 2-phenylimidazole (product name: 2PZ), 2-phenyl-4-methylimidazole (product name: 2P4MZ), 1-benzyl-2-methylimidazole (product name: 1B2MZ), 1-benzyl-2-phenylimidazole (product name: 1B2PZ), 1-cyanoethyl-2-methylimidazole (product name: 2MZ-CN), 1-cyanoethyl-2-undecylimidazole (product name: C11Z-CN), 1-cyanoethyl-2-phenylimidazolium-trimellitate (product name: 2PZCNS-PW), 2,4-diamino-6-[2'-methylimidazolyl-(1')]-ethyl-s-triazine (product name: 2MZ-A), 2,4-diamino-6-[2'-undecylimidazolyl-(1')]-ethyl-s-triazine (product name: C11Z-A), 2,4-diamino-6-[2'-ethyl-4'-methylimidazolyl-(1')]-ethyl-s-triazine (product name: 2E4MZ-A), 2,4-diamino-6-[2'-methylimidazolyl-(1')]-ethyl-s-triazineisocyanuric acid adduct (product name: 2MA-OK), 2-phenyl-4,5-dihydroxymethylimidazole (product name: 2PHZ-PW), 2-phenyl-4-methyl-5-hydroxymethylimidazole (product name: 2P4MHZ-PW), and/or other such imidazole-type curing accelerators may be cited as examples (all manufactured by Shikoku Chemicals Corporation). Of these, because they permit suppression of the degree to which the curing reaction proceeds at kneading temperature, 2-phenyl-4,5-dihydroxymethylimidazole and 2,4-diamino-6-[2'-ethyl-4'-methylimidazolyl-(1')]-ethyl-s-triazine are more preferred, and 2-phenyl-4,5-dihydroxymethylimidazole is still more preferred.

[0034] For every 100 parts by weight of the combined total of epoxy resin and phenolic resin, it is preferred that curing accelerator be present in an amount that is not less than 0.2 part by weight, more preferred that this be not less than 0.5 part

by weight, and still more preferred that this be not less than 0.8 part by weight. For every 100 parts by weight of the combined total of epoxy resin and phenolic resin, it is preferred that curing accelerator be present in an amount that is not greater than 5 parts by weight, and more preferred that this be not greater than 2 parts by weight.

[0035] Thermally curable composition 11 comprises carbon black.

[0036] Thermally curable composition 11 might be manufactured, for example, by a method comprising an operation in which a mixture obtained by kneading phenolic resin, inorganic filler, silicone-type particles, and so forth is molded in the form of a sheet. The upper limit of the range in values for the temperature during kneading might, for example, be 140° C or 130° C. The lower limit of the range in values for the temperature might, for example, be 30° C or 50° C. It is preferred that kneading time be 1 minute to 30 minutes. It is preferred that kneading be carried out under vacuum conditions (in the presence of a vacuum). Pressure under vacuum conditions might, for example, be 1×10^{-4} kg/cm² to 0.1 kg/cm².

[0037] Components (phenolic resin, inorganic filler, silicone-type particles, and so forth) for forming thermally curable composition 11 might be dispersed and/or dissolved in solvent to prepare a varnish therefrom, this varnish might be used to coat a support body, and the film coating might be dried to manufacture thermally curable composition 11. As solvent, methyl ethyl ketone, ethyl acetate, toluene, and so forth may be cited as examples.

[0038] Thermally curable composition 11 may be used to seal an electronic component. As electronic component, a sensor, MEMS (Micro Electro Mechanical Systems), SAW (surface acoustic wave) chip, semiconductor element, capacitor, resistor, and the like may be cited as examples. As sensor, a pressure sensor, vibration sensor, and the like may be cited as examples. As semiconductor element, a semiconductor chip, an IC (integrated circuit), transistor, and the like may be cited as examples. Thermally curable composition 11 may be particularly favorably used to seal a semiconductor element.

[0039] —Device Manufacturing Method—

As shown in FIG. 2, a device manufacturing method comprises an operation in which thermally curable composition 11 is arranged over electronic component 21. As shown in FIG. 3, the device manufacturing method further comprises an operation in which composite body 2, comprising electronic component 21 and thermally curable composition 11 which covers electronic component 21, is formed. The device manufacturing method further comprises an operation in which heating of composite body 2 causes curing of thermally curable composition 11 to occur.

[0040] The device manufacturing method further comprises an operation in which first separator 12 is detached from thermally curable composition 11 prior to the operation in which thermally curable composition 11 is arranged over electronic component 21.

