CLAIMS

1. A polishing composition, comprising:

an abrasive;

optionally, a pH adjuster;

a barrier film removal rate enhancer;

a TEOS removal rate inhibitor;

a cobalt removal rate enhancer;

an azole-containing corrosion inhibitor; and

a cobalt corrosion inhibitor, the cobalt corrosion inhibitor being an anionic surfactant comprising one or more phosphate groups and a combination of a six to twenty four carbon alkyl chain and one to eighteen ethylene oxide groups;

wherein the barrier film removal rate enhancer is different from the cobalt removal rate enhancer.

2. The polishing composition of claim 1, wherein the abrasive is selected from the group consisting of alumina, silica, titania, ceria, zirconia, co-formed products of alumina, silica, titania, ceria, or zirconia, coated abrasives, surface modified abrasives, and mixtures thereof.

3. The polishing composition of claim 1, wherein the abrasive is in an amount of from 0.1% to 25% by weight of the composition.

4. The polishing composition of claim 1, wherein the composition comprises the pH adjuster and the pH adjuster is selected from the group consisting of ammonium hydroxide, sodium hydroxide, potassium hydroxide, cesium hydroxide, monoethanolamine, diethanolamine, triethanolamine, methylethanolamine, methyldiethanolamine tetrabutylammonium hydroxide, tetrapropylammonium hydroxide, tetraethylammonium hydroxide, tetramethylammonium hydroxide, ethyltrimethylammonium hydroxide, diethyldimethylammonium hydroxide, dimethyldipropylammonium hydroxide, benzyltrimethylammonium hydroxide, tris(2-hydroxyethyl)methylammonium hydroxide, choline hydroxide, and any combinations thereof.

5. The polishing composition of claim 1, wherein the pH adjuster in an amount of from 0.01% to 10% by weight of the composition.

6. The polishing composition of claim 1, wherein the barrier film removal rate enhancer is an organic acid or a salt thereof selected from the group consisting of gluconic acid, lactic acid, citric acid, tartaric acid, malic acid, glycolic acid, malonic acid, formic acid, oxalic acid, acetic acid, propionic acid, succinic acid, amino acetic acid, phenoxyacetic acid, bicine, phosphoric acid, diglycolic acid, glyceric acid, tricine, benzoic acid, nitrilotriacetic acid, ethylenediaminetetraacetic acid, pentetic acid, diaminocyclohexanetetraacetic acid, ethyl phosphoric acid, cyanoethyl phosphoric acid, phenyl phosphoric acid, vinyl phosphoric acid, poly(vinylphosphonic acid), 1-hydroxyethane-1,1-diphosphonic acid, nitrilotri(methylphosphonic acid), diethylenetriaminepentakis (methylphosphonic acid), N,N,N',N'-ethylenediaminetetrakis(methylene phosphonic acid), n-hexylphosphonic acid, benzylphosphonic acid, phenylphosphonic acid, and salts and mixtures thereof.

7. The polishing composition of claim 1, wherein the barrier film removal rate enhancer is in an amount of from 0.01% to 3% by weight of the composition.

8. The polishing composition of claim 1, wherein the TEOS removal rate inhibitor is an amine containing compound selected from the group consisting of alkanolamines and cationic polymers.

9. The polishing composition of claim 8, wherein the alkanolamine is a secondary or tertiary amine.

10. The polishing composition of claim 9, wherein the alkanolamine is selected from the group consisting of dimethylethanolamine, diethylethanolamine, triethanolamine, dimethylisopropanolamine, triisopropanolamine, diisopropylethanolamine, methyldiethanolamine, ethyldiethanolamine, isopropanoldiethanolamine,

isopropyldiethanolamine, butyldiethanolamine, cyclohexyldiethanolamine, aminopropyl diethanolamine, aminopropyl diisopropanolamine, diethanolamine, diisopropanolamine, methylethanolamine, di-sec-butanolamine, butylethanolamine, N-acetylethanolamine, and mixtures thereof.

