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^{57}Fe and ^{119}Sn Mössbauer, XRD, FTIR and DC conductivity study of Li_2O-Fe_2O_3-SnO_2-P_2O_5 glass and glass ceramics

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Abstract

Glass samples with a composition of $1.5Li_2O•(1.5\text{-}x)Fe_2O_3•xSnO_2•3P_2O_5$ (x = 0.1, 0.3 and 0.5) were prepared by melt-quench method. X-ray diffraction (XRD) study revealed the glass formation of the as-quenched samples. Each glass sample was heat treated (HT) at 600 ^oC for 1 h to obtain glass ceramics. HT samples showed precipitation of a small amount of crystalline particles assigned to $LiFeP_2O_7$. Local structure of these samples was explored by means of Fourier transform infrared-spectroscopy and Mössbauer spectroscopy. They proved that Fe^{3+} ions occupied the sites of network former, while Fe^{2+} and Sn^{4+} the sites of network modifier. DC conductivity (σ) measurement of these samples showed non-linear temperature dependency. Activation energy showed a slight decrease with an increasing amount of SnO_2, and the σ measured at 500 K increased from 5.6×10^{-5} to 3.9×10^{-4} $S\cdot cm^{-1}$. The σ values of HT samples were one-order of magnitude larger than those of the corresponded as-quenched glass samples, reflecting structural relaxation of the 3D-network composed of distorted FeO_4 and PO_4 tetrahedra. The approximated ratio of electronic- to ionic-conduction, $\sigma_{elec}/\sigma_{ion}$, suggested that the conduction became predominantly "ionic" at high temperatures. The present study will be useful for the development of new cathode active material and solid state electrolyte for lithium ion battery.

Keywords:

Lithium iron tin phosphate glass; FTIR spectroscopy; Mössbauer spectroscopy; DC electrical conductivity.