CLAIMS

What is claimed is:

1. A method for self-organized nanostructured thin film fabrication, comprising the steps of:

providing a substrate in a low pressure chamber; and

depositing a composition of plasmonic-chalcogenide material to form the self-organized nanostructured thin film on the substrate,

wherein the composition of plasmonic material is greater than 60 atomic %, and wherein a pressure of the low pressure chamber is less than atmospheric pressure, and wherein the deposition step forms a nanostructured surface on the self-organized nanostructured thin film, the nanostructured surface comprising metallic nanoparticles.

2. The method in accordance with Claim 1, wherein the deposition step comprises controlling the composition of the plasmonic material and the chalcogenide material for the self-organized nanostructured thin film to have an atomic concentration of the plasmonic material in the range of 60% - 95%.

3. The method in accordance with Claim 1 or 2, wherein the deposition step comprises depositing the plasmonic material and the chalcogenide material from a single plasmonic-chalcogenide target at room temperature.

4. The method in accordance with Claim 1 or 2, wherein the deposition step comprises depositing the plasmonic material and the chalcogenide material

simultaneously from multiple targets or from a single alloy target at room temperature.

5. The method in accordance with Claim 1 or 2, wherein the deposition rate is in the range of 1 to 5 Å/s.

6. The method in accordance with Claim 5, wherein the deposition rate is in the range of 1.5 to 3.5 Å/s.

7. The method in accordance with Claim 6, wherein the deposition rate is in the range of 1.5 to 2.5 Å/s.

8. The method in accordance with Claim 4, wherein one or more of the multiple targets comprises the plasmonic material and wherein the deposition rate of the plasmonic material from the one or more of the multiple targets is in the range of 1 to 5 Å/s.

9. The method in accordance with Claim 8, wherein the deposition rate is in the range of 1.5 to 3.5 Å/s.

10. The method in accordance with Claim 9, wherein the deposition rate is in the range of 1.5 to 2.5 Å/s.

11. The method in accordance with any one of Claims 1 to 3 or 5 to 7, wherein the deposition step comprises sputtering the plasmonic-chalcogenide material at a sputtering pressure in the range of 0.1 to 1.0 Pa.

12. The method in accordance with Claim 11, wherein the deposition step comprises sputtering the plasmonic--chalcogenide material at a sputtering pressure in the range of 0.2 – 0.5 Pa.

13. The method in accordance with any one of the preceding claims, wherein the deposition step comprises depositing for a period greater than 300 seconds and sufficient to define a thickness of the self-organized nanostructured thin film thick enough to define three-dimensional structures therein.

14. The method in accordance with Claim 13, wherein the deposition step comprises sputtering for a period of 900 to 3600 seconds.

15. The method in accordance with any one of the preceding claims, wherein the plasmonic material comprises a metal selected from the group comprising silver, copper, gold, platinum, and aluminum, or a metal nitride comprising a metal selected from the group comprising titanium or zirconium, or a transparent conducting oxide selected from the group comprising indium tin oxide, aluminum zinc oxide, and gallium zinc oxide.

16. The method in accordance with any one of the preceding claims, wherein the chalcogenide material comprises a chalcogenide material selected from the group comprising antimony trisulfide antimony triselenide, bismuth trisulfide, bismuth triselenide, or germanium disulfide.

17. The method in accordance with any one of the preceding claims, wherein the step of providing the substrate comprises providing a flexible substrate.

18. The method in accordance with Claim 17, wherein the step of providing the flexible substrate comprises providing a flexible substrate comprising a material selected from the group comprising plastic, polyethylene terephthalate (PET) and polythiophene (P3HT).

19. The method in accordance with any of the preceding claims, wherein the deposition step comprises depositing the plasmonic material and the chalcogenide material to form the self-organized nanostructured thin film having an area 10 cm^2 or larger on the substrate, and more preferably larger than 80 cm^2 on the substrate

20. The method in accordance with any one of the preceding claims, wherein the deposition step comprises sputtering the plasmonic material at a first deposition rate and the chalcogenide material at a second deposition rate simultaneously to form the nanostructured surface of the self-organized nanostructured thin film wherein a ratio of the first deposition rate to the second deposition rate is greater than 3:2.

21. A nanoporous thin film comprising a plasmonic-chalcogenide material on a substrate, the plasmonic-chalcogenide material having an atomic concentration of a plasmonic material in the plasmonic-chalcogenide material in the range of 87% - 95%, and wherein the plasmonic material comprises a metal selected from the group comprising silver, copper, gold, platinum and aluminum or a metal nitride comprising a metal selected from the group comprising titanium and zirconium or a transparent conducting oxide selected from the group comprising indium tin oxide, aluminum zinc oxide, and gallium zinc oxide, and wherein a chalcogenide material in the plasmonic-chalcogenide material comprises a chalcogenide material selected from the group comprising antimony trisulfide antimony triselenide, bismuth trisulfide, bismuth triselenide, or germanium disulfide.

22. The nanoporous thin film in accordance with Claim 21 wherein the substrate is a flexible substrate.

23. Use of the nanoporous thin film of Claim 21 for biosensing by trapping biomaterial within pores of the nanoporous thin film.

24. A thin film comprising nanowire forests of nanostructures in a plasmonic-chalcogenide material on a substrate, the thin film having an atomic concentration of a plasmonic material in the plasmonic-chalcogenide material in the range of 40% - 87%, and wherein the plasmonic material comprises a metal selected from the group comprising silver, copper, gold, platinum and aluminum or a metal nitride comprising a metal selected from the group comprising titanium and zirconium or a transparent conducting oxide selected from the group comprising indium tin oxide,

aluminum zinc oxide, and gallium zinc oxide, and wherein a chalcogenide material in the plasmonic-chalcogenide material comprises a chalcogenide material selected from the group comprising antimony trisulfide antimony triselenide, bismuth trisulfide, bismuth triselenide, or germanium disulfide.

25. The thin film in accordance with Claim 24 wherein the substrate is a flexible substrate.

26. The thin film in accordance with Claim 24 wherein each nanostructure of the nanowire forests of nanostructures include a tip at an end opposite a base of the nanostructure, the tip consisting of silver for plasmonic resonance.

27. Use of the nanostructured thin film of any of Claims 24 to 26 for trapping light in the visible to infrared range to harvest energy therefrom.