11. The polishing composition of claim 8, wherein the TEOS removal rate inhibitor is a cationic polymer.

12. The polishing composition of claim 11, wherein the cationic polymer is selected from the group consisting of polyethyleneimines, polypropyleneimines, chitosans, poly(diallyldimethylammonium salt)s, poly(ester amine)s, poly(amidoamine)s, polylysines, poly(allylamine)s, poly(amino-co-ester)s, polyornithines, poly(2-ethyl-2-oxazoline)s, polyquaterniums, cationic polymers that include at least one hindered amine containing group, and mixtures thereof.

13. The polishing composition of claim 12, wherein the hindered amine containing group is 2,2,6,6-tetramethylpiperidinyl.

14. The polishing composition of claim 11, wherein the cationic polymer has a number average molecular weight between 500 g/mol and 50,000 g/mol.

15. The polishing composition of claim 1, wherein the TEOS removal rate inhibitor in an amount of from 0.001% to 15% by weight of the composition.

16. The polishing composition of claim 1, wherein the cobalt removal rate enhancer is an organic acid or a salt thereof selected from the group consisting of gluconic acid, lactic acid, citric acid, tartaric acid, malic acid, glycolic acid, malonic acid, formic acid, oxalic acid, acetic acid, propionic acid, succinic acid, amino acetic acid, phenoxyacetic acid, bicine, diglycolic acid, glyceric acid, tricine, alanine, glycine, serine, methionine, leucine, histidine, valine,

phenylalanine, proline, glutamine, aspartic acid, glutamic acid, arginine, lysine, tyrosine, benzoic acid, and salts and mixtures thereof.

17. The polishing composition of claim 1, wherein the cobalt removal rate enhancer is in an amount of from 0.01% to 5% by weight of the composition.

18. The polishing composition of claim 1, wherein the azole-containing corrosion inhibitor is selected from the group consisting of tetrazole, benzotriazole, tolyltriazole, 5-methylbenzotriazole, ethyl benzotriazole, propyl benzotriazole, butyl benzotriazole, pentyl benzotriazole, hexyl benzotriazole, dimethyl benzotriazole, chloro benzotriazole, dichloro benzotriazole, chloromethyl benzotriazole, chloroethyl benzotriazole, phenyl benzotriazole, benzyl benzotriazole, aminotriazole, aminobenzimidazole, pyrazole, imidazole, aminotetrazole, adenine, benzimidazole, thiabendazole, 1,2,3-triazole, 1,2,4-triazole, 1-hydroxybenzotriazole, 2-methylbenzothiazole, 2-aminobenzimidazole, 2-amino-5-ethyl-1,3,4-thiadazole, 3,5-diamino-1,2,4-triazole, 3-amino-5-methylpyrazole, 4-amino-4H-1,2,4-triazole, and combinations thereof.

19. The polishing composition of claim 1, wherein the azole-containing corrosion inhibitor in an amount of from 0.001% to 3% by weight of the composition.

20. The polishing composition of claim 1, wherein the cobalt corrosion inhibitor in an amount of from 0.001% to 1% by weight of the composition.

21. The polishing composition of claim 1, wherein the composition comprises:

the abrasive in an amount of from 0.1% to 25% by weight of the composition;

the pH adjuster in an amount of from 0.01% to 10% by weight of the composition;

the barrier film removal rate enhancer in an amount of from 0.01% to 3% by weight of the composition;

the TEOS removal rate inhibitor in an amount of from 0.001% to 15% by weight of the composition;

the cobalt removal rate enhancer is in an amount of from 0.01% to 5% by weight of the composition;

the azole-containing corrosion inhibitor in an amount of from 0.001% to 3% by weight of the composition; and

the cobalt corrosion inhibitor in an amount of from 0.001% to 1% by weight of the composition.

