Claims:

1. A method of making an electronic device, the method comprising:

providing a substrate;

electrolessly depositing a barrier metal at least over portions of the substrate; and

electrolessly depositing a substantially gold-free wetting layer having solder wettability onto the barrier metal.

2. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer is accomplished using an electroless deposition formulation comprising borane.

3. The method of claim 1, wherein the providing a substrate comprises providing a substrate comprising one or more electrical contact pads and wherein the electrolessly depositing a barrier metal at least over portions of the substrate comprises depositing the barrier metal onto the one or more electrical contact pads.

4. The method of claim 1, wherein the electrolessly depositing a barrier metal at least over portions of the substrate comprises depositing a barrier metal that comprises cobalt.

5. The method of claim 1, wherein the electrolessly depositing a barrier metal at least over portions of the substrate comprises depositing the barrier metal to a thickness of 0.2 micrometer to 1 micrometer and all values and ranges subsumed therein.

6. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing tin.

7. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing silver or a silver alloy.

8. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing silver tungsten alloy with 3-4 atomic percent tungsten.

9. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing cobalt tin alloy, cobalt copper alloy, cobalt silver alloy, cobalt copper tin alloy, cobalt copper silver alloy, cobalt silver tin alloy, or cobalt copper silver tin alloy.

10. The method of claim 9, further comprising incorporating boron and/or phosphorus in the substantially gold-free wetting layer.

11. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing nickel copper alloy, nickel silver alloy, nickel copper silver alloy, nickel copper tin alloy, nickel silver tin alloy, or nickel copper silver tin alloy.

12. The method of claim 11, further comprising incorporating boron and/or phosphorus in the substantially gold-free wetting layer.

13. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing iron tin alloy, iron copper alloy, iron silver alloy, iron copper tin alloy, iron copper silver alloy, iron silver tin alloy, or iron copper silver tin alloy.

14. The method of claim 13, further comprising incorporating boron and/or phosphorus in the substantially gold-free wetting layer.

15. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing a thickness of nickel alloy having a first composition and a thickness of nickel alloy having a second composition.

16. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing a thickness of cobalt tin alloy having a first composition and a thickness of cobalt tin alloy having a second composition.

17. The method of claim 1, wherein the electrolessly depositing a barrier metal at least over portions of the substrate; and the electrolessly depositing a substantially gold-free wetting layer having solder wettability are accomplished using an electroless deposition bath composition in a temperature range to deposit the barrier metal and using the electroless deposition bath composition in another temperature range to deposit the wetting layer.

18. A method of making an electronic device, the method comprising:

providing a substrate comprising one or more electrical contact pads and/or one or more through-substrate via conductors;

electrolessly depositing a barrier metal comprising at least one of the elements nickel and cobalt to a thickness of 0.2 micrometer to 1 micrometer and all values and ranges subsumed therein at least over portions of the one or more electrical contact pads and/or the one or more through-substrate via conductors;

electrolessly depositing at least one of:

1. tin or a tin alloy;

2. silver tungsten alloy with 3-4 atomic percent tungsten;

3. cobalt tin alloy, cobalt copper alloy, cobalt silver alloy, cobalt copper tin alloy, cobalt copper silver alloy, cobalt silver tin alloy, or cobalt copper silver tin alloy;

4. nickel copper alloy, nickel silver alloy, nickel copper silver alloy, nickel copper tin alloy, nickel silver tin alloy, or nickel copper silver tin alloy;

5. iron tin alloy, iron copper alloy, iron silver alloy, iron copper tin alloy, iron copper silver alloy, iron silver tin alloy, or iron copper silver tin alloy;

6. a thickness of nickel alloy having a first composition and a thickness of nickel alloy having a second composition;

7. a thickness of cobalt alloy having a first composition and a thickness of cobalt alloy having a second composition; and

8. a thickness of iron alloy having a first composition and a thickness of iron alloy having a second composition;

to contact the barrier metal so as to form a substantially gold-free wetting layer having solder wettability; and

forming a solder contact to the substantially gold-free wetting layer.

