ZrO_2:PbS nanofilms for nanodosimetry of ionizing radiation

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Nanodosimetry is directed to identify the dose absorbed by nanovolumes of the biological structures. This is important for deeper understanding of radiobiological effects and effectiveness of radiation therapy.

Lead sulfide nanoparticles having diameter of 2.5 nm embedded in a 100 nm thick matrix of zirconium oxide by sol-gel technology (ZrO_2:PbS nanofilms) [1] were studied for application in nanodosimetry of ionizing radiation. ZrO_2:PbS nanofilms were exposed to 0–10 Gy of 9 MeV electron radiation produced by medical linear accelerator. Readout of the delivered dose was provided by measurements of photoelectron emission (PE) current from ZrO_2:PbS nanofilms. It was found that electron radiation decreases concentration of active PE centers of PbS nanoparticles and in order to excite PE current from the emission centers of PbS nanoparticles, photons with energy 4.9–5.5 eV have to be used.

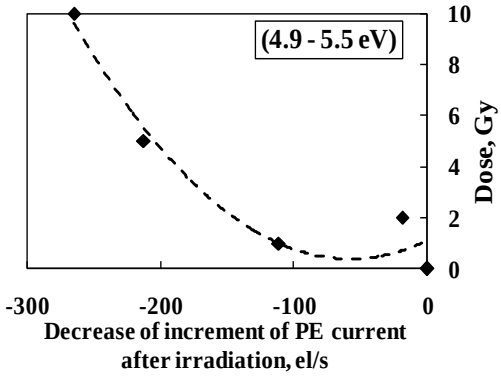

Fig.1. Decrease of increment of PE current depending on delivered dose of electron radiation.

Increments of PE current from ZrO_2:PbS nanofilms in a range of 4.9 to 5.5 eV were calculated before and after irradiation. Second degree polynomial relationship was observed between the difference of the increments and dose of electron radiation in the range of 0–10 Gy (Fig. 1). Dose measurement error was calculated for each delivered dose using the observed relationship. Dose measurement error decreases from 65% to 11% when the delivered dose increases from 2 Gy to 5 Gy. Dose measurement error doesn't exceed 11% for doses up to 10 Gy.

Changes in PE spectra of ZrO_2:PbS nanofilms under influence of electron radiation suggest that the nanofilms have potential to be used in nanodosimetry of ionizing radiation, however further calibrations and metrological studies are required.

References

1. T. Saraidarov, R. Reisfeld, A. Sashchiuk A, et al. J Sol-Gel Sci Techn **34**, 137 (2005)