Anomalous dielectric constant and AC conductivity in mixed transition-metal-ion xFe_2O_3–$(20-x)MnO_2$–$80TeO_2$ glass system

ABSTRACT

Glasses with xFe_2O_3–$(20-x)MnO_2$–$80TeO_2$ (x=2, 5, 10, 15, and 20 mol%) composition were prepared by meltquenching technique to investigate the effects of mixed-transition metal ion $Fe^{2+/3+}//Mn^{3+/4+}$ on AC conductivity and dielectric properties using impedance spectroscopy. Dielectric constant showed strong variation with Fe_2O_3 at a frequency ≥10 kHz, where ε decreased to a minimum value at x =10 mol% before increasing for x> 10%. The decrease in ε may be attributed to some form of hindrance effect on heavy dipoles caused by the mixed transition-ion effect (MTE). Meanwhile, variation of AC conductivity with Fe_2O_3 showed non-linear increase for x ≤ 10 mol% before dropping to a minimum at 15 mol% Fe_2O_3. This result was attributed to Anderson localization because of the disorder in the glass system. Conductivity analysis showed that the conduction mechanism at the dispersion region for x = 2 mol% followed the correlated barrier hopping (CBH) model, while the mechanism transformed to the overlapping large polaron tunnelling (OLPT) model at higher Fe_2O_3, content (x > 2 mol%). The electric modulus of the investigated samples showed asymmetric peak of the imaginary part of electric modulus (M¢¢), which reflected a non-Debye type relaxation.

Keyword: Glasses; Dielectric properties; Electrical conductivity; Transport properties; Mixed transition-ion effect