Measurements of cross-sections of producing short-lived nuclei with 14 MeV neutrons.
- ^{27}Al(n, α)^{24m}Na, ^{144}Sm(n, 2n)^{143m}Sm, ^{206}Pb(n, 2n)^{205m}Pb, ^{208}Pb(n, 2n)^{207m}Pb -

Kazumasa Arakita[1], Toshiaki Shimizu[1], Kiyoshi Kawade[1], Michihiro Shibata[2], Kentaro Ochiai[3], Takeo Nishitani[3]

[1]*School of Engineering , Nagoya University*
[2]*Radioisotope Research Center, Nagoya University*
[3]*Department of Fusion Engineering Research, Japan Atomic Energy Agency*

There are a lot of data of activation cross-sections with 14 MeV neutrons from a viewpoint of the DT fusion reactor design. In general, most data are long-lived nuclides whose half-lives are longer than several minutes. There are few data for very short-lived nuclides whose half-lives are equal to or shorter than a few seconds, however these data are important for the nuclear data base and improvement of accuracies for the evaluated value. Hence, we aimed to measure the cross-sections producing short-lived nuclei with 14 MeV neutrons by using an in-beam method. This method can measure the induced activities during irradiating the neutron.

The d-T neutrons were generated by bombarding a tritiated titanium (Ti-T) target with a 350 keV d$^+$-beam at the 0° beam line of the FNS at the JAEA. The experimental arrangement is shown in Fig.1. The distance between the sample position and the surface of the HPGe detector was 50 mm. A typical neutron fluence rate at the sample position was 6.5×10^5 n·cm^{-2}·s^{-1}. The induced activities were measured with 36% HPGe detector. Samples were 1 mm thick rectangular or disk-shape (10 mm × 20 mm, ϕ = 15 mm), and typical weights were 0.045 to 0.95 g.

In order to reduce neutron damage [1], a neutron collimator at the 0 ° beam line (ϕ = 20 mm, E_n = 14.2 MeV) was used. The damage by neutrons, which were scattered by samples, its holder and an atmosphere, were taken into account using the Monte-Carlo simulation code "MCNP-4C". As a result, it was found that the neutron fluence rate at the surface of the HPGe detector was 4.0×10^{-4} times against the sample position.

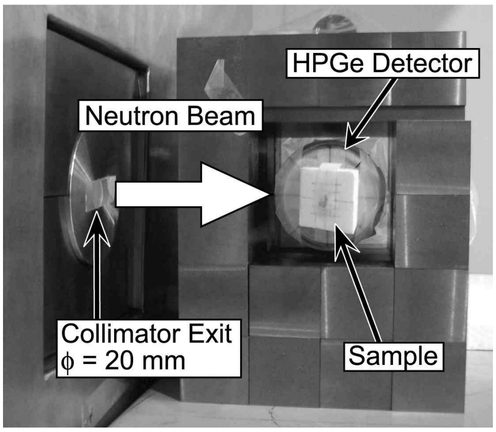

Fig.1 The picture of the experimental arrangement. The distance between the collimator exit and the samples is 150 mm. Tungsten blocks are used to prevent HPGe detector from the background γ-rays.

The cross-section data of ^{27}Al(n, α)^{24m}Na ($T_{1/2}$=20.20 ms), ^{144}Sm(n, 2n)^{143m}Sm (30 ms), ^{206}Pb(n, 2n)^{205m}Pb (5.54 ms), ^{208}Pb(n, 2n)^{207m}Pb (806 ms) reactions were obtained by the in-beam method. That of ^{144}Sm(n, 2n)^{143m}Sm was measured for the first time. Accuracies were 4.4 to 23%, These accuracies were mainly caused by statistics.

The result of the ^{27}Al (n, α) ^{24m}Na reaction is shown in Fig.2. An effect of ^{27}Al(n, α)^{24m}Na reaction that the scattered neutron interacts with the Al of HPGe detector housing was corrected. The amount of the correction was about 12%. The evaluated data for the ^{27}Al (n, α) ^{24m}Na listed in FENDL/A-2.0 were underestimated 0.63 times as small as the present result, approximately. Other previous experimental data were also larger than the evaluated one, re-evaluation for this reaction is recommended.

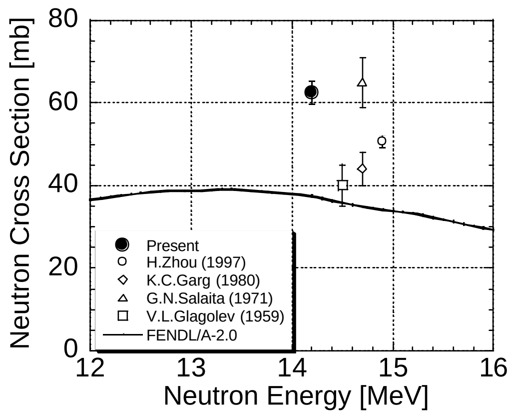

Fig.2 The cross-section of ^{27}Al (n, α) ^{24m}Na reaction ($T_{1/2}$=20.20 ms). The solid line indicate the evaluated data of FENDL/A-2.0. A solid circle shows the present data.

We measured the cross-sections producing short-lived nuclei whose half-lives are between 5.54 and 806 ms by the in-beam method.

Reference [1] M. Sudarshan et al., Meas. Sci. Technol. 2 (1991) 1192-1194.