CLAIMS

What is claimed is:

1. An electrostatic chuck comprising:

a surface layer activated by a voltage in an electrode to form an electric charge to electrostatically clamp a substrate to the electrostatic chuck, the surface layer including a plurality of protrusions comprising a photo-patternable polymer and a charge control layer to which the plurality of polymer protrusions adhere, the plurality of polymer protrusions extending to a height above portions of the charge control layer surrounding the plurality of polymer protrusions to support the substrate upon the plurality of polymer protrusions during electrostatic clamping of the substrate.

2. An electrostatic chuck according to Claim 1, wherein the photo-patternable polymer comprises a photo-patternable polymer that is liquid at room temperature prior to baking.

3. An electrostatic chuck according to Claim 1, wherein the photo-patternable polymer comprises a photo-patternable polymer that is solid at room temperature prior to baking.

4. An electrostatic chuck according to Claim 1, wherein the photo-patternable polymer comprises an epoxy based photo-patternable polymer.

5. An electrostatic chuck according to Claim 1, wherein the photo-patternable polymer comprises at least one of a polyimide based photo-patternable polymer and a benzocyclobutene based photo-patternable polymer.

6. An electrostatic chuck according to Claim 1, wherein the charge control layer comprises silicon carbide.

7. An electrostatic chuck according to Claim 1, wherein the charge control layer comprises diamond like carbon.

8. An electrostatic chuck according to Claim 1, wherein the charge control layer comprises a surface resistivity of between about 10^8 ohms per square to about 10^{11} ohms per square.

9. An electrostatic chuck according to Claim 1, wherein the polymer protrusions comprise a height of between about 3 microns and about 12 microns.

10. An electrostatic chuck according to Claim 1, wherein the polymer protrusions comprise a diameter of about 900 microns.

11. An electrostatic chuck according to Claim 1, further comprising a gas seal ring comprising a photo-patternable polymer.

12. An electrostatic chuck according to Claim 11, wherein the gas seal ring comprises at least one of an epoxy based photo-patternable polymer, a benzocyclobutene based photo-patternable polymer and a polyimide based photo-patternable polymer.

13. An electrostatic chuck according to Claim 1, wherein the plurality of polymer protrusions comprise a surface roughness of between about 0.02 μm and about 0.05 μm.

14. An electrostatic chuck according to Claim 1, wherein the photo-patternable polymer comprises a material having a tensile strength of greater than about 70 megapascals (MPa).

15. An electrostatic chuck according to Claim 1, wherein the photo-patternable polymer comprises a material having a Young's modulus of less than about 3.5 gigapascals (GPa).

16. An electrostatic chuck according to Claim 1, further comprising a conductive path covering at least a portion of a workpiece-contacting surface of a gas seal ring of the electrostatic chuck, the conductive path comprising at least a portion of an electrical path to ground.

17. An electrostatic chuck according to Claim 16, wherein the conductive path comprises diamond-like carbon.

18. An electrostatic chuck according to Claim 16, wherein the photo-patternable polymer comprises a photo-patternable polymer that is liquid at room temperature prior to baking, and wherein the charge control layer comprises a surface resistivity of between about 10^8 ohms per square to about 10^{11} ohms per square.

19. An electrostatic chuck comprising:

a surface layer activated by a voltage in an electrode to form an electric charge to electrostatically clamp a substrate to the electrostatic chuck, the surface layer including a plurality of protrusions comprising a conductive polymer and a charge control layer to which the plurality of polymer protrusions adhere, the plurality of polymer protrusions extending to a height above portions of the charge control layer surrounding the plurality of polymer protrusions to support the substrate upon the plurality of polymer protrusions during electrostatic clamping of the substrate.

20. An electrostatic chuck according to Claim 19, wherein the conductive polymer comprises a polymer from the group consisting of: a blend of a carbon nanotube and a polymer; and a conductive nanoparticle doped polymer.

21. A method of manufacturing an electrostatic chuck, the method comprising:

exposing a photo-patternable polymer, on a surface of the electrostatic chuck, to light through a mask, the electrostatic chuck comprising a charge control layer underlying at least a portion of the photo-patternable polymer; and

removing areas of the surface of the electrostatic chuck based on a pattern of exposure of the surface to the light through the mask, thereby forming a plurality of polymer protrusions on the surface of the electrostatic chuck, the plurality of polymer protrusions adhering to the charge control layer and extending to a height above portions of the charge control layer surrounding the plurality of polymer protrusions.

22. A method according to Claim 21, comprising laminating a polymer sheet including the photo-patternable polymer over at least a portion of the charge control layer.

23. A method according to Claim 21, comprising spraying a liquid polymer including the photo-patternable polymer over at least a portion of the charge control layer.

24. A method according to Claim 21, wherein the photo-patternable polymer comprises a material having a tensile strength of greater than about 70 megapascals (MPa) and having a Young's modulus of less than about 3.5 gigapascals (GPa).

25. A method according to Claim 21, further comprising covering at least a portion of a workpiece-contacting surface of a gas seal ring of the electrostatic chuck with a conductive path, the conductive path comprising at least a portion of an electrical path to ground.

