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Ytterbium and bismuth clusters impact on silica-based light guides optical and luminescence performances

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Yb3+ ions in silica are powerhouses for single mode fiber lasers yielding kilowatts CW output powers at a wavelength near one micrometer. Bismuth in silica fibers features with a wide band luminescence (from 1 to 2 microns), which is topical for applications particularly in telecom systems. There is a guide to suppose that small-size, bismuth clusters are mainly responsible for the near-infrared luminescence and lasing in Bi-doped silica. A possibility to increase concentration of active species in the core glass of the lightguide is a very important condition for obtaining effective waveguide or fiber lasers and amplifiers. Nevertheless, such increasing may yield the formation of clusters. The dynamic pattern of clustering depends on mutual solubility of oxides, host glass composition, concentration of an activator, and preparation technology of the solid solution. Clustering causes quenching of the metastable state excitation responsible for lasing, and adds to the optical waveguide scattering loss. In this communication we present the results of experimental study of optical loss and luminescence performances of Yb3+ ions and bismuth in optical waveguides purpose made from fused and unfused silica vie the SPCVD technology. Glasses having different contents of Yb, Al, P, Bi, B, and Ge additives have been studied. As the result a relationship between spectral-luminescent properties of the samples, structure and sizes of the clusters in them have been found. This work was supported by the Russian Basic Research Foundation (Project 16-07-00371).

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