# Photoinduced defects in Er/Al-doped optical fiber

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Recently, questions of the technology of manufacturing single-frequency fiber lasers have become increasingly important. One of the promising areas is the development and manufacture of distributed feedback (DFB) fiber lasers, designed on the basis of silica fibers with a highly Er doped core [1]. The resonator of such a laser is formed with an extended fiber Bragg grating (FBG) inscribed along its entire length with a phase shift in its structure [2]. In this case, the grating is inscribed directly in the core of the active fiber. FBG is usually made by UV laser irradiation. To increase the efficiency of inscription, the fiber can be previously loaded with molecular hydrogen. In our work [3], we have shown the negative effect of UV irradiation on the gain properties of the active fiber, while the presence of hydrogen in the glass network is an additional negative factor. However, it was found that the photoinduced gain degradation could be partially restored by exposing the fiber to 976 nm pump radiation.

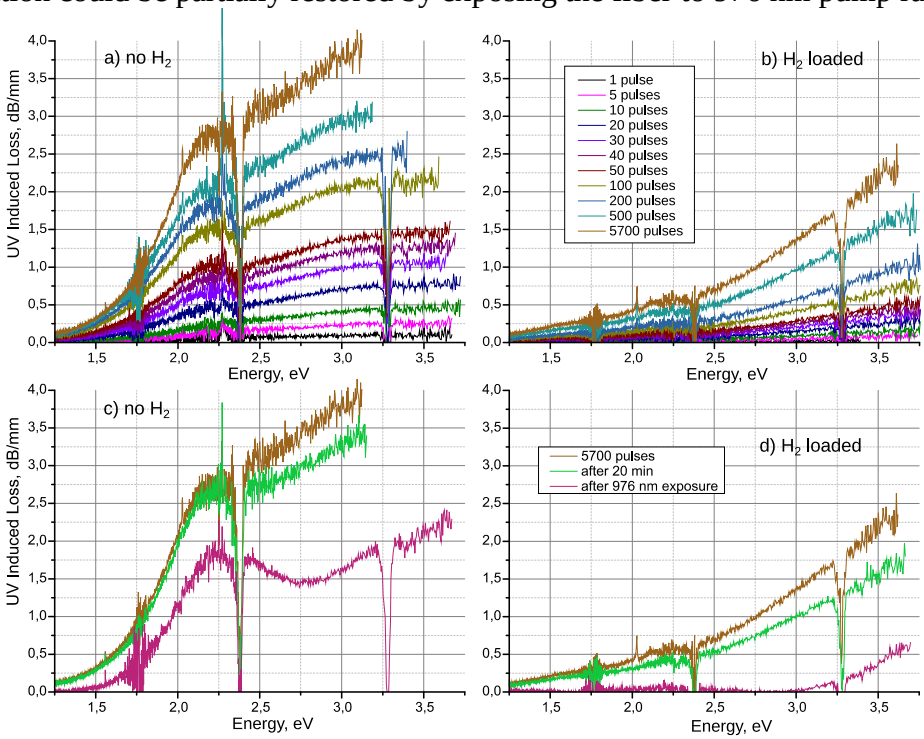


Fig. 1. Induced absorption spectra of the fiber samples in the UV and visible spectral range for pristine (a) and $H_2$-loaded (b) fiber depending on the number of UV laser pulses. Evolution of spectral shape in 20 minutes at room temperature after the UV irradiation and consequent 976 nm exposure of the sample without $H_2$ (c) and $H_2$-loaded fiber (d).

In this work, we investigated the changes in the absorption spectra of an active erbium doped fiber codoped with aluminum under the influence of UV irradiation. The studies were carried out in the UV and visible range, where the most characteristic spectral bands of the main defects in this type of glass are observed. From the change in the absorption spectra, a conclusion was drawn about the dynamics of defects formation and their subsequent decay. The dynamics of changes in absorption spectra

as a result of UV irradiation and subsequent exposure at 976 nm is shown in Fig. 1. For convenience of comparison, we approximated the obtained absorption spectra by three Gaussian functions corresponding to resonant absorption energies of 2.3, 3.2, 4.1 eV. The first two correspond to the absorption bands of aluminum oxygen – hole centers (Al-OHC), the third - to aluminum E 'centers (AlE'). The changes in the intensity of the Gaussian peaks obtained as a result of the approximation are shown in Fig. 2.

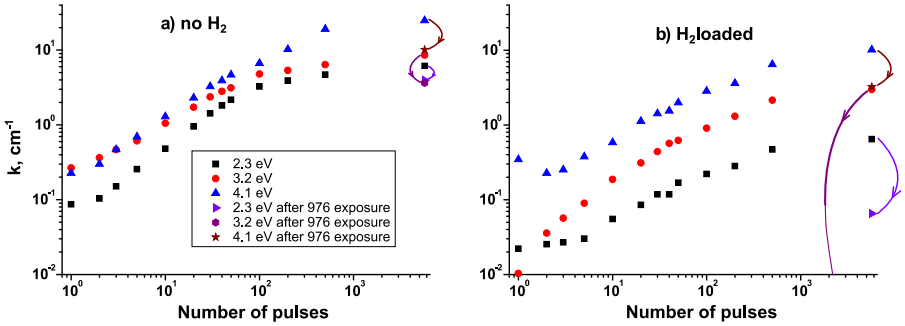


Fig. 2 Intensity of the Gaussian peaks of the induced absorption spectra for a fiber without hydrogen (a) and hydrogen-loaded (b). The arrows show the effect of the 976 nm exposure.

Figure 2 is plotted on a logarithmic scale on both axes for better visualization of the results. We see that the dependence of the absorption peak intensity on the exposed UV dose has a power-law activation nature with saturation at the maximum exposed dose, typical for photoionization processes. The arrows on the right side of the graphs show the decrease in the intensity of the corresponding absorption peaks under the influence of 976 nm exposure. It should be noted that the intensity of the 3.2 eV peak in the $H_2$ loaded sample decreases almost to zero. The 976 nm pump photon energy is only 1.27 eV. In this case, the minimum excitation energy of Al-OHC is ~ 2 eV. It is known that low-intensity green luminescence with a maximum at a wavelength of 483 nm was observed in the spectrum of Er-doped fibers under 976 nm [4]. This luminescence, which corresponds to the $^4F_{7/2} \rightarrow {}^4I_{15/2}$ transitions, despite its low intensity, has a sufficient quantum energy (~ 2.5 eV) to excite Al-OHC centers, leading with a high probability to their photoinduced decay, or, in the presence of hydrogen molecules to their conversion to hydroxyl centers $H - O - Al\equiv$.

## References


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