

problems exist some of which are that some pastes have a tendency to become non-homogeneous at ambient temperatures. Accordingly, there still remains room for improvement of die attach pastes containing electrically conductive filler and polycyanate ester monomer in a variety of ways, e.g., in assuring the stability of paste homogeneity, in extending the pot life of such die attach pastes, in reducing the cost of preparation, as well as the ease of preparation, by avoiding the use of potentially detrimental components (e.g., alkylphenols are acidic species, which are potentially corrosive), by avoiding the use of volatile components (which upon cure may bleed out and/or which may lead to the creation of voids in the cured resin), and the like.

Brief Description of the Invention

In accordance with the present invention, we have developed novel compositions for attaching a semiconductor device to a substrate. The invention compositions comprise liquid polycyanate ester-containing monomer vehicle, electrically conductive filler and a curing catalyst, preferably in the substantial absence of alkylphenol. Optional treatment of the filler to render it free of catalytically active metal ions has the potential to significantly extend the pot life of the composition.

According to a first embodiment of the invention there is provided a composition for attaching a semiconductor device to a substrate comprising:

8 to 20 wt. percent monomer vehicle comprising at least one polycyanate ester monomer;

80 to 92 wt. percent electrically conductive metal filler substantially free of catalytically active metal ions; and

50 to 1500ppm metal catalyst wherein said monomer vehicle is liquid under ambient conditions.

According to a second embodiment of the invention there is provided a composition for attaching a semiconductor device to a substrate comprising:

13 to 20 wt. percent monomer vehicle comprising 1, 1-bis(4-cyanatophenyl)ethane(I) and 2,2-bis(4-cyanatophenyl)propane(II);

80 to 87 wt. percent silver filler substantially free of catalytically free silver ions; and

50 to 500ppm cobalt acetylacetonate.

According to a third embodiment of the invention there is provided a composition for attaching a semiconductor device to a substrate comprising:

8 to 20 wt. percent monomer vehicle comprising at least one polycyanate ester monomer;

80 to 92 wt. percent electrically conductive filler; and

50 to 1500ppm metal catalyst;

composition is free of alkylphenol.

According to a fourth embodiment of the invention there is provided a composition for attaching a semi conductor device to a substrate comprising:

13 to 20 wt. percent monomer vehicle comprising 1,1-bis(4-cyanatophenyl)ethane(I) and 2,2-bis(4-cyanatophenyl)propane(II);

80 to 87 wt. percent silver filler; and

50 to 500ppm cobalt acetylacetonate;

wherein said composition is free of alkylphenol.

According to a fifth embodiment of the invention there is provided a composition for attaching a semi conductor device to a substrate comprising:

8 to 20 wt. percent monomer vehicle comprising at least one polycyanate ester monomer;

80 to 92 wt. percent electrically conductive filler; and

50 to 1500ppm metal catalyst wherein said monomer vehicle is liquid under ambient conditions, and wherein said composition is solvent free.

According to a sixth embodiment there is provided a composition for attaching a semi conductor device to a substrate comprising:

8 to 20 wt. percent monomer vehicle comprising at least two monomers, wherein at least one monomer is a polycyanate ester monomer, and wherein said monomer vehicle is free of solvent;

80 to 92 wt. percent electrically conductive filler; and

50 to 1500ppm metal catalyst;

wherein said monomer vehicle is liquid under ambient conditions.

According to a seventh embodiment there is provided a composition for attaching a semi conductor device to a substrate comprising:

13 to 20 wt. percent monomer vehicle comprising 1,1-bis(4-cyanatophenyl)ethane(I) and 2,2-bis(4-cyanatophenyl)propane(II), wherein said monomer vehicle is free of solvent;

80 to 87 wt. percent silver filler; and

50 to 500ppm cobalt acetylacetonate.

Detailed Description of the Invention

In accordance with the present invention there is provided a paste composition for attaching a semiconductor device to a substrate, said composition comprising a liquid monomer vehicle comprising at least one polycyanate ester monomer, electrically conductive filler, and a metal catalyst, preferably in the substantial absence of alkylphenol.

