CLAIMS

What is claimed is:

1. A battery comprising:

a negative electrode (anode) comprising aluminum and a solid ionically conducting polymer material;

wherein the solid ionically conducting polymer material is formed from the reaction product of a base polymer, electron acceptor, and

an ionic compound;

wherein the ionic compound comprises each at least one cationic and anionic diffusing ion; and

wherein the solid ionically conducting polymer material becomes ionically conductive after being doped by an electron acceptor in the presence of an ionic compound that either contains both a cationic and anionic diffusing ion or is convertible into both the cationic and anionic diffusing ion via reaction with the electron acceptor; and wherein electrochemically active aluminum particles are incorporated into the solid ionically conductive polymer material and wherein the solid ionically conducting polymer material is thermoplastic, and/or wherein the alu-minum is dispersed within the solid ionically conductive polymer material, and/or wherein fine aluminum powder is dispersed within the solid ionically conductive polymer material, and/or wherein aluminum powder is mixed with the solid ionically conducting polymer material;

a positive electrode (cathode) comprising a depolarizer that is capable of electrochemically reacting to produce a hydroxide ion upon reduction; and

an electrolyte interposed between the negative electrode and positive electrode to ionically conduct hydroxide ions between the electrodes.

2. The battery of claim 1, wherein the aluminum powder that is mixed with the solid ionically conducting polymer material is ultra-pure powder or alloy powder.

3. The battery of claim 1, wherein the electrolyte further comprises the solid ionically conducting polymer material.

4. The battery of claim 1, wherein the cathode further comprises the solid ionically conducting polymer material.

5. The battery of claim 1, wherein the depolarizer is a metal oxide, preferably wherein the depolarizer comprises manganese dioxide.

6. The battery of claim 3, wherein the anode further comprises an electrically conducting material.

7. The battery of claim 1, wherein when the aluminum is dispersed within the solid ionically conductive polymer material, the positive electrode comprises the depolarizer comprising manganese dioxide and further the solid ionically con-ducting polymer material.

8. The battery of claim 1, wherein the solid ionically conducting polymer material comprises:
a crystallinity greater than 30%,
wherein polymer crystallinity is the amount of crystalline phase relative to the amount of the polymer and is represented as a percentage, and crystallinity percentage is calculated via x-ray diffraction of the polymer by analysis of the relative areas of amorphous and crystalline phases;
a glassy state;
and both at least one cationic and anionic diffusing ion, wherein at least one diffusing ion is mobile in the glassy state.

9. The battery of claims 1, wherein the electronic conductivity of the solid ionically conducting polymer material is less than 1×10^{-8} S/cm at room temperature and as measured using the potentiostatic method between blocking electrodes.

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

11. The battery of claim 1, wherein the ionic conductivity of the solid ionically conducting polymer material is greater than 1.0×10^{-5} S/cm at 21°C, as measured according to the description.

12. The battery of claim 8, wherein the cationic diffusing ion comprises an alkali metal, an alkaline earth metal, a transition metal, or a post transition metal.

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

14. The battery of claim 1, wherein the solid ionically conducting polymer material is a thermoplastic.

15. The battery of claim 1, wherein the cationic transference number of the solid ionically conducting polymer material, as measured according to the description, is equal to or less than 0.5, and greater than zero.

16. The battery of claim 1, wherein the ionic conductivity of the solid ionically conducting polymer material is isotropic.

17. The battery of claim 1, wherein

(i) the solid ionically conducting polymer material has an ionic conductivity greater than 1×10^{-4} S/cm at 21°C; or

(ii) the solid ionically conducting polymer material has an ionic conductivity greater than 1×10^{-3} S/cm at 80°C; or

(iii) the solid ionically conducting polymer material has an ionic conductivity greater than 1×10^{-5} S/cm at -40°C; and

wherein the ionic conductivity is measured according to the description.

18. The battery of claim 1, wherein the diffusivity of the hydroxide ion, as measured according to the description, is greater than 1.0×10^{-13} m^2/s at room temperature.

19. The battery of claim 1, wherein the base polymer is PPS or a liquid crystal polymer.

20. The battery of claim 1 wherein the depolarizer comprises manganese dioxide, and the manganese dioxide is selected from a group comprising β-MnO_2 (pyrolusite), ramsdellite, γ-MnO2, ε-MnO_2, λ-MnO_2, EMD, CMD, and combinations thereof.