CLAIMS:

1. An etching composition, comprising:

at least one fluorine-containing acid, the at least one fluorine-containing acid comprising hydrofluoric acid or hexafluorosilicic acid;

at least one oxidizing agent;

at least one organic acid or an anhydride thereof, the at least one organic acid comprising formic acid, acetic acid, propionic acid, or butyric acid;

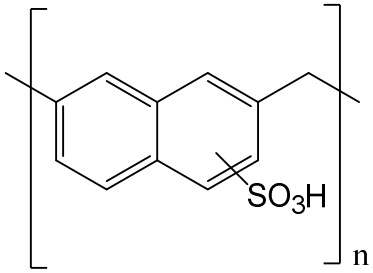
at least one polymerized naphthalene sulfonic acid;

at least one hexafluorosilicate salt;

at least one amine, the at least one amine comprising an amine of formula (I): $N\text{-}R_1R_2R_3$, wherein R_1 is C_1-C_8 alkyl optionally substituted by OH or NH_2, R_2 is H or C_1-C_8 alkyl optionally substituted by OH, and R_3 is C_1-C_8 alkyl optionally substituted by OH; and

water.

2. The composition of claim 1, wherein the at least one polymerized naphthalene sulfonic acid comprises a sulfonic acid having a structure of



in which n is 3 to 6.

3. The composition of claim 1, wherein the at least one polymerized naphthalene sulfonic acid is in an amount of from about 0.005 wt% to about 0.15 wt% of the composition.

4. The composition of claim 1, wherein the amine of formula (I) is diisopropylamine, N-butyldiethanolamine, N-(3-aminopropyl)-diethanolamine, N-

octylglucamine, N-ethylglucamine, N-methylglucamine, or 1-[bis(2-hydroxyethyl)amino]-2-propanol.

5. The composition of claim 4, wherein the at least one amine is in an amount of from about 0.001 wt% to about 0.15 wt% of the composition.

6. The composition of claim 1, wherein the at least one fluorine-containing acid is in an amount of from about 0.05 wt% to about 2 wt% of the composition.

7. The composition of claim 1, wherein the at least one oxidizing agent comprises hydrogen peroxide or peracetic acid.

8. The composition of claim 1, wherein the at least one oxidizing agent is in an amount of from about 5 wt% to about 20 wt% of the composition.

9. The composition of claim 1, wherein the at least one organic acid or an anhydride thereof comprises acetic acid or acetic anhydride.

10. The composition of claim 1, wherein the at least one organic acid or an anhydride thereof is in an amount of from about 30 wt% to about 90 wt% of the composition.

11. The composition of claim 1, wherein the at least one hexafluorosilicate salt comprises ammonium hexafluorosilicate or a tetraalkylammonium hexafluorosilicate.

12. The composition of claim 1, wherein the at least one hexafluorosilicate salt is in an amount of from about 0.01 wt% to about 1 wt% of the composition.

13. The composition of claim 1, wherein the water is in an amount of from about 10 wt% to about 75 wt% of the composition.

14. The composition of claim 1, further comprising at least one organic solvent.

15. The composition of claim 14, wherein the at least one organic solvent comprises an alcohol or an alkylene glycol ether.

16. The composition of claim 15, wherein the at least one organic solvent comprises propylene glycol, hexylene glycol, 1,3-propanediol, or ethylene glycol butyl ether.

17. The composition of claim 14, wherein the at least one organic solvent is in an amount of from about 10 wt% to about 40 wt% of the composition.

18. The composition of claim 1, further comprising at least one inorganic acid.

19. The composition of claim 18, wherein the at least one inorganic acid comprises sulfuric acid or boric acid.

20. The composition of claim 18, wherein the at least one inorganic acid is in an amount of from about 0.1 wt% to about 5 wt% of the composition.