22. The polishing composition of claim 1, wherein the pH of the composition is between 7 and 14.

23. The polishing composition of claim 1, wherein the anionic surfactant comprises one to ten ethylene oxide groups.

24. A polishing composition, comprising:

an abrasive;

optionally, a pH adjuster;

an organic acid or a salt thereof;

an amino acid;

an alkanolamine or a cationic polymer, wherein the alkanolamine is a secondary or tertiary amine and the cationic polymer is selected from the group consisting of polyethyleneimines, polypropyleneimines, chitosans, poly(diallyldimethylammonium salt)s, poly(ester amine)s, poly(amidoamine)s, polylysines, poly(allylamine)s, poly(amino-co-ester)s, polyornithines, polyquaterniums, cationic polymers that include at least one hindered amine containing group, and mixtures thereof;

an azole-containing corrosion inhibitor; and

an anionic surfactant comprising one or more phosphate groups and a combination of a six to twenty four carbon alkyl chain and one to eighteen ethylene oxide groups;

wherein the organic acid is different from the amino acid.

25. The polishing composition of claim 24, wherein the abrasive is selected from the group consisting of alumina, silica, titania, ceria, zirconia, co-formed products of alumina, silica, titania, ceria, or zirconia, coated abrasives, surface modified abrasives, and mixtures thereof.

26. The polishing composition of claim 24, wherein the abrasive is in an amount of from 0.1% to 25% by weight of the composition.

27. The polishing composition of claim 24, wherein the composition comprises the pH adjuster and the pH adjuster is selected from the group consisting of ammonium hydroxide, sodium hydroxide, potassium hydroxide, cesium hydroxide, monoethanolamine, diethanolamine, triethanolamine, methylethanolamine, methyldiethanolamine tetrabutylammonium hydroxide, tetrapropylammonium hydroxide, tetraethylammonium hydroxide, tetramethylammonium hydroxide, ethyltrimethylammonium hydroxide, diethyldimethylammonium hydroxide, dimethyldipropylammonium hydroxide, benzyltrimethylammonium hydroxide, tris(2-hydroxyethyl)methylammonium hydroxide, choline hydroxide, and any combinations thereof.

28. The polishing composition of claim 24, wherein the pH adjuster in an amount of from 0.01% to 10% by weight of the composition.

29. The polishing composition of claim 24, wherein the organic acid or a salt thereof is selected from the group consisting of gluconic acid, lactic acid, citric acid, tartaric acid, malic acid, glycolic acid, malonic acid, formic acid, oxalic acid, acetic acid, propionic acid, succinic acid, amino acetic acid, phenoxyacetic acid, bicine, phosphoric acid, diglycolic acid, glyceric acid, tricine, benzoic acid, nitrilotriacetic acid, ethylenediaminetetraacetic acid, pentetic acid, diaminocyclohexanetetraacetic acid, ethyl phosphoric acid, cyanoethyl phosphoric acid, phenyl phosphoric acid, vinyl phosphoric acid, poly(vinylphosphonic acid), 1-hydroxyethane-1,1-diphosphonic acid, nitrilotri(methylphosphonic acid), diethylenetriaminepentakis (methylphosphonic acid), N,N,N',N'-ethylenediaminetetrakis(methylene phosphonic acid), n-hexylphosphonic acid, benzylphosphonic acid, phenylphosphonic acid, and salts and mixtures thereof.

30. The polishing composition of claim 24, wherein the organic acid or a salt thereof is in an amount of from 0.01% to 3% by weight of the composition.

31. The polishing composition of claim 24, wherein the alkanolamine is a tertiary amine.

32. The polishing composition of claim 24, wherein the alkanolamine is selected from the group consisting of dimethylethanolamine, diethylethanolamine, triethanolamine, dimethylisopropanolamine, triisopropanolamine, diisopropylethanolamine, methyldiethanolamine, ethyldiethanolamine, isopropanoldiethanolamine, isopropyldiethanolamine, butyldiethanolamine, cyclohexyldiethanolamine, aminopropyl diethanolamine, aminopropyl diisopropanolamine, diethanolamine, diisopropanolamine, methylethanolamine, di-sec-butanolamine, butylethanolamine, N-acetylethanolamine, and mixtures thereof.

