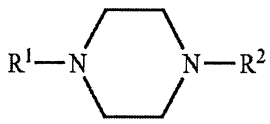
What is claimed is:

1. A composition comprising a cyclic polyamine, a polyphenol based reducing agent having 2 to 5 hydroxyl groups, a quaternary ammonium hydroxide, ascorbic acid, water, and at least one complexing agent selected from the group consisting of aromatic and aliphatic hydroxycarboxylic acids having 1 to 6 carbon atoms (and salts thereof), heterocyclic compounds having at least one of a hydroxyl group having 9 to 23 carbon atoms and a carboxyl group having 9 to 23 carbon atoms, and phosphonic acids having 6 to 9 carbon atoms (and salts thereof), wherein said composition is useful for the removal of material from a surface of a microelectronic device, wherein said microelectronic device comprises copper or copper alloy wiring, and wherein said cyclic polyamine is represented by the general formula (4) and/or formula (5):

Formula 4

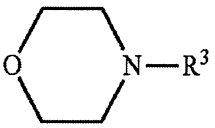
(1)



wherein, R^1 represents a hydrogen atom, an alkyl group, an amino alkyl group, or a hydroxyalkyl group; and R^2 represents an alkyl group, an amino alkyl group, or a hydroxyalkyl group,

Formula 5

(2)



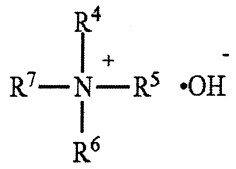
wherein, R^3 represents an amino alkyl group.

2. The composition of claim 1, wherein the material comprises post-CMP residue and/or contaminants.

3. The composition according to claim 1, wherein the polyphenol based reducing agent is selected from the group consisting of catechol, caffeic acid, alizarin, endocrocin, urushiol, flavone, resorcinol, hydroquinone, emodin, pyrogallol, gallic acid, quercetin, catechin, and anthocyanin.

4. The composition according to claim 1, wherein the quaternary ammonium hydroxide is a quaternary ammonium hydroxide represented by the following general formula (6)

Formula 6



wherein, R^4 to R^7 each independently represent an alkyl group having 1 to 4 carbon atoms or a hydroxyalkyl group having 1 to 4 carbon atoms.

5. The composition according to claim 4, wherein the quaternary ammonium hydroxide is selected from the group consisting of tetraalkylammonium hydroxide, (hydroxyalkyl)trialkylammonium hydroxide, bis(hydroxyalkyl)dialkylammonium hydroxide, and tris(hydroxyalkyl)alkylammonium hydroxide.

6. The composition according to claim 1, wherein the cyclic polyamine is selected from the group consisting of N-methylpiperazine, N-ethylpiperazine, N-isobutylpiperazine, N-aminomethylpiperazine, N-aminoethylpiperazine, N-aminopropylpiperazine, N-hydroxymethylpiperazine, N-hydroxyethylpiperazine, N-hydroxypropylpiperazine, 1,4-dimethylpiperazine, 1,4-diethylpiperazine, 1,4-diisopropylpiperazine, 1,4-dibutylpiperazine, 1-aminomethyl-4-methylpiperazine, 1-hydroxymethyl-4-methylpiperazine, 1-aminoethyl-4-ethylpiperazine, 1-hydroxyethyl-4-ethylpiperazine, 1,4-(bisaminoethyl)piperazine, 1,4-(bishydroxyethyl)piperazine, 1,4-(bisaminopropyl)piperazine, 1,4-(bishydroxypropyl)piperazine, 1-aminoethyl-4-hydroxyethylpiperazine, 1-aminopropyl-4-hydroxypropylpiperazine, N-aminoethylmorpholine, N-aminopropylmorpholine, N-aminoisobutylmorpholine, and combinations thereof.

7. The composition according to claim 1, further comprising at least one corrosion inhibitor.

8. The composition according to claim 7, wherein the corrosion inhibitor comprises at least one species selected from the group consisting of N-ribosylpurine, adenosine, guanosine, 2-aminopurine riboside, 2-methoxyadenosine, N-methyladenosine, N,N-dimethyladenosine, trimethylated adenosine, trimethyl N-methyladenosine, C-4′-methyladenosine, 3-deoxyadenosine, adenine, methylated adenine, dimethylated adenine, N4,N4-dimethylpyrimidine-4,5,6-triamine, 4,5,6-triaminopyrimidine, allantoin, hydroxylated C-O-O-C dimers, C-C bridged dimers, ribose, methylated ribose, tetramethylated ribose, methylated hydrolyzed diribose compounds; xylose, glucose, purine, guanine, hypoxanthine, xanthine, theobromine, caffeine, uric acid, isoguanine, triaminopyrimidine, and combinations thereof.

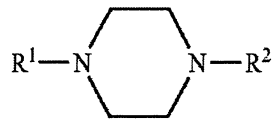
9. The composition of claim 1, wherein the at least one complexing agent comprises aliphatic hydroxycarboxylic acid or a salt thereof or a polycarboxylic acid or a salt thereof.

10. The composition according to claim 1, wherein the amount of cyclic polyamine is in a range from about 0.001 to about 5% by weight, the amount of polyphenol based reducing agent having 2 to 5 hydroxyl groups is in a range from about 0.001 to about 5% by weight, the amount of quaternary ammonium hydroxide is in a range from about 0.01 to about 10% by weight, the amount of ascorbic acid is in a range from about 0.01 to about 5% by weight, the amount of the complexing agent is in a range from about 0.001 to about 0.5% by weight, and the amount of water is in a range from about 69.0 to about 99.9% by weight, based on the total weight of the composition.