1. A composition for attaching a semi-conductor device to a substrate comprising:

8 to 20 wt. percent monomer vehicle comprising at least one polycyanate ester monomer;

80 to 92 wt. percent electrically conductive metal filler substantially free of catalytically active metal ions; and

50 to 1500ppm metal catalyst wherein said monomer vehicle is liquid under ambient conditions.

2. A composition according to claim 1 wherein said filler is rendered substantially free of catalytically active metal ions by treatment with an ionic chelating agent, a reducing agent, a non-ionic lubricant or combinations thereof.

3. A composition according to claim 2 wherein said filler is rendered substantially free of catalytically active metal ions by treatment with an ionic chelating agent.

4. A composition according to claim 3 wherein said chelating agent is tartaric acid, thiodiglycolic acid or dithiosuccinic acid.

5. A composition according to claim 4 wherein said chelating agent is tartaric acid.

6. A composition according to claim 3 wherein said chelating agent is also a lubricating agent.

7. A composition according to claim 6 wherein said chelating/lubricating agent is the reaction product of a dihydride with a hydroxy or amino terminated poly(alkylene oxide).

8. A composition according to claim 2 wherein said filler is rendered substantially free of catalytically active metal ions by treatment with a reducing agent.

9. A composition according to claim 8 wherein said reducing agent is a covalent hydride.

10. A composition according to claim 9 wherein said reducing agent is a silicone hydride.

11. A composition according to claim 2 wherein said filler is rendered substantially free of catalytically active metal ions by treatment with a non-ionic lubricant.

12. A composition according to claim 11 wherein said non-ionic lubricant is a fatty acid monoester of glycerol.

13. A composition according to claim 1 wherein said electrically conductive filler is selected from silver, nickel, copper, aluminium, or mixtures thereof.

14. A composition according to claim 13 wherein said filler is silver.

15. A composition for attaching a semi-conductor device to a substrate

80 to 87 wt. percent monomer vehicle comprising at least one bis(4-cyanatophenyl)ethane(I) and 2,2-bis(4-cyanatophenyl)propane(II);

80 to 87 wt. percent silver filler substantially free of catalytically free silver ions; and

50 to 500ppm cobalt acetylacetonate.

16. A composition according to claim 15 wherein said monomers comprise from about 80 to about 95 wt. percent (I) and from about 5 to about 20 wt. percent (II), with the combined percentages representing total weight percent vehicle.

17. A composition according to claim 1 wherein said vehicle further comprises additional monomer selected from the group consisting of vinyl ethers, divinyl ethers, diallyl ethers, dipropargyl ethers, propargyl allyl ethers, monomaleimides, bismaleimides and mixtures of any two or more such monomers.

18. A composition for attaching a semiconductor device to a substrate, comprising:

8 to 20 wt. percent monomer vehicle comprising at least one polycyanate ester monomer;

80 to 92 wt. percent electrically conductive filler; and

50 to 1500ppm metal catalyst;

wherein said monomer vehicle is liquid under ambient conditions, and wherein said composition is free of alkylphenol.

19. A composition according to claim 18 wherein said filler is rendered substantially free of catalytically active metal ions.

20. A composition according to claim 19 wherein said filler is rendered substantially free of catalytically active metal ions by treatment with an ionic chelating agent.

21. A composition according to claim 20 wherein said chelating agent is tartaric acid, thiodiglycolic acid or dithiosuccinic acid.

22. A composition according to claim 21 wherein said chelating agent is tartaric acid.

23. A composition according to claim 20 wherein said chelating agent is also a lubricating agent.

24. A composition according to claim 23 wherein said chelating/lubricating agent is the reaction product of a dianhydride with a hydroxy or amino terminated poly(alkylene oxide).

25. A composition according to claim 19 wherein said filler is rendered substantially free of catalytically active metal ions by treatment with a reducing agent.

26. A composition according to claim 25 wherein said reducing agent is a covalent hydride.

hydride.

28. A composition according to claim 19 wherein said filler is rendered substantially free of catalytically active metal ions by treatment with a non-ionic lubricant.

29. A composition according to claim 28 wherein said non-ionic lubricant is a fatty acid monoester of glycerol.

30. A composition according to claim 18 wherein said electrically conductive filler is selected from silver, nickel, cobalt, copper, aluminium, or mixtures thereof.

