CLAIMS

1. An etching solution suitable for both tungsten-containing metals and GST metals, which comprises:

water;

at least one phenolic derivative compound other than catechol, said at least one phenolic derivative compound having at least two hydroxyl groups;

at least one strong base selected from the group consisting of (i) a quaternary base having the general formula $NR^1R^2R^3R^4OH$, wherein R^1, R^2, R^3 and R^4 may be the same as or different from one another and are selected from the group consisting of hydrogen, straight-chained or branched C_1-C_6 alkyl, and substituted or unsubstituted C_6-C_{10} aryl, (ii) an organic amine selected from aminoethylethanolamine, aminoethoxyethanol, dimethylaminoethoxyethanol, triethylenediamine and one having the general formula $NR^1R^2R^3$, wherein R^1, R^2 and R^3 may be the same as or different from one another and are selected from the group consisting of hydrogen, straight-chained or branched C_1-C_6 alkyl, and a straight-chained or branched C_1-C_6 alcohol, and (iii) a metal hydroxide;

an ammonium salt of an organic acid; and

optionally a water-miscible solvent, wherein the pH of the etching solution is 10 or greater, and wherein the etching solution is substantially free of a peroxide oxidizer and a metal ion-containing oxidizer.

2. The etching solution of claim 1 wherein the phenolic derivative compound having at least two hydroxyl groups is at least one selected from the group consisting of gallic acid, t-butyl-catechol, p-benzenediol, m-benzenediol, 1,2,3-benzenetriol, 1,2,4-benzenetriol, and 1,3,5-benzenetriol.

3. The etching solution of claim 1 wherein the at least one strong base is a tetraalkylammonium hydroxide.

4. The etching solution of claim 3 wherein the tetraalkylammonium hydroxide is selected from the group consisting of tetraethylammonium hydroxide (TEAH), tetramethyammonium hydroxide (TMAH), tetrapropylammonium hydroxide (TPAH), tetrabutylammonium hydroxide (TBAH), tributylmethylammonium hydroxide (TBMAH), benzyltrimethylammonium hydroxide (BTMAH), and combinations thereof.

5. The etching solution of claim 1 wherein the at least one strong base is a metal hydroxide.

6. The etching solution of claim 5 wherein the metal hydroxide is at least one selected from the group consisting of lithium hydroxide, sodium hydroxide, and potassium hydroxide.

7. The etching solution of claim 1 wherein the at least one strong base is an organic amine.

8. The etching solution of claim 7 wherein the organic amine is at least one selected from the group consisting of aminoethylethanolamine, N-methylaminoethanol, aminoethoxyethanol, dimethylaminoethoxyethanol, diethanolamine, N-methyldiethanolamine, monoethanolamine, triethanolamine, 1-amino-2-propanol, 2-amino-1-butanol, isobutanolamine, triethylenediamine, and combinations thereof.

9. The etching solution of claim 1 wherein the phenolic derivative compound is gallic acid and the strong base is tetraethylammonium hydroxide.

10. The etching solution of claim 1 wherein the ammonium salt of an organic acid is selected from the group consisting of triammonium citrate, ammonium acetate, ammonium lactate, diammonium citrate, diammonium succinate, and combinations thereof.

11. The etching solution of claim 1 wherein said ammonium salt of an organic acid is triammonium citrate.

12. The etching solution of claim 9 wherein said ammonium salt of an organic acid is triammonium citrate.

13. The etching solution of claim 1 wherein the water-miscible solvent is present and is selected from the group consisting of ethylene glycol, propylene glycol, 1,4-butanediol, tripropylene glycol methyl ether, propylene glycol propyl ether, diethylene glycol n-butyl ether, hexyloxypropylamine, poly(oxyethylene)diamine, dimethylsulfoxide, tetrahydrofurfuryl alcohol, glycerol, alcohols, sulfoxides, and mixtures thereof.

14. The etching solution of claim 1 further comprising a corrosion inhibitor.

15. The etching solution of claim 1 wherein the solution is capable of etching both GST metal and tungsten metal at a rate of about 1 to about 40 Å/min at room temperature.

16. The etching solution of claim 1 wherein the solution comprises:

water;

from 0.1% to 15% by weight of said at least one phenolic derivative compound having at least two hydroxyl groups;

from 1% to 60% by weight of said at least one strong base;

from 0.1% to 20% by weight of said ammonium salt of an organic acid; and

from 0% to 75% by weight of said water-miscible solvent.

17. A method for etching both GST metal and tungsten metal from a microelectronic device comprising at least one of GST metal and tungsten metal during the manufacture of the microelectronic device, the method comprising the steps of:

contacting the microelectronic device with an aqueous etching solution for a time sufficient to at least partially remove the GST metal and the tungsten metal from the device at a rate of from 1 to 40 Å/min at room temperature, wherein the aqueous etching solution comprises:

water;

at least one phenolic derivative compound other than catechol, said at least one phenolic derivative compound having at least two hydroxyl groups;

at least one strong base selected from the group consisting of (i) a quaternary base having the general formula $NR^1R^2R^3R^4OH$, wherein R^1, R^2, R^3 and R^4 may be the same as or different from one another and are selected from the group consisting of hydrogen, straight-chained or branched C_1-C_6 alkyl, and substituted or unsubstituted C_6-C_{10} aryl, (ii) an organic amine selected from aminoethylethanolamine, aminoethoxyethanol, dimethylaminoethoxyethanol, triethylenediamine and one having the general formula $NR^1R^2R^3$, wherein R^1, R^2 and R^3 may be the same as or different from one another and are selected from the group consisting of hydrogen, straight-chained or branched C_1-C_6 alkyl, and a straight-chained or branched C_1-C_6 alcohol, and (iii) a metal hydroxide;

an ammonium salt of an organic acid; and

optionally a water-miscible solvent, wherein the pH of the etching solution is 10 or greater, and wherein the etching solution is substantially free of a peroxide oxidizer and a metal ion-containing oxidizer.

