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Abstract of the PhD thesis entitled:

Active optical fibers with glass-ceramics core and polymer cladding – fabrication description and basic optical properties.

An attempt to obtain a glass-ceramics fibers (with appropriate optical parameters) with polymer cladding has been described. A partial (controlled) crystallization of the glassy core only, without modification of glassy cladding in commercial optical fibers is extremely difficult, if possible at all. Therefore, it was decided to use the polymer as a cladding material that is applied to the glass – ceramics fibers at the temperature significantly lower even than the glass transition temperature.

As a consequence, the fibers fabrication process was carried out in several stages, ie. a glass preform casting, a fiber drawing from the preform, the fiber controlled crystallization, and finally a deposition of the polymer cladding and following optical characterization.

Oxy – fluoride glass has been used to manufacture the preform, since the presence of fluorides contributes to the formation of crystallization seeds and under appropriate conditions enables a process of the controlled crystallization. As optically active elements erbium and ytterbium at a concentration of 0.5% Er, 1.5% Yb and of 0.2% Er, 0.6% Yb (mole%) has been selected with respect to their future applications in waveguide networks. After the preform casting the glass fibers have been drawn with the diameter between 14 and 65 mm.

The glass fiber controlled crystallization (heat treatment) conditions were determined by thermal analysis (DTA) of glass powder and the results taken from literature.
To confirm the diffusion of erbium and ytterbium to the growing crystals during heat treatment, X-ray microanalysis of overcrystallized glassy powders has been used in order to determine the elemental composition (semiquantitative) of several crystalline particles preceded by the XRD analysis.

The last step was to cover the glass-ceramic fiber with polymer cladding (polymethyl methacrylate with transmission coefficient of 92% and the refractive index of 1.49). Then the measurements of basic characteristics of optical fibers has been made.

Preforms of initial oxy – fluoride glasses (containing 0.2 mol% of erbium and 0.6 mol% of ytterbium) were subjected to the measurements of absorption, luminescence and lifetimes of erbium excited states. The measurements of absorption spectra indicate that the material can be efficiently optically pumped by laser diodes 980 nm.

The luminescence spectra present a strong band with the peak at 1538 nm, that qualifies material as a potential source in the third telecommunications window. Spectra of absorption / transmission glass-ceramic fibers (Er / Yb) in the polymer cladding show that the fibers meet the basic requirements, as a candidate for fiber lasers at 1550 nm. To clearly determine their suitability as a coherent light source (fiber laser at 1550 nm) optical resonator should be constructed on the basis of these fibers.