Pyrazolium Ionic Liquids: Electrochemistry of 1-Ethyl-2-Methylpyrazolium Tetrafluoroborate

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Interest for ionic liquids originated from the electrochemical studies on molten salts operating at high temperature and from efforts to lower their operating temperature utilizing low melting organic salts. Earlier studies were performed using water and oxygen sensitive ionic liquids, consisting of butylpyridinium or dialkylimidazolium cations and chloroaluminate anion (1). During 1990s a large number of new ionic liquids, that were neither water nor oxygen sensitive, were developed and studied thus facilitating studies for their application in capacitors, batteries, electroplating, electrosynthesis, sensors (2,3). Most electrochemical studies of these liquids were directed toward the basic electrochemical properties such as electrochemical window while only recently studies were described relating to the electrochemical reduction of cations and oxidation of anions in imidazolium based ionic liquids (4).

Electrochemical Systems, Inc. developed and studied pyrazolium based ionic liquids (5). These ionic liquids demonstrated similar physicochemical properties to imidazolium based ionic liquids but also showed unique differences: higher oxidation potential, compatibility with lithium metal in a wide temperature range over a long period of time, which made them very interesting solvents for applications in systems related to active metals (for example, lithium).

This paper deals with a study of electrochemical reactions for reduction of 1-ethyl-2-methylpyrazolium tetrafluoroborate ($EMPBF_4$). Exhaustive constant potential electrolysis was performed and progress in electrolysis was followed by cyclic voltammetry. Reduction products were determined by GC-MS and spectral methods. The electrolysis indicated one electron reduction process. Results obtained were analyzed and possible pathways for the electrochemical reactions were proposed. Results are also discussed with regard to the electrochemistry of imidazolium based ionic liquids and with regard to the lithium batteries employing pyrazolium based ionic liquids.

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