AMENDED CLAIMS
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What is claimed is:

1. An electrostatic chuck comprising:

a surface layer activated by a voltage in an electrode to form an electric charge to electrostatically clamp a substrate to the electrostatic chuck, the surface layer including a plurality of protrusions comprising a hard-baked photo-patterned polymer and a charge control layer to which the plurality of polymer protrusions adhere, the plurality of polymer protrusions extending to a height above portions of the charge control layer surrounding the plurality of polymer protrusions to support the substrate upon the plurality of polymer protrusions during electrostatic clamping of the substrate.

2. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises a polymer that, prior to baking, is photo-patternable, and liquid at room temperature.

3. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises a polymer that, prior to baking, is photo-patternable, and solid at room temperature.

4. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises an epoxy based polymer that, prior to baking, is photo-patternable.

5. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises at least one of a polyimide based polymer and a benzocyclobutene based polymer, the hard-baked photo-patternable polymer being a polymer that, prior to baking, is photo-patternable.

6. An electrostatic chuck according to Claim 1, wherein the charge control layer comprises silicon carbide.

7. An electrostatic chuck according to Claim 1, wherein the charge control layer comprises diamond like carbon.

8. An electrostatic chuck according to Claim 1, wherein the charge control layer comprises a surface resistivity of between about 10^8 ohms per square to about 10^{11} ohms per square.

9. An electrostatic chuck according to Claim 1, wherein the polymer protrusions comprise a height of between about 3 microns and about 12 microns.

10. An electrostatic chuck according to Claim 1, wherein the polymer protrusions comprise a diameter of about 900 microns.

11. An electrostatic chuck according to Claim 1, further comprising a gas seal ring comprising a hard-baked photo-patterned polymer.

12. An electrostatic chuck according to Claim 11, wherein the hard-baked photo-patterned polymer of the gas seal ring comprises at least one of an epoxy based polymer, a benzocyclobutene based polymer and a polyimide based polymer, the hard-baked photo-patternable polymer being a polymer that, prior to baking, is photo-patternable.

13. An electrostatic chuck according to Claim 1, wherein the plurality of polymer protrusions comprise a surface roughness of between about 0.02 μm and about 0.05 μm.

14. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises a material having a tensile strength of greater than about 70 megapascals (MPa).

15. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises a material having a Young's modulus of less than about 3.5 gigapascals (GPa).

16. An electrostatic chuck according to Claim 1, further comprising a conductive path covering at least a portion of a workpiece-contacting surface of a gas seal ring of the

electrostatic chuck, the conductive path comprising at least a portion of an electrical path to ground.

17. An electrostatic chuck according to Claim 16, wherein the conductive path comprises diamond-like carbon.

18. An electrostatic chuck according to Claim 16, wherein the hard-baked photo-patterned polymer comprises a polymer that, prior to baking, is photo-patternable, and liquid at room temperature, and wherein the charge control layer comprises a surface resistivity of between about 10^8 ohms per square to about 10^{11} ohms per square.

19. An electrostatic chuck comprising:

a surface layer activated by a voltage in an electrode to form an electric charge to electrostatically clamp a substrate to the electrostatic chuck, the surface layer including a plurality of protrusions comprising a conductive polymer and a charge control layer to which the plurality of polymer protrusions adhere, the plurality of polymer protrusions extending to a height above portions of the charge control layer surrounding the plurality of polymer protrusions to support the substrate upon the plurality of polymer protrusions during electrostatic clamping of the substrate.

20. An electrostatic chuck according to Claim 19, wherein the conductive polymer comprises a polymer from the group consisting of: a blend of a carbon nanotube and a polymer; and a conductive nanoparticle doped polymer.

21. A method of manufacturing an electrostatic chuck, the method comprising:

exposing a photo-patternable polymer, on a surface of the electrostatic chuck, to light through a mask, the electrostatic chuck comprising a charge control layer underlying at least a portion of the photo-patternable polymer;

removing areas of the surface of the electrostatic chuck based on a pattern of exposure of the surface to the light through the mask, thereby forming a plurality of polymer protrusions on the surface of the electrostatic chuck, the plurality of polymer protrusions adhering to the charge control layer and extending to a height above portions of the charge control layer surrounding the plurality of polymer protrusions; and

hard-baking the plurality of polymer protrusions.

22. A method according to Claim 21, comprising laminating a polymer sheet including the photo-patternable polymer over at least a portion of the charge control layer.

23. A method according to Claim 21, comprising spraying a liquid polymer including the photo-patternable polymer over at least a portion of the charge control layer.

24. A method according to Claim 21, wherein the photo-patternable polymer comprises a material having a tensile strength of greater than about 70 megapascals (MPa) and having a Young's modulus of less than about 3.5 gigapascals (GPa).

25. A method according to Claim 21, further comprising covering at least a portion of a workpiece-contacting surface of a gas seal ring of the electrostatic chuck with a conductive path, the conductive path comprising at least a portion of an electrical path to ground.

