THE CLAIMS

What is claimed is:

1. A composition comprising from about 15 wt % to about 30 wt % of at least one oxidizing agent, from about 0.01 wt % to about 15 wt % of at least one etchant, from about 0.01 wt % to about 2 wt % of at least one metal corrosion inhibitor, from about 0.01 wt % to about 1 wt % of at least one chelating agent, and at least one solvent, wherein:

the etchant comprises a species selected from the group consisting of tetramethylammonium hydroxide (TMAH), tetraethylammonium hydroxide (TEAH), tetrapropylammonium hydroxide (TPAH), tetrabutylammonium hydroxide (TBAH), benzyltrimethylammonium hydroxide (BTMAH), potassium hydroxide, ammonium hydroxide, benzyltriethylammonium hydroxide (BTEAH), tetrabutylphosphonium hydroxide (TBPH), (2-hydroxyethyl) trimethylammonium hydroxide, (2-hydroxyethyl) triethylammonium hydroxide, (2-hydroxyethyl) tripropylammonium hydroxide, (1-hydroxypropyl) trimethylammonium hydroxide, ethyltrimethylammonium hydroxide, diethyldimethylammonium hydroxide (DEDMAH), tris(2-hydroxyethyl) methyl ammonium hydroxide (THEMAH), 1,1,3,3-tetramethylguanidine (TMG), guanidine carbonate, arginine, and combinations thereof;

the metal corrosion inhibitor comprises a species selected from the group consisting of 2-amino-5-ethyl-1,3,4-thiadiazole, ATA-SDS, Ablumine O, 2-benzylpyridine, decyltrimethylammonium chloride (DTAC), carbazole, saccharin, benzoin oxime, polyoxypropylene/polyoxyethylene block copolymer, sodium dodecylbenzenesulfonate (SDS), benzylphosphonic acid, diphenylphosphinic acid, 1,2-ethylenediphosphonic acid, phenylphosphonic acid, cinnamic acid, and combinations thereof; and

wherein the composition has a pH in a range of from about 6 to about 10; and

wherein the composition removes titanium nitride and/or photoresist etch residue from a surface of a microelectronic device having the same thereon and wherein the composition is highly selective to cobalt.

2. The composition of claim 1, wherein the etchant comprises TMAH, choline hydroxide, potassium hydroxide, THEMAH, and any combination thereof.

3. The composition of claim 1, wherein the oxidizing agent comprises a species selected from the group consisting of hydrogen peroxide, $FeCl_3$, FeF_3, $Fe(NO_3)_3$, $Sr(NO_3)_2$, CoF_3, MnF_3, oxone ($2KHSO_5 \cdot KHSO_4 \cdot K_2SO_4$), periodic acid, iodic acid, vanadium (V) oxide, vanadium (IV,V) oxide, ammonium vanadate, ammonium peroxomonosulfate, ammonium chlorite (NH_4ClO_2), ammonium chlorate (NH_4ClO_3), ammonium iodate (NH_4IO_3), ammonium nitrate

(NH_4NO_3), ammonium perborate (NH_4BO_3), ammonium perchlorate (NH_4ClO_4), ammonium periodate (NH_4IO_3), ammonium persulfate ($(NH_4)_2S_2O_8$), ammonium hypochlorite (NH_4ClO), ammonium tungstate ($(NH_4)_{10}H_2(W_2O_7)$), sodium persulfate ($Na_2S_2O_8$), sodium hypochlorite (NaClO), sodium perborate, potassium iodate (KIO_3), potassium permanganate ($KMnO_4$), potassium persulfate, nitric acid (HNO_3), potassium persulfate ($K_2S_2O_8$), potassium hypochlorite (KClO), tetramethylammonium chlorite ($(N(CH_3)_4)ClO_2$), tetramethylammonium chlorate ($(N(CH_3)_4)ClO_3$), tetramethylammonium iodate ($(N(CH_3)_4)IO_3$), tetramethylammonium perborate ($(N(CH_3)_4)BO_3$), tetramethylammonium perchlorate ($(N(CH_3)_4)ClO_4$), tetramethylammonium periodate ($(N(CH_3)_4)IO_4$), tetramethylammonium persulfate ($(N(CH_3)_4)S_2O_8$), tetrabutylammonium peroxomonosulfate, peroxomonosulfuric acid, ferric nitrate ($Fe(NO_3)_3$), urea hydrogen peroxide ($(CO(NH_2)_2)H_2O_2$), peracetic acid ($CH_3(CO)OOH$), 1,4-benzoquinone, toluquinone, dimethyl-1,4-benzoquinone, chloranil, alloxan, N-methylmorpholine N-oxide, trimethylamine N-oxide, and combinations thereof.

