CLAIMS

1. An etching solution suitable for the selective removal of silicon nitride over silicon oxide from a microelectronic device at an etch selectivity for silicon nitride over silicon oxide of over about 1000, which comprises:

water;

phosphoric acid solution (aqueous);

from about 1% to about 15% by weight of an organosilicon compound having a chemical structure represented by Formula A:

$$(R^4O)_{3-m}SiR^2R^3{}_m$$

A

wherein R^2 and R^3 are each independently selected from a hydrogen atom, a C_1 to C_{10} linear alkyl group, a C_3 to C_{10} branched alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_5 to C_{12} aryl group, a C_2 to C_{10} linear or branched alkenyl group, a C_2 to C_{10} linear or branched alkynyl group, and a functional group-containing moiety, wherein the functional group is at least one selected from the group consisting of vinyl, epoxy, styryl, methacyloxy, acyloxy, amino, ureide, isocycanate, isocyanurate, and mercapto; R^4 is selected from a C_1 to C_{10} linear alkyl group, a C_3 to C_{10} branched alkyl group, a C_3 to C_{10} cyclic alkyl group, a C_3 to C_{10} linear or branched alkenyl group, and a C_3 to C_{10} linear or branched alkynyl group, a C_5-C_{12} aryl group and wherein m =0, 1, or 2; and

a hydroxyl group-containing water-miscible solvent,

where the term “about” corresponds to ±5% of the stated values.

2. The etching solution of claim 1 wherein the hydroxyl group-containing water-miscible solvent is selected from the group consisting of an alkane diol or polyol, a glycol, an alkoxyalcohol, a saturated aliphatic monohydric alcohol, an unsaturated non-aromatic monohydric alcohol, and an alcohol containing a ring structure.

3. The etching solution of claim 2 wherein the hydroxyl group-containing water-miscible solvent is the alkane diol or polyol and is selected from the group consisting of 2-methyl-1,3-propanediol, 1,3-propanediol, 2,2-dimethyl-1,3-propanediol, 1,4-butanediol, 1,3-butanediol, 1,2-butanediol, 2,3-butanediol, and pinacol.

4. The etching solution of claim 2 wherein the hydroxyl group-containing water-miscible solvent is the glycol and is selected from the group consisting of ethylene glycol, propylene glycol, diethylene glycol, dipropylene glycol, triethylene glycol and tetraethyleneglycol.

5. The etching solution of claim 2 wherein the hydroxyl group-containing water-miscible solvent is the alkoxyalcohol and is selected from the group consisting of 3-methoxy-3-methyl-1-butanol, 3-methoxy-1-butanol, 1-methoxy-2-butanol, and a glycol monoether.

6. The etching solution of claim 2 wherein the hydroxyl group-containing water-miscible solvent is the saturated aliphatic monohydric alcohol and is selected from the group consisting of methanol, ethanol, n-propyl alcohol, isopropyl alcohol, 1-butanol, 2-butanol, isobutyl alcohol, tert-butyl alcohol, 2-pentanol, t-pentyl alcohol, and 1-hexanol.

7. The etching solution of claim 2 wherein the hydroxyl group-containing water-miscible solvent is the unsaturated non-aromatic monohydric alcohol and is selected from the group consisting of allyl alcohol, propargyl alcohol, 2-butenyl alcohol, 3-butenyl alcohol, and 4-penten-2-ol.

8. The etching solution of claim 5 wherein the hydroxyl group-containing water-miscible solvent is the glycol monoether and is selected from the group consisting of ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, ethylene glycol mono n-propyl ether, ethylene glycol monoisopropyl ether, ethylene glycol mono n-butyl ether, diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monobutylether, triethylene glycol monomethyl ether, triethylene glycol monoethyl ether, triethylene glycol monobutyl ether, 1-methoxy-2-propanol, 2-methoxy-1-propanol, 1-ethoxy-2-propanol, 2-ethoxy-1-propanol, propylene glycol mono-n-propyl ether, dipropylene glycol monomethyl ether, dipropylene glycol monoethyl ether, dipropylene glycol mono-n-propyl ether, tripropylene glycol monoethyl ether, tripropylene glycol monomethyl ether and ethylene glycol monobenzyl ether, and diethylene glycol monobenzyl ether.

9. The etching solution of claim 2 wherein the hydroxyl group-containing water-miscible solvent is the alcohol containing a ring structure and is selected from the group consisting of alpha-terpineol, tetrahydrofurfuryl alcohol, furfuryl alcohol, and 1,3-cyclopentanediol.

10. The etching solution of claim 1 wherein the hydroxyl group-containing water-miscible solvent is di-propylene glycol monoethyl ether (DPGME).

11. The etching solution of claim 10 wherein the di-propylene glycol monoethyl ether (DPGME) is present in an amount of from about 5 % by weight to about 15 % by weight, where the term “about” corresponds to ±5% of the stated values.

12. The etching solution of any of claims 1-11 wherein the organosilicon compound is at least one selected from the group consisting of trimethoxymethylsilane, dimethoxydimethylsilane, triethoxymethylsilane, diethoxydimethylsilane, trimethoxysilane, dimethoxymethylsilane, di-isopropyldimethoxysilane, diethoxymethylsilane, dimethoxyvinylmethylsilane, dimethoxydivinylsilane, diethoxyvinylmethylsilane, and diethoxydivinylsilane.

13. The etching solution of claim 12 wherein the organosilicon compound is trimethoxymethylsilane.

14. The etching solution of any of claims 1-13 further comprising silicic acid.

15. A method of selectively enhancing the etch rate of silicon nitride relative to silicon dioxide on a microelectronic device comprising silicon nitride and silicon dioxide, the method comprising the steps of:

contacting the microelectronic device comprising silicon nitride and silicon dioxide with the composition of any of claims 1-14; and

rinsing the microelectronic device after the silicon nitride is at least partially removed, wherein the selectivity of the etch for silicon nitride over silicon oxide is over about 1000, where the term “about” corresponds to ±5% of the stated value.

16. The method of claim 15 further comprising the step of drying the microelectronic device.

17. The method of claim 15 wherein the selectivity of the etch for silicon nitride over silicon oxide is from about 1500 to about 5000, where the term “about” corresponds to ±5% of the stated values.

18. The method of claim 15 wherein the selectivity of the etch for silicon nitride over silicon oxide is from about 2000 to about 5000, where the term “about” corresponds to ±5% of the stated values.

19. The method of claim 15 wherein the contacting step is performed at a temperature of about 160 °C, where the term “about” corresponds to ±5% of the stated value.