	Experiment title: Thermally induced crystallization of SiO2-Al2O3-CaO based Er-doped optic fibre performs. Links between optical properties and local environment.	**Experiment number**: **08-01-796**
Beamline: BM8-GILDA	**Date of experiment**: from: 6-9-07 to: 10-9-07	**Date of report**: 1-9-2008
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Report:

The development of materials for optical signal processing represents a major issue in present technology. In this contribution we have realized a study on Er-doped fiber preforms where particular attention was devoted on how the addition of CaO in the glass modifies the local environment of the rare earth. The results from photoluminescence and Extended X-ray Absorption Fine Structure (EXAFS) are compared and a clear link between the width of the emission line at 1.5 μm and the amorphous/crystalline local structure around the Er3+ ion has been evidenced.

Fiber preforms were prepared by Modified Chemical Vapor Deposition (MCVD) associated to *solution doping*. Samples of composition SiO2–GeO2–P2O5–Er2O3 with and without CaO were investigated to evidence the role of Ca in the incorporation site for Er in the glass. The preforms were cut in disks of 5mm in diameter where the Er-doped zone was limited to a central core of <1mm in diameter. EXAFS measurements at the Er–LIII edge (E = 8358 eV) were carried out at the GILDA-CRG beamline. The rejection of higher order harmonics was achieved by using a pair of Pd-coated mirrors with a cutoff energy of 20 keV. The second mirror was also used as focusing element in the vertical direction and the setup was optimized to obtain the minimum spot size on the sample; in this way 130μm×90μm Full Width at Half Maximum (FWHM) were obtained. The absorption coefficient was measured in fluorescence mode by selecting the Er–Lα emission line using an high purity Ge detector.

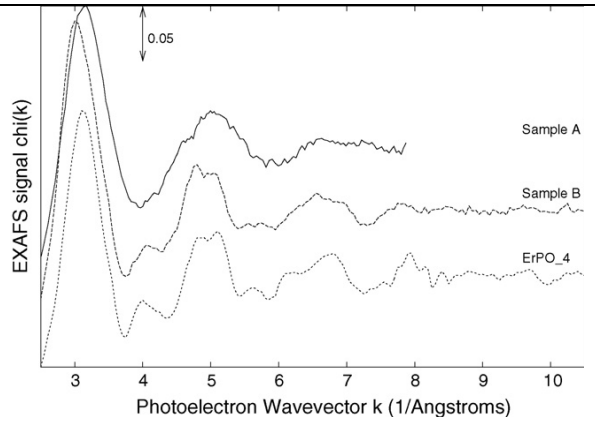

Fig1 EXAFS spectra of the samples A (with Ca) and B (without Ca) compared with a model compound of Erbium phosphate Er PO4.

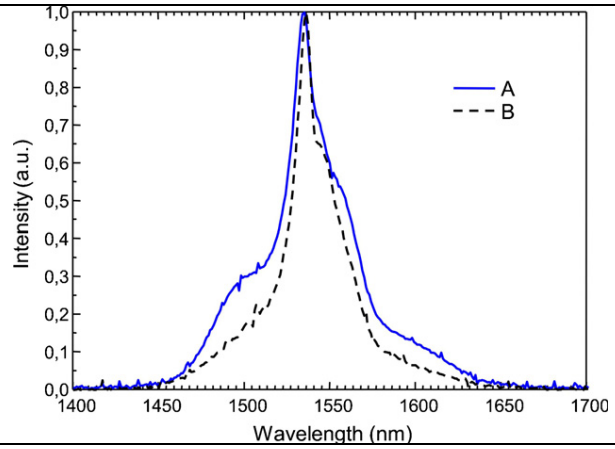

Fig 2. Room temperature optical luminescence spectra from samples A and B, respectively. Samples were excited at 980 nm with a laser diode.

Upon addition of Ca, amorphous nanoparticles (NP) are formed in the glass that contain the major part of the Rare Earth as demonstrated by Transmission Electron Microscopy (TEM) analysis (not shown here for brevity). Without Ca, Er tends to bind to P to form nanoaggregates (non visible by TEM) with the local structure of ErPO4 (Fig1). With the addition of Ca the Er is contained in the NP but it possesses an amorphous environment as evidenced by EXAFS (Fig1). Correspondingly, the width of the luminescence line at 1.54 μm increases (Fig2) due to the inhomogeneous broadening introduced by the amorphous environment. This feature is particularly interesting in the production of materials for optoelectronic applications needing a wide operating range in the light wavelength domain (ex. Wavelength Division Multiplexing).

Related papers

F. d'Acapito, C. Maurizio, M.C. Paul, Th. S. Lee, W. Blanc, B. Dussardier, "**Role of CaO addition in the local order around Erbium in SiO2–GeO2–P2O5 fiber performs"** Materials Science and Engineering B 146 (2008) 167–170.