CLAIMS

What is claimed is:

1. A self-limiting electrospray composition capable of forming a layer of self-limiting thickness comprising a non-charge-dissipative component and a charge-dissipative component,

wherein the non-charge-dissipative component is:

(i) non-volatile under electrospray deposition conditions;~~,~~ and

(ii) electrically insulating or is at least sufficiently resistant to conducting an electrical charge such that a layer comprising the non-charge dissipative component has a self-limiting thickness at which the layer hinders further electrospray deposition of the non-charge-dissipative component onto the layer;

wherein the charge-dissipative component is:

(i) non-volatile under electrospray deposition conditions; and

(ii) not electrically insulating or is at least sufficiently dissipative or conductive such that a layer consisting of only the charge-dissipative component in the absence of the non-charge-dissipative component does not exhibit a self-limiting thickness at which the layer repels further electrospray deposition of the charge-dissipative component onto the layer;

wherein the non-charge dissipative component of the self-limiting electrospray composition is immobilized so as to not allow the non-charge dissipative component to flow and produce interfacial charge transport.

2. The self-limiting electrospray composition according to Claim 1, wherein the non-charge-dissipative component is selected from the group consisting of a non-charge-dissipative polymer, a non-charge-dissipative organosilicon compound, a non-charge-

dissipative polysaccharide, a non-charge-dissipative polypeptide, a non-charge-dissipative collagen derivative, a non-charge-dissipative cellulose derivative, a non-charge-dissipative compound containing an epoxide functional group, a non-charge-dissipative urethane, and combinations thereof.

3. The self-limiting electrospray composition according to Claim 1, wherein the charge-dissipative component is selected from the group consisting of a charge-dissipative polymer, a charge-dissipative curing agent or photoinitiator, a charge-dissipative organic compound, a charge-dissipative ionic compound, a charge-dissipative chalcogenide glass, a charge-dissipative oil, a charge-dissipative saccharide, a charge-dissipative surfactant, a charge-dissipative polymer, a charge-dissipative protein, a nucleic acid, and combinations thereof.

4. A self-limiting electrospray composition comprising a non-charge-dissipative component and a charge-dissipative component, wherein the non-charge-dissipative component comprises a plurality of components that are each individually not capable of forming a layer of self-limiting thickness when electrosprayed and wherein the non-charge dissipative component is capable of forming a layer of self-limiting thickness when electrosprayed;

wherein the non-charge-dissipative component is non-volatile under electrospray deposition conditions; and electrically insulating or is at least sufficiently resistant to conducting an electrical charge such that a layer comprising the non-charge dissipative component has a self-limiting thickness at which the layer hinders further electrospray deposition of the non-charge-dissipative component onto the layer;

wherein the charge-dissipative component is non-volatile under electrospray deposition conditions; and not electrically insulating or is at least sufficiently dissipative or conductive such that a layer consisting of only the charge-dissipative component in the absence of the non-charge-dissipative component does not exhibit a self-limiting thickness at which the layer repels further electrospray deposition of the charge-dissipative component onto the layer; and

wherein the non-charge dissipative component of the self-limiting electrospray composition is immobilized so as to not allow the non-charge dissipative component to flow and produce interfacial charge transport.

5. The self-limiting electrospray composition according to Claim 4, wherein each of the plurality of charge-dissipative components is selected from the group consisting of a charge-dissipative liquid, a charge-dissipative crystalline material, a charge-dissipative protein, a nucleic acid, a lyotropic material, and combinations thereof.

