CLAIMS

1. A thermally conductive composition comprising:

metal particles (A); and

a dispersion medium (B) in which the metal particles (A) are dispersed,

wherein the metal particles (A) form a particle coupling structure by being sintered through a thermal treatment,

the metal particles (A) have a particle size D_{50} at 50% in a volume-based cumulative distribution of equal to or greater than 0.8 μm and equal to or smaller than 5 μm, and

the metal particles (A) have a standard deviation of the particle size of equal to or less than 2.0 μm.

2. The thermally conductive composition according to claim 1,

wherein a value obtained by dividing the standard deviation of the particle size of the metal particles (A) by the particle size D_{50} at 50% in a volume-based cumulative distribution of the metal particles (A) is equal to or less than 2.5.

3. The thermally conductive composition according to claim 1 or 2,

wherein the metal particles (A) have a particle size D_{95} at 95% in a volume-based cumulative distribution of equal to or less than 10 μm.

4. The thermally conductive composition according to any one of claims 1 to 3,

wherein the metal particles (A)have a particle size D_5 at 5% in

a volume-based cumulative distribution of equal to or greater than 0.6 μm.

5. The thermally conductive composition according to any one of claims 1 to 4,

wherein a difference between the particle size D_{95} at 95% in a volume-based cumulative distribution of the metal particles (A) and the particle size D_{50} at 50% in a volume-based cumulative distribution of the metal particles (A) is equal to or less than 5 μm.

6. The thermally conductive composition according to any one of claims 1 to 5,

wherein the metal particles (A) contain one or two or more metals selected from the group consisting of Ag, Au, and Cu.

7. The thermally conductive composition according to any one of claims 1 to 6,

wherein the metal particles (A) include spherical particles.

8. The thermally conductive composition according to any one of claims 1 to 7,

wherein the metal particles (A) include flake-like particles.

9. The thermally conductive composition according to any one of claims 1 to 8,

wherein the metal particles (A) include both of the spherical particles and the flake-like particles.

10. The thermally conductive composition according to any one of claims 1 to 9,

wherein a content of the metal particles (A) with respect to the total amount of the thermally conductive composition is equal to or greater than 80% by mass and equal to or smaller than 95% by mass.

11. The thermally conductive composition according to any one of claims 1 to 10,

wherein in a case where dynamic viscoelasticity is measured under a condition of a measurement frequency of 1 Hz, within a temperature range of 140°C to 180°C, the thermally conductive composition has a temperature width of equal to or larger than 10°C in which a shear modulus of elasticity is equal to or higher than 5,000 Pa and equal to or lower than 100,000 Pa.

12. The thermally conductive composition according to any one of claims 1 to 11,

wherein an acetone insoluble fraction of a sample, which is obtained by removing the metal particles (A) and then heating the composition under conditions of 180°C and 2 hours, is equal to or lower than 5% by mass.

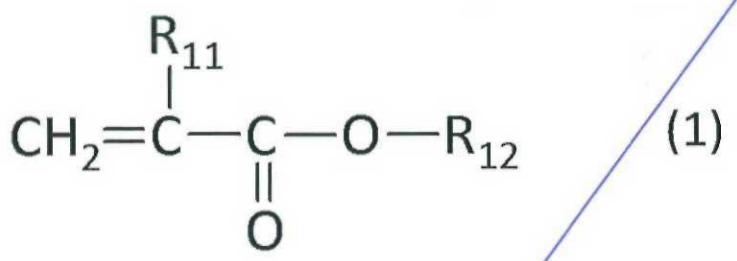
13. The thermally conductive composition according to any one of claims 1 to 12,

wherein the dispersion medium (B) includes a compound having

only one radically polymerizable double bond in a molecule.

14. The thermally conductive composition according to claim 13,

wherein the compound having only one radically polymerizable double bond in a molecule includes a compound represented by Formula (1),



(1)

wherein in Formula (1), R_{11} represents hydrogen or a methyl group, and R_{12} represents a monovalent organic group having 1 to 20 carbon atoms.

