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Preparation and properties of ferromagnetic glass-ceramics and glass fibers in alkali-free and high-iron glass system

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Abstract

We prepared ferromagnetic glass-ceramics in the system $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-SrO-B}_2\text{O}_3\text{-Fe}_2\text{O}_3$ via four different methods, i.e., fiber-drawing, melt-quenching, natural-cooling, and annealing, without performing any nucleation and crystallization heat treatment. The influences of chemical compositions and fabrication methods on the spontaneous crystallization of magnetite in the as-prepared glass ceramics were investigated by X-ray diffraction, scanning and transmission electron microscopy. The X-ray diffraction patterns show that the nanometric magnetite crystals exist in a glass matrix. The spontaneous crystallization of magnetite can be enhanced with increasing alumina content. The size of crystallized magnetite is dependent on the chemical composition. The magnetic hysteresis circles of the glass-ceramic samples were analyzed using a vibrating sample magnetometer (VSM) in a 450 kA/m magnetic field. We find that both the saturation magnetization (M_s) and coercivity (H_{jc}) are changed with the variation of chemical compositions and fabrication methods. Calorimetric measurements were carried out using Orton Standard Dilatometers and we found that the softening point (T_s) and the coefficient of thermal expansion (CTE) of the annealed samples show non-monotonic dependence on the chemical composition.

Keywords: Magnetite; Spontaneous crystallization; Ferrimagnetic glass fibers

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