USE OF NANOPARTICLES FOR PREPARATION OF RARE-EARTH DOPED SILICA FIBERS

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Rare-earth doped optical fibers are used in fiber lasers and fiber amplifiers. Erbium-doped fiber amplifiers (EDFA) for C-band are commercially available today, but new methods for improving their performance are still developed, since emission of the Er^{3+} ions in silica is affected by multi-phonon relaxations and ion-ion interactions. Fibers based on fluoride, telluride or chalcogenide glasses offer low-phonon matrix with good solubility of Er^{3+} ions, but their chemical and physical properties are quite different from silica fibers used in telecommunications. An alternative approach can be preparation of silica fibers co-doped with erbium and nano-structured aluminium oxide (alumina) in its core, since alumina has lower phonon energy and better solubility of Er^{3+} ions compared to silica.
The work deals with preparation of aluminium-erbium co-doped silica fibers. The MCVD method[1] with solution-doping technique[2] were used for preparation of preforms for fiber drawing. At first a porous silica frits were deposited on the inner walls of silica substrate tubes and the frits were soaked either by dispersion of alumina and erbium(III) oxide nanoparticles in water or by aqueous solution of aluminium chloride and erbium chloride. The soaked frits were dried in a flow of dry oxygen and then they were sintered and the tubes were collapsed into preforms. The preforms were analyzed by confocal-microscopy and refraction-index profiler and fibers with diameter of 125 μm were drawn. Fluorescence emission spectra of Er^{3+} ions in the fibers were measured using 980 nm pigtailed laser diode as the excitation source.
It was found that the distribution of Er^{3+} ion concentration is more homogeneous in preforms prepared from dispersions of nanoparticles compared to the preforms prepared using solutions of chlorides (see the fig.1). The fluorescence intensity of Er3+ ions in fibers in range from 1500 nm to 1650 nm was found to be approx. 2.5 times higher in "nanoparticle-doped" fibers compared to the fibers prepared conventionally (see fig.2).
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References:

[1] Nagel S.R., Macchesney J.B., Walker K.L., IEEE J. Quantum. Elect. **18** (1982) 459-476.

[2] Townsend J.E., Poole S.B., Payne D.N., Electron. Lett. **23** (1987) 329-331

Figures:

Figure 1: Emission of Er^{3+} ions in preform cores at 505-550 nm, excited by argon laser (λ=488 nm) scanned by confocal microscope (left - nanoparticle doped fiber, right - "conventionally" doped fiber).

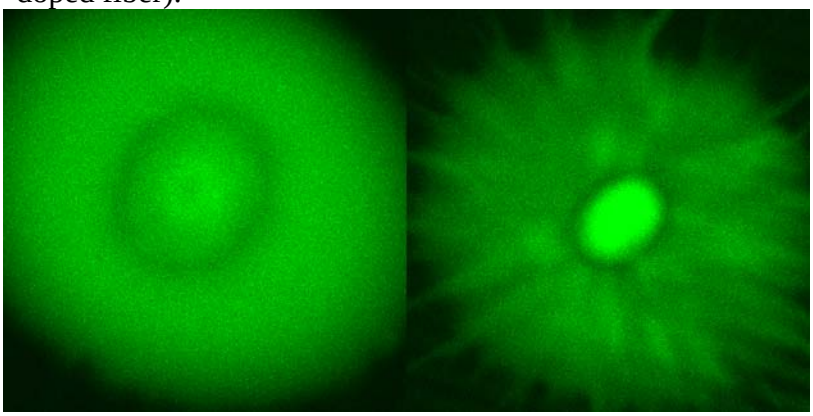

Figure 2: Fluorescence emission spectra of Er^{3+} ions in prepared fibers. (λ_{EX}=980 nm)