6. A method for forming a layer of self-limiting thickness, the method comprising:

exposing a target to a spray in the presence of an electric field, wherein the spray comprises a self-limiting electrospray composition; and

allowing the spray to accumulate on a surface of the target to form the layer of self-limiting thickness, wherein the self-limiting thickness is sufficient to allow the layer to hinder further accumulation of the spray on the conductive target,

wherein the self-limiting electrospray composition comprises a combination selected from the group consisting of

a first combination comprising a non-charge-dissipative component and a charge-dissipative component, wherein the non-charge-dissipative component is non-volatile under electrospray deposition conditions; and electrically insulating or is at least sufficiently resistant to conducting an electrical charge such that a layer comprising the non-charge dissipative component has a self-limiting thickness at which the layer hinders further electrospray deposition of the non-charge-dissipative component onto the layer; wherein the charge-dissipative component is non-volatile under electrospray deposition conditions; and not electrically insulating or is at least sufficiently dissipative or conductive such that a layer consisting of only the charge-dissipative component in the absence of the non-charge-dissipative component does not exhibit a self-limiting thickness at which the layer repels further electrospray deposition of the charge-dissipative component onto the layer; and

a second combination comprising a non-charge dissipative component including a plurality of components that are each individually not capable of forming a layer of self-limiting thickness when electrosprayed and wherein the non-charge dissipative

component is capable of forming a layer of self-limiting thickness when electrosprayed; and wherein the non-charge dissipative component of the self-limiting electrospray composition is immobilized so as to not allow the non-charge dissipative component to flow and produce interfacial charge transport.

7. The method according to Claim 6, wherein the target is conductive.

8. The method according to Claim 6, wherein the target is not conductive, and wherein the method further comprises rendering the target conductive by one selected from the group consisting of exposing the target to a conductive liquid, exposing the target to a conduction-inducing environment, and combinations thereof.

9. The method according to Claim 6, wherein the self-limiting thickness is less than 1 mm.

10. A three-dimensional structure conformally-coated with a thin film, wherein the thin film comprises a self-limiting electrospray composition capable of forming a layer of self-limiting thickness, and wherein the thin film conformally coats the three-dimensional structure such that a thickness of the thin film varies by less than 75% across a surface of the three-dimensional structure, wherein the self-limiting electrospray composition comprises a combination selected from the group consisting of

a first combination comprising a non-charge-dissipative component and a charge-dissipative component, wherein the non-charge-dissipative component is non-volatile under electrospray deposition conditions; and electrically insulating or is at least sufficiently resistant to conducting an electrical charge such that a layer comprising the non-charge dissipative component has a self-limiting thickness at which the layer hinders further electrospray deposition of the non-charge-dissipative component onto the layer; wherein the charge-dissipative component is non-volatile under electrospray deposition conditions; and not electrically insulating or is at least sufficiently dissipative or conductive such that a layer consisting of only the charge-dissipative component in the absence of the non-charge-dissipative component does

not exhibit a self-limiting thickness at which the layer repels further electrospray deposition of the charge-dissipative component onto the layer; and

a second combination comprising a non-charge dissipative component including a plurality of components that are each individually not capable of forming a layer of self-limiting thickness when electrosprayed and wherein the non-charge dissipative component is capable of forming a layer of self-limiting thickness and wherein the non-charge dissipative component of the self-limiting electrospray composition is immobilized so as to not allow the non-charge dissipative component to flow and produce interfacial charge transport.

11. The three-dimensional structure according to Claim 10, wherein the thin film has a thickness of less than 1 mm.

12. The three-dimensional structure according to Claim 10, wherein the non-charge-dissipative component is a non-conductive polymer in the form of a plurality of elongated strands, wherein each of the plurality of elongated strands has at least one dimension less than 100 micrometers.

13. The three-dimensional structure according to Claim 10, wherein the non-charge-dissipative component is a non-conductive polymer in the form of a plurality of spheroidal particles comprising the non-conductive polymer, wherein each of the plurality of spheroidal particles has at least one dimension less than 100 micrometers.

14. The three-dimensional structure according to Claim 10, wherein the non-charge-dissipative component is at least partially densified, and wherein the thin film further comprises a continuous network of conductive filler particles that is at least partially exposed on a surface of the thin film.

