Thermal, Transport, and Electrochemical Studies of Ionic Liquids for Lithium Ion Battery Systems

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Ionic liquid electrolytes are promising new materials in power sources for electric vehicles, hybrid cars, electronic and power-storage devices, especially at extreme conditions. An advantage of ionic liquids is that they are not only conducting, but also non-volatile at ordinary temperatures and, in most cases, thermally stable. Ionic liquids show a large liquid range that allows a larger temperature range for electrochemical devices. For rechargeable lithium ion batteries, we require that any electrolyte, including ionic liquids, provide adequate durability, high conductivity, good transport properties and, very important, chemical and electrochemical stability with safety. The ionic liquids studied in this work include various neat ionic liquids and lithium salt mixtures. Four liquids cations studied were imidazolium, pyridinium and pyrrolidinium, with PF6-, BF4-, trifluoromethansulfonate, and bis(trifluoromethylsulfonyl)imide anions. Thermal analyses have been carried out with Perkin-Elmer DSC 7 and TGA 7. The addition of a lithium salt causes both changes in thermal stability and in phase-behavior. The interfacial resistance in a battery cell system was studied by an AC impedance method in battery test systems. The results show that the magnitude of reactivity due to reduction of the ionic liquid electrolyte has a detrimental effect on battery performance.