CLAIMS

What is claimed is:

1. A battery having a first electrode comprising:
a solid ionically conductive polymer material; and
a polyvalent metal;
wherein a plurality of ions of the polyvalent metal are ionically conducted by said solid ionically conductive polymer material;
wherein the plurality of ions of the polyvalent metal can be reversibly transported into and or out of the first electrode; and
wherein the solid ionically conductive polymer material is ionically conductive through the solid and not through any solvent, gel or liquid phase;
wherein the solid ionically conductive polymer material is a reaction product of a base polymer, an electron acceptor, and an ionic compound;
wherein an ionic conductivity of the solid ionically conductive polymer material is greater than 1.0×10^{-5} S/cm at room temperature; and
wherein the material has a glassy state and at least one cationic and at least one anionic diffusing ion, wherein each diffusing ion is mobile in the glassy state.

2. The battery of claim 1 wherein the polyvalent metal is dispersed in said solid ionically conductive polymer material.

3. The battery of claim 1 wherein the polyvalent metal is encapsulated by said solid ionically conductive polymer material.

4. The battery of claim 1 wherein the polyvalent metal is granulated including a plurality of polyvalent metal particles; and
the plurality of polyvalent metal particles are mixed with the solid ionically conductive polymer material.

5. The battery of claim 4 wherein the plurality of polyvalent metal particles are each less than 100 microns in diameter.

6. The battery of claim 1, wherein the first electrode is extruded.

7. The battery of claim 1, further comprising an electrically conductive material.

8. The battery of claim 1, further comprising
a second electrode which comprises an electrochemically active compound which reacts with the plurality of ions of the polyvalent metal.

9. The battery of claim 8, wherein said electrochemically active compound is sulfur.

10. The battery of claim 8, wherein said electrochemically active compound is manganese dioxide.

11. The battery of claim 8, wherein said second electrode comprises said solid ionically conductive polymer material.

12. The battery of claim 8, wherein the first electrode is thermoformed.

13. The battery of claim 8, wherein the polyvalent metal is selected from a group consisting of: aluminum, calcium, magnesium, zinc, iron, scandium, chromium, copper, and at least two of the aforementioned.

14. The battery of claim 8, further comprising:

an electrolyte layer interposed between the first electrode and the second electrode;

wherein the electrolyte layer comprises the solid ionically conductive polymer material, and wherein said second battery electrode comprises said solid ionically conductive polymer material.

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

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

17. The battery of claim 1,

wherein the solid ionically conductive polymer material further comprises both a cationic diffusing ion and an anionic diffusing ion;

wherein each of the cationic diffusing ion and the anionic diffusion ion is mobile at room temperature, and

wherein a crystallinity of the solid ionically conductive polymer material is greater than 30%.

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

19. The battery of claim 8, wherein a melting temperature of the solid ionically conductive polymer material is greater than 250°C.

20. The battery of claim 8, wherein the ionic conductivity of the solid ionically conductive polymer material is greater than 1.0×10^{-5} S/cm at room temperature.

21. The battery of claim 1,

wherein the solid ionically conductive polymer material comprises a cationic diffusing ion; and

wherein there is a least one mole of the cationic diffusing ion per liter of the solid ionically conductive polymer material.

22. The battery of claim 8,

wherein the solid ionically conductive polymer material comprises a cationic diffusing ion; and

wherein there is at least one mole of the cationic diffusing ion per liter of the solid ionically conductive polymer material.

23. The battery of claim 1,

wherein the solid ionically conductive polymer material is formed from at least one ionic compound; and

wherein the ionic compound comprises the polyvalent metal.

24. The battery of claim 8,

wherein the solid ionically conductive polymer material is formed from at least one ionic compound; and

wherein the ionic compound comprises the polyvalent metal.

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

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

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

28. The 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.

29. The 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.

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

31. The battery of claim 8, wherein the solid ionically conductive polymer material has a Young's modulus of equal to or greater than 3.0 MPa.

32. The battery of claim 1, wherein the base polymer is selected from the group consisting of polyphenylene sulfide

(PPS), Poly(p-phenylene oxide) (PPO), liquid crystal polymers (LCPs), Polyether ether ketone (PEEK), Polyphthalamide (PPA), Polypyrrole, Polyaniline, Polysulfone, Polyaniline Poly-Phenylamine $[C_6H_4NH]n$, Poly-paraphenylene terephthalmide [----CO-C_6H_4-CO-NH----C_6H_4-NH-]n, Polyvinylidene fluoride (PVDF), Polyacrylonitrile (PAN), Polytetrafluoroethylene (PTFE), Polyethylene (PE), a copolymer including monomers of at least two of the aforementioned polymers; and a combination of at least two of the aforementioned polymers.

33. The battery of claim 1, wherein the dopant is selected from the group consisting of 2,3-Dichloro-5,6-dicyano-l ,4-benzoquinone (DDQ) ($C_8Cl_2N_2O_2$), tetrachloro-1,4-benzoquinone (chloranil) ($C_6Cl_4O_2$), tetracyanoethylene (C_6N_4), sulfur trioxide (SO_3), ozone (trioxygen or O_3), oxygen (O_2), air, a transition metal oxide, MnO_2, and a combination of at least two of the aforementioned.

34. The battery of claim 1, wherein the ionic compound is selected from the group consisting of Li_2O, LiOH, ZnO, TiO_2, Al_2O_3, NaOH, KOH, $LiNO_3$, Na_2O, MgO, $CaCl_2$, $MgC1_2$, $A1Cl_3$, LiTFSI (lithium bis-trifluoromethanesulfonimide), LiFSI (Lithium bis(fluorosulfonyl)imide), Lithium bis(oxalato)borate ($LiB(C_2O_4)_2$, LiBOB), and a combination of at least two of the aforementioned.