21. The composition of claim 1, wherein the composition has a pH of 1-3.

22. The composition of claim 1, wherein

the at least one fluorine-containing acid comprises hydrofluoric acid and is in an amount of from about 0.05 wt% to about 0.5 wt% of the composition;

the at least one oxidizing agent is in an amount of from about 5 wt% to about 10 wt% of the composition;

the at least one organic acid or an anhydride thereof is in an amount of from about 50 wt% to about 80 wt% of the composition;

the at least one polymerized naphthalene sulfonic acid is in an amount of from about 0.005 wt% to about 0.1 wt% of the composition;

the at least one hexafluorosilicate salt is in an amount of from about 0.01 wt% to about 1 wt% of the composition;

the at least one amine is in an amount of from about 0.001 wt% to about 0.1 wt% of the composition.

23. The composition of claim 22, wherein the at least one oxidizing agent is from about 6 wt% to about 10 wt% of the composition.

24. The composition of claim 22, wherein the at least one organic acid or an anhydride thereof is from about 60 wt% to about 80 wt% of the composition.

25. The composition of claim 22, wherein the at least one polymerized naphthalene sulfonic acid is from about 0.005 wt% to about 0.05 wt% of the composition.

26. The composition of claim 22, wherein the at least one hexafluorosilicate salt is from about 0.05 wt% to about 0.5 wt% of the composition.

27. The composition of claim 22, wherein the at least one amine is from about 0.005 wt% to about 0.05 wt% of the composition.

28. The composition of claim 22, further comprising an inorganic acid.

29. The composition of claim 28, wherein the at least one inorganic acid comprises sulfuric acid.

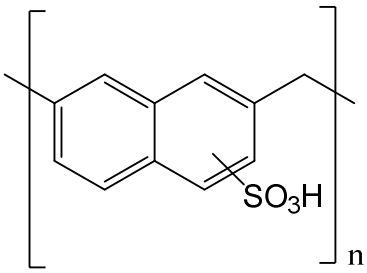
30. The composition of claim 28, wherein the at least one inorganic acid is in an amount of from about 0.1 wt% to about 5 wt% of the composition.

31. The composition of claim 1, wherein the composition comprises:

hydrofluoric acid;

hydrogen peroxide;

acetic acid;

a sulfonic acid having a structure of 

, in which n is 3 to 6;

N-(3-aminopropyl)-diethanolamine;

sulfuric acid;

ammonium hexafluorosilicate; and

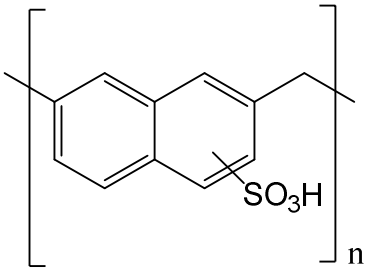
water.

32. The composition of claim 31, wherein the composition comprises:

hydrofluoric acid in an amount of from about 0.05 wt% to about 0.5 wt% of the composition;

hydrogen peroxide in an amount of from about 5 wt% to about 10 wt% of the composition;

acetic acid in an amount of from about 50 wt% to about 80 wt% of the composition;

a sulfonic acid having a structure of 

, in which n is 3 to 6, the sulfonic acid being in an amount of from about 0.005 wt% to about 0.1 wt% of the composition;

N-(3-aminopropyl)-diethanolamine in an amount of from about 0.001 wt% to about 0.1 wt% of the composition;

sulfuric acid in an amount of from about 0.1 wt% to about 5 wt% of the composition;

ammonium hexafluorosilicate in an amount of from about 0.01 wt% to about 1 wt% of the composition; and

water.

33. A method, comprising:

contacting a semiconductor substrate containing a SiGe film with a composition of claim 1 to substantially remove the SiGe film.

34. The method of claim 33, wherein the SiGe film comprises from about 10 wt% to about 25 wt% Ge.

35. The method of claim 33, further comprising rinsing the semiconductor substrate with a rinse solvent after the contacting step.

36. The method of claim 33, further comprising drying the semiconductor substrate after the rinsing step.

37. The method of claim 33, wherein the method does not substantially remove SiN, poly-Si, or SiCO.