DOSIMETRY OF MIXED GAMMA – NEUTRON FLUXES IN THE ACTIVE ZONE OF WORKING REACTOR AND GAMMA-FLUX AFTER QUENCHING

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For carrying out experiments in the channels of nuclear reactor, it is necessary to know the distribution of neutron flux and the intensity of accompanying gamma-radiation both in the working and quenched regimes. Dosimetric parameter of transparent dielectrics is based on the effect of monotonous changing of optical absorption or luminescence under neutrons and/or gamma-radiation. While the radioactivity induced in an element monitor is proportional only to a neutron fluence beginning from a threshold energy.

Therefore the aim of this work was to determine the values of neutron and gamma-component fluxes separately and evaluate the contribution of each into the defect production in dielectrics. We used very pure quartz glass of KU-1 type, produced in Russian State Optical Institute by fusion from $SiCl_4$ in the mixed flow of O_2+H_2 (impurities of Cl and OH up to 10^{-2} % and the rest – below 10^{-4} %), SiO_2 glasses with 30 % Ba, and also pure Ni wire. Since under irradiation in the working reactor samples were undergone mixed neutron and gamma fluxes, we suggested determination of intensity of gamma-radiation from radio-nuclides (products of uranium fission) after quenching the reactor by the current of ionization chamber and glass dosimeters. Samples of SiO_2-BaO together with Ni monitors were irradiated for 1 hour in 18 channels of the active zone of the working reactor both in the sealed ampoules and in the contact with water of the 1-st cooling circuit at 40 °C. The linear dependence of the induced optical density on the absorbed dose of $n^o + \gamma$-radiation was obtained. Ni –monitors not sensitive to γ-radiation gained the induced radioactivity proportional to the absorbed energy of neutron flux above 1 MeV. Neutron fluxes in the 18 channels varied from $9.53 \cdot 10^{11}$ to $1.21 \cdot 10^{13}$ $cm^{-2} \cdot s^{-1}$ corresponding to fluences from $3.43 \cdot 10^{15}$ to $4.3 \cdot 10^{16}$ cm^{-2}. Optical density of band 215 nm ascertained to E′ - center, which is $\equiv Si^\bullet$ near oxygen vacancy, varied within 0.57 – 2.8. Besides, pure SiO_2 samples in the Cd – can filled with water were irradiated in the thermal column of operating reactor for 6 hours. Under these conditions the fast neutron flux was estimated as weak as $6 \cdot 10^{10}$ n/cm^{2}s, the fluence was $1.3 \cdot 10^{15}$ cm^{-2}. The optical density of band 215 nm was 2.5, while the neutron fluence was ~30 times less. Thus, the concentration of E'-centers does not correlate with a neutron fluence.

To extract the contribution from gamma-rays into the induced optical absorption in the glass matrix, samples of pure SiO_2 were irradiated by gamma-rays in 4 hours after quenching the reactor at the ionization current of 50 nA during 30 minutes, 12 and 24 hours; next time in 9 hours after the quenching at 40 nA and for 120 hours at 10 nA. In this case the gamma-spectrum did not include 10 MeV line from oxygen due to the short life-time, which prevails in the spectrum of working reactor. Maximal dose of γ-radiation of the quenched reactor was shown to induce the band at 215 nm up to the density of 0.5. When the sample was in contact with water the efficiency of E'-center production was 2 times higher that in dry condition. Thus, the high efficiency of structure defect production in SiO_2 glass owes to the influence of 10 MeV γ-radiation of the working reactor.

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