15. The thermally conductive composition according to any one of claims 1 to 12,

wherein the dispersion medium (B) includes a compound having only one epoxy group in a molecule.

16. The thermally conductive composition according to any one of claims 1 to 15,

wherein a temperature at 5% weight loss of the composition is equal to or higher than 100°C and equal to or lower than 180°C.

17. A semiconductor device comprising:

a substrate; and

a semiconductor element mounted on the substrate through an adhesive layer obtained by performing thermal treatment on the thermally conductive composition according to any one of claims 1 to 16.

18. The semiconductor device according to claim 17,

wherein a planar shape of the semiconductor element is a rectangle having a side equal to or longer than 5 mm.

19. A method for manufacturing a semiconductor device, comprising:

a step of mounting a semiconductor element on a substrate through the thermally conductive composition according to any one of claims 1 to 16; and

a step of heating the thermally conductive composition.

20. The method for manufacturing a semiconductor device according to claim 19,

wherein the step of heating the thermally conductive composition comprises a step of heating the thermally conductive composition under a temperature condition of lower than 200°C and a step of heating the thermally conductive composition under a temperature condition of equal to or higher than 200°C.

21. The method for manufacturing a semiconductor device according to claim 19 or 20,

wherein the step of heating the thermally conductive composition is performed in a state of applying a pressure to the thermally

conductive composition.

22. A method for bonding a heatsink, comprising:

a step of bonding a heatsink to a semiconductor device through the thermally conductive composition according to any one of claims 1 to 16; and

a step of heating the thermally conductive composition.

23. The method for bonding a heatsink according to claim 22,

wherein the step of heating the thermally conductive composition comprises a step of heating the thermally conductive composition under a temperature condition of lower than 200°C and a step of heating the thermally conductive composition under a temperature condition of equal to or higher than 200°C.

24. The method for bonding a heatsink according to claim 22 or 23,

wherein the step of heating the thermally conductive composition is performed in a state of applying a pressure to the thermally conductive composition.

Claims

1. A thermally conductive composition comprising:

metal particles (A); and

a dispersion medium (B) in which the metal particles (A) are dispersed,

wherein the metal particles (A) form a particle coupling structure by being sintered through a thermal treatment,

the metal particles (A) have a particle size D_{50} at 50% in a volume-based cumulative distribution of equal to or greater than 1 μm and equal to or smaller than 4 μm, and

the metal particles (A) have a standard deviation of the particle size of equal to or less than 2.0 μm.

2. The thermally conductive composition according to claim 1,

wherein a value obtained by dividing the standard deviation of the particle size of the metal particles (A) by the particle size D_{50} at 50% in a volume-based cumulative distribution of the metal particles (A) is equal to or less than 2.5.

3. The thermally conductive composition according to claim 1 or 2,

wherein the metal particles (A) have a particle size D_{95} at 95% in a volume-based cumulative distribution of equal to or less than 10 μm.

4. The thermally conductive composition according to any one of claims 1 to 3,

wherein the metal particles (A) have a particle size D_5 at 5% in a volume-based cumulative distribution of equal to or greater than 0.6 μm.

5. The thermally conductive composition according to any one of claims 1 to 4,

wherein a difference between the particle size D_{95} at 95% in a volume-based cumulative distribution of the metal particles (A) and the particle size D_{50} at 50% in a volume-based cumulative distribution of the metal particles (A) is equal to or less than 5 μm.

6. The thermally conductive composition according to any one of claims 1 to 5,

wherein the metal particles (A) contain one or two or more metals selected from the group consisting of Ag, Au, and Cu.

7. The thermally conductive composition according to any one of claims 1 to 6,

wherein the metal particles (A) include spherical particles.

8. The thermally conductive composition according to any one of claims 1 to 7,

wherein the metal particles (A) include flake-like particles.

