CLAIMS:

1. A method for treating a semiconductor substrate in which a pattern is arranged on a surface of a wafer, wherein

a surface treatment composition is brought into contact with the surface to form a surface treated layer such that a value of a water contact angle of the surface treated layer is 50 degrees or more, the surface treatment composition comprises: at least one solvent comprising a carboxylic acid; at least one trialkylsilyl compound selected from the group consisting of trialkylsilyl alkylsulfonate, trialkylsilyl arylsulfonate, trialkylsilyl trifluoroacetate, trialkylsilyl trichloroacetate, and trialkylsilyl tribromoacetate; and at least one sulfonic acid or salt thereof,

the surface treatment composition substantially does not comprise propylene glycol methyl ether acetate, and substantially does not comprise an additional Si-containing compound other than the at least one trialkylsilyl compound, and the pattern comprises a feature of a dimension of 20 nm or less.

2. The method according to claim 1, wherein the at least one trialkylsilyl compound comprises an SiR_3 group, where each R is independently a C_1 to C_{16} alkyl or a C_1 to C_{16} haloalkyl.

3. The method according to claim 1, wherein the at least one trialkylsilyl compound comprises a trimethylsilyl group, a triethylsilyl group, a tripropylsilyl group, or a tributylsilyl group.

4. The method according to claim 1, wherein the at least one trialkylsilyl compound comprises a trialkylsilyl methanesulfonate, trialkylsilyl trifluoromethanesulfonate, trialkylsilyl perfluorobutanesulfonate, trialkylsilyl p-toluenesulfonate, trialkylsilyl benzenesulfonate, trialkylsilyl trifluoroacetate, trialkylsilyl trichloroacetate, or trialkylsilyl tribromoacetate.

5. The method according to claim 1, wherein the at least one trialkylsilyl compound is 0.1 wt% to 15 wt% of the surface treatment composition.

6. The method according to claim 1, wherein the at least one solvent further comprises a solvent selected from the group consisting of anhydrides, nitriles, glycol ethers, glycol ether acetates, alkanes, aromatic hydrocarbons, sulfones, sulfoxide, ketones, aldehydes, esters, lactams, lactones, acetals, hemiacetals, and ethers.

7. The method according to claim 1, wherein the at least one solvent comprises acetic anhydride, propionic anhydride, trifluoroacetic anhydride, acetonitrile, C_6 to C_{16} alkane, toluene, xylene, mesitylene, tetraethylene glycol dimethyl ether, propylene glycol dimethyl ether, ethylene glycol dimethyl ether, dipropylene glycol dimethyl ether, diethylene glycol dimethyl ether, diethylene glycol diethyl ether, dipropylene glycol dibutyl ether, n-dibutyl ether, anisole, dimethyl sulfone, dimethyl sulfoxide, sulfolane, propylene carbonate, methyl ethyl ketone, cyclohexanone, n-butyl acetate, hexyl acetate, benzyl acetate, amyl acetate, ethyl propionate, ethyl butyrate, propyl propionate, methyl butyrate, acetic acid, formic acid, trifluoroacetic acid, isobutyl methyl ketone, N-methyl-pyrrolidone, hydrofluoroether, or a combination thereof.

8. The method according to claim 1, wherein the at least one solvent is 1 wt% to 99 wt% of the surface treatment composition.

9. The method according to claim 1, wherein the surface treatment composition substantially does not comprise water.

10. The method according to claim 1, wherein the surface treatment composition comprises the at least one trialkylsilyl compound and the at least one solvent.

11. The method according to claim 1, wherein the surface treatment composition has a flash point of 10°C or more.

12. The method according to claim 1, further comprising bringing the surface into contact with at least one aqueous cleaning solution before bringing the surface into contact with the surface treatment composition.

13. The method according to claim 12, wherein the at least one aqueous cleaning solution comprises water, an alcohol, an aqueous ammonium hydroxide solution, an aqueous hydrochloric acid solution, an aqueous hydrogen peroxide solution, an organic solvent, or a combination thereof.

14. The method according to claim 12, further comprising bringing the surface into contact with a first rinsing liquid after bringing the surface into contact with the at least one aqueous cleaning solution and before bringing the surface into contact with the surface treatment composition.

15. The method according to claim 1, further comprising bringing the surface into contact with at least a second rinsing liquid after bringing the surface into contact with the surface treatment composition.

