

CLAIMS

1. An etching composition for selectively removing titanium nitride, comprising:
 - 1) at least one oxidizing agent;
 - 2) at least one chelating agent in an amount of from 0.01% to 1% by weight;
 - 3) at least one metal corrosion inhibitor in an amount of from 0.05% to 1% by weight;
 - 4) at least one organic solvent;
 - 5) at least one amidine base; and
 - 6) water;wherein the composition has a pH from 6.5 to 9.5,
the at least one chelating agent comprises polyaminopolycarboxylic acid, and
the at least one metal corrosion inhibitor comprises a substituted or unsubstituted benzotriazole.
2. The composition of claim 1, wherein the composition has a pH from 6.5 to 9.
3. The composition of claim 1, wherein the at least one oxidizing agent comprises hydrogen peroxide.
4. The composition of claim 1, wherein the composition comprises from 0.1% to 30% by weight of the at least one oxidizing agent.
5. The composition of claim 1, wherein the polyaminopolycarboxylic acid is diethylenetriaminepentaacetic acid.
6. The composition of claim 1, wherein the polyaminopolycarboxylic acid is selected from the group consisting of mono- or polyalkylene polyamine polycarboxylic acids, polyaminoalkane polycarboxylic acids, polyaminoalkanol polycarboxylic acids, and hydroxyalkylether polyamine polycarboxylic acids.
7. The composition of claim 6, wherein the polyaminopolycarboxylic acid is selected from the group consisting of butylenediaminetetraacetic acid, diethylenetriaminepentaacetic acid,

ethylenediaminetetrapropionic acid, triethylenetetraminehexaacetic acid, 1,3-diamino-2-hydroxypropane-N,N,N,N-tetraacetic acid, propylenediaminetetraacetic acid, ethylenediaminetetraacetic acid, trans-1,2-diaminocyclohexane tetraacetic acid, ethylenediamine diacetic acid, ethylenediamine dipropionic acid, 1,6-hexamethylene-diamine-N,N,N,N-tetraacetic acid, N,N-bis(2-hydroxybenzyl)ethylenediamine-N,N-diacetic acid, diaminopropane tetraacetic acid, iminodiacetic acid; 1,4,7,10-tetraazacyclododecane-tetraacetic acid, diaminopropanol tetraacetic acid, and (hydroxyethyl)ethylenediaminetriacetic acid.

8. The composition of claim 1, wherein the composition comprises from 0.1% to 1% by weight of the at least one chelating agent.

9. The composition of claim 1, wherein the substituted or unsubstituted benzotriazole is 5-methyl-1H-benzotriazole.

10. The composition of claim 1, wherein the at least one metal corrosion inhibitor comprises a benzotriazole optionally substituted by at least one substituent selected from the group consisting of alkyl groups, aryl groups, halogen groups, amino groups, nitro groups, alkoxy groups, and hydroxyl groups.

11. The composition of claim 1, wherein the substituted or unsubstituted benzotriazole is selected from the group consisting of benzotriazole, 5-aminobenzotriazole, 1-hydroxybenzotriazole, 5-phenylthiol-benzotriazole, 5-chlorobenzotriazole, 4-chlorobenzotriazole, 5-bromobenzotriazole, 4-bromobenzotriazole, 5-fluorobenzotriazole, 4-fluorobenzotriazole, naphthotriazole, tolyltriazole, 5-phenyl-benzotriazole, 5-nitrobenzotriazole, 4-nitrobenzotriazole, 3-amino-5-mercapto-1,2,4-triazole, 2-(5-amino-pentyl)-benzotriazole, 1-amino-benzotriazole, 5-methyl-1H-benzotriazole, benzotriazole-5-carboxylic acid, 4-methylbenzotriazole, 4-ethylbenzotriazole, 5-ethylbenzotriazole, 4-propylbenzotriazole, 5-propylbenzotriazole, 4-isopropylbenzotriazole, 5-isopropylbenzotriazole, 4-n-butylbenzotriazole, 5-n-butylbenzotriazole, 4-isobutylbenzotriazole, 5-isobutylbenzotriazole, 4-pentylbenzotriazole, 5-pentylbenzotriazole, 4-hexylbenzotriazole, 5-hexylbenzotriazole, 5-methoxybenzotriazole, 5-hydroxybenzotriazole, dihydroxypropylbenzotriazole, 1-[N,N-bis(2-ethylhexyl)aminomethyl]-benzotriazole, 5-t-butyl benzotriazole, 5-(1,1-diimethylpropyl)-benzotriazole, 5-(1,1,3-trimethylbutyl)benzotriazole, 5-n-octyl benzotriazole, and 5-(1,1,3,3-tetramethylbutyl)benzotriazole.

12. The composition of claim 1, wherein the composition comprises from 0.1% to 1% by weight of the at least one metal corrosion inhibitor.
13. The composition of claim 1, wherein the at least one organic solvent comprises a solvent selected from the group consisting of water soluble alcohols, water soluble ketones, water soluble esters, and water soluble ethers.
14. The composition of claim 1, wherein the composition comprises from 1% to 30% by weight of the at least one organic solvent.
15. The composition of claim 1, wherein the at least one amidine base comprises a compound selected from the group consisting of substituted or unsubstituted formamidines, substituted or unsubstituted acetamidines, substituted or unsubstituted benzamidines, diminazen, and compounds containing an amidine group in a fused non-aromatic ring.
16. The composition of claim 15, wherein the compound containing an amidine group in a fused non-aromatic ring is 1,8-diazabicyclo[5.4.0]undec-7-ene or 1,5-diazabicyclo[4.3.0]non-5-ene.
17. The composition of claim 1, wherein the composition comprises from 0.1% to 5% by weight of the at least one amidine base.
18. The composition of claim 1, wherein the composition comprises from 35% to 98% of water.
19. A method, comprising:
contacting a semiconductor substrate containing TiN features with a composition of any of claims 1-18 to remove the TiN features.
20. The method of claim 19, further comprising rinsing the semiconductor substrate with a rinse solvent after the contacting step.

21. The method of claim 20, further comprising drying the semiconductor substrate after the rinsing step.
22. The method of claim 19, wherein the method does not substantially remove Co, SiN, or Cu in the semiconductor substrate.