Synthesis and transport properties of nano-composite solid polymer electrolytes: Applications to solid-state batteries

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Nano-composite polyethylene oxide (PEO) based polymer solid electrolytes consisting of different salts and nano-particulate ceramic filler have been synthesized by solution casting method. These electrolyte films were characterized using, differential scanning calorimetry (DSC), atomic force microscopy, Raman spectroscopy, electrical conductivity and dielectric spectroscopic techniques. The DSC results showed that the addition of TiO_2 particles increased the glass transition temperature, T_g. This was further supported by the observation of the reduced intensity of DLAM mode in the Raman spectra. Interestingly, the AFM images showed the nano-fibrous morphological feature of the electrolyte films. The d.c conductivity of all the films was obtained from the impedance data. The electrolyte film with TiO_2 filler exhibited high conductivity of 2 x 10^{-5} S/cm at room temperature. The observation temperature independency of a.c conductivity below T_g, clearly indicates that the ionic transport is closely coupled to the segmental motion of polymers. The peak in the dielectric loss associated with the segmental motion and its temperature dependence further revealed that the ionic motion is very much governed by segmental motion. Temperature dependence of conductivity and relaxation time (both conductivity and dielectric) obeyed Vogel-Tamman-Fulcher (VTF) equation typical of amorphous polymers. The conductivity relaxation in the form of electrical modulus has been fitted to KWW function describing the non-exponential nature of relaxation typical of amorphous systems.