§12. Radiation Measurements Using CR-39 in Wide Energy Range Neutron Fields

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In nuclear fusion facilities used deuterons, such as LHD, radiation worker may expose by wide energy neutrons (about 10 digits). In the radiation protection point of view, we should measure personal neutron dose and area radiation data in radiation control room and research institute. Recently, passive personal neutron dosimeters based on CR-39 have found wide application for measurement of dose from external neutron exposure at various nuclear facilities. [1] In this research, we increase the sensitivity CR-39 to change radiator design to measure wide energy range neutrons.

Simulation method is based on Monte-Carlo simulation code, Particle Heavy Iron Transport code System (PHITS)[2], the calculation of radiator effect of personal neutron dosimeter with CR-39 was succeed. To apply this calculation method we consider how to increase the sensitivity of wide energy range neutrons. In this year, the angler dependence of neutron detection using CR-39 could be calculated using PHTIS, and checked by experiments using mono-energy neutron. This calculation was good agreement with experimental ones. (See Fig.1)

And using multi-layer radiator which consists metal layer and polyethylene layer, we can control the energy response of neutron and verified this application by experiment and calculation. Fig.2 shows the structure of CR-39 with 2-layer radiator consisting aluminum and polyethylene layers. Fig.3 shows radiator effects irradiated by 14.8 MeV mono-energy neutrons. This experimental and calculated data shows that changing the thickness of aluminum layer can control the sensitivity for high energy neutrons.

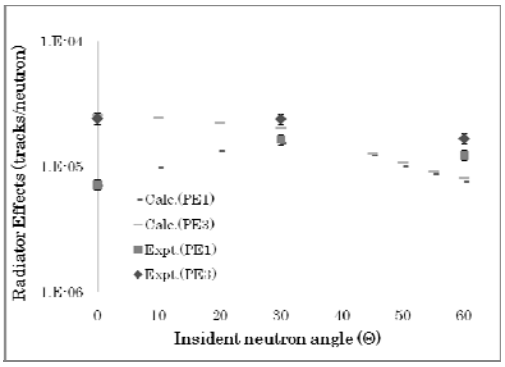

Fig. 1. Calculated and measured angular dependence of radiator effect for 1 mm thick (PE1) and 3 mm (PE3); energy of neutrons 14.8 MeV

We conclude that radiator designs of new personal neutron dosimeters using CR-39 can be calculate by PHITS. The radiator effects of calculation were good agreement with measurements in the neutron energy range up to 14.8MeV. The present investigation to increase sensitivity for high energy neutron above 10 MeV lead to the following conclusions.

(1) The anger dependence of PE1 to 14.8 MeV neutrons have maximum at 30 degree.
(2) The radiator effects of combination PE1 with aluminum sheet to 14.8 MeV neutrons have maximum at 0.5 mm thickness of aluminum.

For these results, the radiator effects for high energy neutron above 10 MeV can be controlled to sandwich metal sheet in this research aluminum between polyethylene and CR-39.

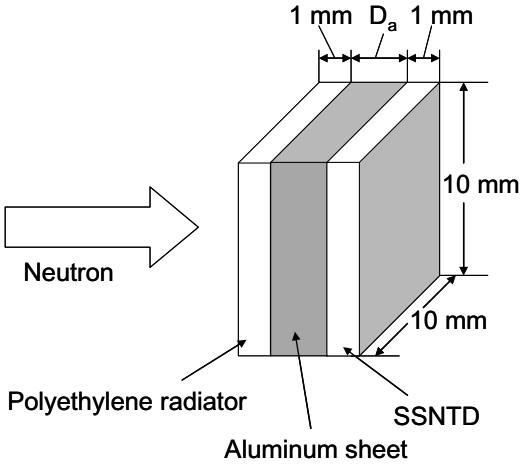

Fig.2 The structure of CR-39 with 2 layer radiator

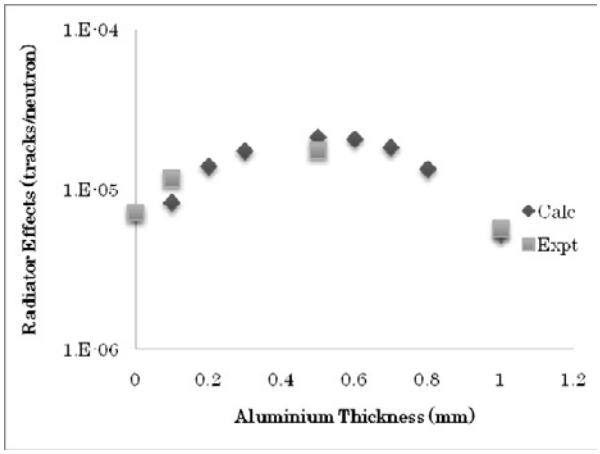

Fig. 3.Calculated and measured 2-layer radiator effects (1 mm of PE + Al) as a function of aluminum thickness; energy of neutrons14.8 MeV

1) K.Oda Nucl Instr and Meth B61 302-308 (1991)
2) H. Iwase J. Nucl. Sci. Technol, 39 1142 (2002)