Claims

1. A carbonized composite comprising:
   a sulfur chain;
   a conductive network;
      a. wherein said sulfur chain is covalently bonded to said conductive network via one or more C-S bonds;
      b. wherein said composite is substantially free of S_8; and
      c. wherein said composite is provided in the form of particles, each particle having a diameter of 1 μm or less.

2. The carbonized composite of claim 1, wherein said sulfur chain comprises 2-7 sulfur atoms.
3. The carbonized composite of claims 1-2, wherein said sulfur chain comprises 2-4 sulfur atoms.
4. The carbonized composite of claims 1-3, wherein said conductive network is a carbon-based conductive network.
5. The carbonized composite of claims 1-4, wherein said conductive network comprises a plurality of C=C and C=N bonds.
6. The carbonized composite of claims 1-5 wherein sulfur content of the composite is about 20-50 wt.% of the total weight of the composite.
7. The carbonized composite of claims 1-6, wherein sulfur content of the composite is about 20-40wt% of the total weight of the composite.
8. The carbonized composite of claims 1-7, wherein carbon content of the composite is about 20-50 wt.% of the total weight of the composite.
9. The carbonized composite of claims 1-8, wherein the composite comprises less than 1 wt.% of hydrogen based on the total weight of the composite.

10.1. A method of preparing the a carbonized composite of claims 1-9, 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 300500-600ºC; and

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

~~11.~~2. The method of claim 1~~0~~, wherein the heating step (b) is performed at a temperature of about 550ºC.

~~12.~~3. The method of claims ~~10-11~~1-2, wherein the contacting step (a) comprises grinding particles of elemental sulfur and said polymer to form a homogenous mixture.

~~13.~~4. The method of claims ~~10-12~~1-3, wherein the conductive network precursor and elemental sulfur are contacted at a weight ratio of 1:2 to 1:10.

~~14.~~5. The method of claims ~~10-13~~1-4, wherein the conductive network precursor is a polymer.

~~15.~~6. The method of claim ~~14~~5, wherein the conductive network precursor is a polymer comprising nitrile-functionalized monomer units.

~~16.~~7. The method of claims ~~14-15~~5-6, wherein the polymer is polyacrylonitrile,

~~17.~~8. The method of claims ~~10-16~~1-7, wherein the heating step (b) is performed for about 2-10 hours.

~~18.~~9. The method of claims ~~10-17~~1-8 wherein the composite is cooled to room temperature after step (b) and before step (c).

~~19.~~10. The method of any of claims ~~10-18~~1-9, wherein the heating step (c) is carried out at a temperature of about 150ºC -300ºC.

11. A carbonized composite obtainable 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 ~~1-9~~11-19; and
    an electrolyte.