CLAIMS

What is claimed is:

1. A composition useful for removing residue from a semiconductor substrate, the composition comprising:

from 25% to 80% by weight of water;

from 0.01% to 5% by weight of a fluoride ion source, based on actives;

from 0.01% to 10% by weight of sulfuric acid;

from 1% to 50% by weight of an alkanolamine;

from 1% to 25% by weight of an organic acid,

wherein the pH of the composition is from 7 to 9.

2. A composition useful for removing residue from a semiconductor substrate, the composition comprising:

from 50% to 62.7% by weight of water;

from 9.5% to 15% by weight of a source of fluoride ions, based on actives;

from 2.0% to 8% by weight of sulfuric acid;

from 25% to 30% by weight of an alkanolamine; and

from 0.8% to 2.0% by weight of an organic acid.

3. The composition of either of claims 1-2 further comprising from 0.1% to 15% by weight of a corrosion inhibitor selected from the group consisting of benzotriazole, o-tolyltriazole, m-tolyltriazole, p-tolyltriazole, carboxybenzotriazole, 1-hydroxybenzotriazole, nitrobenzotriazole and dihydroxypropylbenzotriazole.

4. The composition of any of claims 1-3 further comprising a water-miscible organic solvent selected from the group consisting of propylene glycol, glycerol, dimethylacetamide, tetrahydrofuryl alcohol, ethylene glycol, hexylene glycol, and mixtures thereof.

5. The composition of any of claims 1-4 wherein the fluoride ion source is selected from the group consisting of hydrogen fluoride (HF), ammonium fluoride (NH_4F), ammonium hydrogen difluoride (NH_4HF_2), ammonium fluoroborate (NH_4BF_4), boron trifluoride (BF_3), fluoroboric acid (HBF_4), hydrosilicofluoric acid (H_2SiF_6), and a quaternary ammonium fluoride.

6. The composition of claim 5 wherein the fluoride ion source is ammonium fluoride.

7. The composition of claim 5 wherein the fluoride ion source is HF.

8. The composition of claim 5 wherein the fluoride ion source is a quaternary ammonium compound selected from the group consisting of tetramethylammonium fluoride and tetrabutylammonium fluoride.

9. The composition of any of claims 1-8 wherein the organic acid is selected from the group consisting of l-ascorbic acid, oxalic acid, malonic acid, citric acid, acetic acid, imiodiacetic acid, lactic acid, para-toluene sulfonic acid, gallic acid, and mixtures thereof.

10. A composition comprising:

from 5% to 25% by weight of water;

from 10% to 45% by weight of a water-miscible organic solvent selected from the group consisting of propylene glycol, glycerol, dimethylacetamide, tetrahydrofuryl alcohol, ethylene glycol, hexylene glycol, and mixtures thereof;

from 20% to 30% by weight of at least one alkanolamine;

from 5% to 15% by weight of HF;

from 0.5% to 2% by weight of an organic acid is selected from the group consisting of l-ascorbic acid, oxalic acid, malonic acid, citric acid, acetic acid, imiodiacetic acid, lactic acid, para-toluene sulfonic acid, gallic acid, and mixtures thereof;

from 1.5% to 8% by weight of sulfuric acid; and

0.1% of a triazole selected from the group consisting of benzotriazole, o-tolyltriazole, m-tolyltriazole, p-tolyltriazole, carboxybenzotriazole, 1-hydroxybenzotriazole, nitrobenzotriazole and dihydroxypropylbenzotriazole, wherein the composition has a pH of from 7 to 9.

11. The composition of any of claims 1-10 wherein the organic acid is l-ascorbic acid.

12. A composition comprising:

from 50% to 73% by weight of water;

from 20% to 30% by weight of at least one alkanolamine;

from 5% to 15% by weight of HF;
from 0.5% to 2% by weight of L-ascorbic acid; and
from 1.5% to 8% by weight of sulfuric acid; and
0.1% of a triazole selected from the group consisting of benzotriazole, o-tolyltriazole, m-tolyltriazole, p-tolyltriazole, carboxybenzotriazole, 1-hydroxybenzotriazole, nitrobenzotriazole and dihydroxypropylbenzotriazole, wherein the composition has a pH of from 7 to 9.

13. The composition of any of claims 3-12 wherein the triazole is at least one of benzotriazole, o-tolyltriazole, m-tolyltriazole, and p-tolyltriazole.

14. The composition of any of claims 1-13 wherein the alkanolamine is selected from the group consisting of N-methylethanolamine (NMEA), monoethanolamine (MEA), diethanolamine, mono-, di- and triisopropanolamine, 2-(2-aminoethylamino)ethanol, 2-(2-aminoethoxy)ethanol, triethanolamine, N-ethyl ethanolamine, N,N-dimethylethanolamine, N,N-diethyl ethanolamine, N-methyl diethanolamine, N-ethyl diethanolamine, cyclohexylaminediethanol, and mixtures thereof.

15. The composition of claim 14 wherein the alkanolamine is monoethanolamine.

16. The composition of claim 14 wherein the alkonolamine is triethanolamine.

17. The composition of any of claims 4-11 wherein the water-miscible organic solvent is dimethylacetamide.

18. The composition of any of claims 4-11 wherein the water-miscible organic solvent is propylene glycol.

19. The composition of any of claims 4-11 wherein the water-miscible organic solvent is glycerol.

20. A method for removing residue from a semiconductor substrate, the method comprising the steps of:

contacting the semiconductor substrate with a cleaning composition according to any of claims 1 to 19, wherein the semiconductor substrate comprises a porous dielectric material having a dielectric constant;

rinsing the cleaning composition from the semiconductor substrate; and

drying the semiconductor substrate,

wherein the dielectric constant of the porous dielectric material does not increase more than 0.50, wherein the residue comprises a cobalt residue.

21. The method claim 20 wherein the cleaning composition provides a copper etch rate of 4 Å/min or less.