

Measurement of Gamma Rays from keV-Neutron Capture Reaction by Zr-90, 94

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Currently, a great interest has been taken in the study on the nuclear transmutation of Long-Lived Fission Products (LLFPs: Se-79, Zr-93, Tc-99, Pd-107, Sn-126, I-129, Cs-135) generated in nuclear fission reactors. In ordinary design of transmutation system, neutron capture reaction is utilized to transmute LLFPs into stable or short-lived nuclides. On the other hand, the stable isotopes of LLFPs are also produced in fission reactors and they accompany LLFPs to a transmutation system unless the isotopic separation of LLFPs is performed. Therefore, the neutron capture cross sections of LLFPs and their stable isotopes are indispensable for the transmutation study. Moreover, the systematic data analysis of both keV-neutron capture cross sections and capture γ -ray spectra of the stable isotopes of a LLFP is important to accurately predict the capture cross sections of the LLFP. However, the present status of those experimental data is quite inadequate both in quality and in quantity. In this situation, the keV-neutron capture cross sections and capture γ -ray spectra of Zr-91, 92, the major stable isotopes of an important LLFP nuclide Zr-93, have been studied [1].

In this study, the capture cross sections and capture γ -ray spectra of Zr-90, 94 have been measured in the neutron energy region from 10 to 600 keV. Pulsed keV neutrons were generated by the ${}^7\text{Li}(p,n){}^7\text{Be}$ reaction with a 1.5-ns bunched proton beam from the 3-MV Pelletron accelerator of Research Laboratory for Nuclear Reactors at the Tokyo Institute of Technology. The neutron spectrum on a capture sample was measured by means of a time-of-flight (TOF) method with a Li-6 glass scintillation detector. About 3 g (Zr-90) or 1 g (Zr-94) of isotopically enriched oxide powder (ZrO_2) was contained in a graphite case with an inner diameter of 20 mm. A gold disk with a diameter of 20 mm was used as a standard. The capture γ rays from each sample were detected with an anti-Compton NaI(Tl) spectrometer. The signals from the spectrometer were recorded in a personal computer as two-dimensional data of pulse height (PH) and TOF. A PH weighting technique was applied to the observed capture γ -ray PH spectra and the corresponding capture yields, *i.e.* the numbers of capture events, were obtained. The capture cross sections of Zr-90, 94 were derived from the capture yields and the standard capture cross sections of Au-197. The capture γ -ray spectra of Zr-90, 94 were obtained by unfolding the observed capture γ -ray PH spectra. The multiplicities of observed γ rays were derived from the γ -ray spectra.

[1] K. Ohgama, M. Igashira and T. Ohsaki., *J. Nucl. Sci. Technol.*, **42**, 333 (2005).

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