CLAIMS

What is claimed is:

1. A solid, semicrystalline, ionically conductive, polymer material having:

a plurality of monomers;

a plurality of charge transfer complexes, wherein each charge transfer complex is positioned on a monomer;

wherein each of the plurality of charge transfer complexes is formed by a reaction of a polymer and an electron acceptor;

wherein the solid, semicrystalline, ionically conductive, polymer material has a glassy state, and at least one cationic and at least one anionic diffusing ion each being mobile in the glassy state; and

wherein the electrical conductivity of the material is less than 1.0×10^{-5} S/cm at room temperature.

2. The material of claim 1, wherein the crystallinity of the material is greater than 30%.

3. The material of claims 1, wherein the material further comprises a glassy state which exists at temperatures below the melting temperature of the material.

4. The material of claim 3, wherein the material further comprises both a cationic and anionic diffusing ion, whereby each diffusing ion is mobile in the glassy state, and wherein the crystallinity of the material is greater than 30%.

5. The material of claim 1, having at least three diffusing ions.

6. The material of claim 1, having more than one anionic diffusing ion.

7. The material of claim 1, wherein the melting temperature of the material is greater than 250°C.

8. The material of claim 1, wherein the ionic conductivity of the material is greater than 1.0 x 10^{-5} S/cm at room temperature.

9. The material of claim 1, wherein the material comprises a single cationic diffusing ion, wherein the diffusivity of the cationic diffusing ion is greater than 1.0 x 10^{-12} m^2/s at room temperature.

10. The material of claim 1, wherein the material comprises a single anionic diffusing ion, wherein the diffusivity of the anionic diffusing ion is greater than 1.0 x 10^{-12} m^2/s at room temperature.

11. The material of claim 1, wherein at least one cationic diffusing ion comprises an alkali metal, an alkaline earth metal, a transition metal, or a post transition metal.

12. The material of claim 1, wherein there is at least one anionic diffusing ion per monomer.

13. The material of claim 1, wherein there is at least one cationic diffusing ion per monomer.

14. The material of claim 1, wherein there is at least one mole of the cationic diffusing ion per liter material.

15. The material of claim 1, wherein the charge transfer complex is formed by the reaction of a polymer, electron acceptor, and an ionic compound, wherein each cationic and anionic diffusing ion is a reaction product of the ionic compound.

16. The material of claims 1, wherein the material is formed from at least one ionic compound, wherein the ionic compound comprises each cationic and anionic diffusing ion.

17. The material of claim 1, wherein the material is a thermoplastic.

18. The material of claim 1, wherein the cationic diffusing ion comprises lithium.

19. The material of claim 1, wherein each at least one cationic and anionic diffusing ion have a diffusivity, wherein the cationic diffusivity is greater than the anionic diffusivity.

20. The material of claim 1, wherein the cationic transference number of the material is greater than 0.5 and less than 1.0.

21. The material of claim 18, wherein the concentration of lithium is greater than 3 moles of lithium per liter of material.

22. The material of claim 20, wherein the cationic diffusing ion comprise lithium.

23. The material of claim 1, wherein the diffusing cation is monovalent.

24. The material of claim 1, wherein the valence of the diffusing cation is greater than one.

25. The material of claim 1, wherein the material includes greater than one diffusing anion per monomer.

26. The material of claim 1, wherein the diffusing anion is a hydroxyl ion.

27. The material of claim 1, wherein diffusing anion is monovalent.

28. The material of claim 1, wherein both the diffusing anion and the diffusing cation are monovalent.

29. The material of claim 1, wherein each at least one cationic and anionic diffusing ion have a diffusivity, wherein the anionic diffusivity is greater than the cationic diffusivity.

30. The material of claim 1, wherein the cationic transference number of the material is equal to or less than 0.5, and greater than zero.

31. The material of claim 1, wherein one of the at least cationic diffusing ion, has a diffusivity greater than 1.0×10^{-12} m^2/s.

32. The material of claim 1, wherein one of the at least one anionic diffusing ion has a diffusivity greater than 1.0×10^{-12} m^2/s.

33. The material of claim 1, wherein one of both the at least one anionic diffusing ion and at least one cationic diffusing ion has a diffusivity greater than 1.0×10^{-12} m^2/s.

34. The material of claim 1, wherein each monomer comprises an aromatic or heterocyclic ring structure positioned in the backbone of the monomer.

35. The material of claim 34, wherein the material further includes a heteroatom incorporated in the ring structure or positioned on the backbone adjacent the ring structure.

36. The material of claim 35, wherein the heteroatom is selected from the group consisting of sulfur, oxygen or nitrogen.

37. The material of claim 36, wherein the heteroatom is positioned on the backbone of the monomer adjacent the ring structure.

38. The material of claim 36, wherein the heteroatom is sulfur.

39. The material of claim 1, wherein the material is pi-conjugated.

40. The material of claim 34, wherein there is at least one anionic diffusing ion per monomer, and wherein at least one monomer comprises a lithium ion.

41. The material of claim 1, wherein the polymer comprises a plurality of monomers, wherein the molecular weight of the monomer is greater than 100 grams/mole.

42. The material of claim 1, wherein the material is hydrophilic.

43. The material of claim 1, wherein the ionic conductivity of the material is isotropic.

44. The material of claim 1, having an ionic conductivity greater than 1×10^{-4} S/cm at room temperature.

45. The material of claim 1, having an ionic conductivity greater than 1×10^{-3} S/cm at 80ºC.

46. The material of claim 1, having an ionic conductivity greater than 1×10^{-5} S/cm at -40ºC.

47. The material of claim 1, where the cationic diffusing ion comprises lithium, and wherein the diffusivity of lithium ion is greater than 1.0×10^{-13} m^2/s at room temperature.

48. The material of claim 1, wherein the material in non-flammable.

49. The material of claim 1, wherein the material remains is non-reactive when mixed with a second material wherein the second material is selected from a group comprising a electrochemically active material, an electrically conductive material, a rheological modifying material, and a stabilizing material.

50. The material of claim 1, wherein the material is in the shape of a film.

51. The material of claim 1, wherein the Young's modulus of the material is equal to or greater than 3.0 MPa.

52. The material of claim 1, wherein the material becomes ionically conductive after being doped by an electron acceptor.

53. The material of claim 1, wherein the material becomes ionically conductive after being doped by an electron acceptor in the presence of an ionic compound that either contains both the cationic and anionic diffusing ion or is convertible into both the cationic and anionic diffusing ion via oxidation by the electron acceptor.

54. The material of claim 1, wherein the material is formed from the reaction product of a base polymer, electron acceptor and an ionic compound.

55. The material of claim 54, wherein the base polymer is a conjugated polymer.

56. The material of claim 54, wherein the base polymer is PPS or a liquid crystal polymer.

57. The material of claim 54, wherein the ionic compound is an oxide, chloride, hydroxide or a salt.

58. The material of claim 54, wherein the electron acceptor is a quinone or oxygen.