What is claimed is:

1. A battery comprising:

an anode comprising a first electrochemically active material;

a cathode comprising both a second electrochemically active material and a first electrolyte;

a second electrolyte interposed between the anode and the cathode;

wherein at least one of the first electrolyte and the second electrolyte comprises a solid polymer electrolyte;

wherein the solid polymer electrolyte has a glassy state, and comprises both at least one cationic diffusing ion and at least one anionic diffusing ion;

wherein at least one of the at least one cationic diffusing ion comprises lithium; wherein at least one of the at least one cationic diffusing ion and the at least one anionic diffusing ion is mobile in the glassy state;

wherein the solid polymer electrolyte comprises a crystallinity greater than 30%;

wherein the glassy state extends in a range of temperatures of the solid polymer electrolyte from a melting temperature of the solid polymer electrolyte to a temperature lower than the melting temperature;

and wherein at least one of the at least one anionic diffusing ion and the at least one cationic diffusing ion has a diffusivity greater than $1.0x10^{-12}$ m^2/s.

2. The battery of claim 1, wherein the solid polymer electrolyte further comprises a plurality of charge transfer complexes.

3. The battery of claim 2, wherein the solid polymer electrolyte comprises a plurality of monomers, and wherein each of the plurality of charge transfer complexes is positioned on a corresponding monomer of the plurality of monomers.

4. The battery of claim 1, wherein an electronic conductivity of the solid polymer electrolyte is less than $1x10^{-8}$ S/cm at room temperature.

5. The battery of claim 1, wherein the solid polymer electrolyte comprises:

a plurality of monomers; and

a plurality of charge transfer complexes;

wherein each of the plurality of charge transfer complexes is positioned on a corresponding monomer of the plurality of monomers; and

wherein an electronic conductivity of the solid polymer electrolyte is less than $1x10^{-8}$ S/cm at room temperature.

6. The battery of claim 1, wherein the melting temperature of the solid polymer electrolyte is greater than 250° C.

7. The battery of claim 1, wherein the solid polymer electrolyte is a thermoplastic.

8. The battery of claim 1, wherein an ionic conductivity of the solid polymer electrolyte is isotropic.

9. The battery of claim 1, wherein the solid polymer electrolyte is non-flammable.

10. The battery of claim 1, wherein a Young's modulus of the solid polymer electrolyte is equal to or greater than 3.0 MPa.

11. The battery of claim 5, wherein each of the at least one cationic diffusing ion and the at least one anionic diffusing ion is mobile in the glassy state.

12. The battery of claim 1, wherein an ionic conductivity of the solid polymer electrolyte is greater than $1.0x10^{-5}$ S/cm at room temperature.

13. The battery of claim 1, wherein the solid polymer electrolyte comprises a single cationic diffusing ion, wherein at least one of the at least one the anionic diffusing ion comprises lithium, and wherein the diffusivity of the single cationic diffusing ion is greater than $1.0x10^{-12}$ m^2/s at room temperature.

14. The battery of claim 1, wherein the solid polymer electrolyte comprises a single anionic diffusing ion, and wherein the diffusivity of the single anionic diffusing ion is greater than $1.0x10^{-12}$ m^2/s at room temperature.

15. The battery of claim 1, wherein at least one of the at least one cationic diffusing ion has the diffusivity greater than $1.0x10^{-12}$ m^2/s.

16. The battery of claim 1, wherein at least one of the at least one anionic diffusing ion has the diffusivity greater than $1.0x10^{-12}$ m^2/s.

17. The battery of claim 1, wherein the solid polymer electrolyte has an ionic conductivity greater than $1x10^{-4}$ S/cm at room temperature.

18. The battery of claim 1, wherein the solid polymer electrolyte has an ionic conductivity greater than $1x10^{-3}$ S/cm at 80° C.

19. The battery of claim 1, wherein the solid polymer electrolyte has an ionic conductivity greater than $1x10^{-5}$ S/cm at -40° C.

20. The battery of claim 1, wherein a concentration of lithium is greater than 3 moles of lithium per liter of solid polymer electrolyte.

21. The battery of claim 1, wherein the at least one cationic diffusing ion has a cationic diffusivity and the at least one anionic diffusing ion has an anionic diffusivity, and wherein the cationic diffusivity is greater than the anionic diffusivity.

22. The battery of claim 1, wherein a cationic transference number of the solid polymer electrolyte is greater than 0.5 and less than 1.0.

