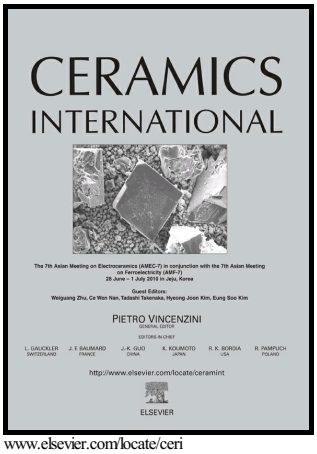

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Enhanced visible emissions of Pr^{3+}-doped oxyfluoride transparent glass-ceramics containing SrF_2 nanocrystals

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Abstract

The Pr^{3+}-doped oxyfluoride transparent glass and glass-ceramic (GC) with the composition of $41SiO_2 + 10Al_2O_3 + 25.5LiF + 23SrF_2 + 0.5Pr_2O_3$ were prepared and investigated their optical and luminescence properties. The formation of SrF_2 nanocrystals in GC has been confirmed by X-ray diffraction (XRD) and transmission electron micrographs (TEM). The Fourier transform infrared spectroscopy (FT-IR) studies were used to examine the network structure characteristics of silicates in the glass matrices. The XRD and TEM results suggest that the Pr^{3+} ions are progressively incorporated into the SrF_2 nanocrystals in the GC with increase in time of thermal treatment at 650 ^{0}C, corresponding to the first crystallization temperature of the glass. The obtained visible emissions of Pr^{3+}-doped GC are several times enhanced than that in the glass and the lifetime of the $^3P_0$ level of the Pr^{3+} ions in glass and GC are found to be 7 and 12 μs, respectively. Therefore, the enhanced visible emission and lifetimes in GC are due to the incorporation of Pr^{3+} ions into the lower phonon energy of SrF_2 nanocrystals in the GCs. Moreover, the smaller difference in ionic radius between the added trivalent ions (Pr^{3+}) and Sr^{2+} induces the larger enhancement of luminescence intensity in the GC. Hence, these enhanced visible luminescence properties indicate that the present glass and GC could be useful for photonic device applications.

Keywords: Pr^{3+}-doped glass; Oxyfluoride glass-ceramics; SrF_2 nanocrystals; Optical properties; Judd-Ofelt analysis.

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