16. The method according to claim 1, further comprising drying the surface.

17. The method according to claim 1, further comprising removing the surface treated layer.

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

19. A surface treatment composition comprising:

at least one trialkylsilyl compound of an amount of 0.1 wt% to 15 wt% of the surface treatment composition, the at least one trialkylsilyl compound selected from the

group consisting of trialkylsilyl alkylsulfonate, trialkylsilyl arylsulfonate, trialkylsilyl trifluoroacetate, trialkylsilyl trichloroacetate, and trialkylsilyl tribromoacetate;

at least one solvent of an amount of 1 wt% to 99 wt% of a surface treatment composition, the at least one solvent comprising carboxylic acid; and

at least one sulfonic acid or salt thereof, wherein

the surface treatment composition substantially does not comprise propylene glycol methyl ether acetate, and substantially does not comprise an additional Si-containing compound other than the at least one trialkylsilyl compound.

20. The surface treatment composition according to claim 19, wherein the at least one trialkylsilyl compound comprises an SiR_3 group, where each R is independently a C_1 to C_{16} alkyl or a C_1 to C_{16} haloalkyl.

21. The surface treatment composition according to claim 19, wherein the at least one trialkylsilyl compound comprises a trimethylsilyl group, a triethylsilyl group, a tripropylsilyl group, or a tributylsilyl group.

22. The surface treatment composition according to claim 19, wherein the at least one trialkylsilyl compound comprises a trialkylsilyl methanesulfonate, trialkylsilyl trifluoromethanesulfonate, trialkylsilyl perfluorobutanesulfonate, trialkylsilyl p-toluenesulfonate, trialkylsilyl benzenesulfonate, trialkylsilyl trifluoroacetate, trialkylsilyl trichloroacetate, or trialkylsilyl tribromoacetate.

23. The surface treatment composition according to claim 19, wherein the at least one trialkylsilyl compound is 1 wt% to 10 wt% of the surface treatment composition.

24. The surface treatment composition according to claim 19, wherein the at least one solvent further comprises a solvent selected from the group consisting of anhydrides, nitriles, glycol ethers, glycol ether acetates, alkanes, aromatic hydrocarbons,

sulfones, sulfoxide, ketones, aldehydes, esters, lactams, lactones, acetals, hemiacetals, and ethers.

25. The surface treatment composition according to claim 19, wherein the at least one solvent comprises acetic anhydride, propionic anhydride, trifluoroacetic anhydride, acetonitrile, C_6 to C_{16} alkane, toluene, xylene, mesitylene, tetraethylene glycol dimethyl ether, propylene glycol dimethyl ether, ethylene glycol dimethyl ether, dipropylene glycol dimethyl ether, diethylene glycol dimethyl ether, diethylene glycol diethyl ether, dipropylene glycol dibutyl ether, n-dibutyl ether, anisole, dimethyl sulfone, dimethyl sulfoxide, sulfolane, propylene carbonate, methyl ethyl ketone, cyclohexanone, n-butyl acetate, hexyl acetate, benzyl acetate, amyl acetate, ethyl propionate, ethyl butyrate, propyl propionate, methyl butyrate, acetic acid, formic acid, trifluoroacetic acid, isobutyl methyl ketone, N-methyl-pyrrolidone, hydrofluoroether, or a combination thereof.

26. The surface treatment composition according to claim 19, wherein the at least one solvent is 85 wt% to 99 wt% of the surface treatment composition.

27. The surface treatment composition according to claim 19, wherein the surface treatment composition substantially does not comprise water.

28. The surface treatment composition according to claim 19, wherein the surface treatment composition comprises the at least one trialkylsilyl compound and the at least one solvent.

29. The surface treatment composition according to claim 19, wherein the surface treatment composition has a flash point of 10°C or more.

30. The surface treatment composition according to claim 19, wherein the surface treatment composition forms a surface treated layer on the surface such that a water contact angle of the surface treated layer is 50 degrees or more.

31. An article (article) comprising

a semiconductor substrate and

the surface treatment composition according to any one of claims 19 to 30 supported by the semiconductor substrate.

32. The article (article) according to claim 31, wherein

the semiconductor substrate is a silicon wafer, a copper wafer, a silicon dioxide wafer, a silicon nitride wafer, a silicon oxynitride wafer, a carbon-doped silicon oxide wafer, a SiGe wafer, or a GaAs wafer.