Claims

1. A method of preparing a carbonized composite, the method comprising the steps of:

a) contacting elemental sulfur and a conductive network precursor to form a mixture, wherein an organic solvent is absent from the mixture;

b) heating the mixture obtained in step (a) to form a composite is performed at a temperature of 500-600ºC; and

c) heating the composite under inert conditions under a temperature sufficient to remove bulk or unbonded sulfur to thereby obtain said carbonized composite.

2. The method of claim 1, wherein the heating step (b) is performed at a temperature of about 550ºC.

3. The method of claims 1-2, wherein the contacting step (a) comprises grinding particles of elemental sulfur and said polymer to form a homogenous mixture.

4. The method of claims 1-3, wherein the conductive network precursor and elemental sulfur are contacted at a weight ratio of 1:2 to 1:10.

5. The method of claims 1-4, wherein the conductive network precursor is a polymer.

6. The method of claim 5, wherein the conductive network precursor is a polymer comprising nitrile-functionalized monomer units.

7. The method of claims 5-6, wherein the polymer is polyacrylonitrile,

8. The method of claims 1-7, wherein the heating step (b) is performed for about 2-10 hours.

9. The method of claims 1-8 wherein the composite is cooled to room temperature after step (b) and before step (c).

10. The method of any of claims 1-9, wherein the heating step (c) is carried out at a temperature of about 150ºC -300ºC.

11. A carbonized composite obtained from the method of any one of claims 1-10, the carbonized composite comprising:

    a sulfur chain;

    a conductive network;

wherein said sulfur chain is covalently bonded to said conductive network via one or more C-S bonds;

wherein said composite is free of S_8; and

wherein said composite is provided in the form of particles, each particle having a diameter of 1 μm or less.

12. The carbonized composite of claim 11, wherein said sulfur chain comprises 2-7 sulfur atoms.
13. The carbonized composite of claims 11-12, wherein said sulfur chain comprises 2-4 sulfur atoms.
14. The carbonized composite of claims 11-13, wherein said conductive network is a carbon-based conductive network.
15. The carbonized composite of claims 11-14, wherein said conductive network comprises a plurality of C=C and C=N bonds.
16. The carbonized composite of claims 11-15 wherein sulfur content of the composite is 20-50 wt.% of the total weight of the composite.
17. The carbonized composite of claims 11-16, wherein sulfur content of the composite is 20-40wt% of the total weight of the composite.
18. The carbonized composite of claims 11-17, wherein carbon content of the composite is 20-50 wt.% of the total weight of the composite.
19. The carbonized composite of claims 11-18, wherein the composite comprises less than 1 wt.% of hydrogen based on the total weight of the composite.
20. An electrochemical cell comprising:
    a) a sodium anode;
    b) a cathode comprising the carbonized composite obtained from a method of any one of claims 1-10 or as defined in any one of claims 11-19; and
    an electrolyte.