The cathode can further include electrically conductive fillers in order to add electrical conductivity, and the solid, ionically conductive polymer material can **e**ncapsulate at least one particle of the active material or other components of the cathode.

The solid, ionically conducting polymer material is formed from a reactant product of a base polymer, an electron acceptor, and a compound including a source of ions. The base polymer is selected from a group comprising conjugated polymers, polyphenylene sulfide, liquid crystal polymer, a polyether ether ketone (PEEK) or a semicrystalline polymer with a crystallinity index of greater than 30%, and combinations thereof, and can be oxidatively doped in the presence of Li+ cations. The electron acceptor is selected from a group comprising Dichloro Dicyano Quinone ($C_8Cl_2N_2O_2$), TCNE (C_6N_4), Sulfur Trioxide (SO_3) or chloranil and combinations thereof. The compound including an ion source is preferably LiOH, Li_2O or a mixture of the two.

The cathode including sulfur as the active material, and an ionically conductive polymer is preferably incorporated into an electrochemical cell which further includes an anode. The anode active material is preferably lithium but can be alternatively selected from a group comprising Lithium, Tin, Silicon, graphite, or any alloy or mixture thereof.

The demonstrated voltage of the electrochemical cell is greater than 1.0 volts, and the the cathode specific capacity is greater than 500 mAh/g, preferably the cathode specific capacity is greater than 1000 mAh/g, and most preferably the cathode specific capacity is greater than 1500 mAh/g, while demonstrating rechargeable behavior over two thousand cycles.

The solid, ionically conductive polymer material can also be useful as a separator film, as it is electrically non-conductive, and ionically conductive. Therefore the solid, ionically conductive polymer material cast or otherwise rendered as a film can be used as a separator positioned between an anode and cathode. In addition, the solid, ionically conductive polymer material can be coated onto an electrode to function as a separator or alternatively to isolate the electrode or an electrode component from another battery component such as an aqueous electrolyte. The solid, ionically conductive polymer material enables ionic communication between such an isolated component despite it being physically separated, and electrically segmented from the rest of the battery component. The material can also comprise an aggregated or cast agglomeration of small particles of the solid, ionically conductive polymer material. Such an aggregation can take any shape but include an engineered porosity while possessing an engineered surface area. Fillers, such as hydrophobic materials can be mixed in the material to provide desirable physical properties such as low effective aqueous porosity. Thus the solid,

CLAIMS

1. A cathode electrode comprising sulfur as an active material, and a solid ionically conductive polymer having an ionic conductivity of greater than $1x10^{-4}$ S/cm at room temperature.

2. The cathode of claim 1 wherein the polymer is electrically insulative.

3. The cathode of claim 1 wherein the polymer has Lithium cation diffusivity greater than 1×10^{-11} meters squared per second at room temperature.

4. The cathode of claim 1 further comprising electrically conductive fillers are used to add electrical conductivity.

5. The cathode of claim 1 wherein the solid, ionically conductive polymer material **e**ncapsulates at least one particle of the active material

6. The cathode of claim 1 wherein the solid, ionically conducting polymer material is formed from a reactant product of a base polymer, an electron acceptor, and a compound including a source of ions.

7. The cathode of claim 1 wherein the solid, ionically conducting polymer material contains a base polymer which is oxidatively doped in the presence of Li+ groups.

8. A cathode electrode comprising sulfur as an active material, and a solid ionically conductive polymer having an ionic conductivity of greater than $1x10^{-4}$ S/cm at room temperature, wherein the solid ionically conductive polymer material is formed from a reactant product of a base polymer, an electron acceptor, and a compound including an ion source, where the compound including the ion source is either LiOH, Li_2O or a mixture of the two.

9. The cathode of claim 7 or claim 8 where the base polymer is one that can be oxidized, and wherein the base polymer is a conjugated polymer.

10. The cathode of claim 8 where the base polymer is selected from a group comprising polyphenylene sulfide, liquid crystal polymer, a polyether ether ketone (PEEK) or a semicrystalline polymer with a crystallinity index of greater than 30%, and combinations thereof.

11. The cathode of claim 8 where the electron acceptor is selected from a group comprising Dichloro Dicyano Quinone ($C_8Cl_2N_2O_2$), TCNE (C_6N_4), Sulfur Trioxide (SO_3) or chloranil and combinations thereof.

12. An electrochemical cell comprising, an anode, and a cathode, said cathode comprising sulfur as an active material, and a solid ionically conductive polymer having an ionic conductivity of greater than $1x10^{-4}$ S/cm at room temperature.

13. The electrochemical cell of claim 12, wherein the cathode specific capacity is greater than 500 mAh/g.

14. The electrochemical cell of claim 12, wherein the cathode specific capacity is greater than 1000 mAh/g.

15. The electrochemical cell of claim 12, wherein the cathode specific capacity is greater than 1500 mAh/g.

16. The electrochemical cell of claim 12, wherein the voltage of cell is greater than 1.0 volts.

17. The electrochemical cell of claim 12, wherein the anode is selected from a group comprising Lithium, Tin, Silicon, graphite, or any alloy or mixture thereof.

18. The electrochemical cell of claim 12, wherein the cell is a secondary cell.

19. The electrochemical cell of claim 18, wherein the cathode specific capacity is greater than 1000 mAh/g.