CLAIMS

1. A nanoimprint lithography method comprising:

disposing a pretreatment composition on a substrate to form a liquid pretreatment coating on the substrate, wherein the pretreatment composition comprises a polymerizable component;

disposing discrete portions of imprint resist on the liquid pretreatment coating, each discrete portion of the imprint resist covering a target area of the substrate, wherein the imprint resist is a polymerizable composition;

forming a composite polymerizable coating on the substrate as each discrete portion of the imprint resist spreads beyond its target area, wherein the composite polymerizable coating comprises a mixture of the pretreatment composition and the imprint resist;

contacting the composite polymerizable coating with a nanoimprint lithography template; and

polymerizing the composite polymerizable coating to yield a composite polymeric layer on the substrate,

wherein the interfacial surface energy between the liquid pretreatment composition and air exceeds the interfacial surface energy between the imprint resist and air or between at least a component of the imprint resist and air.

2. The method of claim 1, wherein the difference between the interfacial surface energy between the pretreatment composition and air and the interfacial surface energy between the imprint resist and air is in a range of 0.5 mN/m to 25 mN/m, 0.5 mN/m to 15 mN/m, or 0.5 mN/m to 7 mN/m; and/or wherein the interfacial surface energy between the imprint resist and air is in a range of 20 mN/m to 60 mN/m, 28 mN/m to 40 mN/m, or 32 mN/m to 35 mN/m; and/or wherein the interfacial surface energy between the pretreatment composition and air is in a range of 30 mN/m to 45 mN/m.

3. The method of claim 1, wherein the viscosity of the pretreatment composition is in a range of 1 cP to 200 cP, 1 cP to 100 cP, or 1 cP to 50 cP at 23°C; and/or wherein the viscosity of the imprint resist is in a range of 1 cP to 50 cP, 1 cP to 25 cP, or 5 cP to 15 cP at 23°C.

4. The method of claim 1, wherein the pretreatment composition comprises a monomer; and/or wherein the pretreatment composition comprises a monofunctional, difunctional, or multifunctional acrylate monomer.

5. The method of claim 1, wherein the imprint resist comprises:

0 wt% to 80 wt%, 20 wt% to 80 wt%, or 40 wt% to 80 wt% of one or more monofunctional acrylates;

20 wt% to 98 wt% of one or more difunctional or multifunctional acrylates;

1 wt% to 10 wt% of one or more photoinitiators; and

1 wt% to 10 wt% of one or more surfactants.

6. The method of claim 1, wherein the polymerizable component of the pretreatment composition and a polymerizable component of the imprint resist react to form a covalent bond during the polymerizing of the composite polymerizable coating; and/or wherein the pretreatment composition and the imprint resist each comprises a monomer having a common functional group.

7. The method of claim 1, wherein disposing the pretreatment composition on the nanoimprint lithography substrate comprises spin coating the pretreatment composition on the nanoimprint lithography substrate; and/or wherein a discrete portion of the imprint resist contacts at least one other discrete portion of the imprint resist, forming a boundary between the two discrete portions before the composite polymerizable coating is contacted with the nanoimprint lithography template.

8. A nanoimprint lithography stack formed by the method of claim 1, wherein the nanoimprint lithography stack comprises the composite polymeric layer on the substrate.

9. A method for manufacturing a device, the method comprising the nanoimprint lithography method of claim 1.

10 The device formed by the method of claim 9.

11. A nanoimprint lithography kit comprising:

a pretreatment composition; and

an imprint resist;

wherein the pretreatment composition comprises a polymerizable component, the imprint resist is a polymerizable composition, and the interfacial surface energy between the pretreatment composition and air exceeds the interfacial surface energy between the imprint resist and air or between at least a component of the imprint resist and air.