23. The battery of claim 1, wherein the at least one anionic diffusing anion is monovalent.

24. The battery of claim 1, wherein the at least one anionic diffusing ion comprises fluorine or boron.

25. The battery of claim 1, wherein the solid polymer electrolyte comprises a plurality of monomers; and wherein there is at least one of the at least one anionic diffusing ion per monomer.

26. The battery of claim 1, wherein the solid polymer electrolyte comprises a plurality of monomers; and wherein there is at least one of the at least one cationic diffusing ion per monomer.

27. The battery of claim 1, wherein there is at least one mole of lithium per liter of solid polymer electrolyte.

28. The battery of claim 1, wherein the solid polymer electrolyte further includes a heteroatom incorporated in a ring structure or positioned on a backbone adjacent the ring structure.

29. The battery of claim 28, wherein the heteroatom is selected from the group consisting of sulfur, oxygen and nitrogen.

30. The battery of claim 29, wherein the heteroatom is sulfur.

31. The battery of claim 1, wherein the solid polymer electrolyte comprises a plurality of monomers, and wherein a molecular weight of each of the plurality of monomers is greater than 100 grams/mole.

32. The battery of claim 5, wherein the charge transfer complex is formed by the reaction of a polymer, electron acceptor, and an ionic compound, and wherein each of the at least one cationic diffusing ion and the at least one anionic diffusing ion is a reaction product of the ionic compound.

33. The battery of claim 1, wherein the solid polymer electrolyte is formed from at least one ionic compound, and wherein the at least one ionic compound comprises each of the at least one cationic diffusing ion and the at least one anionic diffusing ion.

34. The battery of claim 2, wherein each of the plurality of the charge transfer complexes is formed by a reaction of a base polymer and an electron acceptor.

35. The battery of claim 1, wherein the solid polymer electrolyte becomes ionically conductive after being doped by an electron acceptor in the presence of an ionic compound that either contains the at least one cationic diffusing ion and the at least one anionic diffusing ion or is

convertible into both the at least one cationic diffusing ion and the at least one anionic diffusing ion via reaction with the electron acceptor.

36. The battery of claim 1, wherein the solid polymer electrolyte is formed from a reaction product of a base polymer, an electron acceptor and an ionic compound.

37. The battery of claim 34, wherein the base polymer is Polyphenylene Sulfide (PPS) or a liquid crystal polymer.

38. The battery of claim 1, wherein both the first electrolyte and the second electrolyte comprise the solid polymer electrolyte, and wherein an electronic conductivity of the second electrolyte is less than $1x10^{-8}$ S/cm at room temperature.

39. The battery of claim 1, wherein both the first electrolyte and the second electrolyte comprise the solid polymer electrolyte.

40. The battery of claim 1, wherein the anode comprises a third electrolyte, and wherein the third electrolyte comprises the solid polymer electrolyte.

41. The battery of claim 1, wherein the second electrolyte comprises the solid polymer electrolyte and is formed into a film, and wherein the thickness of the film is between 200 and 15 micrometers.

42. The battery of claim 1, wherein the second electro-chemically active material comprises an intercalation material.

43. The battery of claim 1, wherein the second electrochemically active material comprises a lithium oxide comprising a component selected from the group consisting of nickel, cobalt, manganese, and a combination of at least two of the aforementioned.

44. The battery of claim 1, wherein the second electrochemically active material has an electrochemical potential greater than 4.2 volts relative lithium metal.

45. The battery of claim 1, wherein the cathode has an electrode potential greater than 4.2 volts relative lithium metal.

46. The battery of claim 1, wherein the second electrochemically active material is intermixed with an electrically conductive material and the solid polymer electrolyte.

47. The battery of claim 46, wherein the electrically conductive material comprises carbon.

48. The battery of claim 1, wherein the cathode comprises 70-90 percent by weight of the second electrochemically active material.

49. The battery of claim 1, wherein the cathode comprises 4-15 percent by weight of the solid polymer electrolyte.

50. The battery of claim 1, wherein the cathode comprises 2-10 percent by weight of an electrically conductive material.

51. The battery of claim 50, wherein the electrically conductive material comprises carbon.

52. The battery of claim 1, wherein the cathode is formed from a slurry.

53. The battery of claim 1, wherein the cathode is positioned on a cathode collector.

54. The battery of claim 1, wherein the second electrochemically active material comprises a lithium oxide or a lithium phosphate, each of the lithium oxide or the lithium phosphate containing nickel, cobalt or manganese.

55. The battery of claim 1, wherein the second electrochemically active material comprises a lithium intercalation material, and wherein the lithium intercalation material comprises lithium.

