CLAIMS

1. An etching solution suitable for the simultaneous removal of silicon and silicon-germanium from a microelectronic device, which comprises:

water;

an oxidizer;

a buffer composition comprising an amine compound and a polyfunctional organic acid, wherein the amine compound includes at least one alkanolamine;

a water-miscible solvent; and

a fluoride ion source selected from the group consisting of hydrofluoric acid, ammonium fluoride, quaternary ammonium fluoroborates, fluoroboric acid, quaternary ammonium hexafluoroaluminates and a fluoride salt of an aliphatic primary, secondary or tertiary amine having the formula $R^1NR^2R^3R^4F$, wherein R^1,R^2,R^3 and R^4 individually represent H or a C_1-C_4 alkyl group.

2. The etching solution of claim 1, wherein the buffer composition comprises additionally an ammonium compound.

3. The etching solution of claim 1 or 2 wherein the oxidizer is selected 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 mixtures thereof.

4. The etching solution of claim 3 wherein the oxidizer is hydrogen peroxide.

5. The etching solution of any one of claims 1 to 4 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 ethanolamine, N,N-dimethylethanolamine, N,N-diethyl ethanolamine, N-methyl diethanolamine, N-ethyl diethanolamine, cyclohexylaminediethanol, diisopropanolamine, cyclohexylaminediethanol, and mixtures thereof.

6. The etching solution of claim 5 wherein the alkanolamine is amino(ethoxy) ethanol (AEE).

7. The etching solution of any one of claims 1 to 6 wherein the water-miscible solvent is selected from the 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.

8. The etching solution of any one of claims 1 to 6 wherein the water-miscible solvent is selected from the group consisting of ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol monobutyl ether, ethylene glycol dimethyl ether, ethylene glycol diethyl ether, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monopropyl ether, diethylene glycol monoisopropyl ether, diethylene glycol monobutyl ether, diethylene glycol monoisobutyl ether, diethylene glycol monobenzyl ether, diethylene glycol dimethyl ether, diethylene glycol diethyl ether, triethylene glycol monomethyl ether, triethylene glycol dimethyl ether, polyethylene glycol monomethyl ether, diethylene glycol methyl ethyl ether, triethylene glycol methyl ethyl ether, ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, propylene glycol methyl ether acetate, propylene glycol monomethyl ether, propylene glycol dimethyl ether, propylene glycol monobutyl ether, propylene glycol monopropyl ether, dipropylene glycol monomethyl ether (DPM), dipropylene glycol monopropyl ether, dipropylene glycol monoisopropyl ether, dipropylene monobutyl ether, dipropylene glycol diisopropyl ether, tripropylene glycol monomethyl ether, 1-methoxy-2- butanol , 2-methoxy-1-butanol, 2-methoxy-2-methylbutanol, 1,1-dimethoxyethane and 2-(2-butoxyethoxy) ethanol.

9. The etching solution of any one of claims 1 to 6 wherein the water miscible solvent is selected from the list consisting of ethylene glycol dimethyl ether, ethylene glycol diethyl ether, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monopropyl ether, diethylene glycol monoisopropyl ether, diethylene glycol monobutyl ether, diethylene glycol monoisobutyl ether, diethylene glycol monobenzyl ether, diethylene glycol dimethyl ether, diethylene glycol diethyl ether, triethylene glycol monomethyl ether, triethylene glycol dimethyl ether, polyethylene glycol monomethyl ether, diethylene glycol methyl ethyl ether, triethylene glycol methyl ethyl ether, ethylene glycol monomethyl ether acetate, ethylene glycol monoethyl ether acetate, propylene glycol methyl ether acetate, propylene glycol dimethyl ether, dipropylene glycol monomethyl ether, dipropylene glycol monopropyl ether,

dipropylene glycol monoisopropyl ether, dipropylene monobutyl ether, diproplylene glycol diisopropyl ether, tripropylene glycol monomethyl ether, and 2-(2-butoxyethoxy) ethanol.

10. The etching solution of any one of claims 1 to 6 wherein the water-miscible solvent is diethylene glycol monobutyl ether.

11. The etching solution of any one of claims 1 to 6 wherein the water-miscible solvent is butyl diglycol.

12. The etching solution of any one of claims 1 to 11, wherein the polyfunctional organic acid is a polyprotic acid having at least three carboxylic acid groups.

13. The etching solution of any one of claims 1 to 12, wherein the polyfunctional acid is selected from the group consisting of citric acid, 2-methylpropane-1,2,3-triscarboxylic, benzene-1,2,3-tricarboxylic [hemimellitic], propane-1,2,3-tricarboxylic [tricarballylic], 1,cis-2,3-propenetricarboxylic acid [aconitic], 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.

14. The etching solution of any one of claims 1 to 13 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.

15. The etching solution of claim 14 wherein the buffer comprises triammonium citrate (TAC).

16. 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 of any of the preceding claims; 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 3:1 to 1:3.

17. The method of claim 16 further comprising the step of drying the microelectronic device.

18. The method of claim 16 or 17 wherein the etch rate for silicon relative to silicon-germanium is from 2:1 to 1:2.

19. The method of any one of claims 16 to 18 wherein the etch rate for silicon relative to silicon-germanium is substantially 1:1.

20. The method of any one of claims 16 to 19 wherein the contacting step is performed at a temperature of from 25 °C to 100 °C.