Activation Cross Section Measurements by 15-35 MeV Quasi-Monoenergetic p-Be Neutrons

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V. 2 Activation Cross Section Measurements by 15-35 MeV Quasi-Monoenergetic p-Be Neutrons

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The experimental data on neutron activation cross sections are limited to the neutron energy lower than 20 MeV in general, except for several reactions. This may be because of the lack of the intense monoenergetic neutron beam of energy higher than 20 MeV. We have developed a quasi-monoenergetic neutron beam of energy from 15 MeV to 35 MeV by the Be(p,n) reaction, with changing the proton energy from 20 MeV up to 40 MeV.

The beryllium target of 1 or 2 mm in thickness backed by the cooling water was bombarded through a 20-mm diam carbon collimator by a proton beam from a cyclotron. The neutron energy spectra at 0 degree to the proton beam were measured with a NE-213 scintillator for proton energies of 20, 25, 30, 35 and 40 MeV. The neutron spectra unfolded from the measured pulse height distributions, shown in Fig. 1, indicated pretty good monoenergetic spectra having the energy resolution of about 4 MeV, although they included the contamination of low energy neutron components. The amounts of monoenergetic neutrons in the peak area were about a half of total amounts of produced neutrons of energy above 4 MeV. Total neutron yield was about $1.6\text{-}0.4\times10^{10}$ n/(sr·μC).

By using this quasi-monoenergetic neutrons, the activation cross section measurements were performed for target materials of C, Na, Mg, Al, Si, Ca, Ti, V, Cr, Mn, Co, Cu, Zn, Zr, Nb, Mo and Au. These target samples were irradiated by this neutron beam at a position of 20 cm behind the beryllium target. The neutron fluxes during irradiation were monitored with the aluminum and gold foils just attached on the sample.

The activation rates were obtained from the gamma-ray activities of the samples measured by the high purity Ge detector. The average activation cross sections in the energy region from 15 to 35 MeV could be obtained from the measured activation rates. Figures 2 to 4 show the average cross sections of ^{12}C(n,2n), ^{27}Al(n,α) and ^{197}Au(n,2n), ^{197}Au(n,4n) reactions, as some examples that other data presently exist. Our experimental results are compared with our previous results[1)], the O5S data[2)] and Greenwood's results.[3)] Our results give pretty good agreement with other results.

We are now performing to obtain the excitation functions of these neutron activation cross sections by unfolding technique.

References

1) Uwamino Y., Ohkubo T., Torii A. and Nakamura T., in press of Nucl. Instrum. Methods.
2) Textor R. E. and Verbinski V. V., ORNL-4160 (1968).
3) Greenwood L. R., ANL/FPP/TM-115 (1978).

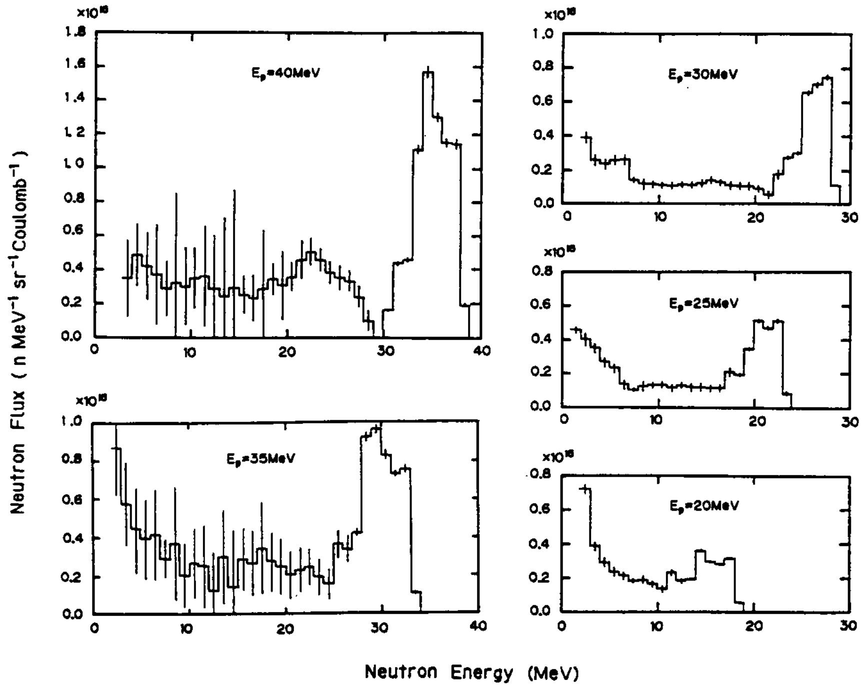

Fig. 1. Neutron energy spectra at 0 deg from Be for proton energies of 40, 35, 30, 25 and 20 MeV.

