CLAIMS

1. A method for treating a semiconductor substrate having a pattern disposed on a surface of the substrate, comprising:

contacting the surface with a surface treatment composition, wherein the surface treatment composition comprises at least one aprotic solvent and at least one surface treatment agent, the at least one surface treatment agent comprises a Si-containing compound, and the surface treatment composition forms a surface treatment layer on the surface such that the surface has a water contact angle of at least about 50 degrees;

wherein the pattern comprises a feature having a dimension of at most about 20 nm.

2. The method of claim 1, wherein the surface comprises SiO_2, SiN, TiN, SiOC, SiON, Si, SiGe, Ge, or W.

3. The method of claim 1, wherein the at least one aprotic solvent is selected from the group consisting of carbonate solvents, lactones, ketones, aromatic hydrocarbons, siloxanes, glycol dialkyl ethers, glycol alkyl ether acetates, esters, ureas, lactams, dimethyl sulfoxide, and N-methyl pyrrolidone.

4. The method of claim 1, wherein the at least one aprotic solvent comprises a carbonate solvent.

5. The method of claim 4, wherein the carbonate solvent is propylene carbonate.

6. The method of claim 1, wherein the at least one aprotic solvent comprises a lactone.

7. The method of claim 6, wherein the lactone is gamma-butyrolactone.

8. The method of claim 1, wherein the at least one aprotic solvent is from about 90 wt% to about 99.9 wt% of the surface treatment composition.

9. The method of claim 1, wherein the Si-containing compound is a disilazane.

10. The method of claim 9, wherein the disilazane is hexamethyldisilazane, heptamethyldisilazane, N-methyl hexamethyldisilazane, 1,3-diphenyltetramethyldisilazane, or 1,1,3,3-tetraphenyl-1,3-dimethyldisilazane.

11. The method of claim 1, wherein the Si-containing compound comprises a trimethylsilyl group.

12. The method of claim 11, wherein the Si-containing compound is N-(trimethylsilyl)dimethylamine, N-(trimethylsilyl)diethylamine, 4-trimethylsilyloxy-3-penten-2-one, bis-trimethylsilylsulfate, methoxytrimethylsilane, N-allyl-N,N-bis(trimethylsilyl)amine, N-(trimethylsilyl)diethylamine, N, N-bis-trimethylsilyl urea, or tris-trimethylsilylphosphite.

13. The method of claim 1, wherein the Si-containing compound is an aminosilane.

14. The method of claim 13, wherein the aminosilane is bis(dimethylamino)dimethylsilane or phenethyldimethyl(dimethylamino)silane.

15. The method of claim 1, wherein the at least one surface treatment agent is from about 0.5 wt% to about 10 wt% of the surface treatment composition.

16. The method of claim 1, wherein the surface treatment composition further comprises a catalyst.

17. The method of claim 16, wherein the catalyst is benzotriazole, phthalic anhydride, acetic anhydride, methanesulfonic acid, sulfuric acid, or trifluoromethanesulfonic acid.

18. The method of claim 16, wherein the catalyst is from about 0.1 wt% to about 1 wt% of the surface treatment composition.

19. The method of claim 1, wherein the surface treatment composition further comprises water, the water is at most about 2 wt% of the surface treatment composition.

20. The method of claim 1, wherein the surface treatment composition is substantially free of water.

21. The method of claim 1, wherein the surface treatment composition forms a surface treatment layer on a surface such that the surface has a water contact angle of at least about 65 degrees.

22. The method of claim 1, further comprising contacting the surface with at least one aqueous cleaning solution before contacting the surface with the surface treatment composition.

23. The method of claims 22, wherein the at least one aqueous cleaning solution comprise water, an alcohol, aqueous ammonium hydroxide, aqueous hydrochloric acid, aqueous hydrogen peroxide, an organic solvent, or a combination thereof.

24. The method of claim 22, further comprising contacting the surface with a first rinsing solution after contacting the surface with the at least one aqueous cleaning solution but before contacting the surface with the surface treatment composition.

25. The method of claim 1, further comprising contacting the surface with a second rinsing solution after contacting the surface with the surface treatment composition.

26. The method of claim 1, further comprising drying the surface.

27. The method of claim 1, further comprising removing the surface treatment layer.

28. A surface treatment composition, comprising:

at least one aprotic solvent, and

at least one surface treatment agent, the surface treatment agent being a Si-containing compound comprising a trimethylsilyl group, an aminosilyl group, or a disilazane group, provided that the disilazane group comprises no Si-H bond,

wherein the surface treatment composition forms a surface treatment layer on a surface such that the surface has a water contact angle of at least about 50 degrees, and the surface has a pattern comprising a feature having a dimension of at most about 20 nm.

29. The composition of claim 28, wherein the at least one aprotic solvent is selected from the group consisting of carbonate solvents, lactones, ketones, aromatic hydrocarbons, siloxanes, glycol dialkyl ethers, glycol alkyl ether acetates, esters, ureas, lactams, dimethyl sulfoxide, and N-methyl pyrrolidone.

30. The composition of claim 29, wherein the at least one aprotic solvent comprises a carbonate solvent.

31. The composition of claim 30, wherein the carbonate solvent is propylene carbonate.

32. The composition of claim 28, wherein the at least one aprotic solvent comprises a lactone.

33. The composition of claim 32, wherein the lactone is gamma-butyrolactone.

34. The composition of claim 28, wherein the at least one aprotic solvent is from about 90 wt% to about 99.9 wt% of the surface treatment composition.

