Resolved-detrimental langasite-type surface crystallization in yttrium lanthanum gallium-rich heavy metal oxide glasses for infra-red optical fiber applications

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Abstract

The ability to produce robust fiber-based integrated optical systems operating over a wide spectral domain from the ultra-violet up to mid-infrared is one of today's key challenges in photonics. For this purpose, there is a critical need in the design of novel materials capable of filling in the gaps of the widely used silica fibers in terms of infrared transparency, nonlinear optical properties and rare - earth (RE) solubility. Over recent decades, several glass systems (fluorides, heavy metal oxides, and chalcogenides) appeared to be promising alternatives to SiO2 glasses, but have not yet been able to compete with its high thermal robustness and remarkable mechanical assets. Recently, we reported on the production of light guiding fibers from rich rare-earth gallium oxide-based glass composition in the multi – component system GaO3/2 – GeO2 – BaO – REO3/2 (RE = La and/or Y), outperforming the thermal and the surface micro-hardness assets compared to those reported in fluoride and chalcogenide glasses.Herein, taking advantage of structural/chemical information from X-Ray Photoelectron Spectroscopy (XPS) and vibrational spectroscopies (Raman/Infrared) combined with 71Ga and 89Y Solid-State Nuclear Magnetic Resonance (SSNMR) , we describe the key role of yttrium rare – earth with respect to lanthanum ions onto the glass structure and the impact on the capability to draw those new glass compositions into optical fibers using the classical preform-to-fiber process. This study remains particularly relevant for the development of highly robust power scaled fiber devices operating from the visible up to the challenging 2 – 6 μm optical domain while being capable of combining superior thermal, mechanical and optical properties.

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