56. The battery of claim 55, wherein the lithium intercalation material comprises at least one material selected from the group consisting of Lithium Nickel Cobalt Aluminum Oxide; Lithium Nickel Cobalt Manganese Oxide; Lithium Iron Phosphate; Lithium Manganese Oxide; Lithium Cobalt Phosphate; Lithium Manganese Nickel Oxide, Lithium Cobalt Oxide, $LiTiS_2$, $LiNiO_2$, and a combination of at least two of the aforementioned materials.

57. The battery of claim 1, wherein the second electrochemically active material comprises an electrochemically active cathode component that reacts with lithium in a solid state redox reaction.

58. The battery of claim 57, wherein the electrochemically active cathode component comprises a material selected from the group consisting of a metal halide; Sulfur; Selenium; Tellurium; Iodine; Pyrite (FeS_2) and Li_2S.

59. The battery of claim 56, wherein the lithium intercalation material comprises a material of Lithium Nickel Cobalt Manganese Oxide, and wherein an atomic concentration of nickel in the

Lithium Nickel Cobalt Manganese Oxide is greater than an atomic concentration of cobalt or manganese.

60. The battery of claim 1, wherein the first electrochemically active material comprises an intercalation material.

61. The battery of claim 60, wherein the anode further comprises the solid polymer electrolyte, and wherein the first electrochemically active material is mixed with the solid polymer electrolyte.

62. The battery of claim 1, wherein the first electrochemically active material comprises lithium metal.

63. The battery of claim 1, further comprising an anode current collector in ionic communication with the anode, wherein lithium deposits on the anode current collector when the battery is charged.

64. The battery of claim 63, wherein a density of the lithium deposited on the anode current collector is greater than 0.4 g/cc.

65. The battery of claim 1, further comprising an anode current collector in ionic communication with the anode, wherein the solid polymer electrolyte is positioned adjacent the anode current collector.

66. The battery of claim 60, wherein the first electrochemically active material comprises a material selected from the group consisting of Silicon, Tin, Antimony, Lead, Cobalt, Iron, Titanium, Nickel, Magnesium, Aluminum, Gallium, Germanium, Phosphorus, Arsenic, Bismuth, Zinc, Carbon and a mixture of at least two of the aforementioned.

67. The battery of claim 1, wherein the second electrochemically active material comprises an intercalation material, and wherein the first electrochemically active material comprises lithium metal.

68. The battery of claim 67, wherein a charged voltage of the battery is greater than 4.1 volts.

69. The battery of claim 67, wherein a charged voltage of the battery is greater than 4.5 volts.

70. The battery of claim 67, wherein a charged voltage of the battery is greater than 5.0 volts.

71. The battery of claim 1, wherein lithium is cycled between the anode and the cathode at a rate greater than 0.5 mA/cm^2 at room temperature.

72. The battery of claim 1, wherein lithium is cycled between the anode and the cathode at a rate greater than 1.0 mA/cm^2 at room temperature.

73. The battery of claim 63, wherein lithium is cycled between the anode and the cathode for greater than 150 cycles.

74. The battery of claim 1, wherein lithium is cycled between the anode and the cathode at a rate greater than 3.0 mAh/cm^2 at room temperature for greater than ten cycles.

75. The battery of claim 1, wherein lithium is cycled between the anode and the cathode at a rate greater than 18.0 mAh/cm^2.

76. The battery of claim 1, wherein lithium is cycled between the anode and the cathode at a rate greater than 0.25 mAh/cm^2 at room temperature for greater than 150 cycles.

77. The battery of claim 1, further comprising an anode current collector, wherein lithium is plated onto the anode current collector when the battery is charged, and wherein a density of lithium plated onto the anode current collector is greater than 0.4 g/cc.

78. The battery of claim 1, wherein a lithium cycling efficiency is greater than 99%.

79. The battery of claim 1, wherein the second electrolyte comprises the solid polymer electrolyte and is formed into a film, and wherein the first electrolyte comprises the solid polymer electrolyte, whereby the second electrolyte is attached to the cathode.

80. The battery of claim 1, wherein the second electrolyte comprises the solid polymer electrolyte and is formed into a film, and wherein the anode comprises a third electrolyte, and wherein the third electrolyte comprises the solid polymer electrolyte, whereby the second electrolyte is attached to the anode.

81. The battery of claim 3, wherein an electronic conductivity of the solid polymer electrolyte is less than $1x10^{-8}$ S/cm at room temperature.

82. The battery of claim 5, wherein each of the plurality of charge transfer complexes is formed by a reaction of a polymer and an electron acceptor.