33. The polishing composition of claim 24, wherein the cationic polymer is selected from the group consisting of polyethyleneimines, chitosans, poly(diallyldimethylammonium salt)s, poly(ester amine)s, poly(amidoamine)s, polylysines, poly(allylamine)s, poly(amino-co-ester)s, polyornithines, poly(2-ethyl-2-oxazoline)s, polyquaterniums, cationic polymers that include at least one hindered amine containing group, and mixtures thereof.

34. The polishing composition of claim 33, wherein the hindered amine containing group is 2,2,6,6-tetramethylpiperidinyl.

35. The polishing composition of claim 24, wherein the cationic polymer has a number average molecular weight between 500 g/mol and 50,000 g/mol.

36. The polishing composition of claim 24, wherein the alkanolamine or cationic polymer is in an amount of from 0.001% to 15% by weight of the composition.

37. The polishing composition of claim 24, wherein the amino acid is selected from the group consisting of amino acetic acid, bicine, tricine, alanine, glycine, serine, methionine, leucine, histidine, valine, phenylalanine, proline, glutamine, aspartic acid, glutamic acid, arginine, lysine, tyrosine, and mixtures thereof.

38. The polishing composition of claim 24, wherein the amino acid is in an amount of from 0.01% to 5% by weight of the composition.

39. The polishing composition of claim 24, wherein the azole-containing corrosion inhibitor is selected from the group consisting of tetrazole, benzotriazole, tolyltriazole, 5-methylbenzotriazole, ethyl benzotriazole, propyl benzotriazole, butyl benzotriazole, pentyl benzotriazole, hexyl benzotriazole, dimethyl benzotriazole, chloro benzotriazole, dichloro benzotriazole, chloromethyl benzotriazole, chloroethyl benzotriazole, phenyl benzotriazole, benzyl benzotriazole, aminotriazole, aminobenzimidazole, pyrazole, imidazole, aminotetrazole, adenine, benzimidazole, thiabendazole, 1,2,3-triazole, 1,2,4-triazole, 1-hydroxybenzotriazole, 2-methylbenzothiazole, 2-aminobenzimidazole, 2-amino-5-ethyl-1,3,4-thiadazole, 3,5-diamino-1,2,4-triazole, 3-amino-5-methylpyrazole, 4-amino-4H-1,2,4-triazole, and combinations thereof.

40. The polishing composition of claim 24, wherein the azole-containing corrosion inhibitor in an amount of from 0.001% to 3% by weight of the composition.

41. The polishing composition of claim 24, wherein the anionic surfactant is in an amount of from 0.001% to 1% by weight of the composition.

42. The polishing composition of claim 24, wherein the composition comprises:

the abrasive in an amount of from 0.1% to 25% by weight of the composition;

the pH adjuster in an amount of from 0.01% to 10% by weight of the composition;

the organic acid or a salt thereof in an amount of from 0.01% to 3% by weight of the composition;

the alkanolamine or cationic polymer is in an amount of from 0.001% to 15% by weight of the composition;

the amino acid is in an amount of from 0.01% to 5% by weight of the composition;

the azole-containing corrosion inhibitor in an amount of from 0.001% to 3% by weight of the composition; and

the anionic surfactant in an amount of from 0.001% to 1% by weight of the composition.

43. The polishing composition of claim 24, wherein the pH of the composition is between 7 and 14.

44. The polishing composition of claim 24, wherein the anionic surfactant comprises one to ten ethylene oxide groups.

45. A method of polishing a substrate, comprising the steps of:

applying the polishing composition of claim 1 to a surface of a substrate, wherein the surface comprises cobalt; and

bringing a pad into contact with the surface of the substrate and moving the pad in relation to the substrate.

46. A method of polishing a substrate, comprising the steps of:

applying the polishing composition of claim 24 to a surface of a substrate, wherein the surface comprises cobalt; and

bringing a pad into contact with the surface of the substrate and moving the pad in relation to the substrate.