11. A method of removing post-CMP residue and/or contaminants from a microelectronic device having said residue and contaminants thereon, said method comprising contacting the microelectronic device with a composition for sufficient time to at least partially clean said residue and contaminants from the microelectronic device, wherein the microelectronic device comprises copper or copper alloy wiring, said composition comprising a cyclic polyamine, a polyphenol based reducing agent having 2 to 5 hydroxyl groups, a quaternary ammonium hydroxide, ascorbic acid, water, and at least one complexing agent selected from the group consisting of aromatic and aliphatic hydroxycarboxylic acids having 1 to 6 carbon atoms (and salts thereof), heterocyclic compounds having at least one of a hydroxyl group having 9 to 23 carbon atoms and a carboxyl group having 9 to 23 carbon atoms, and phosphonic acids having 6 to 9 carbon atoms (and salts thereof), wherein said composition is useful for the removal of material from a surface of a microelectronic device, wherein said microelectronic device comprises copper or copper alloy wiring, and wherein said cyclic polyamine is represented by the general formula (4) and/or formula (5):

Formula 4

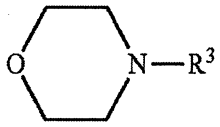
(1)



wherein, R^1 represents a hydrogen atom, an alkyl group, an amino alkyl group, or a hydroxyalkyl group; and R^2 represents an alkyl group, an amino alkyl group, or a hydroxyalkyl group,

Formula 5

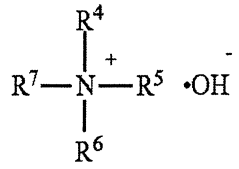
(2)



wherein, R^3 represents an amino alkyl group.

12. The method according to claim 11, wherein the polyphenol based reducing agent is selected from the group consisting of catechol, caffeic acid, alizarin, endocrocin, urushiol, flavone, resorcinol, hydroquinone, emodin, pyrogallol, gallic acid, quercetin, catechin, and anthocyanin.

13. The method according to claim 11, wherein the quaternary ammonium hydroxide is a quaternary ammonium hydroxide represented by the following general formula (6)



wherein, R^4 to R^7 each independently represent an alkyl group having 1 to 4 carbon atoms or a hydroxyalkyl group having 1 to 4 carbon atoms.

14. The method according to claim 13, wherein the quaternary ammonium hydroxide is selected from the group consisting of tetraalkylammonium hydroxide, (hydroxyalkyl)trialkylammonium hydroxide, bis(hydroxyalkyl)dialkylammonium hydroxide, and tris(hydroxyalkyl)alkylammonium hydroxide.

15. The method according to claim 11, wherein the cyclic polyamine is selected from the group consisting of N-methylpiperazine, N-ethylpiperazine, N-isobutylpiperazine, N-aminomethylpiperazine, N-aminoethylpiperazine, N-aminopropylpiperazine, N-hydroxymethylpiperazine, N-hydroxyethylpiperazine, N-hydroxypropylpiperazine, 1,4-dimethylpiperazine, 1,4-diethylpiperazine, 1,4-diisopropylpiperazine, 1,4-dibutylpiperazine, 1-aminomethyl-4-methylpiperazine, 1-hydroxymethyl-4-methylpiperazine, 1-aminoethyl-4-ethylpiperazine, 1-hydroxyethyl-4-ethylpiperazine, 1,4-(bisaminoethyl)piperazine, 1,4-(bishydroxyethyl)piperazine, 1,4-(bisaminopropyl)piperazine, 1,4-(bishydroxypropyl)piperazine, 1-aminoethyl-4-hydroxyethylpiperazine, 1-aminopropyl-4-hydroxypropylpiperazine, N-aminoethylmorpholine, N-aminopropylmorpholine, N-aminoisobutylmorpholine, and combinations thereof.

16. The method according to claim 11, wherein the composition further comprises at least one corrosion inhibitor.

17. The method according to claim 16, wherein the corrosion inhibitor comprises at least one species selected from the group consisting of N-ribosylpurine, adenosine, guanosine, 2-aminopurine riboside, 2-methoxyadenosine, N-methyladenosine, N,N-dimethyladenosine, trimethylated adenosine, trimethyl N-methyladenosine, C-4′-methyladenosine, 3-deoxyadenosine, adenine, methylated adenine, dimethylated adenine, N4,N4-dimethylpyrimidine-4,5,6-triamine, 4,5,6-triaminopyrimidine, allantoin, hydroxylated C-O-O-C dimers, C-C bridged dimers, ribose, methylated ribose, tetramethylated ribose, methylated hydrolyzed diribose compounds; xylose, glucose, purine, guanine, hypoxanthine, xanthine, theobromine, caffeine, uric acid, isoguanine, triaminopyrimidine, and combinations thereof.

18. The method according to claim 11, wherein the at least one complexing agent comprises aliphatic hydroxycarboxylic acid or a salt thereof or a polycarboxylic acid or a salt thereof.

19. The method according to claim 11, wherein the amount of cyclic polyamine is in a range from about 0.001 to about 5% by weight, the amount of polyphenol based reducing agent having 2 to 5 hydroxyl groups is in a range from about 0.001 to about 5% by weight, the amount of quaternary ammonium hydroxide is in a range from about 0.01 to about 10% by weight, the amount of ascorbic acid is in a range from about 0.01 to about 5% by weight, the amount of the complexing agent is in a range from about 0.001 to about 0.5% by weight, and the amount of water is in a range from about 69.0 to about 99.9% by weight, based on the total weight of the composition.