Crystallization of physical properties of aluminate glasses

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Abstract

Aluminate glasses represent a suitable host matrix for optically active dopants. They are transparent in UV, vis and NIR, have lower phonon energies in comparison to common silicate glasses, and can accommodate higher concentrations of optically active dopants in comparison to their single- or polycrystalline counterparts of similar composition, such as yttrium- or ytterbium aluminium garnets, or the respective rare earth aluminate perovskites. The luminescence intensity and wavelength can be tuned by deliberate change of chemical environment of activators, either through tailoring chemical composition of the host matrix, or by changing the coordination sphere of the activator through controlled crystallization of the system. They can be also used as precursor powders for preparation of polycrystalline materials with various types of microstructures (e.g. submicrometre-sized polycrystalline materials, materials with eutectic miscrostructures etc.) In all three cases, detailed knowledge on mechanism and crystallization kinetics of host glass is required. Thermal and crystallization behaviour of various aluminate glasses prepared in the form of microspheres by flame synthesis from powder precursors obtained by the Pechini method was therefore studied by DSC, SEM-EDS, XRD and high temperature XRD. Fundamental thermal characteristics of glass microspheres with various compositions in the systems Al2O3-Y2O3, Al2O3-La2O3 and Al2O3-Yb2O3, both undoped, and doped with up to 5 mol % of optically active elements (Ce, Er, Eu, Mn) were determined. The DSC data were analysed with the use of the Johnson-Mehl-Avrami-Kolmogorov (JMAK) model. In some cases the raw data were mathematically deconvoluted into two peaks representing two overlapping thermal effects. These were examined by the nucleation – growth Johnson – Mehl – Avrami model, autocatalytic Sestak – Berggren model and by Malek z(α) and y(α) functions. The influence of glass composition on crystallization characteristics and kinetic parameters was evaluated and discussed.

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