

Claims:

1. A sintering powder comprising copper particles, wherein:
the particles are at least partially coated with a capping agent, and
5 the particles exhibit a D10 of greater than or equal to 100 nm and a D90 of less than or equal to 2000 nm.
2. The sintering powder of claim 1, for die attach.
- 10 3. The sintering powder of claim 1 or claim 2, wherein the capping agent comprises triethanol amine.
4. The sintering powder of any preceding claim comprising up to 1 wt.% capping agent, preferably from 0.1 to 0.5 wt.% capping agent, more preferably
15 from 0.2 to 0.4 wt.% capping agent.
5. The sintering powder of any preceding claim, wherein the particles exhibit a D90 of less than or equal to 1000 nm, preferably less than or equal to 500 nm, more preferably less than or equal to 450 nm.
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6. The sintering powder of any preceding claim, 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.
- 25 7. The sintering powder of any preceding claim, 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.
8. The sintering powder of any preceding claim, in the form of a powder
30 compact.
9. A sintering paste comprising the sintering powder of any preceding claim.

10. The sintering paste of claim 9, wherein the paste comprises 70 to 90 wt.% of the sintering powder.
- 5 11. The sintering paste of claim 9 or claim 10, wherein the paste comprises 1 to 5 wt.% of a binder.
12. The sintering paste of any of claims 9 to 11, wherein the binder comprises epoxy methacrylate urethane.
- 10 13. The sintering paste of any of claims 9 to 12, wherein the paste comprises 0.5 to 3 wt.% of an activator, preferably from 1 to 3 wt.%.
14. The sintering paste of claim 13, wherein the activator comprises a
- 15 dicarboxylic acid.
15. The sintering paste of claim 14, wherein the dicarboxylic acid comprises malonic acid.
- 20 16. The sintering paste of any of claims 9 to 15, wherein the paste comprises 0.5 to 2 wt.% of a dispersing agent.
17. The sintering paste of claim 16, wherein the dispersing agent comprises a surfactant.
- 25 18. The sintering paste of any of claims 9 to 17, wherein the paste comprises 10 to 15 wt.% of an organic solvent.
19. The sintering paste of claim 18, wherein the organic solvent comprises
- 30 terpineol.
20. The sintering paste of any of claims 9 to 19, 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
5 optionally, 1 to 5 wt.% of a binder.

21. The sintering paste of any of claims 9 to 20, wherein the paste is printable and/or dispensable and/or jettable and/or pin transferable and/or screen printable.
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22. A sintering film comprising the sintering paste of any of claims 9 to 21.
23. The sintering film of claim 22, wherein the film is pre-applied to a wafer.
- 15 24. The sintering film of claim 22, wherein the film is on a polymer substrate.
25. The sintering film of claim 22, wherein the film is free standing.
26. A method of manufacturing a sintering powder, preferably the sintering
20 powder of any of claims 1 to 8, 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.
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27. The method of claim 26, wherein the molar ratio of copper ions : capping agent in the solution is from 1:1 to 10:1, preferably from 2:1 to 7:1, more preferably from 4:1 to 6:1.
- 30 28. The method of claim 26 or claim 27, wherein the copper ions in the solution are provided in the form of a copper salt, and the copper salt comprises copper acetate.

29. The method of any of claims 26 to 28, wherein the capping agent comprises triethanolamine.

5 30. The method of any of claims 26 to 29, wherein the solution has a pH greater than 7.

31. The method of any of claims 26 to 30, wherein the molar ratio of reducing agent to copper ions is greater than 1:1.

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32. The method of any of claims 26 to 31, wherein the reducing agent comprises hydrazine.

33. The method of any of claims 26 to 32, wherein the solution comprising
15 copper ions and a capping agent is contacted with the reducing agent for from 5 to 30 hours, preferably from 10 to 20 hours.

34. The method of any of claims 26 to 33, wherein recovering comprises one
or more of decanting the resulting solution from the sintering powder, washing the
20 sintering powder and drying the sintering powder.

35. The method of any of claims 26 to 34, wherein the method is carried out in a non-inert atmosphere, preferably air.

25 36. A method of manufacturing the sintering paste of any of claims 9 to 21, the method comprising:

providing the sintering powder according to any of claims 1 to 8, 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.

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37. The method of claim 36, further comprising milling the sintering paste.

38. The method of claim 36 or claim 37, further comprising casting the sintering paste into a film.

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

providing two or more work pieces to be joined,

providing the sintering powder of any of claims 1 to 8 and/or the sintering
paste of any of claims 9 to 21 and/or the sintering film of any of claims 22 to 25 in
the vicinity of the two or more work pieces,

10 drying the sintering powder and/or sintering paste and/or sintering film,
and

heating the sintering powder and/or sintering paste and/or sintering film to
at least partially sinter the metal.

15 40. The method of claim 39, wherein the two or more work pieces comprise a
die and a substrate.

41. The method of claim 39 or 40, wherein the drying is carried out at a
temperature of from 30 to 100 °C, preferably from 40 to 80 °C, more preferably
20 from 50 to 70 °C.

42. The method of claim 41, wherein the drying is carried out for from 1 to 60
minutes, preferably from 5 to 40 minutes, more preferably from 10 to 30 minutes.

25 43. The method of any of claims 39 to 42, wherein a pressure of from 2 to 18
MPa is applied during the step of heating, preferably from 3 to 15 MPa, more
preferably from 5 to 13 MPa, even more preferably from 8 to 12 MPa.

44. The method of any of claims 39 to 43, wherein:
30 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.

45. Use of the sintering powder of any of claims 1 to 8, and/or the sintering
5 paste of any of claims 9 to 21, and/or the film of any of claims 22 to 25 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.
- 10 46. A sintered joint formed using the sintering powder of any of claims 1 to 8,
and/or the sintering paste of any of claims 9 to 21, and/or the sintering film of any
of claims 22 to 25.