CLAIMS

1. A composition for selectively removing at least one of titanium nitride and photoresist etch residue material from the surface of a microelectronic device having same thereon, said composition comprising:

oxidizing agent;

solvent;

etchant agent;

ammonium salt;

metal corrosion inhibitor selected from the group consisting of 2-aminobenzothiazole, 2-mercapto-5-methylbenzimidazole, 8-hydroxyquinoline, 1-thioglycerol, ascorbic acid, sorbitol, maltitol, mannitol, theophylline, caffeine, triton X-100, surfynol-485, decanoic acid, 11-mercaptoundecanoic acid (MUDA), hexylamine, 3,4-diaminotoluene, p-anisidine, 4-Methyl-o-phenylenediamine, 4-Nitroaniline, 4-carboxy-o-phenylenediamine, 8-Aminoquinoline, 5-Amino-2-benzimidazolinone, N,N-dimethyl-p-phenylenediamine, and combinations thereof; and

oxidizing stabilizer selected from HEDTA, 1,3-diaminopropane-N,N,N',N'-tetraacetic acid or gluconic acid; and

optional fluoride source,

wherein the composition has a pH ranging from 5.5 to 14.

~~2. The composition of claim 1, wherein the metal corrosion inhibitor is selected from 1,2,4-triazole (TAZ), benzotriazole (BZT), methyl-1H-benzotriazole, tolyltriazole (TTL), 2-aminobenthothiazole, benzimidazole, 2-mercapto-5-methylbenzimidaole, 8-hydroxyquinoline, 1-thioglycerol, ascorbic acid, pyrazole, sorbitol, maltitol, mannitol, theophylline, caffeine, polyethylene glycol, poly(propylene glycol), PEG400, triton X-100, surfynol-485, uric acid, decanoic acid, 11-mercaptoundecanoic acid (MUDA), hexadecyl trimethylammonium p-toluene sulfonate (CTAT), hexylamine, 3,4-diaminotoluene, p-anisidine, 4-Methyl-o-phenylenediamine, 4-Nitroaniline, 4-carboxy-o-phenylenediamine, 8-Aminoquinoline, 5-Amino-2-benzimidazolinone, N,N-dimethyl-p-phenylenediamine, and combinations thereof.~~

~~3.~~2. The composition of claim 1 wherein the metal corrosion inhibitor is selected from the group consisting of sorbitol, maltitol, mannitol, theophylline, ~~tolyltriazole (TTL),~~ 11-mercaptoundecanoic acid (MUDA), ~~poly(propylene glycol), PEG400,~~ triton X-100, 3,4-

diaminotoluene, p-anisidine, 4-methyl-o-phenylenediamine, 4-nitroaniline, 4-carboxy-o-phenylenediamine, 8-aminoquinoline, 5-amino-2-benzimidazolinone, and combinations thereof.

~~4.~~3. The composition of claim 1 wherein the metal corrosion inhibitor is selected from the group consisting of theophylline, sorbitol, maltitol, ~~tolyltriazole (TTL),~~ 3,4-diaminotoluene,11-mercaptoundecanoic acid (MUDA), p-anisidine, 4-methyl-o-phenylenediamine, 4-Nitroaniline, 4-carboxy-o-phenylenediamine, 8-aminoquinoline, 5-amino-2-benzimidazolinone, and combinations thereof.

~~5.~~4. The composition of claim 1, wherein the etchant agent is selected from the group consisting of tetraethylammonium hydroxide (TEAH), trimethylphenylammonium hydroxide (TMPAH), tetramethylammonium hydroxide (TMAH), tetrapropylammonium hydroxide (TPAH), tetrabutylammonium hydroxide (TBAH), choline 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), dimethyldipropylammonium hydroxide, diethylenetriamine, monoethanolamine, 1,8-Diazabicyclo(5.4.0)undec-7-ene, triethanolamine, 1-Amino-2-propanol, 3-Morpholinopropylamine, 1-(2-Aminoethyl)Piperazine, N-(2-Hydroxyethyl)-ethylenediamine, 2-(Methylamino)ethanol, and combinations thereof.

~~6.~~5. The composition of claim 1, wherein the etchant agent is selected from the group consisting of tetraethylammonium hydroxide (TEAH), choline hydroxide, tetramethylammonium hydroxide (TMAH), trimethylphenylammonium hydroxide (TMPAH), tetrabutylammonium hydroxide (TBAH), ethyltrimethylammonium, hydroxide, ammonium hydroxide, 1,8-diazabicyclo(5.4.0)undec-7-ene, 1-(2-aminoethyl)piperazine, and combinations thereof.

