CLAIMS

1. An autocatalytic gold bath capable of depositing gold from solution onto a surface, the autocatalytic gold bath comprising:

    a. a chelator, wherein the chelator is selected from the group consisting of phosphoric acid, boric acid, Rochelle salt, citric acid, gluconic acid, tartaric acid, lactic acid, malic acid, ethylenediamine, triethanolamine, ethylenediamine tetraacetic acid, nitrilotriacetic acid, diethylenetriamine pentaacetic acid, hydroxyethylethylenediamine triacetic acid, triethylenetetramine hexaacetic acid, 1,3-propanediamine tetraacetic acid, 1,3-diamino-2-hydroxypropane tetraacetic acid, hydroxyethylimino diacetic acid, dihydroxyl glycine, glycol ether diamine tetraacetic acid, dicarboxymethyl glutamic acid, hydroxyethylidene diphosphoric acid, ethylenediamine tetra(methylenephosphoric acid), alkali salts, alkaline earth metal salts and ammonium salts of any of the foregoing, and combinations of the foregoing;

    b. a gold salt, wherein the gold salt is a gold cyanide salt; and

    c. a reducing agent, wherein the reducing agent is selected from the group consisting of 2-methoxybenzaldehyde sodium bisulfite addition compound, acetone sodium bisulfite addition compound, P-anisaldehyde sodium bisulfite addition compound, glutaraldehyde bisulfite addition compound and combinations of the foregoing.

2. The autocatalytic gold bath according to claim 1, wherein the bath is maintained at a pH in the range of about 6 to about 9.

3. The autocatalytic gold bath according to claim 1, wherein the bath is maintained at a temperature in the range of about 75 to about 95°C.

4. A method of providing a gold final finish on a substrate by autocatalytic gold plating, the method comprising the steps of:

    a) providing a substrate with one or more metal layers thereon; and

b) contacting the substrate with the one or more metal layers with a gold plating bath to deposit gold metal thereon, the gold plating bath comprising:

i) a chelator, wherein the chelator is selected from the group consisting of phosphoric acid, boric acid, Rochelle salt, citric acid, gluconic acid, tartaric acid, lactic acid, malic acid, ethylenediamine, triethanolamine, ethylenediamine tetraacetic acid, nitrilotriacetic acid, diethylenetriamine pentaacetic acid, hydroxyethylethylenediamine triacetic acid, triethylenetetramine hexaacetic acid, 1,3-propanediamine tetraacetic acid, 1,3-diamino-2-hydroxypropane tetraacetic acid, hydroxyethylimino diacetic acid, dihydroxyl glycine, glycol ether diamine tetraacetic acid, dicarboxymethyl glutamic acid, hydroxyethylidene diphosphoric acid, ethylenediamine tetra(methylenephosphoric acid), alkali salts, alkaline earth metal salts and ammonium salts of any of the foregoing, and combinations of the foregoing;

ii) a gold salt, wherein the gold salt is a gold cyanide salt; and

iii) a reducing agent, wherein the reducing agent is selected from the group consisting of 2-methoxybenzaldehyde sodium bisulfite addition compound, acetone sodium bisulfite addition compound, P-anisaldehyde sodium bisulfite addition compound, glutaraldehyde bisulfite addition compound and combinations of the foregoing;

wherein the gold is deposited on the one or more metal layers, wherein the solderability of the one or more metal layers is increased.

5. The method according to claim 4, wherein the one or more metal layers comprise palladium and/or nickel.

6. The method according to claim 4, wherein the gold is plated onto an electroless nickel plated layer over copper features of a semiconductor substrate or printed circuit board.

7. The method according to claim 6, wherein the electroless nickel layer comprises a palladium-plated film over the top of the nickel layer to prevent diffusion of the nickel layer to the gold deposit.

8. The method according to claim 4, wherein the gold plating bath deposits a final finish to the surface of the one or more metal layers, wherein the one or more metal layers are formed in an electroless nickel/immersion gold (ENIG), electroless nickel, electroless palladium/immersion gold (ENEPIG), electroless nickel autocatalytic gold (ENAG), direct gold over copper or gold over silver process.

9. The method according to claim 4, wherein the substrate is a circuit board and gold is deposited as a final finish to the one or more metal layers on the circuit board, wherein the deposited gold increases solderability of the one or more metal layers.

10. A method of manufacturing a circuit board comprising a metal film stack thereon, the method comprising the steps of:

    a. forming one or more metal layers comprising the metal film stack formed in an electroless nickel/immersion gold (ENIG), electroless nickel, electroless palladium/immersion gold (ENEPIG), electroless nickel autocatalytic gold (ENAG), direct gold over copper or gold over silver process, wherein a gold plated finish is deposited; and

    b. depositing a gold plated finish on the metal film stack by the method of claim 4.

