Claims

1. A solder paste, consisting of:

50wt% to 90wt% of a first solder alloy powder, the first solder alloy powder consisting of an SnSbCuAg solder alloy that has a wt% ratio of Sn:Sb of 0.75 to 1.1;

10wt% to 50wt% of a second solder alloy powder, the second solder alloy powder consisting of an Sn solder alloy including at least 80wt% of Sn; and

a remainder of flux.

2. The solder paste of claim 1, wherein the solder paste consists of 75wt% to 90wt% of the first solder alloy powder, 10wt% to 25wt% of the second solder alloy powder, and [[a]]the remainder of the flux.

3. The solder paste of claim 1, wherein the solidus temperature of the first solder alloy powder is 300°C to 360°C, and wherein the solidus temperature of the second solder alloy powder is 200°C to 250°C.

4. The solder paste of claim 3, wherein the solidus temperature of the second solder alloy powder is 215°C to 245°C.

5. The solder paste of claim 3, wherein the liquidus temperature of the first solder alloy powder is no greater than 360°C.

6. The solder paste of claim 3, wherein the liquidus temperature of the second solder alloy powder is no greater than 250°C.

7. The solder paste of claim 4, wherein the liquidus temperature of the second solder alloy powder is no greater than 245°C.

8. The solder paste of claim 1, wherein the first solder alloy powder consists of:

4wt% to 10wt% of Cu;

4wt% to 20wt% of Ag;

optionally, 0.5wt% or less of Bi, Co, In, Ge, Ni, P, or Zn; and

a remainder of Sn and Sb in the ratio of 0.75 to 1.1.

9. The solder paste of claim 1, wherein the second solder alloy powder is SnAg, SnCu, SnAgCu, SnSb, SnAgCuSb, SnAgY (Y= Bi, Co, Ge, In, Ni, P, Sb, or Zn), SnCuY(Y= Bi, Co, Ge, In, Ni, P, Sb, or Zn), SnAgCuY (Y= Bi, Co, Ge, In, Ni, P, Sb, or Zn), or SnAgCuSbY (Y= Bi, Co, Ge, In, Ni, P, Sb, or Zn).

10. The solder paste of claim 9, wherein the second solder alloy powder comprises 0.1 to 4 wt% Ag, 0.1 to 1 wt% Cu, or 0.1 to 11wt% Sb.

11. The solder paste of claim 10, wherein the second solder alloy powder comprises 0.1 to 4 wt% Ag, 0.1 to 1 wt% Cu, and 0.1 to 11wt% Sb.

12. The solder paste of claim 11, wherein the second solder alloy powder is doped with Bi, Co, Ge, In, Ni, P, Sb, or Zn.

13. The solder paste of claim 1, wherein a ratio of heat absorption from a first melting peak of the solder paste to heat absorption from a second melting peak of the solder paste is 0.15 or less.

14. A method, comprising:

applying a solder paste between a substrate and device to form an assembly, wherein the solder paste consists of: 50wt% to 90wt% of a first solder alloy powder, the first solder alloy powder consisting of an SnSbCuAg solder alloy that has a wt% ratio of Sn:Sb of 0.75 to 1.1; 10wt% to 50wt% of a second solder alloy powder, the second solder alloy powder consisting of an Sn solder alloy including at least 80wt% of Sn; and a remainder of flux;

performing a first reflow soldering process with the assembly at a peak temperature of greater than 320°C to form a solder joint from the solder paste; and

after forming the solder joint, performing a second reflow soldering process with the assembly at a peak temperature of 230°C to 270°C.

15. The method of claim 14, wherein the device is a silicon die, the substrate comprises a Cu lead frame, and the solder paste is applied between the Cu lead frame and the silicon die.

16. The method of claim 14, wherein:

the solidus temperature of the first solder alloy powder is 300°C to 360°C; and

the solidus temperature of the second solder alloy powder is 200°C to 250°C.

17. The method of claim 14, wherein during the second reflow soldering process, the solder joint maintains a bond shear strength greater than or equal to 10 MPa.

18. A solder joint formed by the process of:

applying a solder paste between a substrate and a device to form an assembly; and

reflow soldering the assembly to form the solder joint;

wherein the solder paste consists of:

50wt% to 90wt% of a first solder alloy powder, the first solder alloy powder consisting of an SnSbCuAg solder alloy that has a wt% ratio of Sn:Sb of 0.75 to 1.1;

10wt% to 50wt% of a second solder alloy powder, the second solder alloy powder consisting of an Sn solder alloy including at least 80wt% of Sn; and

a remainder of flux.