~~7.~~6. The composition of claim 1 further comprising a weak acid selected from the group consisting of citric acid, oxalic acid, malonic acid, lactic acid, adipic acid, acetic acid, methanesulfonic acid, p-toluenesulfonic acid, and combinations thereof.

~~8.~~7. The composition of claim 1, wherein the oxidizing agent is selected from the group consisting of hydrogen peroxide, ammonium persulfate, peracetic acid, peroxybenzoic acid, oxone ($2KHSO_5.KHSO_4.K_2SO_4$), n-methylmorpholine oxide(NMMO

or NMO), benzoyl peroxide, tetrabutylammonium peroxymonosulfate, ferric chloride, permanganate peroxoborate, periodic acid, iodic acid, vanadium (V) oxide, vanadium(IV, V) oxide, ammonium vanadate, perchlorate, persulfate, ammonium peroxydisulfate, per acetic acid, urea hydroperoxide, nitric acid (HNO_3), ammonium hypochlorite (NH_4ClO), ammonium tungstate ($(NH_4)_{10}H_2(W_2O_7)$), ammonium chlorite (NH_4ClO_2), ammonium chlorate (NH_4ClO_3), ammonium iodate (NH_4IO_3), ammonium perborate (NH_4BO_3), ammonium perchlorate (NH_4ClO_4), ammonium periodate (NH_4IO_3), ammonium persulfate ($(NH_4)_2S_2O_8$), 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 ($(N(CH_3)_4)S_2O_8$), ($(CO(NH_2)_2)H_2O_2$), peracetic acid (CH(CO)OOH), and combinations thereof.

~~9.~~8. The composition of claim 1, wherein the oxidizing agent comprises hydrogen peroxide.

~~10.~~9. The composition of claim 1, wherein the ammonium salt is selected from the group consisting of triammonium citrate, ammonium acetate, ammonium malonate, ammonium adipate, ammonium lactate, ammonium iminodiacetate, ammonium chloride, ammonium bromide, ammonium sulfate, ammonium oxalate, ammonium lactate, ammonium tartrate, ammonium citrate tribasic, ammonium acetate, ammonium carbamate, ammonium carbonate, ammonium benzoate, tetraammonium EDTA, ethylenediaminetetraacetic acid diammonium salt, ammonium succinate, ammonium formate, ammonium 1-H-pyrazole-3-carboxylate, and combinations thereof.

~~11.~~10. The composition of claim 1, wherein the ammonium salt ~~may be~~is selected from the group consisting of ammonium citrate tribasic, ammonium acetate, tetraammonium EDTA, ethylenediaminetetraacetic acid diammonium salt, ammonium chloride, ammonium bromide, and combinations thereof.

~~12.~~11. The composition of claim 1, wherein said solvent is water.

~~13.~~12. The composition of claim 1, wherein the composition further comprises one or more non-aqueous solvents selected from the group consisting of sulfolane, dimethyl sulfoxide (DMSO), dimethyl sulfone($DMSO_2$), DMAC, n-methylpyrrolidone (NMP), diethylene glycol butyl ether, proplyglycol, ethylene glycol, dipropyleneglycolmethyl ether, tripropyleneglycolmethyl ether and combinations thereof.

~~14.~~13. The composition of claim 1 comprising a fluoride source selected from the group consisting of H_2ZrF_6, H_2TiF_6, HPF_6, HF, ammonium fluoride, tetrafluoroboric acid, hexafluorosilicic acid, tetrabutylammonium tetrafluoroborate (TBA-BF_4), ammonium hexafluorosilicate, ammonium hexafluorotitanate, ammonium bifluoride (NH_4HF_2), and tetramethylammonium fluoride (TMAF), and combinations thereof.

~~15.~~14. The composition of claim 1, wherein the composition comprises 1-30 wt percent of the oxidizing agent, 50ppm-15 wt percent of the etchant agent, 10ppm-3 wt percent of the ammonium salt, and at least 45 wt percent solvent.

~~16.~~15. The composition of claim 1 wherein the metal corrosion inhibitor is at least one selected from the group consisting of theophylline~~-~~, sorbitol, 3,4-diaminotoluene, p-anisidine, 4-methyl-o-phenylenediamine, 4-Nitroaniline, 4-carboxy-o-phenylenediamine, 8-aminoquinoline, and 5-amino-2-benzimidazolinone.

