CLAIMS

1. A metal-air battery comprising:

an air electrode that includes an electrically conductive material, and a solid ionically conducting polymer material;

a negative electrode comprising a first electrochemically active metal;

and an ionically conducting, dielectric non-electrochemically active material interposed between the air electrode and the negative electrode and in contact with the air electrode,

wherein the air electrode acts to reduce oxygen when the air electrode is exposed to an oxygen gas source and when the battery is under load.

2. The battery of claim 1, wherein the solid ionically conducting polymer material comprises

a crystallinity greater than 30%; a melting temperature;

wherein the ionic conductivity of the solid ionically conducting polymer material is greater than 1.0×10^{-5} S/cm at room temperature;

and both at least one cationic and anionic diffusing ion, wherein at least one diffusing ion is mobile at room temperature.

3. The battery of claims 1, wherein the electronic conductivity of the solid ionically conducting polymer material is less than $1x\ 10^{-8}$ S/cm at room temperature.

4. The battery of claim 2, wherein at least one cationic diffusing ion comprises an alkali metal, an alkaline earth metal, a transition metal, or a post transition metal.

5. The battery of claim 2, wherein there is at least one mole of the cationic diffusing ion per liter of solid ionically conducting polymer material.

6. The battery of claim 1, wherein the solid ionically conducting polymer material is formed by the reaction of a polymer, electron acceptor, and an ionic compound.

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

8. The battery of claim 1, wherein the air cathode produces hydroxide ion when it reduces oxygen, and wherein the solid ionically conducting polymer material ionically conducts hydroxide ion.

9. The battery of claim 2, wherein the diffusing anion is a hydroxide ion.

10. The battery of claim 2, wherein the ionic conductivity of the solid ionically conducting polymer material is isotropic.

11. The battery of claim 1, wherein the solid ionically conducting polymer material has an ionic conductivity greater than 1×10^{-4} S/cm at room temperature.

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

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

14. The battery of claim 1, wherein the air electrode further comprises a second electrochemically active material.

15. The battery of claim 14, wherein the second electrochemically active material comprises a metal oxide.

16. The battery of claim 14, wherein the metal oxide is manganese dioxide.

17. The battery of claim 1, wherein the first electrochemically active material comprises zinc.

18. The battery of claim 1, wherein the first electrochemically active material is selected from a group comprising zinc, aluminum, calcium, magnesium, potassium, sodium or lithium.

19. The battery of claim 1, wherein the battery is non-aqueous and the ionically conducting, dielectric non-electrochemically active material comprises solid ionically conducting polymer material.

20. The battery of claim 1, wherein the electrically conductive material comprises carbon.

21. The battery of claim 1, wherein the ionically conducting, dielectric non-electrochemically active material comprises both a nonwoven separator disposed adjacent the air electrode and an aqueous electrolyte.

22. The air cathode of claim 1, wherein the air cathode further comprises an oxygen reduction catalyst.