CLAIMS

What is claimed is:

1. A method of making an electronic device, the method comprising:

providing a substrate;

electrolessly depositing a barrier metal at least over portions of the substrate; and

electrolessly depositing a substantially gold-free wetting layer having solder wettability onto the barrier metal.

2. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer is accomplished using an electroless deposition formulation comprising borane.

3. The method of claim 1, wherein the providing a substrate comprises providing a substrate comprising one or more electrical contact pads and wherein the electrolessly depositing a barrier metal at least over portions of the substrate comprises depositing the barrier metal onto the one or more electrical contact pads.

4. The method of claim 1, wherein the providing a substrate comprises providing a substrate comprising one or more through-substrate via conductors and wherein the electrolessly depositing the barrier metal at least over portions of the substrate comprises depositing the barrier metal onto the one or more through-substrate via conductors.

5. The method of claim 1, wherein the providing a substrate comprises providing a substrate having one or more vias and wherein the electrolessly depositing the barrier metal at least over portions of the substrate comprises depositing the barrier metal onto the walls of the one or more vias.

6. The method of claim 1, wherein the electrolessly depositing a barrier metal at least over portions of the substrate comprises depositing a barrier metal that comprises cobalt.

7. The method of claim 1, wherein the electrolessly depositing a barrier metal at least over portions of the substrate comprises depositing the barrier metal to a thickness of 0.2 micrometer to 1 micrometer and all values and ranges subsumed therein.

8. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing tin.

9. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing silver or a silver alloy.

10. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing silver tungsten alloy with 3-4 atomic percent tungsten.

11. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing cobalt tin alloy, cobalt copper alloy, cobalt silver alloy, cobalt copper tin alloy, cobalt copper silver alloy, cobalt silver tin alloy, or cobalt copper silver tin alloy.

12. The method of claim 11, further comprising incorporating boron and/or phosphorus in the substantially gold-free wetting layer.

13. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing nickel copper alloy, nickel silver alloy, nickel copper silver alloy, nickel copper tin alloy, nickel silver tin alloy, or nickel copper silver tin alloy.

14. The method of claim 13, further comprising incorporating boron and/or phosphorus in the substantially gold-free wetting layer.

15. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing iron tin alloy, iron copper alloy, iron silver alloy, iron copper tin alloy, iron copper silver alloy, iron silver tin alloy, or iron copper silver tin alloy.

16. The method of claim 15, further comprising incorporating boron and/or phosphorus in the substantially gold-free wetting layer.

17. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing a thickness of nickel alloy having a first composition and a thickness of nickel alloy having a second composition.

18. The method of claim 1, wherein the electrolessly depositing a substantially gold-free wetting layer comprises electrolessly depositing a thickness of cobalt tin alloy having a first composition and a thickness of cobalt tin alloy having a second composition.

19. The method of claim 1, wherein the electrolessly depositing a barrier metal at least over portions of the substrate; and the electrolessly depositing a substantially gold-free wetting layer having solder wettability are accomplished using an electroless deposition bath composition in a temperature range to deposit the barrier metal and using the electroless deposition bath composition in another temperature range to deposit the wetting layer.

20. A method of making an electronic device, the method comprising:

providing a substrate comprising one or more electrical contact pads and/or one or more through-substrate via conductors;

electrolessly depositing a barrier metal comprising at least one of the elements nickel and cobalt to a thickness of 0.2 micrometer to 1 micrometer and all values and ranges subsumed therein at least over portions of the one or more electrical contact pads and/or the one or more through-substrate via conductors;

electrolessly depositing at least one of:

1. tin or a tin alloy;
2. silver tungsten alloy with 3-4 atomic percent tungsten;
3. cobalt tin alloy, cobalt copper alloy, cobalt silver alloy, cobalt copper tin alloy, cobalt copper silver alloy, cobalt silver tin alloy, or cobalt copper silver tin alloy;
4. nickel copper alloy, nickel silver alloy, nickel copper silver alloy, nickel copper tin alloy, nickel silver tin alloy, or nickel copper silver tin alloy;
5. iron tin alloy, iron copper alloy, iron silver alloy, iron copper tin alloy, iron copper silver alloy, iron silver tin alloy, or iron copper silver tin alloy;
6. a thickness of nickel alloy having a first composition and a thickness of nickel alloy having a second composition;
7. a thickness of cobalt alloy having a first composition and a thickness of cobalt alloy having a second composition; and
8. a thickness of iron alloy having a first composition and a thickness of iron alloy having a second composition;

to contact the barrier metal so as to form a substantially gold-free wetting layer having solder wettability; and

forming a solder contact to the substantially gold-free wetting layer.