[0041] The operation in which thermally curable composition 11 is arranged over electronic component 21, in more specific terms, is an operation in which a sheet, comprising thermally curable composition 11 and second separator 13 which is provided over the second face of thermally curable composition 11, is arranged over electronic component 21.

[0042] The operation in which composite body 2 is formed comprises a step in which softening of thermally curable composition 11 is made to occur. At the step in which softening of thermally curable composition 11 is made to occur, it is preferred that thermally curable composition 11 be heated at not less than 40° C, more preferred that this be not less than 50° C, and still more preferred that this be not less than 60° C. At the step in which softening of thermally curable composition 11 is made to occur, it is preferred that thermally curable composition 11 be heated at not greater than 150° C, more preferred that this be not greater than 100° C, and still more preferred that this be not greater than 90° C. The operation in which composite body 2 is formed further comprises a step in which electronic component 21 is covered with thermally curable composition 11. The step in which electronic component 21 is covered with thermally curable composition 11, in more specific terms, is a step in which electronic component 21 is embedded within thermally curable composition 11 under vacuum

conditions. Vacuum conditions might, for example, be 0.1 kPa to 5 kPa, 0.1 Pa to 100 Pa, or the like.

[0043] At the operation in which curing of thermally curable composition 11 is made to occur, it is preferred that heating of composite body 2 be carried out at not less than 100° C, and more preferred that this be carried out at not less than 120° C. At the operation in which curing of thermally curable composition 11 is made to occur, it is preferred that heating of composite body 2 be carried out at not greater than 200° C, and more preferred that this be carried out at not greater than 180° C.

[0044] As shown in FIG. 4, following the operation in which curing of thermally curable composition 11 is made to occur, composite body 2 comprises electronic component 21 and post-curing thermally curable composition 31 which covers electronic component 21. Following the operation in which curing of thermally curable composition 11 is made to occur, the device manufacturing method comprises an operation in which wiring is formed and so forth.

[0045] Representative examples of semiconductor device manufacturing methods are described below.

[0046] As shown in FIG. 5, laminated body 101 comprises temporarily secured body 141, thermally curable composition 11 which is arranged over temporarily secured body 141, and second separator 13 which is arranged over thermally curable composition 11. Laminated body 101 is arranged between lower heating plate 161 and upper heating plate 162. Temporarily secured body 141 comprises support plate 142, adhesive layer 143 which is arranged over support plate 142, and semiconductor chip 121 which is secured to adhesive layer 143. As material for adhesive layer 143, thermally foamable adhesives and other such thermally detachable adhesives and so forth may be cited as examples.

[0047] As shown in FIG. 6, lower heating plate 161 and upper heating plate 162 are used in accordance with a parallel plate technique to hot-press laminated body 101 under vacuum conditions to form chip composite body 102. Chip composite body 102 comprises semiconductor chip 121 and thermally curable composition 11 which covers semiconductor chip 121. Chip composite body 102 is in contact with adhesive layer 143. Chip composite body 102 is in contact with second separator 13.

[0048] Second separator 13 is detached from chip composite body 102. Curing of thermally curable composition 11 is made to occur. Adhesive layer 143 is heated, and chip composite body 102 is detached from adhesive layer 143. As shown in FIG. 7, wiring 171 and so forth are formed. Following formation of wiring 171 and so forth, chip composite body 102 is diced. As a result of the foregoing procedure, a semiconductor device is obtained.

[0049] Description will now be given as well with respect to an example of a method for manufacturing a semiconductor device.

[0050] As shown in FIG. 8, laminated structure 201 comprises packaged wafer 241, thermally curable composition 11 which is arranged over packaged wafer 241, and second separator 13 which is arranged over thermally curable composition 11. Laminated structure 201 is arranged between lower heating plate 261 and upper heating plate 262. Packaged wafer 241 comprises semiconductor wafer 242, semiconductor chip 221, and underfill material 243 which is sandwiched between semiconductor wafer 242 and semiconductor chip 221. Semiconductor wafer 242 has electrode(s).

[0051] As shown in FIG. 9, lower heating plate 261 and upper heating plate 262 are used in accordance with a parallel plate technique to hot-press laminated structure 201 to form wafer composite body 202. Wafer composite body 202 comprises semiconductor wafer 242, semiconductor chip 221, underfill material 243 which is sandwiched between semiconductor wafer 242 and semiconductor chip 221, and thermally curable composition 11 which covers semiconductor chip 221. Wafer composite body 202 is in contact with second separator 13.

[0052] Second separator 13 is detached from wafer composite body 202. Curing of thermally curable composition 11 is made to occur. As shown in FIG. 10, grinding of wafer composite body 202 is carried out. As shown in FIG. 11, wiring 271 and so forth are formed. Following formation of wiring 271 and so forth, wafer composite body 202 is diced. As a result of the foregoing procedure, a semiconductor device is obtained.

