

WHAT IS CLAIMED IS:

1. A method of copper electroplating in the manufacture of printed circuit boards, the method comprising the steps of:
 - a) preparing an electronic substrate to receive copper electroplating thereon;
 - b) forming at least one of one or more through-holes and/or one or more micro-vias in the electronic substrate; and
 - c) electroplating copper in the at one or more through-holes and/or one or more micro-vias by contacting the electronic substrate with an acid copper electroplating solution comprising:
 - a. a source of copper ions;
 - b. sulfuric acid;
 - c. a source of chloride ions;
 - d. a brightener;
 - e. a wetter; and
 - f. a leveler;wherein the acid copper electroplating solution is configured for a single-step process, wherein the same acid copper electroplating solution plates the one or more through-holes and/or the one or more micro-vias until metallization is complete.
2. The method according to claim 1, wherein the step of preparing the printed circuit board to accept electroplating thereon comprises the step of cleaning the printed circuit board prior to metallizing the one or more through-holes and/or one or more micro-vias.
3. The method according to claim 2, further comprising the step of microetching the cleaned printed circuit board.
4. The method according to claim 1, wherein the one or more metallized through-holes and/or one or more micro-vias do not exhibit any defects.

5. The method according to claim 4, wherein the metallized electroplated copper deposit completely fills the one or more through-holes and/or the one or more micro-vias and deposits a conformal copper deposit on the electronic substrate.
6. The method according to claim 1, wherein the electronic substrate has a thickness of between about 0.005 and about 3 mm.
7. The method according to claim 6, wherein the one or more through-holes and/or one or more micro-vias have a diameter of about 0.005 and about 1 mm.
8. The method according to claim 7, wherein the one or more through-holes and/or one or more micro-vias have a diameter of about 0.075 to about 0.25 mm.
9. The method according to claim 6, wherein the one or more through-holes and/or one or more micro-vias have an aspect ratio of between about 0.5:1 and about 6:1.
10. The method according to claim 5, wherein the conformal deposit has a thickness of between about 5 and about 100 μm .
11. The method according to claim 1, wherein the acid copper electroplating bath is maintained at a temperature of between about 10 and about 50°C.
12. The method according to claim 1, wherein the acid copper electroplating bath comprises:
 - a) 100-300 g/L copper sulfate
 - b) 10-150 g/L sulfuric acid;
 - c) 20-200 ppm chloride ions;
 - d) 0.1-30 ppm brightener;
 - e) 0.1-50 g/L wetter; and
 - f) 0.001-200 ppm.
13. The method according to claim 1, wherein the single-step acid copper electroplating process comprises a plating cycle comprising, in order:

- a) pulse plating for a time period, wherein the pulse plating uses two pulse forms on opposite sides of the electronic substrate, wherein the pulse forms exhibit a phase shift; and
 - b) direct current plating using forward current for a time period.
14. The method according to claim 13, wherein steps a) and b) are repeated to completely fill the one or more through-holes.
15. The method according to claim 13, further comprising the step of direct current plating using forward current for a time period prior to step a).
16. The method according to claim 15, wherein direct current plating for the first time period deposits a flash copper layer on the surfaces of the one or through-holes and/or one or more micro-vias.
17. The method according to claim 13, wherein pulse plating for the first time period accelerates filling of the middle of the one or more through-holes while minimizing an amount of surface copper plated.
18. The method according to claim 17, wherein as the center of the one or more through holes closes, the wave form transitions to direct current in the same acid copper plating solution to completely fill the one or more through-holes.
19. The method according to claim 1, wherein the electronic substrate is contacted with the acid copper electroplating solution by a method selected from the group consisting of spraying, wiping, dipping, and immersing.
20. The method according to claim 19, wherein the electronic substrate is contacted with the acid copper electroplating solution by immersing the electronic substrate in the acid copper plating bath.