35. The composition of claim 28, wherein the Si-containing compound is a disilazane.

36. The composition of claim 35, wherein the disilazane is hexamethyldisilazane, heptamethyldisilazane, N-methyl hexamethyldisilazane, 1,3-diphenyltetramethyldisilazane, or 1,1,3,3-tetraphenyl-1,3-dimethyldisilazane.

37. The composition of claim 28, wherein the Si-containing compound comprises a trimethylsilyl group.

38. The composition of claim 37, wherein the Si-containing compound is N-(trimethylsilyl)dimethylamine, N-(trimethylsilyl)diethylamine, 4-trimethylsilyloxy-3-penten-2-one, bis-trimethylsilylsulfate, methoxytrimethylsilane, N-allyl-N,N-bis(trimethylsilyl)amine, N-(trimethylsilyl)diethylamine, N, N-bis-trimethylsilyl urea, or tris-trimethylsilylphosphite.

39. The composition of claim 28, wherein the Si-containing compound is an aminosilane.

40. The composition of claim 39, wherein the aminosilane is bis-dimethylaminodimethylsilane or phenethyldimethyl(dimethylamino)silane.

41. The composition of claim 28, wherein the at least one surface treatment agent is from about 0.5 wt% to about 10 wt% of the surface treatment composition.

42. The composition of claim 28, further comprising a catalyst.

43. The composition of claim 42, wherein the catalyst is benzotriazole, phthalic anhydride, acetic anhydride, methanesulfonic acid, sulfuric acid, or trifluoromethanesulfonic acid.

44. The composition of claim 42, wherein the catalyst is from about 0.1 wt% to about 1 wt% of the surface treatment composition.

45. The composition of claim 28, wherein the surface treatment composition further comprises water, the water is at most about 2 wt% of the surface treatment composition.

46. The composition of claim 28, wherein the surface treatment composition is substantially free of water.

47. The composition of claim 28, wherein the surface treatment composition forms a surface treatment layer on a surface such that the surface has a water contact angle of at least about 65 degrees.

48. A surface treatment composition, comprising:

from about 90 wt% to about 99.5 wt% at least one aprotic solvent selected from the group consisting of lactones, ketones, aromatic hydrocarbons, siloxanes, glycol dialkyl ethers, glycol alkyl ether acetates, esters, ureas, lactams, dimethyl sulfoxide, and N-methyl pyrrolidone, and

from about 0.5 wt% to about 10 wt% at least one surface treatment agent, the surface treatment agent is a Si-containing compound comprising a trimethylsilyl group, an aminosilyl group, or a disilazane group, provided that the disilazane group comprises no Si-H bond;

wherein the surface treatment composition forms a surface treatment layer on a surface such that the surface has a water contact angle of at least about 50 degrees, and the surface has a pattern comprising a feature having a dimension of at most about 20 nm.

49. The composition of claim 48, further comprising a catalyst or water.

50. A surface treatment composition, consisting of:

at least one aprotic solvent, and

at least one surface treatment agent, the surface treatment agent being a Si-containing compound comprising a trimethylsilyl group, an aminosilyl group, or a disilazane group, provided that the disilazane group comprises no Si-H bond.

51. The composition of claim 50, wherein the at least one aprotic solvent is selected from the group consisting of carbonate solvents, lactones, ketones, aromatic hydrocarbons, siloxanes, glycol dialkyl ethers, glycol alkyl ether acetates, esters, ureas, lactams, dimethyl sulfoxide, and N-methyl pyrrolidone.

52. The composition of claim 51, wherein the at least one aprotic solvent comprises a carbonate solvent.

53. The composition of claim 52, wherein the carbonate solvent is propylene carbonate.

54. The composition of claim 50, wherein the at least one aprotic solvent comprises a lactone.

55. The composition of claim 54, wherein the lactone is gamma-butyrolactone.

56. The composition of claim 50, wherein the at least one aprotic solvent is from about 90 wt% to about 99.9 wt% of the surface treatment composition.

57. The composition of claim 50, wherein the Si-containing compound is a disilazane.

58. The composition of claim 57, wherein the disilazane is hexamethyldisilazane, heptamethyldisilazane, N-methyl hexamethyldisilazane, 1,3-diphenyltetramethyldisilazane, or 1,1,3,3-tetraphenyl-1,3-dimethyldisilazane.

59. The composition of claim 50, wherein the Si-containing compound comprises a trimethylsilyl group.

60. The composition of claim 59, wherein the Si-containing compound is N-(trimethylsilyl)dimethylamine, N-(trimethylsilyl)diethylamine, 4-trimethylsilyloxy-3-penten-2-one, bis-trimethylsilylsulfate, methoxytrimethylsilane, N-allyl-N,N-bis(trimethylsilyl)amine, N-(trimethylsilyl)diethylamine, N, N-bis-trimethylsilyl urea, or tris-trimethylsilylphosphite.

61. The composition of claim 50, wherein the Si-containing compound is an aminosilane.

62. The composition of claim 61, wherein the aminosilane is bis-dimethylaminodimethylsilane or phenethyldimethyl(dimethylamino)silane.

63. The composition of claim 50, wherein the at least one surface treatment agent is from about 0.5 wt% to about 10 wt% of the surface treatment composition.

64. The composition of claim 50, wherein the composition consists of:

the at least one aprotic solvent in an amount of from about 90 wt% to about 99.5 wt% of the composition, wherein the at least one aprotic solvent is selected from the group consisting of lactones, ketones, aromatic hydrocarbons, siloxanes, glycol dialkyl ethers, glycol alkyl ether acetates, esters, ureas, lactams, dimethyl sulfoxide, and N-methyl pyrrolidone, and

the at least one surface treatment agent in an amount of from about 0.5 wt% to about 10 wt% of the composition.