Laboratoire des Solides Irradiés, UMR 7642

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13H30

Radiation hardening of Er^{3+}-doped silica fiber preforms through fictive temperature reduction and nanoparticules doping

The Erbium-doped fiber amplifiers (EDFAs) have substantially substituted most of the electronic amplification systems of the optical fiber communications over long distances. The amplification of the optical signal without optical-to-electrical conversion has enhanced considerably the data transmission speed. Moreover, the gain bandwidth of the EDFAs paved the way for wavelength division multiplexing (WDM) technology and T bits/s data rates. The use of these amplifiers is not only restricted to undersea and terrestrial systems but it also has a potential interest for space applications, such as satellites-based communications. The deployment of EDFAs in space environment is not straightforward, mainly due to the presence of ionizing radiations (doses up to 3 kGy) that affects obviously the optical properties of the amplifiers. In particular, such radiations produce an additional attenuation in the fibers, called Radiation-Induced Attenuation (RIA), which decreases the amplification efficiency (and gain) of the EDFAs. The main cause of quantum yield or gain degradation in the irradiated samples is the absorption of near infrared red (NIR) photons by defect centers, which leads to a decrease in the population inversion. These defects are therefore playing a significant role as acceptors inside the material and their quantum efficiency becomes quenched.

The RIA is due to the optical absorption of point defects induced in the silica matrix during irradiation. For above-mentioned doses, these defects are mainly occurred as a result of the ionization of pre-existing defects known as defect precursors during the fiber manufacturing process. In the case of EDFAs, the precursors are principally related to the codopants (Ge, P, Al, F and Ce) needed to ensure fiber guiding properties and broadening of the Er^{3+} gain bandwidth. In the present case, we explored an impact of the fictive temperature (T_f) but also the introduction of SiO_2 and Al_2O_3 nanoparticles into optical fiber preforms and fibers on the evolution of point defects and RIA. Non-doped and Er^{3+}-doped silica glasses and optical fibers were studied and compared to the Suprasil F300 and the Infrasil 301 glasses, before and after γ-irradiation. The main objective of this work is to develop radiation-resistant fibers for space related applications but maybe also for more radiation environments.