Claims

1. A sintering powder comprising copper particles and up to 1 wt.% capping agent, wherein:

the particles are at least partially coated with the capping agent, and

the particles exhibit a D10 of greater than or equal to 100 nm and a D90 of less than or equal to 2000 nm, wherein the D10 describes the equivalent spherical diameter that 10% of the volume distribution are lower than and the D90 describes the equivalent spherical diameter that 90% of the volume distribution are lower than.

2. The sintering powder of claim 1, for die attach.

3. The sintering powder of claim 1, wherein the capping agent comprises triethanol amine.

4. The sintering powder of claim 1, wherein the particles exhibit a D90 of less than or equal to 1000 nm.

5. The sintering powder of claim 1, wherein the particles exhibit a D10 of greater than or equal to 125 nm and a D90 of less than or equal to 450 nm.

6. The sintering powder of claim 1, wherein the particles exhibit a D10 of greater than or equal to 150 nm and a D90 of less than or equal to 400 nm.

7. The sintering powder of claim 1, in the form of a powder compact.

8. A sintering paste comprising the sintering powder of any of claims 1 to 3 and 5 to 8.

9. The sintering paste of claim 8, wherein the paste comprises 70 to 90 wt.% of the sintering powder.

10. The sintering paste of claim 8, wherein the paste comprises 1 to 5 wt.% of a binder.

11. The sintering paste of claim 10, wherein the binder comprises epoxy methacrylate urethane.

12. The sintering paste of claim 8, wherein the paste comprises 0.5 to 3 wt.% of an activator, wherein the activator comprises a dicarboxylic acid.

13. The sintering paste of claim 12, wherein the dicarboxylic acid comprises malonic acid.

14. The sintering paste of claim 8, wherein the paste comprises 0.5 to 2 wt.% of a dispersing agent.

15. The sintering paste of claim 14, wherein the dispersing agent comprises a surfactant.

16. The sintering paste of claim 8, wherein the paste comprises 10 to 15 wt.% of an organic solvent.

17. The sintering paste of claim 16, wherein the organic solvent comprises terpineol.

18. The sintering paste of claim 8, wherein the paste comprises:
70 to 90 wt.% of the sintering powder,
1 to 3 wt.% of an activator,
0.5 to 2 wt.% of a dispersing agent,
10 to 15 wt.% of an organic solvent, and
optionally, 1 to 5 wt.% of a binder,
wherein the activator comprises a dicarboxylic acid.

19. The sintering paste of claim 8, wherein the paste is printable, dispensable, jettable, pin transferable,or screen printable.

20. A sintering film comprising the sintering paste of claim 8.

21. The sintering film of claim 20, wherein the film is pre-applied to a wafer.

22. The sintering film of claim 20, wherein the film is on a polymer substrate.

23. The sintering film of claim 20, wherein the film is free standing.

24. A method of manufacturing a sintering powder of any of claims 1 to 3 and 4 to 7, the method comprising:

providing a solution comprising copper ions and a capping agent,

contacting the solution with a reducing agent to provide the sintering powder, and

recovering the sintering powder.

25. The method of claim 24, wherein the molar ratio of copper ions : capping agent in the solution is from 1:1 to 10:1.

26. The method of claim 24, wherein the copper ions in the solution are provided in the form of a copper salt, and the copper salt comprises copper acetate.

27. The method of claim 24, wherein the capping agent comprises triethanolamine.

28. The method of claim 24, wherein the solution has a pH greater than 7.

29. The method of claim 24, wherein the molar ratio of reducing agent to copper ions is greater than 1:1.

30. The method of claim 24, wherein the reducing agent comprises hydrazine.

31. The method of claim 24, wherein the solution comprising copper ions and a capping agent is contacted with the reducing agent for from 5 to 30 hours.

32. The method of claim 24, wherein recovering comprises one or more of decanting the resulting solution from the sintering powder, washing the sintering powder and drying the sintering powder.

33. The method of claim 24, wherein the method is carried out in a non-inert atmosphere.

34. A method of manufacturing the sintering paste comprising the sintering powder of any of claims 1 to 3 and 4 to 7, the method comprising:

providing the sintering powder according to any of claims claims 1 to 3 and 4 to 7, and

mixing the sintering powder with an organic solvent and optionally one or more of an activator, a dispersing agent, a capping agent and a binder, wherein the activator comprises a dicarboxylic acid.

35. The method of claim 34, further comprising milling the sintering paste.

36. The method of claim 34, further comprising casting the sintering paste into a film.

37. A method of forming a joint between two or more work pieces, the method comprising:

providing two or more work pieces to be joined,

providing the sintering paste of any of claim 8 in the vicinity of the two or more work pieces,

drying the sintering paste, and

heating the sintering paste to at least partially sinter the metal.

38. The method of claim 37, wherein the two or more work pieces comprise a die and a substrate.

39. The method of claim 37, wherein the drying is carried out at a temperature of from 30 to 100 °C.

40. The method of claim 39, wherein the drying is carried out for from 1 to 60 minutes.

41. The method of claim 37, wherein a pressure of from 2 to 18 MPa is applied during the step of heating.

42. The method of claim 37, wherein:

the sintering paste is screen-printed onto one or more of the work pieces to be joined to form a screen-printed pattern; and

solder is applied to the screen-printed pattern,

optionally wherein the screen-printed pattern is coated by an electroless nickel immersion gold (ENIG) technique prior to the solder being applied.

43. The sintering powder of any of claims 1 to 3 and 4 to 7, the sintering powder is used in a method selected from: die attachment, wafer-to-wafer bonding, hermetic and near hermetic sealing, sintering films comprising a sintering powder and a binder formed in a film on a backing layer, dispensing and the production of interconnect lines.

44. A sintered joint formed using the sintering powder of any of claims 1 to 3 and 4 to 7.