CLAIMS

1. A bipolar battery comprising:

at least one bipolar electrode, each having a positive electrode comprising a first electrochemically active material on one side of an electrically conducting sheet and a negative electrode comprising a second electrochemically active material on the other side of the sheet;

a plurality of electrolyte layers, each comprising a solid ionically conductive polymer material;

both a terminal negative electrode and terminal positive electrode, wherein the terminal negative electrode is located opposed to a positive electrode located on a first adjacent bipolar electrode with an electrolyte layer interposed therebetween, wherein the terminal positive electrode is located opposed to a negative electrode layer on a second adjacent bipolar electrode with an electrolyte layer interposed therebetween;

wherein the solid ionically conductive polymer material has an ionic conductivity greater than 1×10^{-4} S/cm at room temperature, and comprises both at least one cationic and anionic diffusing ion, wherein at least one diffusing ion is mobile at room temperature.

2. The bipolar battery of claim 1, wherein each positive electrode and the adjacent anode comprise a sub-stack which also includes an electrolyte layer, wherein each sub-stack is separated from an adjacent sub-stack by an electrically conductive sheet, wherein each sub-stack has a voltage, and wherein the voltage of each sub-stack is equal to or less than 3 volts.

3. The bipolar battery of claim 1, wherein the first electrochemically active material is selected from a group consisting of zinc, aluminum, lithium or an intercalation material.

4. The bipolar battery of claim 1, wherein the second electrochemically active material comprises manganese dioxide, sulfur or an intercalation material.

5. The bipolar battery of claim 1 further comprising a second sub-stack comprising a second separator layer comprising solid ionically conductive polymer electrolyte positioned between a second anode and second cathode layer, wherein said second sub-stack is positioned adjacent and

in electrical but not in ionic communication with said first sub-stack and further comprising a third current collector layer positioned adjacent second sub-stack.

6. The bipolar battery of claim 1 wherein each positive electrode comprises the solid ionically conductive polymer material.

7. The bipolar battery of claim 1 wherein each negative electrode comprises the solid ionically conductive polymer material.

8. The bipolar battery of claim 1, wherein the voltage of the battery is greater than 8 volts, and the distance between the terminal positive electrode and the terminal negative electrode is less than six millimeters.

9. The bipolar battery of claim 1, wherein the electrolyte layer is extruded.

10. The bipolar battery of claim 1, wherein the positive electrode is extruded.

11. The battery of claim 1, wherein the solid ionically conductive polymer material comprises a crystallinity greater than 30%.

12. The bipolar battery of claims 1, wherein the electronic conductivity of the solid ionically conductive polymer material is less than 1×10^{-8} S/cm at room temperature.

13. The bipolar battery of claim 1, wherein the melting temperature of the solid ionically conductive polymer material is greater than 250°C.

14. The bipolar battery of claims 1, wherein the electronic conductivity of the solid ionically conductive polymer material is less than 1×10^{-8} S/cm at room temperature.

15. The bipolar battery of claim 1, wherein the ionic conductivity of the solid ionically conductive polymer material is isotropic.

16. The bipolar battery of claim 1, wherein the Young's modulus of the solid ionically conductive polymer material is equal to or greater than 3.0 MPa.

17. The bipolar battery of claim 1, wherein the solid ionically conductive polymer material has an ionic conductivity greater than 1×10^{-3} S/cm at 80°C.

18. The bipolar battery of claim 1, wherein the solid ionically conductive polymer material has an ionic conductivity greater than 1×10^{-5} S/cm at -40°C.

19. The bipolar battery of claim 1, wherein the cationic transference number of the solid ionically conductive polymer material is greater than 0.5 and less than 1.0.

20. The bipolar battery of claim 1, wherein at least one anionic diffusing ion comprises hydroxide, fluorine or boron.

21. The bipolar battery of claim 1, wherein there is at least one mole of the cationic diffusing ion per liter of solid ionically conductive polymer material.

22. The bipolar battery of claim 1, wherein at least one of the electrolyte layers is formed into a film, wherein the thickness of the film is between 200 and 10 micrometers.

23. The bipolar battery of claim 1, wherein the first electrochemically active material comprises a lithium oxide comprising nickel, cobalt or manganese.

24. The bipolar battery of claim 1, wherein the first electrochemically active material is intermixed with an electrically conductive material and the solid ionically conductive polymer material.

25. The bipolar battery of claim 1, wherein the positive electrode comprises 70-90 percent by weight of the first electrochemically active material.

26. The bipolar battery of claim 1, wherein the positive electrode comprises 4-15 percent by weight of the solid ionically conductive polymer material.

27. The bipolar battery of claim 1, wherein the first electrochemically active material is selected from a group consisting of Lithium Nickel Cobalt Aluminum Oxide; Lithium Nickel Cobalt Manganese Oxide; Lithium Iron Phosphate; Lithium Manganese Oxide; Lithium cobalt phosphate or lithium manganese nickel oxide, Lithium Cobalt Oxide, $LiTiS_2$, $LiNiO_2$, or combinations thereof.

28. The bipolar battery of claim 1, wherein the first electrochemically active material comprises an electrochemically active cathode compound that reacts with lithium in a solid state redox reaction.

29. The bipolar battery of claim 1, wherein the first electrochemically active material is selected from a group consisting of a metal halide, Sulfur; Selenium; Tellurium; Iodine; FeS_2 or Li_2S.

30. The bipolar battery of claim 1, wherein the second electrochemically active material comprises lithium metal.

31. The bipolar battery of claim 1, wherein the charged voltage of the battery is greater than 12 volts.

32. The bipolar battery of claim 1, wherein the charged voltage of the battery is greater than 20 volts.

33. The bipolar battery of claim 1, having a second cycle cycling efficiency greater than 99%.