Claims

1. A surface-enhanced Raman spectroscopy (SERS) sensor comprising:

a flexible substrate; and

3D metallic anisotropic nanostructures deposited on the flexible substrate by an ink-based printing process that printed anisotropic ink on the flexible substrate, the anisotropic ink comprising the metallic anisotropic nanostructures,

wherein each metallic anisotropic nanostructure comprises a plurality of pointed end portions extending from a central core portion.

2. The SERS sensor according to claim 1, wherein the flexible substrate is formed of one of paper, plastic, and metallic materials.

3. The SERS sensor according to claim 2, wherein the flexible substrate is a plastic substrate comprising polyethylene terephthalate (PET) film.

4. The SERS sensor according to claim 2, wherein the flexible substrate is a metallic substrate comprising aluminum foil.

5. The SERS sensor according to claim 2, wherein the flexible substrate is a paper substrate comprising one of copy paper, filter paper, and chromatography paper.

6. The SERS sensor according to claim 5, wherein the paper substrate is silanized.

7. The SERS sensor according to any one of claims 1 to 6, wherein the metallic anisotropic nanostructures comprise nanostars and/or nanocubes.

8. The SERS sensor according to any one of claims 1 to 7, wherein the metallic anisotropic nanostructures comprise gold material.

9. The SERS sensor according to any one of claims 1 to 8, wherein the metallic anisotropic nanostructures are modified with a thiolated polyethylene glycol (PEG) derivative.

10. The SERS sensor according to claim 9, wherein the thiolated PEG derivative is SH-PEG-methoxyl or SH-PEG-carboxyl.

11. The SERS sensor according to any one of claims 1 to 10, wherein the ink-based printing process comprises one of inkjet printing, drop casting, and gravure printing.

12. The SERS sensor according to claim 11, wherein said drop casting is assisted by wax printing.

13. A method of manufacturing a surface-enhanced Raman spectroscopy (SERS) sensor, the method comprising:

preparing a flexible substrate;

preparing anisotropic ink comprising 3D metallic anisotropic nanostructures, each metallic anisotropic nanostructure comprising a plurality of pointed end portions extending from a central core portion; and

performing an ink-based printing process to print the anisotropic ink on the flexible substrate, thereby depositing the metallic anisotropic nanostructures on the flexible substrate and forming the SERS sensor.

14. The method according to claim 13, wherein the flexible substrate is formed of one of paper, plastic, and metallic materials.

15. The method according to claim 14, wherein the flexible substrate is a plastic substrate comprising polyethylene terephthalate (PET) film.

16. The method according to claim 14, wherein the flexible substrate is a metallic substrate comprising aluminum foil.

17. The method according to claim 14, wherein the flexible substrate is a paper substrate comprising one of copy paper, filter paper, and chromatography paper.

18. The method according to claim 17, said preparing of the paper substrate comprising silanizing the paper substrate.

19. The method according to claim 18, said silanizing of the paper substrate comprising:

immersing the paper substrate in a toluene solvent comprising phenyltriethoxysilane;

incubating the paper substrate after said immersing;

rinsing the paper substrate with ethanol after said incubating; and

thermal curing the paper substrate after said rinsing.

20. The method according to any one of claims 13 to 19, wherein the metallic anisotropic nanostructures comprise nanostars and/or nanocubes.

21. The method according to any one of claims 13 to 20, wherein the metallic anisotropic nanostructures comprise gold material.

22. The method according to any one of claims 13 to 21, said preparing of the anisotropic ink comprising modifying the metallic anisotropic nanostructures with a thiolated polyethylene glycol (PEG) derivative.

23. The method according to claim 22, said modifying of the metallic anisotropic nanostructures comprising immersing them in a solution comprising the thiolated PEG derivative.

24. The method according to claim 23, wherein the thiolated PEG derivative is SH-PEG-methoxyl or SH-PEG-carboxyl.

25. The method according to any one of claims 13 to 24, wherein the ink-based printing process comprises inkjet printing using the anisotropic ink.

26. The method according to any one of claims 13 to 24, wherein the ink-based printing process comprises drop casting using a patterned ink barrier comprising the anisotropic ink on its surface.

27. The method according to claim 26, wherein the patterned ink barrier is fabricated by wax printing.

28. The method according to any one of claims 13 to 24, wherein the printing process comprises gravure printing using a metallic plate comprising a predefined pattern, wherein the metallic anisotropic nanostructures are printed on the flexible substrate according to the predefined pattern.