
Borophosphate Glass Structure affected by various Network Modifiers

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Abstract

Rare earth ion-doped materials are widely used in photonic devices and other lighting applications because of their superior optical performance as well as their long and stable lifetime. Phosphate glasses are good host matrices due to their high solubility for rare earth ions and their low melting temperatures. However, they can be highly sensitive to humidity. Incorporating alkaline earth ions, such as Ba²⁺ or Ca²⁺, and adding B₂O₃ as a second network former can improve their durability. The emission properties of Dy³⁺ doped borophosphate (BP) glasses have been shown to depend on the ionic field strength of the network modifier and the theoretical optical basicity of the host glass.

Building on these results, this study presents investigations on the structure of Dy³⁺-doped BP glasses with the molar composition 40MO-10B₂O₃-50P₂O₅, M=Ca²⁺, Ba²⁺ or Zn²⁺. The glasses are doped with 0.1 mol% Dy₂O₃ and prepared by melt-quenching. The structure of the glasses is investigated by Raman and 1D 11B and 31P and 2D 11B/31P MAS NMR spectroscopy, the physical and thermal properties are determined using helium pycnometry and DSC measurements.

The 1D 11B MAS NMR spectra of the glasses are very similar and show only a single site of fourfold coordinated B ((4)B) and an invariant B/P mixing scheme. This was also confirmed with 2D 11B (31P) D-HMQC NMR experiments. Small deviations can be visualized by deconvoluting the 1D 31P MAS NMR spectra: the QB proportion increases from Ba²⁺ to Zn²⁺, suggesting a higher B/P mixing ratio. Comparing the NMR spectra of the doped and undoped glasses enables to conclude that the Dy³⁺ ions are homogeneously distributed in the glass matrix.

Keywords: Borophosphate, NMR, Glass Structure

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