RESEARCH REACTOR PRODUCED EPITHERMAL NEUTRONS DOSIMETRY USING LiF BASED THERMOLUMINESCENT DETECTORS

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Introduction: Neutron dosimetry is known to be more difficult than gamma dosimetry because neutron field is always accompanied by gamma field. The epithermal neutron dosimetry is even more difficult because of thermal neutrons besides gamma field that come together. In the present work we investigated the detection of epithermal neutrons produced by a research reactor using thermoluminescent (TL) detectors based on LiF. LiF detectors are sensitive to slow neutrons. Their response to neutrons is enhanced by ^{6}Li-enriched lithium or suppressed by using lithium consisting entirely of ^{7}Li. Depending on the doping elements these detectors can be divided into MTS group if LiF is doped with Mg and Ti, or to MCP group when they are doped with Mg, Cu and P. In MTS-N and MCP-N detectors Li with natural abundance of isotopes is used; in MTS-7 and MCP-7 Li enriched with ^{7}Li, and in MTS-6 and MCP-6 Li enriched with ^{6}Li is used. Here we used MTS and MCP detectors produced at the IFJ. These detectors routinely enable measurements of radiation doses from the microgray level up to a few kilograys, and in addition, based on the recently observed high-dose features of MCP detectors [1], it is possible to measure doses from about 1 kGy up to about 1 MGy.

Experimental: For the irradiation in the IPEN reactor, MTS and MCP detectors were sealed inside a silica tube. This tube was then wrapped with 1.0 mm thick Cd foil to avoid thermal neutrons to enter the tube. Thermal neutrons are captured by Cd which has a very large thermal neutron capture cross section. Cd has smaller cross section for capture of epithermal neutrons; about 15% of them are captured by Cd. We are interested in detecting the remaining epithermal neutrons. Up to now the irradiation were carried out with three neutron fluences: (1) $1x10^{10}$ n.cm^{-2}, (2) $1x10^{14}$ n.cm^{-2} and (3) $1x10^{16}$ n.cm^{-2}. We also irradiated MCP-7 detectors with γ-ray from 1 to 30 kGy.

Results and Discussion: The TL readings have been carried out using 10 K/s heating rate. Fig. 1a presents glow-curves of MCP-7 detectors after high-dose gamma exposures (^{60}Co). Figs 1(b-d) show, respectively, glow-curves of several types of detectors from the first, second and third irradiation in the reactor. The detectors have been shielded by Cd foil, therefore, the glow-curves of the detectors are due to gamma radiation and the remaining epithermal neutrons produced by the reactor. The behaviour of the glow-curves is similar to that after thermal neutron exposures obtained by Obryk et al. (2011) at the JSI research reactor in Ljubljana [2].

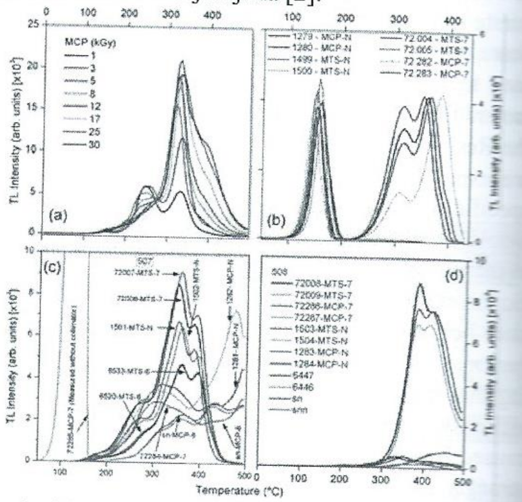

Fig. 1. Glow-curves of different types of LiF detectors irradiated with gammas (a), and with different neutron fluences accompanied with gammas at the IPEN research reactor (b, c, and d).

Conclusions: The method applied gives a significant epithermal neutron signal. We observed that the higher neutron fluence the lower contribution of gamma dose to the total TL signal registered. This is in agreement with results obtained at the JSI research reactor in Ljubljana [2]. However, quantification of the TL signal from epithermal neutrons requires further investigation.

Acknowledgements. We are thankful to FAPESP for financial support.

References:

[1] Obryk, B., Bilski, P., Fuerstner, M., Glaser, M., Ilgner, C.J., Olko, P., Pajor, A. and Stuglik, Z., 2009. Development of a method for passive measurement of radiation doses at ultra-high dose range, IEEE Trans. Nucl. Sci. *56*, 3759-3763.

[2] Obryk, B., Glaser, M., Mandic, I., Bilski, P., Olko, P. and Sas-Bieniarz, A. **2011**. Response of various types of lithium fluoride MCP detectors to high and ultra-high thermal neutron doses, Radiat. Meas. *46*, 1882-1885.