Crystallization pathways and some properties of lithium disilicate oxynitride glasses

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Abstract

Lithium silicates have been used as model glasses for scientific and technological studies of glass-ceramics because they easily crystallize in the interiors, even without the addition of any nucleating agent. On the other hand, partial replacement of oxygens with nitrogens affects most properties of oxide glasses, but its effect on the crystallization kinetics of the glasses has been poorly documented. In this work, we report, for the first time, on the crystallization kinetics of nitrited lithium silicate glasses. The oxynitride glasses were prepared by partial substitution of oxygen by nitrogen, up to 6 at.% N/(N+O), by melt-quenching the liquid under N2 atmosphere inside a glove box. As expected, the density, microhardness, and Young's modulus of the glasses improved with increasing nitrogen content. Higher values of glass transition and crystallization peak temperatures were also obtained with an increase in the nitrogen content. Rietveld refinement analysis after adequate thermal treatment revealed that addition of nitrogen led to increasingly higher contents of lithium metasilicate at the expense of the (expected) lithium disilicate crystal phase. Crystallization kinetic parameters such as the activation energy and Avrami index were calculated using Ozawa's equations. These two parameters also increased with increasing nitrogen content, whereas the crystal growth rates decreased with increasing nitrogen content. The above-described changes in the properties of the oxynitride glasses are straightforwardly explained by the increase in the connectivity of the glass network, which results in enhancement of the atomic packing density owing to partial substitution of two-coordinated oxygens by three-coordinated nitrogens.

Keywords: Crystallization, oxynitride glasses

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