CLAIMS

1. A method of synthesizing a transition metal sulfide-based carbon material for use as an electrode in lithium-sulfur battery, the method comprising:

providing a solution containing group VI transition metal sulfide precursor and a solvent;

immersing a porous carbon cloth into the solution;

subjecting the solution with the porous carbon cloth to a temperature of about 200°C to allow loading of transition metal sulfide onto the porous carbon cloth; and

drying the loaded porous carbon cloth to obtain a transition metal sulfide-based loaded carbon material; and

preparing an electrode to be used in a lithium-sulfur battery using the transition metal sulfide-based loaded carbon material, wherein the preparation comprises depositing a sulfur-containing slurry onto the transition metal sulfide-based loaded carbon material.

2. The method according to claim 1, wherein the transition metal sulfide precursor is selected from the group consisting of ammonium tetrathiomolybdate and ammonium tetrathiotungstate.

3. The method according to claim 2, wherein the transition metal sulfide is selected from the group consisting of molybdenum disulfide and tungsten disulfide.

4. The method according to claim 1, wherein the solvent is selected from the group consisting of dimethylformamide, deionised water and a combination thereof.

5. The method according to claim 1, wherein the porous carbon cloth is immersed in the solvent contained in the solution prior to the step of providing the solution containing group VI transition metal sulfide precursor and the solvent.

6. The method according to claim 5, wherein the solvent comprises cetyltrimethylammonium bromide dissolved in deionised water.

7. The method according claim 3, wherein the transition metal sulfide is molybdenum disulfide and the transition metal sulfide-based loaded carbon material is loaded with edge-oriented molybdenum disulfide.

8. The method according claim 6, wherein the transition metal sulfide is molybdenum disulfide and the transition metal sulfide-based loaded carbon material is loaded with basal plane-oriented molybdenum disulfide.

9. The method according to claim 3, wherein the transition metal sulfide is tungsten disulfide and the transition metal sulfide-based loaded carbon material is loaded with edge-oriented tungsten disulfide or basal plane-oriented tungsten disulfide.

10. The method according to claim 1, further comprising:

annealing the transition metal sulfide-based loaded carbon material to form a semiconducting transition metal sulfide-based loaded carbon material.

11. The method according to claim 1, wherein the preparation of the electrode for lithium-sulfur battery further comprises:

mixing and heating sulfur with carbon black to obtain a sulfur-carbon black mixture;

mixing the sulfur-carbon black mixture with a binder and a solvent to obtain the sulfur-containing slurry prior to depositing the sulfur-containing slurry onto the transition metal sulfide-based loaded carbon material; and

drying the transition metal sulfide-based loaded carbon material to obtain a sulfur-loaded transition metal sulfide-based carbon cloth electrode.

12. The method according to claim 11, wherein the electrode is a cathode.

13. The method according to claim 11, further comprising:

repeating the steps of deposition and drying to obtain an areal sulfur loading between 1.5 $mg \cdot cm^{-2}$ and 5.5 $mg \cdot cm^{-2}$.

14. The method according to claim 11, further comprising:

heating the sulfur-carbon black mixture to remove excess surface sulfur from the sulfur-carbon black mixture prior to mixing the sulfur-carbon black mixture with the binder and the solvent.

15. A transition metal sulfide-based carbon cloth electrode for use in a lithium-sulfur battery, the transition metal sulfide-based carbon cloth electrode comprising:

a transition metal sulfide-based carbon material loaded with sulfur, wherein the transition metal sulfide-based carbon material comprising a porous carbon cloth and a group VI transition metal sulfide selected from the group consisting of molybdenum disulfide and tungsten disulfide, and the transition metal sulfide is loaded onto the porous carbon cloth by having nanocrystals formed on the surface of the porous carbon.

16. The transition metal sulfide-based carbon cloth electrode according to claim 15, wherein the transition metal sulfide is molybdenum disulfide.

17. The transition metal sulfide-based carbon cloth electrode according to claim 16, wherein the molybdenum disulfide is an edge-oriented molybdenum disulfide or a basal plane-oriented molybdenum disulfide.

18. The transition metal sulfide-based carbon cloth electrode according to claim 15, wherein the transition metal sulfide is tungsten disulfide.

19. The transition metal sulfide-based carbon cloth electrode according to claim 18, wherein the tungsten disulfide is an edge-oriented tungsten disulfide or a basal plane-oriented tungsten disulfide.

20. A lithium-sulfur battery comprising an anode and a cathode, wherein the cathode comprises a transition metal sulfide-based carbon cloth electrode according to any of the preceding claims 15-19.