12. A method for pretreating a nanoimprint lithography substrate, the method comprising:

coating the substrate with a pretreatment composition, wherein the pretreatment composition comprises a polymerizable component;

disposing discrete portions of an imprint resist on the pretreatment composition, wherein the imprint resist disposed in discrete portions on the pretreatment composition spreads more rapidly than the same imprint resist disposed on the same substrate in the absence of the pretreatment composition; and

contacting the imprint resist with a nanoimprint lithography template after a defined length of time has elapsed between the disposing of the discrete portions of the imprint resist on the pretreatment composition and the contacting of the imprint resist with the nanoimprint lithography template, wherein, upon contacting of the imprint resist with the nanoimprint lithography template, interstitial voids between the discrete portions of the imprint resist disposed on the pretreatment composition are smaller in volume than interstitial voids between the same imprint resist disposed on the same substrate in the absence of the pretreatment composition when the defined length of time has elapsed between the disposing of the discrete portions of the imprint resist on the substrate in the absence of the pretreatment composition.

13. The method of claim 12, wherein the pretreatment composition is free of a polymerization initiator.

14. A nanoimprint lithography stack comprising:

a nanoimprint lithography substrate; and

a composite polymeric layer formed on a surface of the nanoimprint lithography substrate,

wherein the chemical composition of the composite polymeric layer is non-uniform, and comprises a plurality of center regions separated by boundaries, wherein the chemical composition of the composite polymeric layer at the boundaries differs from the chemical composition of the composite polymeric layer at the interior of the center regions.

15. The nanoimprint lithography stack of claim 14, wherein the center regions and the boundaries of the polymeric layer are formed from an inhomogeneous mixture of a pretreatment composition and an imprint resist, wherein a polymerizable component of the imprint resist and a polymerizable component of the pretreatment composition react to form a covalent bond during formation of the composite polymeric layer.

16. An imprint method comprising:

disposing a discrete portion of an imprint resist on a liquid pretreatment coating on a substrate such that the discrete portion of the imprint resist spreads on the liquid pretreatment coating to yield a spread imprint resist, wherein the liquid pretreatment coating comprises a polymerizable component and the imprint resist is a polymerizable composition;

contacting the spread imprint resist with a template; and

polymerizing the spread imprint resist and the liquid pretreatment coating to yield a polymeric layer on the substrate;

wherein a surface tension of the liquid pretreatment coating exceeds a surface tension of the imprint resist.

17. The imprint method according to claim 16, wherein the liquid pretreatment coating is free of a polymerization initiator.

18. The imprint method according to claim 16, wherein the spread imprint resist and the liquid pretreatment coating form a composite polymerizable coating before the contacting the spread imprint resist with the template.

19. The imprint method according to claim 16, further comprising separating the template from the polymeric layer.

20. The imprint method according to claim 16, wherein a thickness of the liquid pretreatment coating on the substrate is between 1 nm and 15 nm.

21. The imprint method according to claim 16, wherein the surface tension of the liquid pretreatment coating exceeds the surface tension of the imprint resist by 0.5 mN/m to 25 mN/m.

22. A method for manufacturing a semiconductor device, the method comprising:

providing a liquid pretreatment coating on a substrate, wherein the liquid pretreatment coating comprises a polymerizable component;

disposing a discrete portion of an imprint resist on the liquid pretreatment coating such that the discrete portion of the imprint resist spreads on the liquid pretreatment coating to yield a spread imprint resist, wherein the imprint resist is a polymerizable composition, and a surface tension of the liquid pretreatment coating exceeds a surface tension of the imprint resist;

contacting the spread imprint resist with a template;

polymerizing the spread imprint resist and the liquid pretreatment coating to yield a polymeric layer on the substrate;

separating the template from the polymeric layer; and

etching the substrate via the polymeric layer.

23. The method according to claim 22, wherein:

providing the liquid pretreatment coating comprises coating the substrate using spin-coating, dip coating, chemical vapor deposition (CVD), or physical vapor deposition (PVD), and further comprising:

processing the substrate to yield the polymeric layer on the substrate using an imprint lithography system; and

etching the substrate using reactive ion etching or high-density etching.