18. The method of claim 17 wherein the phenolic derivative compound having at least two hydroxyl groups is at least one selected from the group consisting of gallic acid, t-butyl catechol, p-benzenediol, m-benzenediol, 1,2,3-benzenetriol, 1,2,4-benzenetriol, and 1,3,5-benzenetriol.

19. The method of claim 17 wherein the at least one strong base is a tetraalkylammonium hydroxide.

20. The method of claim 19 wherein the tetraalkylammonium hydroxide is selected from the group consisting of tetraethylammonium hydroxide (TEAH), tetramethyammonium hydroxide (TMAH), tetrapropylammonium hydroxide (TPAH), tetrabutylammonium hydroxide (TBAH), tributylmethylammonium hydroxide (TBMAH), benzyltrimethylammonium hydroxide (BTMAH), and combinations thereof.

21. The method of claim 17 wherein the at least one strong base is a metal hydroxide.

22. The method of claim 21 wherein the metal hydroxide is at least one selected from the group consisting of lithium hydroxide, sodium hydroxide, and potassium hydroxide.

23. The method of claim 17 wherein the at least one strong base is an organic amine.

24. The method of claim 23 wherein the organic amine is at least one selected from the group consisting of aminoethylethanolamine, N-methylaminoethanol, aminoethoxyethanol, dimethylaminoethoxyethanol, diethanolamine, N-methyldiethanolamine, monoethanolamine, triethanolamine, 1-amino-2-propanol, 2-amino-1-butanol, isobutanolamine, triethylenediamine, and combinations thereof.

25. The method of claim 17 wherein the phenolic derivative compound is gallic acid and the strong base is tetraethylammonium hydroxide.

26. The method of claim 17 wherein the water-miscible solvent is present and is selected from the group consisting of ethylene glycol, propylene glycol, 1,4-butanediol, tripropylene glycol methyl ether, propylene glycol propyl ether, diethylene glycol n-butyl ether, hexyloxypropylamine, poly(oxyethylene)diamine, dimethylsulfoxide, tetrahydrofurfuryl alcohol, glycerol, alcohols, sulfoxides, and mixtures thereof.

27. The method of claim 17 wherein the etching solution further comprises a corrosion inhibitor.

28. The method of claim 17 wherein the ammonium salt of an organic acid is selected from the group consisting of triammonium citrate, ammonium acetate, ammonium lactate, diammonium citrate, diammonium succinate, and combinations thereof.

29. The method of claim 28 wherein said ammonium salt of an organic acid is triammonium citrate.

30. The method of claim 25 wherein said ammonium salt of an organic acid is triammonium citrate.

31. An etching solution suitable for both tungsten-containing metals and GST metals, which comprises:

water;

at least one phenolic derivative compound having at least two hydroxyl groups;

at least one strong base selected from the group consisting of (i) a quaternary base having the general formula $NR^1R^2R^3R^4OH$, wherein R^1, R^2, R^3 and R^4 may be the same as or different from one another and are selected from the group consisting of hydrogen, straight-chained or branched C_1-C_6 alkyl, and substituted or unsubstituted C_6-C_{10} aryl and (ii) an organic amine selected from aminoethylethanolamine, aminoethoxyethanol, dimethylaminoethoxyethanol, triethylenediamine and one having the general formula $NR^1R^2R^3$, wherein R^1, R^2 and R^3 may be the same as or different from one another and are selected from the group consisting of hydrogen, straight-chained or branched C_1-C_6 alkyl, and a straight-chained or branched C_1-C_6 alcohol;

an ammonium salt of an organic acid; and

optionally a water-miscible solvent, wherein the pH of the etching solution is 10 or greater, wherein the etching solution is substantially free of a peroxide oxidizer and a metal ion-containing oxidizer, and

wherein the etching solution is substantially free of monoethanolamine.

32. A method for etching both GST metal and tungsten metal from a microelectronic device comprising at least one of GST metal and tungsten metal during the manufacture of the microelectronic device, the method comprising the steps of:

contacting the microelectronic device with an aqueous etching solution for a time sufficient to at least partially remove the GST metal and the tungsten metal from the device at a rate of from 1 to 40 Å/min at room temperature, wherein the aqueous etching solution comprises:

water;

at least one phenolic derivative compound having at least two hydroxyl groups;

at least one strong base selected from the group consisting of (i) a quaternary base having the general formula $NR^1R^2R^3R^4OH$, wherein R^1, R^2, R^3 and R^4 may be the same as or different from one another and are selected from the group consisting of hydrogen, straight-chained or branched C_1-C_6 alkyl, and substituted or unsubstituted C_6-C_{10} aryl and (ii) an organic amine selected from aminoethylethanolamine, aminoethoxyethanol, dimethylaminoethoxyethanol, triethylenediamine and one having the general formula $NR^1R^2R^3$, wherein R^1, R^2 and R^3 may be the same as or different from one another and are selected from the group consisting of hydrogen, straight-chained or branched C_1-C_6 alkyl, and a straight-chained or branched C_1-C_6 alcohol;

an ammonium salt of an organic acid; and

optionally a water-miscible solvent, wherein the pH of the etching solution is 10 or greater, wherein the etching solution is substantially free of a peroxide oxidizer and a metal ion-containing oxidizer, and

wherein the aqueous etching solution is substantially free of monoethanolamine.