CLAIMS

What is claimed is:

1. A method for reducing electrode gap distances in an electronic device having a first electrode spatially separated from a second electrode by an electrode gap, the method comprising:

selecting a nanometer gap size to bind a biological material based on a size of the biological material and binding effects with the biological material;

coating at least one surface of each of the first electrode and the second electrode with a first layer including molecular recognition groups;

coating the at least one surface with a second layer including electrically-conductive solids that are configured to bond with the molecular recognition groups; and

coating the electronic device with additional alternating layers of the molecular recognition groups and the electrically-conductive solids to reach the nanometer gap size between a first electrode and a second electrode of the electronic device.

2. The method of claim 1, wherein the biological material is one of a virus and a biomarker of the virus.

3. The method of claim 1, wherein the molecular recognition groups are configured to selectively bind with the biological material, and the molecular recognition groups are at least one of aptamers, antigens, and antibodies.

4. The method of claim 2, wherein the biological material is the virus and the method further comprising:

selecting the nanometer gap size to bind a virus type based on a size of the virus type and binding effects with the virus type.

5. The method of claim 4, wherein:

the virus type is selected from the group consisting of: *Adenoviridae*, *Papovaviridae*, *Parvoviridae*, *Herpesviridae*, *Poxviridae*, *Anelloviridae*, *Pleolipoviridae*, *Reoviridae*, *Picornaviridae*, *Caliciviridae*, *Togaviridae*, *Arenaviridae*, *Flaviviridae*, *Orthomyxoviridae*, *Paramyxoviridae*, *Bunyaviridae*, *Rhabdoviridae*, *Filoviridae*, *Coronoviridae*, *Astroviridae*, *Bornaviridae*, *Arteriviridae*, *Hepeviridae*, *Retroviridae*, *Calimoviridae*, *Hepadnasviridae*, and combinations thereof; or

the virus type is a subviral agent selected from the group consisting of: viroids, satellites, defective interfering particles, prions, and combinations thereof.

6. The method of claim 4, further comprising:

selecting the nanometer gap size to bind the virus type based on the size of the virus type wherein the size of the virus type is less than at least one of: 500 nm, 400 nm, 300 nm, 200 nm, 100 nm, 50 nm, 20 nm, and 15 nm.

7. The method of claim 2, wherein the biological material is the biomarker and the method further comprising:

selecting the nanometer gap size to bind the biomarker of the virus based on the size of the biomarker and binding effects with the biomarker, wherein the biomarker has a biomarker size of less than at least one of 10 nm, 5 nm, 2 nm, and 1 nm.

8. The method of claim 7, wherein the biomarker is an antibody for the virus type.

9. The method of claim 1, further comprising:

coating the electronic device with the additional alternating layers to reach the nanometer gap size less than at least one of: 100 nm, 10 nm, and 5 nm.

10. The method of claim 1, wherein the electrode gap before coating is greater than 1 μm.

11. The method of claim 1, wherein the first and second layers are monolayers having a thickness of a single particle or a single molecule.

12. The method of claim 1, wherein the electrically conductive solids include at least one of: carbon-based nanoparticles, metal nanoparticles, semiconductor nanoparticles, metal microbeads, semiconductor microbeads, and combinations thereof.

13. The method of claim 12, wherein the electrically conductive solids include at least one of: gold nanoparticles, silver nanoparticles, palladium nanoparticles, platinum nanoparticles, and combinations thereof.

14. The method of claim 1, wherein the electronic device is a sensor based on a field-effect transistor or an electron tunneling device.

15. A micrometer-scale device comprising:

a first electrode including alternating layers of coated molecular recognition groups and coated electrically-conductive solids;

a second electrode including alternating layers of coated molecular recognition groups and coated electrically-conductive solids; and

a nanometer gap size between the first electrode and the second electrode, wherein the nanometer gap size is reduced from a larger gap size by the alternating layers of the coated molecular recognition groups and the coated electrically-conductive solids.

16. The micrometer-scale device of claim 15, wherein each layer of the alternating layers of the coated molecular recognition groups and the coated electrically-conductive solids is a monolayer including a thickness having a single particle.

17. The micrometer-scale device of claim 15, wherein the nanometer gap size less than at least one of: 1 μm, 500 nm, 400 nm, 300 nm, 200 nm, 100 nm, 50 nm, 20 nm, 10 nm, 5 nm, 2 nm, and 1 nm.

18. The micrometer-scale device of claim 15, wherein the larger gap size is greater than 1 μm.

19. The micrometer-scale device of claim 15, wherein the coated molecular recognition groups are selected to bind with at least one of a virus type and a biomarker, and are at least one of an aptamer, an antibody, and an antigen.

20. The micrometer-scale device of claim 15, wherein the electrically-conductive solids include at least one of: carbon-based nanoparticles, metal nanoparticles, semiconductor nanoparticles, metal microbeads, semiconductor microbeads, and combinations thereof.

21. The micrometer-scale device of claim 15, wherein the electrically conductive solids include at least one of: gold nanoparticles, silver nanoparticles, palladium nanoparticles, platinum nanoparticles, and combinations thereof.

22. The micrometer-scale device of claim 15, wherein the micrometer-scale device is a sensor based on a field-effect transistor or an electron tunneling device.