~~17.~~16. A cleaning composition for selectively removing at least one of titanium nitride and photoresist etch residue material from the surface of a microelectronic device having same thereon, said cleaning composition comprising

(a) concentrated composition comprising 0.1-30 wt% etchant agent, 50 ppm-5 wt% oxidizing stabilizer selected from HEDTA, 1,3-diaminopropane-N,N,N',N'-tetraacetic acid or gluconic acid, 100ppm-8 wt% ammonium salt, 0.1ppm-5 wt% corrosion inhibitor selected from the group consisting of 2-aminobenzothiazole, 2-mercapto-5-methylbenzimidazole, 8-hydroxyquinoline, 1-thioglycerol, ascorbic acid, sorbitol, maltitol, mannitol, theophylline, caffeine, triton X-100, surfynol-485, decanoic acid, 11-mercaptoundecanoic acid (MUDA), hexylamine, 3,4-diaminotoluene, p-anisidine, 4-Methyl-o-phenylenediamine, 4-Nitroaniline, 4-carboxy-o-phenylenediamine, 8-Aminoquinoline, 5-Amino-2-benzimidazolinone, N,N-dimethyl-p-phenylenediamine, and combinations thereof, 34-99.5 wt% solvent, 0-8 wt% fluoride source and 0-10% weak acid; and

(b) oxidizing agent combined with the concentrated composition in a weight ratio of 99:1 to 1:99.

~~18.~~17. A cleaning composition for selectively removing at least one of titanium nitride and photoresist etch residue material from the surface of a microelectronic device having same thereon, said cleaning composition comprising

(a) concentrated composition comprising 0.1-30 wt% etchant agent, 50 ppm-5 wt% oxidizing stabilizer selected from HEDTA, 1,3-diaminopropane-N,N,N',N'-tetraacetic acid or gluconic acid, 100ppm-8 wt% ammonium salt, 0.1ppm-5 wt% corrosion inhibitor selected from the group consisting of 2-aminobenzothiazole, 2-mercapto-5-methylbenzimidazole, 8-hydroxyquinoline, 1-thioglycerol, ascorbic acid, sorbitol, maltitol, mannitol, theophylline, caffeine, triton X-100, surfynol-485, decanoic acid, 11-mercaptoundecanoic acid (MUDA), hexylamine, 3,4-diaminotoluene, p-anisidine, 4-Methyl-o-phenylenediamine, 4-Nitroaniline, 4-carboxy-o-phenylenediamine, 8-Aminoquinoline, 5-Amino-2-benzimidazolinone, N,N-dimethyl-p-phenylenediamine, and combinations thereof, 34-99.5 wt% solvent, 0-8 wt% fluoride source and 0-10% weak acid;

(b) diluting solvent that is added to the concentrated composition in a weight ratio of 1:100 to 100:1 of the concentrated composition to solvent to make a diluted composition; and

(c) oxidizing agent combined with the diluted composition in a weight ratio of 99:1 to 1:99.

~~19.~~18. A system for selectively removing titanium nitride from a surface of a microelectronic device, comprising:

the semiconductor device comprising the titanium nitride and a second material selected from the group consisting of Cu, Co, low-k dielectric material and combinations thereof,

the composition of claim 1, wherein the titanium nitride and the second material are in direct contact with the composition.

~~20.~~19. A method of selectively removing titanium nitride comprising:

providing a semiconductor device comprising the titanium nitride and a second material selected from the group consisting of Cu, Co, low-k dielectric material;

contacting the semiconductor device with the composition of claim 1; and selectively removing the titanium nitride.

~~21.~~20. A method for preparing a cleaning co~~o~~mposition comprising:

preparing a concentrated composition comprising a solvent, an etchant agent, an ammonium salt, a metal corrosion inhibitor selected from the group consisting of 2-aminobenzothiazole, 2-mercapto-5-methylbenzimidazole, 8-hydroxyquinoline, 1-thioglycerol, ascorbic acid, sorbitol, maltitol, mannitol, theophylline, caffeine, triton X-100, surfynol-485, decanoic acid, 11-mercaptoundecanoic acid (MUDA), hexylamine, 3,4-diaminotoluene, p-anisidine, 4-Methyl-o-phenylenediamine, 4-Nitroaniline, 4-carboxy-o-phenylenediamine, 8-Aminoquinoline, 5-Amino-2-benzimidazolinone, N,N-dimethyl-p-phenylenediamine, and combinations thereof and oxidizing stabilizer selected from HEDTA, 1,3-diaminopropane-N,N,N',N'-tetraacetic acid or gluconic acid, optional fluoride, and optional weak acid;

diluting the concentrated composition with water to form a diluted composition; and

mixing the diluted composition with an oxidizing agent to form a cleaning composition.

~~22.~~21. A method of selectively removing titanium nitride comprising:

contacting a semiconductor device with the cleaning composition ~~prepared according to the method~~ of claim ~~21~~16 or claim 17; and

~~, which results in the selective removal of~~selectively removing the titanium nitride from the semiconductor device.