Exceptionally Fast Ion Diffusion in Block Copolymer-Based Porous Carbon Fibers

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Abstract:

Confinement of ionic liquids in hydrophilic porous solid media has previously been shown to disrupt the lattice structures of the ionic liquids. An immobile ion layer adheres to the surface of the material, while the inner layer exhibits increased mobility compared to bulk ionic liquids. In this work, porous carbon fibers (PCF) synthesized from a polyacrylonitrile-*block*-polymethyl methacrylate (PAN-*b*-PMMA) block copolymer were used to study the effects of confinement on the dynamics of 1-butyl-3-methylimidazolium tetrafluoroborate (BMIM BF_4). PCF contain mesoporous networks with unimodal pore diameters ranging from 8 to 30 nm depending on polymer composition. Elastic neutron scattering scans confirmed confinement effects in 13.6 nm diameter pores due to a lack of a freezing transition point between 20 K and 300 K. Quasi-elastic neutron scattering (QENS) was used to determine the diffusion coefficients of the bulk BMIM BF_4 and of the BMIM BF_4 confined in the pores. A seven-fold increase in diffusion coefficient was obtained from the QENS data for the confined BMIM BF_4 compared to the bulk. The tunability of the pore sizes and the hydrophilicity of the PCF offers opportunities for further work exploring the limits of confinement in the unique mesoporous networks of PCF.