ABSTRACT

The effect of varying iron content on the crystallization behavior, electrical conductivity mechanism, and mechanical properties of glass nanocomposite based on the system $xFe\cdot(1-x)\cdot(0.3V_2O_5\cdot0.2MoO_3\cdot0.4CdO\cdot0.1ZnO)$ (x = 0.0, 0.05, 0.1, 0.2, 0.3, and 0.4) was investigated by differential scanning calorimetry (DSC), Fourier transform infrared (FTIR), X-ray diffraction (XRD), and field emission-scanning electron microscopy (FESEM). Different crystal phases and average sizes of the developed nanocrystallites in the as-prepared samples have been obtained from the XRD diffraction data. FESEM micrographs confirm the formation of plate-like and dendrite nano crystallites throughout the glass matrix. Energy-dispersive X-ray spectroscopy (EDX) mapping analysis shows the weight percentage of each constituent element. The density and molar volume data of as prepared samples show the inverse relation due to the formation of non-bridging oxygens. The DC activation energy (E_σ)as well as activation energy (E_H) for the hopping frequency of as-prepared samples gradually decreased with increasing Fe content whereas AC and DC conductivity gradually increased. AC conductivity scaling data has explored that the common electrical relaxation mechanism is temperature-independent as well as composition-dependent. Vickers Microhardness measurement of all samples has been performed by using an indentation load (0.049 N to 0.980 N) at room temperature as well as different heat treatment conditions. The experimental microhardness results have been analyzed using Meyer's law, the elastic/plastic deformation model, the proportional specimen resistance model, the Hays–Kendall approach, and the indentation-induced cracking (IIC) model.