11. An autocatalytic gold bath capable of depositing gold from solution onto a surface, the autocatalytic gold bath comprising:

    a. a chelator; wherein the chelator comprises ethylenediamine tetraacetic acid or an alkali metal salt thereof;

    b. a gold salt, wherein the gold salt is a gold cyanide salt;

    c. a reducing agent selected from the group consisting of 2-methoxybenzaldehyde sodium bisulfite addition compound, acetone sodium bisulfite addition compound, P-anisaldehyde sodium bisulfite addition compound, glutaraldehyde bisulfite addition compound and combinations of one or more of the foregoing; and

    d. an amine selected from the group consisting of hydroxyethylethylenediamine, diethylene triamine, triethylenetetramine, and pentaethylenehexamine.

12. The autocatalytic gold bath according to claim 11, wherein the chelator comprises a sodium salt of ethylenediamine tetraacetic acid and sodium malate.

13. The autocatalytic gold bath according to claim 11, wherein the amine is hydroxyethylethylenediamine.

14. The autocatalytic gold bath according to claim 11, wherein the amine is selected from the group consisting of diethylenetriamine, triethylenetetramine, and pentaethylenehexamine.

15. The autocatalytic gold bath according to claim 1, wherein the chelator consists of a sodium salt of ethylenediamine tetraacetic acid and sodium malate.

16. An autocatalytic gold bath capable of depositing gold from solution onto a surface, the autocatalytic gold bath consisting essentially of:

    a. 10 to 50 g/L of a chelator; wherein the chelator is selected from the group consisting of phosphoric acid, boric acid, Rochelle salt, citric acid, gluconic acid, tartaric acid, lactic acid, malic acid, ethylenediamine, triethanolamine, ethylenediamine tetraacetic acid, nitrilotriacetic acid, diethylenetriamine pentaacetic acid, hydroxyethylethylenediamine triacetic acid, triethylenetetramine hexaacetic acid, 1,3-propanediamine tetraacetic acid, 1,3-diamino-2-hydroxypropane tetraacetic acid, hydroxyethylimino diacetic acid, dihydroxyl glycine, glycol ether diamine tetraacetic acid, dicarboxymethyl glutamic acid, hydroxyethylidene diphosphoric acid, ethylenediamine tetra(methylenephosphoric acid), alkali salts, alkaline earth metal salts and ammonium salts of any of the foregoing, and combinations of the foregoing;

    b. 0.5 to 1.5 g/L of a gold salt, wherein the gold salt is a gold cyanide salt;

    c. 3 to 10 g/L of a reducing agent selected from the group consisting of 2-methoxybenzaldehyde sodium bisulfite addition compound, acetone sodium bisulfite addition compound, P-anisaldehyde sodium bisulfite addition compound, glutaraldehyde bisulfite addition compound and combinations of one or more of the foregoing; and

d. 0.5 to 10 g/L of an amine selected from the group consisting of hydroxyethylethylenediamine, diethylene triamine, triethylenetetramine, and pentaethylenehexamine; and

e. a pH adjuster; and

f. balance water,

wherein the bath is at least substantially free of formaldehyde or a bisulfite addition compound of formaldehyde.

17. An autocatalytic gold bath capable of depositing gold from solution onto a surface, the autocatalytic gold bath consisting of:

a. 10 to 50 g/L of a chelator; wherein the chelator is selected from the group consisting of phosphoric acid, boric acid, Rochelle salt, citric acid, gluconic acid, tartaric acid, lactic acid, malic acid, ethylenediamine, triethanolamine, ethylenediamine tetraacetic acid, nitrilotriacetic acid, diethylenetriamine pentaacetic acid, hydroxyethylethylenediamine triacetic acid, triethylenetetramine hexaacetic acid, 1,3-propanediamine tetraacetic acid, 1,3-diamino-2-hydroxypropane tetraacetic acid, hydroxyethylimino diacetic acid, dihydroxyl glycine, glycol ether diamine tetraacetic acid, dicarboxymethyl glutamic acid, hydroxyethylidene diphosphoric acid, ethylenediamine tetra(methylenephosphoric acid), alkali salts, alkaline earth metal salts and ammonium salts of any of the foregoing, and combinations of the foregoing;

b. 0.5 to 1.5 g/L of a gold salt, wherein the gold salt is selected from the group consisting of potassium gold cyanide, gold sulfite, gold iodide, gold chloride, gold bromide, and combinations of one or more of the foregoing;

c. 3 to 10 g/L of a reducing agent selected from the group consisting of 2-methoxybenzaldehyde sodium bisulfite addition compound, acetone sodium bisulfite addition compound, P-anisaldehyde sodium bisulfite addition compound, glutaraldehyde bisulfite addition compound and combinations of one or more of the foregoing; and

d. 0.5 to 10 g/L of an amine selected from the group consisting of hydroxyethylethylenediamine, diethylene triamine, triethylenetetramine, and pentaethylenehexamine; and

e. a pH adjuster;

f. one or more additives selected from the group consisting of surfactants, crystallization modifiers, buffers, flattening agents, thickness controlling agents, and antifoaming agents; and

g. balance water,

wherein the bath is at least substantially free of formaldehyde or a bisulfite addition compound of formaldehyde.

18. The autocatalytic gold bath according to claim 17, wherein a molar ratio between the reducing agent and the amine is between 1:10 to 1:1.

19. The autocatalytic gold bath according to claim 17, wherein the chelator consists of a sodium salt of ethylenediamine tetraacetic acid and sodium malate.