[0053] —Variation 1—

In accordance with a first variation, thermally curable composition 11 constitutes a multilayer structure having a plurality of layers.

WORKING EXAMPLES

[0054] Below, exemplary detailed description of this invention is given in terms of preferred working examples. Note, however, that except where otherwise described as limiting, the materials, blended amounts, and so forth described in these working examples are not intended to limit the scope of the present invention thereto.

[0055] Fabrication of Resin Sheet

Components used to fabricate a resin sheet will now be described.

Epoxy Resin 1: EPPN-501HY manufactured by Nippon Kayaku Co., Ltd. (epoxy resin that has a softening point of 51° C to 57° C and an epoxy equivalent that is 162 g/eq. to 172 g/eq.)

Epoxy Resin 2: jER828 manufactured by Mitsubishi Chemical Corporation (bisphenol-A-type epoxy resin that is liquid at 25° C and has an epoxy equivalent that is 184 g/eq. to 194 g/eq.)

Epoxy Resin 3: HP7200 manufactured by DIC Corporation (dicyclopentadiene-type epoxy resin that has a softening point of 56° C to 66° C and an epoxy equivalent that is 254 g/eq. to 264 g/eq.)

Phenolic resin: LVR-8210DL manufactured by Gunei Chemical Industry Co., Ltd. (novolac-type phenolic resin that has a softening point of 60° C and a hydroxyl group equivalent that is 104 g/eq.)

Filler: FB-9454FC manufactured by Denki Kagaku Kogyo Kabushiki Kaisha (fused spherical silica)

Silicone-type particles: EP-2601 manufactured by Dow Corning Toray Co., Ltd. (spherical silicone elastomer particles having an epoxy group and an average particle diameter of 2 μm)

Carbon black: #20 manufactured by Mitsubishi Chemical Corporation

Catalyst: 2PHZ-PW manufactured by Shikoku Chemicals Corporation (2-phenyl-4,5-dihydroxymethylimidazole)

Silane coupling agent: KBM-403 manufactured by Shin-Etsu Chemical Co., Ltd. (3-glycidoxypyltrimethoxysilane)

[0056] Fabrication of Resin Sheet

The various components were blended together as listed at TABLE 1, and a roll kneader was used to melt and knead these together under vacuum conditions (0.01 kg/cm^2) for 10 minutes at 60° C to 120° C to prepare a mixture. The flat press method was used to cause the mixture to be molded into sheet-like form to prepare a resin sheet of thickness 1 mm.

[0057] Evaluation

Evaluation was carried out as follows. Results are shown in TABLE 1.

[0058] —Viscosity—

The resin sheet was pierced to obtain circular samples of diameter 25 mm. An ARES viscoelasticity measuring device (manufactured by Rheometrics Scientific, Inc.) was used to measure the melt viscosity of the samples. More specifically, samples were sandwiched between parallel plates of diameter 25 mm, and melt viscosity was measured at a frequency of 1 Hz, a strain of 10%, a temperature rise rate of 10° C/min . The minimum value for melt viscosity between 50° C and 150° C was taken to be the minimum melt viscosity.

[0059] —Unevenness/Pinholes—

A chip-bearing wafer was prepared which had an 8-inch mirror wafer, and 150 adhesive-sheet-bearing silicon chips—each of which was 7 mm square and $500 \mu\text{m}$ in thickness—that were affixed to the mirror wafer in such fashion that there was uniform spacing therebetween. A disk-shaped piece of resin of diameter 8 inches and thickness $1000 \mu\text{m}$ was cut out of the resin sheet. The disk-shaped piece of resin was laminated to the chip-bearing wafer to form a laminated body. A flat press apparatus was used to press the laminated body to obtain a structure that was provided with a mirror wafer, the 150 adhesive-sheet-bearing silicon chips secured to the mirror wafer, and protective resin of thickness $70 \mu\text{m}$ which covered the 150 adhesive-sheet-bearing silicon chips. A recirculating hot-air oven was used to heat the structure for 2 hours at 180° C to cure the protective resin. Evaluation was determined to be BAD if there was at least one of either a pinhole of diameter greater than or equal to 0.5 mm or unevenness of such size that the diameter thereof was greater than or equal to 1 mm at the surface of the protective resin following curing. Evaluation was determined to be GOOD if there was

neither a pinhole of diameter greater than or equal to 0.5 mm nor unevenness of such size that the diameter thereof was greater than or equal to 1 mm.

