Claims

1. An etching formulation comprising:

(a) at least one phosphorous containing acid or salt thereof;

(b) at least one oxidizing agent;

(c) at least one cationic polymer corrosion inhibitor; and

(d) water.

2. The etching formulation of claim 1, wherein the at least one phosphorous containing acid or salt thereof comprises one or more of phosphoric acid, tetramethylammonium phosphate, tetrabutylammonium phosphate, tetraethylammonium phosphate, tetrapropylammoniumphosphate, etidronic acid, amino trimethylene phosphonic acid, tripolyphosphoric acid, tetrapolyphosphoric acid, pyrophosphoric acid, polymetaphosphoric acid, hypophosphorous acid, phosphorous acid, diphosphorous acid, triphosphorous acid, (aminomethyl)phosphonic acid, (aminoethyl)phosphonic acid, (aminopropyl)phosphonic acid, mono-n-dodecyl phosphate, tetramethylammonium phosphate, tetrabutylammonium phosphate, tetraethylammonium phosphate, tetrapropylammoniumphosphate and combinations thereof.

3. The etching formulation of claim 1, wherein the at least one phosphorous containing acid or salt thereof comprises phosphoric acid.

4. The etching formulation of claim 1, wherein the formulation comprises about 25 wt% to about 50 wt% of phosphoric acid.

5. The etching formulation of claim 1, wherein the at least one oxidizing agent comprises one or more 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 ($(N(CH_3)_4)ClO_2$), tetramethylammionium 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.

6. The etching formulation of claim 1, wherein the at least one oxidizing agent comprises hydrogen peroxide.

7. The etching formulation of claim 1, wherein the formulation comprises about 6 wt% to about 20 wt% of neat hydrogen peroxide.

8. The etching formulation of claim 1, wherein the at least one cationic polymer corrosion inhibitor comprises one or more of polyalkyleneimine and its derivatives, poly(diallyldimethylammonium chloride), diallyldimethylammonium chloride and combinations thereof.

9. The etching formulation of claim 1, wherein the at least one cationic polymer corrosion inhibitor comprises polyethyleneimine.

10. The etching formulation of claim 1, wherein the formulation comprises about 0.001 wt% to about 5 wt% of the at least one cationic polymer corrosion inhibitor.

11. The etching formulation of claim 1, wherein the formulation comprises about 40 wt% to about 50 wt% of water.

12. The etching formulation of claim 1 comprising:

(a) about 30 wt% to about 75 wt% of neat phosphoric acid;

(b) about 1.5 wt% to about 19.5 wt% of neat H_2O_2;

(c) about 0.001 wt% to about 3.0 wt% of at least one neat cationic polymer corrosion inhibitor; and

(d) a balance of water.

13. The etching formulation of claim 1 comprising:

(a) about 30 wt% to about 75 wt% of neat phosphoric acid;

(b) about 6 wt% to about 19.5 wt% of neat H_2O_2;

(c) about 0.001 wt% to about 3.0 wt% of at least one neat cationic polymer corrosion inhibitor; and

(d) a balance of water.

14. The etching formulation of claim 1 comprising:

(a) about 42.5 wt% of neat phosphoric acid;

(b) about 13.5 wt% of neat H_2O_2;

(c) about 0.001 wt% of at least one neat cationic polymer corrosion inhibitor comprising polyethyleneimine; and

(d) a balance of water.

15. The etching formulation of claim 1 comprising:

(a) about 42.5 wt% of neat phosphoric acid;

(b) about 13.5 wt% of neat H_2O_2;

(c) about 0.001 wt% of at least one neat cationic polymer corrosion inhibitor; and

(d) a balance of water.

16. The etching formulation of claim 1 comprising:

(a) about 42.5 wt% of neat phosphoric acid;

(b) about 13.5 wt% of neat H_2O_2;

(c) about 0.01 wt% of at least one neat cationic polymer corrosion inhibitor comprising polyethyleneimine; and

(d) a balance of water.

17. The etching formulation of claim 1 comprising:

(a) about 42.5 wt% of neat phosphoric acid;

(b) about 13.5 wt% of neat H_2O_2;

(c) about 0.01 wt% of at least one neat cationic polymer corrosion inhibitor; and

(d) a balance of water.

18. The etching formulation of claim 1 comprising:

(a) about 42.5 wt% of neat phosphoric acid;

(b) about 13.5 wt% of neat H_2O_2;

(c) about 0.06 wt% of at least one neat cationic polymer corrosion inhibitor; and

(d) a balance of water.

19. The etching formulation of claim 1 comprising:

(a) about 42.5 wt% of neat phosphoric acid;

(b) about 13.5 wt% of neat H_2O_2;

(c) about 0.0525 wt% of at least one neat cationic polymer corrosion inhibitor; and

(d) a balance of water.

20. The etching formulation of claim 1 comprising:

(a) about 42.5 wt% of neat phosphoric acid;

(b) about 13.5 wt% of neat H_2O_2;

(c) about 0.175 wt% of at least one neat cationic polymer corrosion

inhibitor; and

(d) a balance of water.

21. The etching formulation of claim 1 comprising:

(a) about 42.5 wt% of neat phosphoric acid;

(b) about 13.5 wt% of neat H_2O_2;

(c) about 0.525 wt% of at least one neat cationic polymer corrosion inhibitor; and

(d) a balance of water.

22. A method of forming the etching composition of any of claims 1-21 comprising the steps of:

(i) forming a part A composition by combining **(a)** the at least phosphorous containing acid, **(c)** the at least at least cationic polymer corrosion inhibitor, and **(d)** the water;

(ii) combining the part A composition with **(b)** the at least one oxidizing agent.