9. The thermally conductive composition according to any one of claims 1 to 8,

wherein the metal particles (A) include both of the spherical

particles and the flake-like particles.

10. The thermally conductive composition according to any one of claims 1 to 9,

wherein a content of the metal particles (A) with respect to the total amount of the thermally conductive composition is equal to or greater than 80% by mass and equal to or smaller than 95% by mass.

11. The thermally conductive composition according to any one of claims 1 to 10,

wherein in a case where dynamic viscoelasticity is measured under a condition of a measurement frequency of 1 Hz, within a temperature range of 140°C to 180°C, the thermally conductive composition has a temperature width of equal to or larger than 10°C in which a shear modulus of elasticity is equal to or higher than 5,000 Pa and equal to or lower than 100,000 Pa.

12. The thermally conductive composition according to any one of claims 1 to 11,

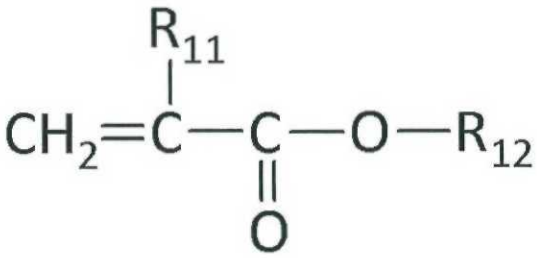
wherein an acetone insoluble fraction of a sample, which is obtained by removing the metal particles (A) and then heating the composition under conditions of 180°C and 2 hours, is equal to or lower than 5% by mass.

13. The thermally conductive composition according to any one of claims 1 to 12,

wherein the dispersion medium (B) includes a compound having only one radically polymerizable double bond in a molecule.

14. The thermally conductive composition according to claim 13,

wherein the compound having only one radically polymerizable double bond in a molecule includes a compound represented by Formula (1),



(1)

wherein in Formula (1), R_{11} represents hydrogen or a methyl group, and R_{12} represents a monovalent organic group having 1 to 20 carbon atoms.

15. The thermally conductive composition according to any one of claims 1 to 12,

wherein the dispersion medium (B) includes a compound having only one epoxy group in a molecule.

16. The thermally conductive composition according to any one of claims 1 to 15,

wherein a temperature at 5% weight loss of the composition is equal to or higher than 100°C and equal to or lower than 180°C.

17. A semiconductor device comprising:

a substrate; and

a semiconductor element mounted on the substrate through an adhesive layer obtained by performing thermal treatment on the thermally conductive composition according to any one of claims 1 to 16.

18. The semiconductor device according to claim 17,

wherein a planar shape of the semiconductor element is a rectangle having a side equal to or longer than 5 mm.

19. A method for manufacturing a semiconductor device, comprising:

a step of mounting a semiconductor element on a substrate through the thermally conductive composition according to any one of claims 1 to 16; and

a step of heating the thermally conductive composition.

20. The method for manufacturing a semiconductor device according to claim 19,

wherein the step of heating the thermally conductive composition comprises a step of heating the thermally conductive composition under a temperature condition of lower than 200°C and a step of heating the thermally conductive composition under a temperature condition of equal to or higher than 200°C.

21. The method for manufacturing a semiconductor device according to claim 19 or 20,

wherein the step of heating the thermally conductive composition

is performed in a state of applying a pressure to the thermally conductive composition.

22. A method for bonding a heatsink, comprising:

a step of bonding a heatsink to a semiconductor device through the thermally conductive composition according to any one of claims 1 to 16; and

a step of heating the thermally conductive composition.

23. The method for bonding a heatsink according to claim 22,

wherein the step of heating the thermally conductive composition comprises a step of heating the thermally conductive composition under a temperature condition of lower than 200°C and a step of heating the thermally conductive composition under a temperature condition of equal to or higher than 200°C.

24. The method for bonding a heatsink according to claim 22 or 23,

wherein the step of heating the thermally conductive composition is performed in a state of applying a pressure to the thermally conductive composition.