§14. Investigating the Ability of Using Imaging Plate BASMS for Neutron Dosimetry in the Mixed Radiation Field

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Imaging plate (IP) is very sensitive with alpha, beta, photon radiation, but is not directly sensitive with neutron and it can not be used to measure neutron dose directly. However actual radiation fields around the reactors and accelerators are usually the mixed radiation fields of photons and neutrons so it is necessary to develop the method for neutron dosimetry by using IP. There are various attempts to develop IP for neutron radiography by doping Gd to the BaFBr:Eu^{2+} phosphor layer like commercial IP BAS-ND[1,2]. Nevertheless this IP is much more expensive than BAS-MS and not only sensitive to neutrons but also sensitive to photons so it can not be used to separate neutron doses from the mixed radiation fields. Previously, BAS-MS IP was investigated to measure photon dose[3,4]. Therefore this study was carried out to investigate the ability of use BAS-MS IP for neutron dosimetry of the mixed radiation field.

IP with Golden foils (Au foils) and Gadolinium foils (Gd foils) attached in IP's front side were exposed in the experimental hole of Kinki University Research Reactor during 1 hour, 2.5 hours, 3.5 hours and 6 hours. Photon dose rate & neutron dose rate of radiation field at the reference point were checked by ionization chamber and Remcounter frequently. Photon spectra of radiation field also were observed at the different moments by NaI spectrometer during exposure. After finishing the irradiation from Research Reactor with power of 1 W, Au foils and Gd foils were removed immediately or after 4 hours, 12 hours and 24 hours and more than 24 hours later PSL of IPs were evaluated by IP reader.

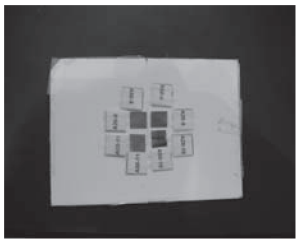

Fig.1 The front side of IP

Fig.2 Exposure of IP in the experimental hole of Reactor

While exposure of the IP, Photo-Stimulated Luminescence (PSL) is increased by direct gamma and secondary radiations emitted from activated foil. After the exposure, the PSL of IP is further increased by delayed gamma & beta radiations emitted from activated foil and is proportional to the Au, Gd foil activation due to thermal neutron dose. Therefore PSL increment rate of IP area under Au, Gd foils after the exposure can be used to measure thermal neutron dose. PSL value of IP bare (without foil) area can be used to determine photon dose.

PSL value increment under each foil with removal time and its variation with exposure time has been shown in Fig 3. PSL increment rate after the exposure has been shown in Fig 4.

When Au foil removed at known time, a direct relationship between PSL value developed after the exposure and neutron exposure dose can be obtained and has been shown in Fig 5 for 4,12 and 24 hour foil removal period.

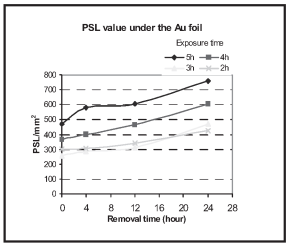

Fig.3 PSL increment under each foil

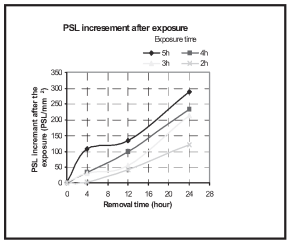

Fig.4 PSL increment after exposure with removal time

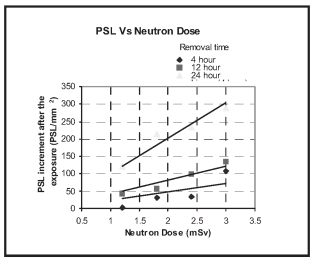

Fig.5 Relationship between thermal neutron dose and PSL value increment after exposure

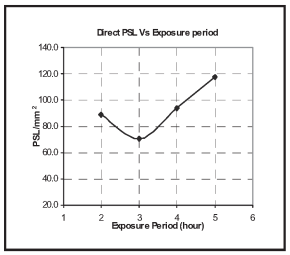

Fig.6 Relationship between photon dose and PSL value increment after exposure

Value on bare part of IP (without foil) for each exposure has been shown in Fig 6. According to the obtained results PSL is not proportional to expected exposed photon dose. That may be the reasons of IP response variation with photon energy and changing photon energy spectrum of reactor with in it operation time. However from photon spectra at reference point measured at different moments by NaI spectrometer (Fig. 7) and simulated, this effect could not be explained clearly so further study on this should be investigated.

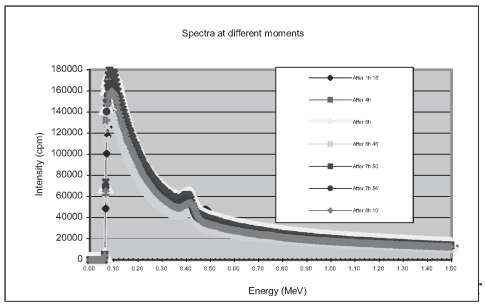

Fig.7 Photon spectra at reference point of reactor

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3. Azuma, S., Unpublished Master's Thesis, Dept. Nuc.. Eng. Management, The University of Tokyo (2007)
4. Ohta, A.,Unpublished Master's Thesis, Faculty of Engineering, Tokyo University of Science (2007)