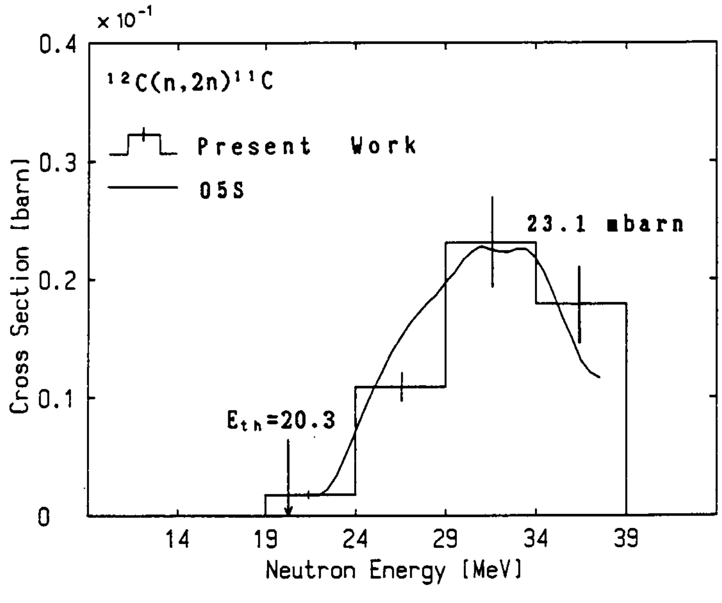

Fig. 2. Data comparison of $^{12}C(n,2n)$ reaction cross section.

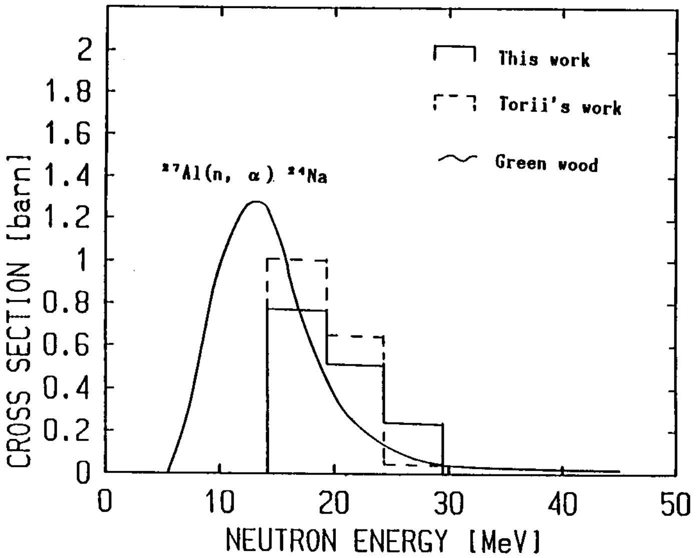

Fig. 3. Data comparison of ^{27}Al(n,α) reaction cross section.

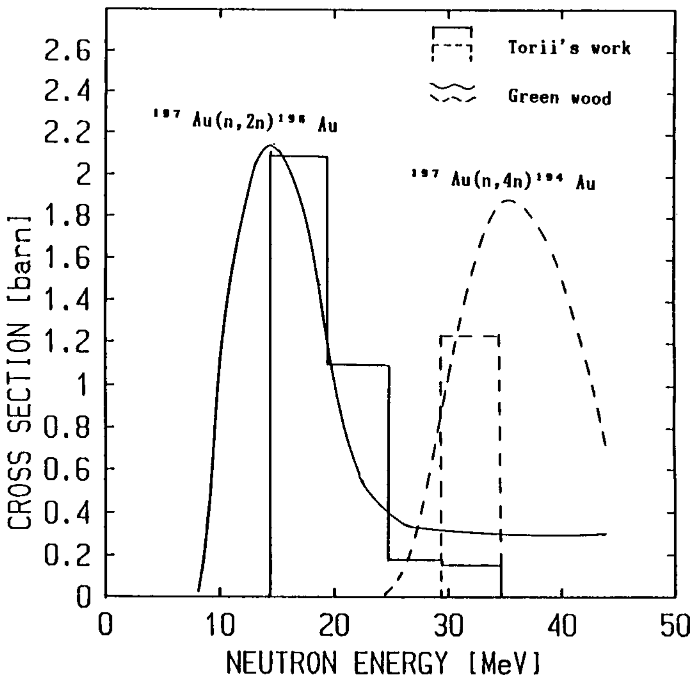

Fig. 4. Data comparison of ^{197}Au(n,2n) and ^{197}Au(n,4n) reaction cross sections.