Progress Toward Imaging Chemical Dynamics in Ionic Liquid Electrolytes Using 2D IR Microscopy

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The overarching goal of this project is to better understand the role of molecular templating and dynamical behaviors of ionic liquid (IL) electrolytes across multiple length scales. A major goal in this project is to connect the behaviors of IL electrolytes at interfaces to the behaviors of IL electrolytes in bulk environments. In addition, we seek insights into the roles external electric fields and molecular templating play in dictating the dynamical behaviors in ILs and water-in-salt (WIS) electrolytes. In this talk, our progress made towards observing bulk characteristics of target IL and WIS electrolytes using polarization-dependent 2D IR spectroscopy will be discussed. Initial experiments have been carried out on the imidazolium-based IL, $BmimBF_4$ doped with dicyanamide (DCA). The WIS electrolyte was formed by adjusting the mole fraction of water in the $BmimBF_4$:BmimDCA IL from $\chi_{water} = 0.0$ to $\chi_{water} = .25$. The range of water content was chosen to capture possible dynamical regimes proposed to exist in WIS electrolytes including an ice-like regime at very low mole fractions of water, a nanocluster regime at moderate water mole fractions, and a fluid regime at high water mole fractions. Linear IR spectroscopy and polarization-dependent 2D IR spectroscopy measurements have been used to observe dynamics of these bulk IL and WIS electrolytes. These initial experiments have revealed interesting avenues to pursue during this project. In addition to discussing these initial experiments on bulk electrolytes of interest, progress towards spatially resolving dynamics of these systems in structured environments will also be presented. Throughout this talk, particular attention will be paid to improvements made in our measurements.