CLAIMS:

1. A polishing composition, comprising:

an abrasive;

a pH adjuster;

a low-k removal rate inhibitor;

an azole-containing corrosion inhibitor; and

a ruthenium removal rate enhancer selected from the group consisting of ammonium sulfate, ammonium carbonate, ammonium hydrogen carbonate, ammonium nitrate, ammonium phosphate, ammonium acetate, ammonium thiocyanate, potassium thiocyanate, sodium thiocyanate, nitric acid, sodium nitrate, rubidium nitrate, cesium nitrate, sodium fluoride, potassium fluoride, rubidium fluoride, cesium fluoride, sodium chloride, potassium chloride, rubidium chloride, cesium chloride and mixtures thereof.

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 50% by weight of the composition.

4. The polishing composition of claim 1, wherein the composition further comprises a barrier film removal rate enhancer, 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, peracetic acid, succinic acid, lactic acid, potassium acetate, potassium citrate, amino acetic acid, phenoxyacetic acid, bicine, diglycolic acid, glyceric acid, tricine, alanine, histidine, valine, phenylalanine, proline, glutamine, aspartic acid, glutamic acid, arginine, lysine, tyrosine, benzoic acid, salts thereof, and mixtures thereof.

5. The polishing composition of claim 1, wherein the barrier film removal rate enhancer is in an amount of from 0.002% to 4% by weight of the composition.

6. The polishing composition of claim 1, wherein the low-k removal rate inhibitor is a nonionic surfactant.

7. The polishing composition of claim 6, where the nonionic surfactant is selected from the group consisting of alcohol alkoxylates, alkylphenol alkoxylates, tristyrylphenol alkoxylates, sorbitan ester alkoxylates, polyalkoxylates, polyalkylene oxide block copolymers, tetrahydroxy oligomers, alkoxylated diamines, and mixtures thereof.

8. The polishing composition of claim 1, wherein the low-k removal rate inhibitor is in an amount of from 0.0005% to 5% by weight of the composition.

9. The polishing composition of claim 1, wherein the azole-containing corrosion inhibitor is selected from the group consisting of triazole, tetrazole, benzotriazole, tolyltriazole, 1,2,4-triazole, 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, and mixtures thereof.

10. The polishing composition of claim 1, wherein the azole-containing corrosion inhibitor is in an amount of from 0.0001% to 1% by weight of the composition.

11. The polishing composition of claim 1, wherein the pH adjustor 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.

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

13. The polishing composition of claim 1, wherein the ruthenium removal rate enhancer further comprises ammonium hydroxide, ammonium chloride, ammonium fluoride, ammonium bromide, potassium nitrate, or mixtures thereof.

14. The polishing composition of claim 1, wherein the ruthenium removal rate enhancer is in an amount of from 0.0001% to 5% by weight of the composition.

15. The polishing composition of claim 1, further comprising:
a chelating agent selected from the group consisting of ethylenediaminetetracetic acid, iminodiacetic acid, N-hydroxyethyl-ethylenediaminetriacetic acid, nitrilotriacetic acid, diethylenetriaminepentacetic acid, hydroxyethylethylenediaminetriacetic acid, triethylenetetraaminehexaacetic acid, diaminocycloheanetetraacetic acid, nitrilotrimethylphosphonic acid, ethylenediaminetetra(methylenephosphonic acid), 1-hydroxyl ethylidene-1,1-diphosphonic acid, diethylenetriamine penta (methylene phosphonic acid), and combinations thereof.

16. The polishing composition of claim 15, wherein the chelating agent is in an amount of from 0.001% to 1% by weight of the composition.

17. The polishing composition of claim 1, further comprising an oxidizing agent selected from the group consisting of hydrogen peroxide, orthoperiodic acid, metaperiodic acid, dimesoperiodic acid, diorthoperiodic acid, ammonium periodate, potassium periodate, sodium periodate, ammonium persulfate, iodic acid, iodate salts, perchloric acid, perchloroate salts, hydroxylamine and hydroxylamine salts, and any combinations thereof.

18. The polishing composition of claim 4, wherein the composition comprises:

the abrasive in an amount of from 0.1% to 50% 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 0.002% to 4% by weight of the composition;

the low-k removal rate inhibitor in an amount of from 0.0005% to 5% by weight of the composition;

the azole-containing corrosion inhibitor in an amount of from 0.0001% to 1% by weight of the composition; and

the ruthenium removal enhancer in an amount of from 0.0001% to 5% by weight of the composition.

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

20. A polishing composition, comprising:

an abrasive;

a pH adjuster;

an organic acid or a salt thereof;

a nonionic surfactant;

an azole-containing corrosion inhibitor; and

a compound selected from the group consisting of an ammonium salt, a thiocyanate salt, a halide salt, nitric acid, and a mixture thereof.

21. 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 ruthenium or a hard mask material; and

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