The role of Bi2O3 on the thermal, structural and optical properties of tungsten-phosphate glasses

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The role of Bi2O3 on the thermal, structural and optical properties of tungsten-phosphate glasses

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Glasses in the ternary system (70 – x)NaPO3-30WO3-xBi2O3, with x = 0–30 mol %, were prepared by the conventional melt-quenching technique. X-ray diffraction (XRD) measurements were performed to confirm the noncrystalline nature of the samples. The influence of the Bi2O3 on the thermal, structural, and optical properties was investigated. Differential scanning calorimetry analysis showed that the glass transition temperature, Tg, increases from 405 to 440 °C for 0 ≤ x ≤ 15 mol % and decreases to 417 °C for x = 30 mol %. The thermal stability against devitrification decreases from 156 to 67 °C with the increase of the Bi2O3 content. The structural modifications were studied by Raman scattering, showing a bismuth insertion into the phosphate chains by Bi–O–P linkage. Furthermore, up to 15 mol % of Bi2O3 formation of BiO6 clusters is observed, associated with Bi–O–Bi linkage, resulting in a progressive break of the linear phosphate chains that leads to orthophosphate Q0 units. The linear refractive index, n0, was measured using the prism-coupler technique at 532, 633, and 1550 nm, whereas the nonlinear (NL) refractive index, n2 was measured at 1064 nm using the Z-scan technique. Values of 1.58 ≤ n0 ≤ 1.88, n2 ≥ 10–15 cm2/W and NL absorption coefficient, α2 ≤ 0.01 cm/GW, were determined. The linear and NL refractive indices increase with the increase of the Bi2O3 concentration. The large values of n0 and n2, as well as the very small α2, indicate that these materials have large potential for all-optical switching applications in the near-infrared.

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