CLAIMS

1. A method, comprising:

a. providing a substrate having a surface, a surface neutralization layer, a block copolymer, in which the block copolymer forms nanometer scale patterns, and a top coat;

b. treating the substrate surface with the surface neutralization layer under conditions such that a first layer is created;

c. coating the surface neutralization layer with block copolymer under conditions such that a second layer on the surface is created comprising a block copolymer film, and

d. coating the block copolymer with a top coat, in which the top coat is dissolved in a liquid comprised of a mixture of any two or more of the group consisting of water, alcohol and organic solvent, in which the liquid further contains an amine base, so as to create a third layer on the surface, in which the third layer enables the orientation of the block copolymer domains perpendicular to the plane of the film by thermal annealing alone.

2. A method according to Claim1, in which thermal annealing in the absence of the top coat layer does not produce perpendicular features.

3. A method according to Claim1, in which a top coat of step d) is in a solvent or solvent mixture that will not damage, dissolve, or substantially swell the block copolymer.

4. A method according to Claim 1, in which the top coat of step d) is in a solvent that reacts with the top coat.

5. A method according to Claim 1, in which the top coat of step d) is in a solvent mixture, and the solvent mixture contains a component that reacts with the top coat.

6. A method, comprising:

a. providing a substrate having a surface, a surface neutralization layer, a block copolymer, in which the block copolymer forms nanometer scale patterns, and a top coat;

b. treating the substrate surface with the surface neutralization layer under conditions such that a first layer is created;

c. coating the surface neutralization layer with block copolymer under conditions such that a second layer on the surface is created comprising a block copolymer film, and

d. coating the block copolymer with a top coat, in which the top coat is dissolved in a liquid comprised of a mixture of any two or more of the group consisting of water, alcohol and organic solvent, in which the liquid further contains an alkyl ammonium hydroxide base, so as to create a third layer on the surface, in which the third layer enables the orientation of the block copolymer domains perpendicular to the plane of the film by thermal annealing alone.

7. A method according to Claim 1, in which the base comprises trimethylamine.

8. A method according to Claim 1, in which the base comprises a mixture of a salt and an amine.

9. A method according to Claim 4, in which the reacted top coat is re-isolated.

10. A method according to Claim 1, in which the dissolved top coat is re-isolated.

11. A method according to Claim 10, in which the re-isolated top coat is used again in a method according to claim 1.

12. A method according to Claim 10, in which the top coat is re-isolated by one or more techniques selected from the group consisting of precipitation, evaporation and distillation.

13. A method according to Claim 1, further comprising after step d) thermal annealing.

14. A method according to Claim 13, further comprising removing the top coat from the block copolymer with stripping solvent that does not damage, dissolve, or significantly swell the block copolymer.

15. A method according to Claim 3, in which the top coat comprises an anhydride.

16. A method according to Claim 15, in which the anhydride derives from maleic anhydride.

17. A method according to Claim 1, in which the substrate is selected from the group consisting of silicon, silicon oxide, glass, surface-modified glass, plastic, ceramic, transparent substrates, flexible substrates, and substrates used in roll-to-roll processing.

18. A method according to Claim 1, in which the block copolymer is comprised of plurality of different blocks.

19. A method according to Claim 18, in which the block copolymer comprises at least one block that etches at a different rate than the other block(s).

20. A method according to Claim 18, in which the block copolymer comprises silicon in at least one block.

21. A method according to Claim 18, in which the block copolymer is poly(styrene-block-4-trimethylsilylstyrene-block-styrene).

22. A method according to Claim 13, in which the thermal annealing creates block copolymer domains perpendicular to the plane of the film.

23. A method according to Claim 22, in which the morphology of the domains is selected from the group consisting of lamellar and cylindrical.

24. A method according to Claim 13, in which the thermal annealing is performed under conditions selected from the group consisting of an air environment, an environment of inert gas, reduced pressure, and increased pressure.

25. A method according to Claim 2, in which the surface neutralization layer comprises components selected from the group consisting of cross-linked polymer, brushes, self-assembled monolayers, chemically modified surfaces, physically modified surfaces, and thermally cured surfaces.

26. A method, comprising:

a. providing a substrate having a surface, a surface neutralization layer, a block copolymer that forms nanometer scale patterns, and a top coat;

b. treating the substrate surface with the surface neutralization layer under conditions such that a first layer is created;

c. coating the surface neutralization layer with block copolymer under conditions such that a second layer on the surface is created comprising a block copolymer film; and

d. coating the block copolymer with a top coat, in which the top coat is dissolved in trimethylamine, so as to create a third layer on the surface;

e. treating the third layer under conditions which enable the orientation of block copolymer features perpendicular to the plane of the film.

27. A method according to Claim 26, in which the treating of step e) comprises thermal annealing.

28. A method according to Claim 27, in which thermal annealing in the absence of the top coat layer does not produce perpendicular features.

29. A method according to Claim 26, in which the coating comprises spin coating.