ABSTRACT

A Study of the Effects of $LiClO_4$ on Poly(ethylene oxide), (PEO) Melt Dynamic Behavior Using Fabry-Perot Interferometry

by

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Poly(ethylene oxide)/lithium perchlorate ($PEO/LiClO_4$) complexes are widely studied as a prototype solid polymer electrolyte in rechargeable lithium-polymer batteries. Characterizing the structure and dynamics of the system in its molten state is important for understanding the role of the polymer environment in lithium ion transport and conductivity. We implement a fiber-optic coupled Fabry-Perot interferometer to investigate the electrolyte elastic properties and structural response times, which are both related to the intrachain local mobility and therefore to ion diffusion. We propose a simple and inexpensive fiber-optic experimental design combining two experimental techniques, Fabry-Perot interferometry and photon correlation spectroscopy. Our tests and evaluation show that the setup performs very well giving good resolution and numerous advantages to both techniques. We report Brillouin scattering results on PEO-1K melts and PEO-1K/$LiClO_4$ complexes at temperatures in the range from 40 to 80^oC and salt concentrations from 0% to 31% (by weight). The temperature dependence for the no-salt samples revealed a monotonic decrease in the sound velocity and the longitudinal modulus in the medium. The system undergoes a glass transition in this temperature-frequency range. Upon addition of salt the longitudinal modulus increases significantly, which we interpret as stiffening and stabilization of the polymer network. That behavior is consistent with previous PCS results and should have great importance in optimizing the polymer electrolyte performance.