4. The composition of claim 1, wherein the oxidizing agent comprises hydrogen peroxide.

5. The composition of claim 1, wherein the at least one solvent comprises a species selected from the group consisting of water, methanol, ethanol, isopropanol, butanol, pentanol, hexanol, 2-ethyl-1-hexanol, heptanol, octanol, ethylene glycol, propylene glycol, butylene glycol, hexylene glycol, butylene carbonate, ethylene carbonate, propylene carbonate, choline bicarbonate, dipropylene glycol, dimethylsulfoxide, sulfolane, tetrahydrofurfuryl alcohol (THFA), 1,2-butanediol, 1,4-butanediol, tetramethyl urea, diethylene glycol monomethyl ether, triethylene glycol monomethyl ether, diethylene glycol monoethyl ether, triethylene glycol monoethyl ether, ethylene glycol monopropyl ether, ethylene glycol monobutyl ether, diethylene glycol monobutyl ether, triethylene glycol monobutyl ether, ethylene glycol monohexyl ether, diethylene glycol monohexyl ether, ethylene glycol phenyl ether, propylene glycol methyl ether, dipropylene glycol methyl ether (DPGME), tripropylene glycol methyl ether (TPGME),dipropylene glycol dimethyl ether, dipropylene glycol ethyl ether, propylene glycol n-propyl ether, dipropylene glycol n-propyl ether (DPGPE), tripropylene glycol n-propyl ether, propylene glycol n-butyl ether, dipropylene glycol n-butyl ether, tripropylene glycol n-butyl ether, propylene glycol phenyl ether, 2,3-dihydrodecafluoropentane, ethyl perfluorobutylether, methyl perfluorobutylether, alkyl carbonates, 4-methyl-2-pentanol, and combinations thereof.

6. The composition of claim 1, wherein the at least one solvent comprises water.

7. The composition of claim 1, wherein the metal corrosion inhibitor comprises one or more

species selected from the group consisting of ATA-SDS, polyoxyethylene (20) sorbitan monooleate, polyoxyethylene (20) sorbitan monopalmitate, polyoxyethylene (20) sorbitan monolaurate, polyoxypropylene/polyoxyethylene block copolymers, DTAC, and combinations thereof.

8. The composition of claim 1, wherein the at least one chelating agent comprises a species selected from the group consisting of acetylacetonate, 1,1,1-trifluoro-2,4-pentanedione, 1,1,1,5,5,5-hexafluoro-2,4-pentanedione, glycine, serine, proline, leucine, alanine, asparagine, aspartic acid, glutamine, valine, and lysine, iminodiacetic acid (IDA), malonic acid, oxalic acid, succinic acid, boric acid, nitrilotriacetic acid, malic acid, citric acid, acetic acid, maleic acid, ethylenediaminetetraacetic acid (EDTA), ethylenediaminetetraacetic acid diammonium salt, (1,2-cyclohexylenedinitrilo)tetraacetic acid (CDTA), diethylenetriamine pentaacetic acid (DTPA), 2-phosphonobutane-1,2,4-tricarboxylic acid (PBTCA), ethylendiamine disuccinic acid, propylenediamine tetraacetic acid, phosphonic acid, hydroxyethylidene diphosphonic acid (HEDP), 1-hydroxyethane-1,1-diphosphonic acid, nitrilo-tris(methylenephosphonic acid) (NTMP), amino tri (methylene phosphonic acid), diethylenetriamine penta(methylene phosphonic acid), ethylenediamine tetra(methylene phosphonic acid) (EDTMPA), ethylenediamine, 2,4-pentanedione, benzalkonium chloride, 1-imidazole, tetraglyme, pentamethyldiethylenetriamine (PMDETA), 1,3,5-triazine-2,4,6-thithiol trisodium salt solution, 1,3,5-triazine-2,4,6-thithiol triammonium salt solution, sodium diethyldithiocarbamate, disubstituted dithiocarbamates, sulfanilamide, monoethanolamine (MEA), 2-hydroxypyridine 1-oxide, sodium triphosphate penta basic, and combinations thereof.

