SELF-TRAPPED EXCITONS AND HOLES IN SIO2

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Dependence of gamma-luminescence (GL) and optical absorption (OA) on temperature in the interval of 77-300 K was studied in various types of silica monoblocks, quartz tubes and optical fibers (OF) with silica core nonirradiated and preliminary irradiated by γ-radiation of ^{60}Co source, neutrons and protons within the 200-800 nm wavelength range. It was found that in GL spectra of all types of preliminary nonirradiated silica monoblocks and tubes the luminescence band with maximum at 490 nm dominates at 77 K and the band with maximum 470 nm is revealed clearly at 120 K. In GL spectrum at 77 K only 470 nm band is observed the intensity of which decreases down to 120 K. It's shown that up to the certain doses of γ-radiation, neutron and proton fluencies the intensity of 490 nm band in monoblocks and tubes doesn't change and then decreases. The decreasing of intensity is accompanied with the growth of 470 nm band. In temperature dependence of intensity of 470 nm band the maximum in the 240-250 nm range is observed intensity of which increases proportionally with irradiation dose.

It's shown that at 77 K e in OA spectra of all γ-irradiated samples the bands at 210, 240-260, 330 and 560nm are observed. Heating of samples irradiated at 77K brings to decreasing the intensity of absorption band at 560nm and its disappearing at 120 K. This correlates clearly with the temperature dependence of 490nm GL band caused by emission of self trapped excitons (STE) arising from recombination of itinerant electrons with self trapped holes (STH): $O_2^{3-} + e^- \rightarrow (O_2^{3-} . e^-)^* \rightarrow h\nu_{490nm}$. Keeping samples at 77 K for 2 hours brings to strong decrease of OA and only 240-260, 330 and 560 nm bands are observed. At the same time the relaxation of 560 and 330 nm bands occurs symbately. During photobleaching with λ=550 nm light there are observed 560 and 330 nm bands in photoannealed losses spectra. At the same time the bands at 210, 240,-260, 610 nm remains in spectra and 560 nm band disappears completely. When photobleaching this sample with light of λ=260 nm the intensities of 210, 240-260 bands decrease and the 560 nm band recovers again. Taking into account that the defects attributed to 210 nm band and 260, 610 nm bands have electron and hole natures. We suppose that arising of 560 nm band is caused by hole defect too.

No correlation was found between Al concentration and intensity of low temperature band at 560 nm. No intensity saturation of 560 nm band was observed up to the dose of γ-radiation 10^8 Rad, which would be typical for a band of impurity origin. Based on this fact and existence of two types of STH in the form of O_2^{3-} in pure silica γ-irradiated at 77 K (Griscom, 1999) we ascribe the low temperature absorption at 560 nm region to STH. We suggest that increasing of hole mobility in the interval 77-120K results in decreasing of STE emission and growth of GL intensity at 470 nm caused by recombination of mobile holes with electrons localized at E'-centers. With the growth of E'-centers concentration the probability of recombination of holes with them increases before self-trapping. At the same time the 490 nm band decreases and the intensity of 470 nm band increases.