ABSTRACT

The research work, under report, aims to address critical issues of ion transport and stability (thermal, mechanical, voltage) properties in ion conducting polymer films. To address these issues, polymer nanocomposite films have been prepared by two distinct routes; (1) nanoscopic confinement of an optimized combination of Li^+ cation coordinated polymer matrix into dodecyl amine (DDA) modified montmorillonite clay galleries having channel width ~16 Å and (2) reinforcement of optimized SPE matrix via homogeneous dispersion of nanoscopic ceramic particles with size in the range ~20-50 nm. The incorporation of nanoceramics, such as layered silicate clays or inert oxide nanoparticles arranged at the nanometer scale having high aspect ratio and extremely large surface area, into an ion conducting polymer matrix has indeed shown reasonable improvements in the ambient temperature conductivity, wear characteristics and stability (thermal, voltage and interfacial) properties. In addition to the characterization of three series of PNC films based on an optimized ratio of polymethyl methacrylate-salt (PS) complex (i.e. $PMMA_4$-$LiClO_4$), particular attention has been focused on understanding the correlation between their structure and property. An ion transport mechanism has also been proposed for both the intercalated and dispersed phase nanocomposite films in order to understand the associated physics of electrical transport phenomena in polymer nanocomposite (PNC) type ionic conductors. The scheme of the proposed ion transport mechanism is based on the evidenced interactions between the cation coordinated polymer host and the clay/nanoceramics fillers, i.e., polymer–ion–filler/clay interaction.

The addition of nanoceramic fillers, such as layered silicate clays or inert oxide nanoparticles, caused substantial improvement in the ambient temperature conductivity and stability properties (i.e. mechanical, thermal and voltage). Finally, the number of charge carriers and its variation with temperature and filler concentration has been analyzed using Almond West formalism.

The experimental results on structure property correlation have indicated excellent agreement. It is concluded that PNC films exhibit improved conduction and stability properties suitable as separator component for device applications such as lithium polymer batteries, supercapacitors etc.

Key Words: Polymer Nanocomposites, Conductivity Mechanism, Ion Transport, Intercalation, Dielectric Properties