31. A composition according to claim 30 wherein said filler is silver.

32. A composition for attaching a semi conductor device to a substrate comprising:

13 to 20 wt. percent monomer vehicle comprising 1, 1-bis(4-cyanatophenyl)ethane(I) and 2,2-bis(4-cyanatophenyl)propane(II);

80 to 87 wt. percent silver filler; and

50 to 500ppm cobalt acetylacetonate;

wherein said composition is free of alkylphenol.

33. A composition according to claim 32 wherein said monomers comprise from about 80 to about 95 wt. percent (I) and from about 5 to about 20 wt. percent (II), with the combined percentages representing total weight percent vehicle.

34. A composition according to claim 18 wherein said vehicle further comprises additional monomer selected from the group consisting of vinyl ethers, divinyl ethers, diallyl ethers, dipropargyl ethers, propargyl allyl ethers, monomaleimides, bismaleimides and mixtures of any two or more such monomers.

35. A composition for attaching a semi conductor device to a substrate comprising:

8 to 20 wt. percent monomer vehicle comprising at least one polycyanate ester monomer;

80 to 92 wt. percent electrically conductive filler; and

50 to 1500ppm metal catalyst wherein said monomer vehicle is liquid under ambient conditions, and wherein said composition is solvent free.

36. A composition for attaching a semi conductor device to a substrate comprising:

8 to 20 wt. percent monomer vehicle comprising at least two monomers, wherein at least one monomer is a polycyanate ester monomer, and wherein said monomer vehicle is free of solvent;

80 to 92 wt. percent electrically conductive filler; and

50 to 1500ppm metal catalyst;

wherein said monomer vehicle is liquid under ambient conditions.

selected from:

- vehicles consisting essentially of liquid monomers,
- vehicles consisting essentially of solid monomer(s) miscible and/or soluble in liquid monomer(s), or
- vehicles consisting essentially of solid monomers which, when combined, provide a liquid monomer mixture.

38. A composition according to claim 37 wherein said liquid monomer vehicle liquid consists essentially of liquid monomers.

39. A composition according to claims 37 wherein said liquid monomer vehicle consists essentially of solid monomers, miscible and/or soluble in liquid monomer(s).

40. A composition according to claim 37 wherein said liquid monomer vehicle consists essentially of solid monomers which, when combined, provide a liquid monomer mixture.

41. A composition for attaching a semi conductor device to a substrate comprising:

13 to 20 wt. percent monomer vehicle comprising 1,1-bis(4-cyanatophenyl)ethane(I) and 2,2-bis(4-cyanatophenyl)propane(II), wherein said monomer vehicle is free of solvent;

80 to 87 wt. percent silver filler; and
50 to 500ppm cobalt acetylacetonate.

42. A composition according to claim 41 wherein said monomers comprise from about 80 to about 95 wt. percent (I) and from about 5 to about 20 wt. percent (II), with the combined percentages representing total wt. percent monomer vehicle.

43. A composition according to claim 36 wherein additional monomer is selected from the group consisting of vinyl ethers, divinyl ethers, propargyl allyl ethers, monomaleimides, bismaleimides and mixtures of any two or more such monomers.

44. A composition according to claim 39 wherein said liquid monomer vehicle consists essentially of 1,1-bis(4-cyanatophenyl)ethane and cyclohexanedimethanol monovinyl ether.

45. A composition according to claim 40 wherein said liquid monomer vehicle consists essentially of 1,1-bis(4-cyanatophenyl)ethane and 1,1-bis(propargyloxyphenyl)ethane.

46. A composition according to claim 40 wherein said liquid monomer vehicle comprises at least one monomer selected from 2,2,4-trinethylhexanethylene-1,6-bismaleimide, 1,1-bis(4-propargyloxyphenyl)ethane, 3-(2,2-dimethyltrimethylene acetal)-1-maleimidobenzene or 2,2-bis[4-(4-maleimidophenoxy)phenyl]propane and 1,1-bis(4-cyanatophenyl)ethane.

47. A composition according to claim 40 wherein said liquid monomer vehicle comprises 2,2-bis(4-cyanatophenyl)propane and 1,1-bis(4-cyanatophenyl)ethane.

48. A composition according to claim 36 wherein an additional monomer is selected from diallyl ethers or dipropargyl ethers.