Photodarkening in optical fibres: comparative study of photo-induced defects using different photon sources

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Yb-doped high power fibre lasers are attracting a lot of interest thanks to the unique combination of high efficiency, high beam quality, mechanical robustness and low maintenance costs [1]. However a phenomenon called "photodarkening" severely affects the performance of the lasers by gradually decreasing output power: the main problem is the occurrence of so called absorption centres in the laser system which may lead in time to a decrease of device performance [2].

Aim of this research work is to understand the mechanism of photodarkening by studying the defects created by high intensity irradiation. Several works studied the dynamics of photodarkening and improved optical fibre compositions could strongly reduce photodarkening [3]. However the knowledge of the structural changes associated to photodarkening is still far from being exhausted due to a large number of variables which play a significant role, i.e. fibre configuration, preform fabrication conditions, type and concentration of co-dopants, pumping mechanism, type of laser output (pulsed or CW). Modification of glass structure by adding new dopants such as P and, particularly, Ce shows PD reduction [4], yet the structural impact is still subject of debate. In this paper we present our recent investigation on Ce-doped fibres and we perform, for the first time, parallel irradiation with high intensity photons in the NIR, UV, XRay and gamma ray wavelength regions in order to study the materials structure and its relationship with photodarkening. A set of preform core samples are prepared with appropriate Al/Yb and Yb/Ce concentrations. The obtained defects are identified by UV-VIS spectroscopy, fluorescence spectroscopy and Electron Paramagnetic Resonance (EPR) spectroscopy.

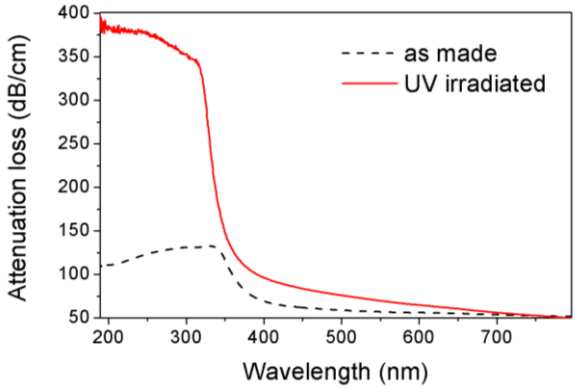

Fig. 1 Effect of UV laser irradiation on the UV-edge absorption band for one of the Ce/Yb-doped preform core samples.

The effect of Ce^{3+} is assessed and compared with literature and the results show a general increase of defects by irradiating the samples. Fig. 1 shows the effect of UV irradiation on the UV-edge of one of the samples. Preliminary results using gamma ray irradiation allowed identification of paramagnetic defects.

References

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