Structural and optical properties of Er^{3+}-doped willemite glass-ceramics from waste materials

ABSTRACT

The production of Er^{3+}-doped willemite glass-ceramic using waste soda lime silica (SLS) glass was reported in this study. The precursor glass and glass-ceramics were prepared using conventional melt-quenching technique with empirical formula $(Er_2O_3)_x[(ZnO)_{0.5}(SLS)_{0.5}]_{1-x}$ where x = 1 wt.% and sintered at various temperatures. The trend of density and the linear shrinkage of the glass-ceramic samples were increased with the progression of sintering temperature. The crystallization behaviour and surface morphology of the glass-ceramics was studied using X-ray diffraction (XRD) and field emission scanning electron microscopy (FESEM). It was revealed that at a lower sintering temperature (700 °C), the stable state of α-willemite (α-Zn_2SiO_4) phase was formed. Fourier transform infrared (FTIR) spectroscopy reveals that the presence of different functional groups in the samples. Three transition states of excitation were shown in UV–visible (UV–vis) spectra which arise from the ground state $^4I_{15/2}$ to the excited states $^4F_{7/2}$, $^2H_{11/2}$, $^4F_{9/2}$. Broad green emission at 557 nm under excitation 385 nm was obtained. These spectra reveal that the luminescence of the samples was increased with the progression of sintering temperature due to the presence of Er^{3+} ions into the willemite crystal. Such luminescence of glass and glass-ceramics are expected to have potential applications in optoelectronic devices.

Keyword: Glass-ceramic; Willemite; Erbium oxide; Photoluminescence