21. An electronic device comprising a metallization stack, the metallization stack comprising a barrier metal deposited electrolessly and a substantially gold-free

wetting layer deposited electrolessly, the barrier metal contacting the wetting layer, and the wetting layer being wettable by solder.

22. The electronic device of claim 21, further comprising electrical contact pads at least partially covered by the barrier metal.

23. The electronic device of claim 21, further comprising a through-substrate via conductor at least partially covered by the barrier metal.

24. The electronic device of claim 21, wherein the substrate has one or more through-substrate vias, the walls of the substrate forming the one or more vias are at least partially covered by the barrier metal and further comprising solder contacting the wetting layer to substantially fill the one or more vias.

25. The electronic device of claim 21, wherein the barrier metal has a thickness of 0.2 micrometer to 1 micrometer and all values and ranges subsumed therein.

26. The electronic device of claim 21, wherein the barrier metal comprises cobalt.

27. The electronic device of claim 21, wherein the wetting layer comprises tin or a tin alloy.

28. The electronic device of claim 21, wherein the wetting layer comprises silver tungsten alloy with 3-4 atomic percent tungsten.

29. The electronic device of claim 21, wherein the wetting layer comprises cobalt tin alloy, cobalt copper alloy, cobalt silver alloy, cobalt copper tin alloy, cobalt copper silver alloy, cobalt silver tin alloy, or cobalt copper silver tin alloy.

30. The electronic device of claim 29, wherein the wetting layer further comprises boron and/or phosphorus.

31. The electronic device of claim 21, wherein the wetting layer comprises nickel copper alloy, nickel silver alloy, nickel copper silver alloy, nickel copper tin alloy, nickel silver tin alloy, or nickel copper silver tin alloy.

32. The electronic device of claim 31, wherein the wetting layer further comprises boron and/or phosphorus.

33. The electronic device of claim 21, wherein the wetting layer comprises iron tin alloy, iron copper alloy, iron silver alloy, iron copper tin alloy, iron copper silver alloy, iron silver tin alloy, or iron copper silver tin alloy.

34. The electronic device of claim 33, wherein the wetting layer further comprises boron and/or phosphorus.

35. The electronic device of claim 21, wherein the wetting layer comprises a thickness of nickel tin alloy having a first composition and a thickness of nickel tin alloy having a second composition.

36. The electronic device of claim 21, wherein the wetting layer comprises a thickness of cobalt tin alloy having a first composition and a thickness of cobalt tin alloy having a second composition.

37. The electronic device of claim 21, wherein the barrier metal has a thickness of 0.2 micrometer to 1 micrometer and all values and ranges subsumed therein, the barrier metal comprises at least one of the elements nickel and cobalt;

wherein the wetting layer comprises:

1. tin or a tin alloy;
2. silver tungsten alloy with 3-4 atomic percent tungsten;
3. cobalt tin alloy, cobalt copper alloy, cobalt silver alloy, cobalt copper tin alloy, cobalt copper silver alloy, cobalt silver tin alloy, or cobalt copper silver tin alloy;
4. nickel copper alloy, nickel silver alloy, nickel copper silver alloy, nickel copper tin alloy, nickel silver tin alloy, or nickel copper silver tin alloy;
5. iron tin alloy, iron copper alloy, iron silver alloy, iron copper tin alloy, iron copper silver alloy, iron silver tin alloy, or iron copper silver tin alloy;
6. a thickness of nickel alloy having a first composition and a thickness of nickel alloy having a second composition;
7. a thickness of cobalt alloy having a first composition and a thickness of cobalt alloy having a second composition; or
8. a thickness of iron alloy having a first composition and a thickness of iron alloy having a second composition;

further comprising one or more electrical contact pads being at least partially covered by the barrier metal and/or one or more through-substrate via conductors being at least partially covered by the barrier metal; and solder contacting the wetting layer.