9. The composition of claim 1, wherein the at least one chelating agent comprises CDTA.

10. The composition of claim 1, wherein the at least one chelating agent comprises a species selected from the group consisting of ammonium cation or a tetraalkylammonium cation of acetate, chloride, bromide, iodide, sulfate, benzoate, propionate, citrate, formate, oxalate, tartarate, succinate, lactate, maleate, malonate, fumarate, malate, ascorbate, mandelate, and phthalate, and combinations thereof.

11. The composition of claim 1, wherein the at least one chelating agent comprises ammonium bromide and/or ammonium chloride.

12. The composition of claim 1, further comprising at least one additional component selected from the group consisting of at least one surfactant, at least one low-k passivating agent, and combinations thereof.

13. The composition of claim 1, wherein the composition is substantially devoid of, silicates, abrasive materials, metal halides, and combinations thereof.

14. A method of etching titanium nitride material from a surface of a microelectronic device having same thereon, said method comprising contacting the surface with a composition, wherein the composition comprising from about 15 wt % to about 30 wt % of at least one oxidizing agent, from about 0.01 wt % to about 15 wt % of at least one etchant, from about 0.01 wt % to about 2 wt % of at least one metal corrosion inhibitor, from about 0.01 wt % to about 1 wt % of at least one chelating agent, and at least one solvent, wherein:

the etchant comprises a species selected from the group consisting of tetramethylammonium hydroxide (TMAH), tetraethylammonium hydroxide (TEAH), tetrapropylammonium hydroxide (TPAH), tetrabutylammonium hydroxide (TBAH), benzyltrimethylammonium hydroxide (BTMAH), potassium hydroxide, ammonium hydroxide, benzyltriethylammonium hydroxide (BTEAH), tetrabutylphosphonium hydroxide (TBPH), (2-hydroxyethyl) trimethylammonium hydroxide, (2-hydroxyethyl) triethylammonium hydroxide, (2-hydroxyethyl) tripropylammonium hydroxide, (1-hydroxypropyl) trimethylammonium hydroxide, ethyltrimethylammonium hydroxide, diethyldimethylammonium hydroxide (DEDMAH), tris(2-hydroxyethyl) methyl ammonium hydroxide (THEMAH), 1,1,3,3-tetramethylguanidine (TMG), guanidine carbonate, arginine, and combinations thereof;

the metal corrosion inhibitor comprises a species selected from the group consisting of 2-amino-5-ethyl-1,3,4-thiadiazole, ATA-SDS, Ablumine O, 2-benzylpyridine, decyltrimethylammonium chloride (DTAC), carbazole, saccharin, benzoin oxime, polyoxypropylene/polyoxyethylene block copolymer, sodium dodecylbenzenesulfonate (SDS), benzylphosphonic acid, diphenylphosphinic acid, 1,2-ethylenediphosphonic acid, phenylphosphonic acid, cinnamic acid, and combinations thereof; and

wherein the composition has a pH in a range of from about 6 to about 10; wherein the composition removes titanium nitride and/or photoresist etch residue from a surface of a microelectronic device having the same thereon and wherein the composition is highly selective to cobalt.

15. The method of claim 14, wherein the contacting comprises time in a range from about 0.3 minute to about 30 minutes at temperature in a range of from about 20ºC to about 100ºC.

16. The method of claim 14, wherein the composition is rinsed from the surface following the desired etching action.