~~15. A method of thickness-limited, electrospray deposition comprising:~~

~~exposing an electrically-conductive target to an incident spray comprising a thermo-responsive polymer solution, in the presence of an electric field,~~

~~wherein the electrically-conductive target has a surface temperature,~~

~~wherein the thermo-responsive polymer solution comprises a non-conductive polymer,~~

~~wherein the thermo-responsive polymer solution has a solution temperature;~~

~~allowing the solution temperature to deviate toward the surface temperature to a deposited temperature at which the non-conductive polymer is immobile so as to not allow the non-conductive polymer to flow and produce interfacial charge transport; and~~

~~allowing the non-conductive polymer to accumulate on the electrically conductive target to form a layer, having a thickness sufficient to repulse the incident spray.~~

~~16. The method according to Claim 15, wherein the layer has a spherical shell surface morphology.~~

~~17. The method according to Claim 15, wherein allowing the solution temperature to deviate toward the surface temperature to the deposited temperature at which the non-conductive polymer is immobile prompts a spinodal decomposition of the thermo-responsive polymer solution.~~

~~18. The method according to Claim 15, wherein non-conductive polymer is selected from the group consisting of poly(n-isopropylacrylamide) and methylcellulose.~~

~~19. The method according to Claim 15, wherein the thermo-responsive polymer solution further comprises water in an amount of from about 0.0001 to about 80 percent by weight.~~

15~~20~~. A method for determining a conductivity of a material, the method comprising

exposing a material to a spray in the presence of an electric field, wherein the spray comprises a self-limiting electrospray composition of any one of claims 1 to 5;

allowing the spray to accumulate on a surface of the material to form the layer of self-limiting thickness, wherein the self-limiting thickness is sufficient to allow the layer to hinder further accumulation of the spray on the material;

measuring the self-limiting thickness of the layer; and

determining the conductivity of the material by comparing the self-limiting thickness to a thickness achieved by exposing a test material having a known conductivity to the spray in the presence of the electric field.

16~~21~~. The method according to Claim 15~~20~~, wherein the self-limiting electrospray composition comprises a thermo-responsive polymer solution.

1722. A method for repairing a flaw in a layer on a surface of an object, the method comprising

applying a charge to the layer;

exposing the flaw to a spray in the presence of an electric field, wherein the spray comprises a self-limiting electrospray composition of any one of claims 1 to 5; and

allowing the spray to accumulate on the flaw to form a repair layer having a self-limiting thickness, wherein the self-limiting thickness is sufficient to hinder further accumulation of the spray on the repair layer.

1823. The method according to Claim 1722, wherein the self-limiting electrospray composition comprises a thermo-responsive polymer solution.

1924. The method according to Claim 1722, wherein the layer on the surface of the object is not conductive, and wherein the step of applying a charge to the layer comprises applying a solids-free spray to the layer.

2025. The method according to Claim 1722, wherein the layer on the surface of the object is conductive, and wherein the step of applying a charge to the layer comprises contacting the layer with a voltage source.

2126. A self-limiting electrospray composition capable of forming a layer of self-limiting thickness comprising

a first charge-dissipative component selected from the group consisting of DNA, RNA, and combinations thereof, and

an additional component comprising a non-charge-dissipative component,

wherein the non-charge-dissipative component is:

(i) non-volatile under electrospray deposition conditions; and

(ii) electrically insulating or is at least sufficiently resistant to conducting an electrical charge such that a layer comprising the non-charge dissipative component has a self-limiting thickness at which the layer hinders further electrospray deposition of the non-charge-dissipative component onto the layer;

wherein the first charge-dissipative component is:

(i) non-volatile under electrospray deposition conditions; and

(ii) not electrically insulating or is at least sufficiently dissipative or conductive such that a layer consisting of only the first charge-dissipative component in the absence of the additional component does not exhibit a self-limiting thickness at which the layer repels further electrospray deposition of the first charge-dissipative component onto the layer;

wherein the first charge-dissipative components is incapable of forming a layer of self-limiting thickness when electrosprayed without the additional component, and

wherein the non-charge dissipative component of the self-limiting electrospray composition is immobilized so as to not allow the non-charge dissipative component to flow and produce interfacial charge transport.