[0060] —Internal Voids/Unfilled Regions—

A recirculating hot-air oven was used to heat the structure for 2 hours at 180° C to cure the protective resin. Observation to detect internal voids and unfilled regions—internal spaces—at the structure following heating was carried out using an ultrasonic imaging apparatus (FS200II manufactured by Hitachi Finetech, Ltd.). A 25 MHz probe was used to carry out observations in reflection mode. Evaluation was determined to be BAD if there was at least one of either an internal void that was greater than or equal to 0.5 mm or an unfilled region that was greater than or equal to 0.5 mm. Evaluation was determined to be GOOD if there was neither a void that was greater than or equal to 0.5 mm nor an unfilled region that was greater than or equal to 0.5 mm.

[0061] —Flow Marks—

A recirculating hot-air oven was used to heat the structure for 2 hours at 180° C to cure the protective resin. Visual inspection of the surface of the protective resin was carried out following curing. Evaluation was determined to be BAD if a pattern was visible thereon. Evaluation was determined to be GOOD if no pattern was visible thereon.

[0062] TABLE 1

		Working Example 1	Working Example 2	Working Example 3	Comparative Example 1
Blending ratio (parts by weight)	Epoxy Resin 1 (EPPN-501HY)	100	100	100	100
	Epoxy Resin 2 (jER828)	29	29	29	29
	Epoxy Resin 3 (HP7200)	34	34	34	34
	Phenolic resin (LVR-8210DL)	80	80	80	80
	Inorganic filler (FB-9454FC)	1926	2406	3901	1916
	Silicone-type particles (EP-2601)	1.3	63	254	-
	Carbon black (#20)	4.4	5.4	8.8	4.3
	Catalyst (2PHZ-PW)	1.7	1.7	1.7	1.7
	Silane coupling agent (KBM-403)	12	14	16	18

Total		2188.4	2733.1	4424.5	2183.0
Total weight (%) of silicone-type particles if take weight of resin sheet less total weight of inorganic filler to be 100%		0.5	19.3	48.5	-
Amount (wt%) of inorganic filler present within resin sheet		88.0	88.0	88.2	87.8
Evaluation	Minimum melt viscosity (Pa·s)	110	1000	9000	70
	Unevenness/pinholes	GOOD	GOOD	GOOD	BAD
	Internal voids/unfilled regions	GOOD	GOOD	GOOD	BAD
	Flow marks	GOOD	GOOD	GOOD	BAD

EXPLANATION OF REFERENCE NUMERALS

- [0063] 1 Sheet
- 11 Thermally curable composition
- 12 First separator
- 13 Second separator
- 21 Electronic component
- 2 Composite body
- 31 Post-curing thermally curable composition
- [0064] 101 Laminated body
- 141 Temporarily secured body
- 142 Support plate
- 143 Adhesive layer
- 121 Semiconductor chip
- 161 Lower heating plate
- 162 Upper heating plate
- 102 Chip composite body
- 171 Wiring
- [0065] 201 Laminated structure
- 241 Packaged wafer
- 242 Semiconductor wafer
- 243 Underfill material
- 221 Semiconductor chip
- 261 Lower heating plate

262	Upper heating plate
202	Wafer composite body
271	Wiring

CLAIMS

[CLAIM 1] A sheet-like thermally curable composition comprising a phenolic resin,
an inorganic filler, and silicone-type particles, wherein the silicone-type particles have
5 an epoxy group.

[CLAIM 2] The thermally curable composition according to claim 1 further
comprising an epoxy resin.

10 [CLAIM 3] The thermally curable composition according to claim 1 or 2 wherein,
taking a first weight which is a weight of the thermally curable composition less a total
weight of the inorganic filler to be 100%, a total weight of the silicone-type particles is
0.5% to 50%.

15 [CLAIM 4] The thermally curable composition according to any of claims 1 through
3 wherein minimum melt viscosity is 100 Pa·s to 10000 Pa·s.

[CLAIM 5] The thermally curable composition according to any of claims 1 through
4 which is for sealing an electronic component.

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[CLAIM 6] A sheet comprising the thermally curable composition according to any
of claims 1 through 5, and further comprising,

where two faces of the thermally curable composition are defined such that there
is a first face and a second face opposite the first face,

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a first separator which is provided over the first face; and

a second separator which is provided over the second face.

[CLAIM 7] A device manufacturing method comprising:
an operation in which the thermally curable composition according to any of
30 claims 1 through 5 is arranged over an electronic component;

an operation in which a composite body is formed which comprises the electronic component and the thermally curable composition which covers the electronic component; and

5 an operation in which heating of the composite body causes curing of the thermally curable composition to occur;

wherein the operation in which the composite body is formed comprises a step in which softening of the thermally curable composition is made to occur.