What is claimed is:

1. An electrostatic chuck comprising:

a surface layer activated by a voltage in an electrode to form an electric charge to electrostatically clamp a substrate to the electrostatic chuck, the surface layer including a plurality of protrusions comprising a hard-baked photo-patterned polymer and a charge control layer to which the plurality of polymer protrusions adhere, the plurality of polymer protrusions extending to a height above portions of the charge control layer surrounding the plurality of polymer protrusions to support the substrate upon the plurality of polymer protrusions during electrostatic clamping of the substrate.

2. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises a polymer that, prior to baking, is photo-patternable, and liquid at room temperature.

3. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises a polymer that, prior to baking, is photo-patternable, and solid at room temperature.

4. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises an epoxy based polymer that, prior to baking, is photo-patternable.

5. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises at least one of a polyimide based polymer and a benzocyclobutene based polymer, the hard-baked photo-patternable polymer being a polymer that, prior to baking, is photo-patternable.

6. An electrostatic chuck according to Claim 1, wherein the charge control layer comprises silicon carbide.

7. An electrostatic chuck according to Claim 1, wherein the charge control layer comprises diamond like carbon.

8. An electrostatic chuck according to Claim 1, wherein the charge control layer comprises a surface resistivity of between about 10^8 ohms per square to about 10^{11} ohms per square.

9. An electrostatic chuck according to Claim 1, wherein the polymer protrusions comprise a height of between about 3 microns and about 12 microns.

10. An electrostatic chuck according to Claim 1, wherein the polymer protrusions comprise a diameter of about 900 microns.

11. An electrostatic chuck according to Claim 1, further comprising a gas seal ring comprising a hard-baked photo-patterned polymer.

12. An electrostatic chuck according to Claim 11, wherein the hard-baked photo-patterned polymer of the gas seal ring comprises at least one of an epoxy based polymer, a benzocyclobutene based polymer and a polyimide based polymer, the hard-baked photo-patternable polymer being a polymer that, prior to baking, is photo-patternable.

13. An electrostatic chuck according to Claim 1, wherein the plurality of polymer protrusions comprise a surface roughness of between about 0.02 μm and about 0.05 μm.

14. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises a material having a tensile strength of greater than about 70 megapascals (MPa).

15. An electrostatic chuck according to Claim 1, wherein the hard-baked photo-patterned polymer comprises a material having a Young's modulus of less than about 3.5 gigapascals (GPa).

16. An electrostatic chuck according to Claim 1, further comprising a conductive path covering at least a portion of a workpiece-contacting surface of a gas seal ring of the

electrostatic chuck, the conductive path comprising at least a portion of an electrical path to ground.

17. An electrostatic chuck according to Claim 16, wherein the conductive path comprises diamond-like carbon.

18. An electrostatic chuck according to Claim 16, wherein the hard-baked photo-patterned polymer comprises a polymer that, prior to baking, is photo-patternable, and liquid at room temperature, and wherein the charge control layer comprises a surface resistivity of between about 10^8 ohms per square to about 10^{11} ohms per square.

19. An electrostatic chuck comprising:

a surface layer activated by a voltage in an electrode to form an electric charge to electrostatically clamp a substrate to the electrostatic chuck, the surface layer including a plurality of protrusions comprising a conductive polymer and a charge control layer to which the plurality of polymer protrusions adhere, the plurality of polymer protrusions extending to a height above portions of the charge control layer surrounding the plurality of polymer protrusions to support the substrate upon the plurality of polymer protrusions during electrostatic clamping of the substrate.

20. An electrostatic chuck according to Claim 19, wherein the conductive polymer comprises a polymer from the group consisting of: a blend of a carbon nanotube and a polymer; and a conductive nanoparticle doped polymer.

21. A method of manufacturing an electrostatic chuck, the method comprising:

exposing a photo-patternable polymer, on a surface of the electrostatic chuck, to light through a mask, the electrostatic chuck comprising a charge control layer underlying at least a portion of the photo-patternable polymer;

removing areas of the surface of the electrostatic chuck based on a pattern of exposure of the surface to the light through the mask, thereby forming a plurality of polymer protrusions on the surface of the electrostatic chuck, the plurality of polymer protrusions adhering to the charge control layer and extending to a height above portions of the charge control layer surrounding the plurality of polymer protrusions; and

hard-baking the plurality of polymer protrusions.

22. A method according to Claim 21, comprising laminating a polymer sheet including the photo-patternable polymer over at least a portion of the charge control layer.

23. A method according to Claim 21, comprising spraying a liquid polymer including the photo-patternable polymer over at least a portion of the charge control layer.

24. A method according to Claim 21, wherein the photo-patternable polymer comprises a material having a tensile strength of greater than about 70 megapascals (MPa) and having a Young's modulus of less than about 3.5 gigapascals (GPa).

25. A method according to Claim 21, further comprising covering at least a portion of a workpiece-contacting surface of a gas seal ring of the electrostatic chuck with a conductive path, the conductive path comprising at least a portion of an electrical path to ground.