Electrolytic Conductivities and Viscosities of Hydrophobic Room-Temperature Ionic Liquids

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At atmospheric pressure, the electrolytic conductivities and viscosities of four hydrophobic room-temperature ionic liquids (RTILs) were measured as functions of temperature and water content. The RTILs studied were 1-butyl-3-methylimidazolium hexafluorophosphate, 1-hexyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide, 1-butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide, and 1-ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide. Using a mechanical pump and a liquid nitrogen trap, the RTILs were initially dried under vacuum with stirring. Coulometric Karl Fischer titration was used to determine the water contents of the RTILs before and after each set of measurements. For measurements on the dried liquids, the water content of the RTILs was less than about 30 ppm by mass. However, some measurements were purposely performed with up to about 1 % water by mass. Electrolytic conductivity measurements were made with a commercial conductivity cell with platinum black electrodes. In order to control water content, the conductivity cell was modified so that it could be sealed during measurements. The conductivity of the RTILs was found to increase with increasing temperature or with increasing water content. For example, the conductivity of 1-butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)amide increased by about 30 % with the addition of about 1 % water. Viscosity measurements were made with Ubbelohde capillary viscometers or with a rotational coaxial cylinder viscometer. Again, water content was carefully controlled. The viscosity of the RTILs decreased with increasing temperature or with increasing water content. For example, the viscosity of 1-butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)amide decreased by about 30 % with the addition of about 1 % water. The inverse relationship between electrolytic conductivity and viscosity, as expressed by the Walden rule, was obeyed in these systems.