

CLAIMS

1. A polishing composition comprising:
at least one abrasive;
at least one nitride removal rate reducing agent comprising a hydrophobic portion and a
5 hydrophilic portion; wherein the hydrophobic portion comprises a C₁₂ to C₄₀ hydrocarbon group
and is separated by zero to ten alkylene oxide groups from the hydrophilic portion;
an acid or a base; and
water;
wherein the polishing composition has a pH of about 2 to about 6.5; and
10 wherein the polishing composition has a ratio of a removal rate for a silicon oxide to a
removal rate for a silicon nitride of at least about 3:1 when polishing a patterned wafer
comprising at least silicon nitride patterns overlayed with at least silicon oxide.
2. The polishing composition of claim 1, wherein the hydrophobic portion contains
15 a C₁₄ to C₃₂ hydrocarbon group.
3. The polishing composition of claim 1, wherein the hydrophobic portion
comprises a C₁₆ to C₂₂ hydrocarbon group.
- 20 4. The polishing composition of claim 1, wherein the hydrophilic portion comprises
at least one group selected from the group consisting of a sulfinite group, a sulfate group, a
sulfonate group, a carboxylate group, a phosphate group, and a phosphonate group.
5. The polishing composition of claim 1, wherein the hydrophilic portion comprises
25 a phosphate group or a phosphonate group.
6. The polishing composition of claim 1, wherein the nitride removal rate reducing
agent is selected from the group consisting of naphthalenesulfonic acid-formalin condensate,
lauryl phosphate, myristyl phosphate, stearyl phosphate, octadecylphosphonic acid, oleyl

phosphate, behenyl phosphate, octadecyl sulfate, lacceryl phosphate, oleth-3-phosphate, and oleth-10-phosphate.

7. The polishing composition of claim 1, wherein the at least one abrasive is
5 selected from the group consisting of alumina, silica, titania, ceria, zirconia, co-formed products thereof, coated abrasives, surface modified abrasives, and mixtures thereof.

8. The polishing composition of claim 1, wherein the at least one abrasive is
10 selected from the group consisting of cationic abrasives, substantially neutral abrasives, and anionic abrasives.

9. The polishing composition of claim 1, wherein the abrasive is a silica-based
abrasive.

15 10. The polishing composition of claim 1, further comprising:
at least one dishing reducing agent;
wherein the at least one dishing reducing agent is a compound comprising at least one
group selected from the group consisting of hydroxyl, sulfate, phosphonate, phosphate,
sulfonate, amine, nitrate, nitrite, carboxylate, and carbonate groups.

20 11. The polishing composition of claim 10, wherein the at least one dishing reducing
agent is at least one selected from the group consisting of a polysaccharide and a substituted
polysaccharide.

25 12. The polishing composition of claim 1, wherein the polishing composition has a
ratio of a removal rate for a silicon oxide to a removal rate for a silicon nitride of at least about
4:1 when polishing a patterned wafer comprising at least silicon nitride patterns overlayed with
at least silicon oxide.

13. The polishing composition of claim 1, wherein the removal rate selectivity of silicon oxide to silicon nitride is at least about 5:1 and at most about 1000:1.

5 14. The polishing composition of claim 1, wherein the composition has a silicon oxide dishing of at most about 1000 Å and at least about 0 Å.

15. The polishing composition of claim 1, wherein the composition has a silicon oxide dishing of at most about 375 Å.

10 16. The polishing composition of claim 1, wherein the composition has a silicon nitride erosion of at most about 500 Å and at least about 0 Å.

15 17. The polishing composition of claim 1, wherein the composition has a silicon nitride erosion of at most about 75 Å.

18. The polishing composition of claim 1, wherein the composition has a planarization efficiency of at least about 14% and at most about 100%.

20 19. The polishing composition of claim 1, wherein the composition has a planarization efficiency at least about 20% and at most about 99.9%.

25 20. The polishing composition of claim 1, wherein the composition forms at most a total of 175 defects on a patterned wafer having a diameter of about 300 mm when polishing the patterned wafer using the composition.

21. A method, comprising:
applying the polishing composition of claim 1 to a substrate having at least silicon nitride and at least silicon oxide on a surface of the substrate; and

bringing a pad into contact with the surface of the substrate and moving the pad in relation to the substrate.

5 22. The method of claim 21 wherein at least one of the silicon nitride and silicon oxide is doped with at least one dopant selected from the group consisting of carbon, nitrogen, oxygen, and hydrogen.

10 23. The method of claim 21, further comprising forming a semiconductor device from the substrate.

24. The method of claim 22, further comprising forming a semiconductor device from the substrate.