

CLAIMS

1. An etching solution suitable for the simultaneous removal of silicon and silicon-
5 germanium from a microelectronic device, which comprises:
water;
an oxidizer;
a buffer composition comprising an amine compound and a polyfunctional organic acid;
a water-miscible solvent; and
10 a fluoride ion source.
2. An etching solution suitable for the simultaneous removal of silicon and silicon-
germanium from a microelectronic device, which comprises:
water;
15 amine;
oxidizer;
buffer composition comprising an ammonium compound and a polyfunctional organic
acid;
water-miscible solvent; and
20 fluoride ion source.
3. The etching solution of claim 1 wherein the oxidizer is elected from the group consisting
of hydrogen peroxide, periodic acid, potassium iodate, potassium permanganate, ammonium
persulfate, ammonium molybdate, ferric nitrate, nitric acid, potassium nitrate, ammonia, and
25 mixtures thereof.
4. The etching solution of claim 2 wherein the oxidizer is elected from the group consisting
of hydrogen peroxide, periodic acid, potassium iodate, potassium permanganate, ammonium
persulfate, ammonium molybdate, ferric nitrate, nitric acid, potassium nitrate, ammonia, and
30 mixtures thereof.
5. The etching solution of claim 4 wherein the oxidizer is hydrogen peroxide.
6. The etching solution of claim 1 wherein the amine compound is an alkanolamine
35 compound selected from the group consisting of N-methylethanolamine (NMEA),

monoethanolamine (MEA), diethanolamine, triethanolamine, triisopropanolamine, 2-(2-aminoethylamino)ethanol, 2-(2-aminoethoxy)ethanol (AEE), triethanolamine, N-ethyl ethanolamine, N,N-dimethylethanolamine, N,N-diethyl ethanolamine, N-methyl diethanolamine, N-ethyl diethanolamine, cyclohexylaminediethanol, diisopropanolamine, 5 cyclohexylaminediethanol, and mixtures thereof.

7. The etching solution of claim 2 wherein the amine compound is an alkanolamine compound selected from the group consisting of N-methylethanolamine (NMEA), monoethanolamine (MEA), diethanolamine, triethanolamine, triisopropanolamine, 2-(2-aminoethylamino)ethanol, 2-(2-aminoethoxy)ethanol (AEE), triethanolamine, N-ethyl 10 ethanolamine, N,N-dimethylethanolamine, N,N-diethyl ethanolamine, N-methyl diethanolamine, N-ethyl diethanolamine, cyclohexylaminediethanol, diisopropanolamine, cyclohexylaminediethanol, and mixtures thereof.

15 8. The etching composition of claim 7 wherein alkanolamine is amino(ethoxy) ethanol (AEE).

9. The etching composition of claim 1 wherein the water-miscible solvent is selected from the group consisting of ethylene glycol, propylene glycol, 1,4-butanediol, tripropylene glycol 20 methyl ether, propylene glycol propyl ether, diethylene glycol n-butyl ether, hexyloxypropylamine, poly(oxyethylene)diamine, dimethylsulfoxide, tetrahydrofurfuryl alcohol, glycerol, alcohols, sulfoxides, or mixtures thereof.

10. The etching solution of claim 2 wherein the water-miscible solvent is selected from the 25 group consisting of ethylene glycol, propylene glycol, 1,4-butanediol, tripropylene glycol methyl ether, propylene glycol propyl ether, diethylene glycol n-butyl ether, hexyloxypropylamine, poly(oxyethylene)diamine, dimethylsulfoxide, tetrahydrofurfuryl alcohol, glycerol, alcohols, sulfoxides, or mixtures thereof.

30 11. The etching solution of claim 2 wherein the water-miscible solvent is butyl diglycerol.

12. The etching solution of claim 1, wherein the amine compound is an alkanolamine and the polyfunctional organic acid is a polyprotic acid having at least three carboxylic acid groups.

13. The etching solution of claim 2, wherein the amine compound is an alkanolamine and the polyfunctional organic acid is a polyprotic acid having at least three carboxylic acid groups.

14. The etching solution of claim 2, wherein the polyfunctional acid is selected from the group consisting of citric acid, 2-methylpropane-1,2,3-tricarboxylic, benzene-1,2,3-tricarboxylic [hemimellitic], propane-1,2,3-tricarboxylic [tricarballic], 1,cis-2,3-propenetricarboxylic acid [aconitic], e.g., butane-1,2,3,4-tetracarboxylic, cyclopentanetetra-1,2,3,4-carboxylic, benzene-1,2,4,5-tetracarboxylic [pyromellitic], benzenepentacarboxylic, and benzenehexacarboxylic [mellitic]), and mixtures thereof.

15. The etching solution of claim 2 wherein the buffer comprises an ammonium salt selected from the group consisting of ammonium chloride, ammonium sulfate, ammonium nitrate, ammonium carbonate, ammonium hypochlorite, ammonium chlorate, ammonium permanganate, ammonium acetate, dibasic ammonium phosphate, diammonium citrate, triammonium citrate (TAC), ammonium sulfamate, ammonium oxalate, ammonium formate, ammonium tartrate, ammonium bitartrate and ammonium glycolate.

16. The etching solution of claim 15 wherein the buffer comprises triammonium citrate (TAC).

17. A method for simultaneously etching silicon and silicon-germanium from a microelectronic device comprising silicon and silicon-germanium, the method comprising the steps of:

contacting the microelectronic device comprising silicon and silicon-germanium with an etching solution comprising water; an oxidizer; a buffer composition comprising an amine compound and a polyfunctional organic acid; a water-miscible solvent; and a fluoride ion source; and

rinsing the microelectronic device after the silicon and silicon-germanium are at least partially removed, wherein the etch rate for silicon relative to silicon-germanium is from about 3:1 to 1:3.

18. A method for simultaneously etching silicon and silicon-germanium from a microelectronic device comprising silicon and silicon-germanium, the method comprising the steps of:

contacting the microelectronic device comprising silicon and silicon-germanium with an etching solution comprising water; an oxidizer; an amine; a buffer composition comprising an ammonium compound and a polyfunctional organic acid; a water-miscible solvent; and a fluoride ion source; and

5 rinsing the microelectronic device after the silicon and silicon-germanium are at least partially removed, wherein the etch rate for silicon relative to silicon-germanium is from about 3:1 to 1:3.

19. The method of claim 18 further comprising the step of drying the microelectronic device.
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20. The method of claim 18 wherein the etch rate for silicon relative to silicon-germanium is from about 2:1 to about 1:2.

21. The method of claim 18 wherein the etch rate for silicon relative to silicon-germanium is
15 substantially 1:1.

22. The method of claim 18 wherein the contacting step is performed at a temperature of from about 25 °C to about 80 °C.