Fabrication and characterization of new ytterbium-doped silica glasses compositions using a plasma method (SPCVD) for laser fiber applications

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Abstract

Ytterbium-doped silica optical fibers are widely used for high power laser applications for several years. These powers keep on increasing due to continuous improvements in optical fibers fabrication processes. The aim of this PhD is to synthesize ytterbium-doped silica optical fibers' cores using a plasma process named SPCVD. This method has been created in 1986 for telecommunications optical fibers synthesis, and we have adapted it to fit the fabrication of rare earth-doped large-mode-area optical fiber cores. We first present the development of ways of evaporating low vapor pressure reagents. All the synthesized optical fiber cores are silica-rich, and slightly doped with both aluminum, fluorine and ytterbium. Radial and longitudinal homogeneities are discussed, and we propose several options in order to improve them. Then, the glassy network structure of the fabricated cores and also the neighborhood and dispersal of Yb3+ ion in the silicate network are studied. Thus, we used several spectroscopic studies: nuclear magnetic resonance enables to focus on non-zero nuclear spin nucleus (29Si, 27Al, 19F) whereas electronic paramagnetic resonance is used to probe the neighborhood and the dispersal of Yb3+ ions. We also based our study on optical characterizations as absorption and luminescence of Yb3+ ions. Finally, the fibers' cores we synthesized using the SPCVD process have been characterized in a laser cavity. We present the power conversion efficiency, the beam quality and the resistance to photodarkening of several ytterbium and fluorine-co-doped aluminosilicate cores.

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