Stabilization Effect of Imidazole on Tetra-alkylammonium Hydroxide and Imidazolium Alkaline Ionic Liquid Electrolyte Materials

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Over strongly acidic polymer electrolyte fuel cells, Alkaline Electrolyte Membrane Fuel Cells (AEMFC) take advantages to allow the variety of available non-noble oxygen reduction reaction (ORR) catalysts composed of transition metal oxide, Ni and Ag transition metal catalysts etc. The drive to replace expensive and scarce Pt-based catalysts has significantly led to blooming R&D interests on AEMFCs, which offers much lower cost, easier water management, and opportunity for use of non-hydrogen liquid fuels such as ammonia. AEMs commonly feature tetra-alkyl ammonium cations, which suffers from instability to base and attack by oxygen radical species such as OH and superoxide. Imidazolium cations may be more stable. Imidazole may solvate hydroxide well and provide the means of fast ion transport. Excess of imidazole provides solvation for hydroxide in the absence of water, which allows feasible operation up to 150°C. Imidazole provides mechanisms for fast charge transport through proton transfer or structure diffusion by rotation of the imidazole carrying OH.

In this presentation, given the stabilization effect of imidazole and imidazolium cations in alkaline media, the ionic liquid mixtures of tetraethylammonium hydroxide (TEAOH) and imidazole at molar ratio of 4:1, showed good thermal stability to temperatures above 100°C. The presence of the imidazole significantly enhanced the thermal stability by TGA experiments. The conductivity of the TEAOH-imidazole mixtures is in the range of $10^{-2}$ to $10^{-1}$ S/cm at the temperature ranging from 60 to 150°C. Followed by this strategy, introducing the imidazolium cation tethered polysiloxane as alkaline ionic liquid electrolyte, was conducted to immobilize the imidazolium cation ring in alkaline media. After three months storage of imidazolium cation tethered siloxane oligomer at room temperature, TGA analysis showed the sample to have the same weight loss characteristics as a fresh sample. Water insolubility of imidazolium hydroxide tethered polysiloxane is desired. Accordingly, synthesis of neutral polysiloxane followed by post-tethering of imidazolium cations before hydroxide anion conversion will be of interest.

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