§ 7. Experimental Study on the Neutron Emission Spectra and ^{7}Be Accumulation in Li(d,n) Reaction

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To establish the database required for the design of IFMIF, we have been conducting a systematic experiments on the neutron emission spectrum and radioactivity accumulation in the Li(d,n) reaction. In the last report, results for 25 MeV deuterons were reported. The experiments are carried out using the Tohoku University AVF cyclotron (K=110 MeV) equipped with a beam swinger system and the TOF method.

Last year, we have carried out new experiments for 40 MeV deuterons with extended techniques and obtained new results for

1) neutron emission spectrum from a thick Li target,
2) neutron emission spectrum from thin Li target,
3) ^{7}Li activity accumulated in the Li target during the irradiation, and
4) Li(d.x)^{7}Be cross-sections for eight energy points between 40 and 7 MeV target using a stacked target technique.

The experimental method was almost the same with previous experiments and only briefly described here.

The beam from the Tohoku University cyclotron was transported to the Li target in the vacuum chamber in the center of the beam swinger system at the No.5 target room. The neutron spectrum was obtained by the TOF method using two NE213 scintillators, 14-cm-diam and 10-cm-thick and 5-cm-diam and 5-cm-thick with n- γ discrimination. The smaller one was employed for the measurement of low energy region. The data were accumulated as three-parameter data for TOF, n- γ spectra and pulse-height of the NE213 detector. The detection efficiency was obtained by calculation using the code SCINFUL.

The activity in the Li targets were measured after irradiation using high-pure Ge detectors by detecting 477 keV gamma-rays due to the decay of ^{7}Be accumulated by the deuteron bombardment.

Lithium targets were prepared by mechanically pressing a Li metal ingot under argon atmosphere within a groove box to avoid oxygen and carbon contaminant. For activation cross-section measurement, several thin targets with appropriate thickness were prepared and stacked. The target was set on a remotely-controlled target changer together with a beam viewer. ed and operated at -500 V.

The beam current was around a few nano-amps or less. A Cu grid for secondary electron suppression was used. The beam charge accumulated on the target was measured with an ORTEC current digitizer and a multi-channel scaler to record the time history of the beam.

Figure 1 shows thick target neutron emission spectrum as a function of emission angle. Neutron spectra are observed over almost entire range of secondary energies. A main peaks are observed around 15 MeV but the high energy tail extends beyond 50 MeV. The shape and angular dependence is similar with the data at 25 MeV. In Fig.2, Li(d,n) neutron spectrum for a thin target is shown. This is just the spectrum induced by 40 MeV deuterons and clearly shows two components; high-energy direct component and medium energy stripping components. Such data are very few and will be useful for the model development of the neutron emission.

In Fig.3, the results of the Li(d,x)^{7}Be cross-section are shown, together with other experiments and IRAC calculation. No other data are available for the present energy region but the present values are consistent with other data in the lowest energy end, and about two-times as large as the IRAC calculation as suggested from the integral activity in the thick target observed in the experiment 3).

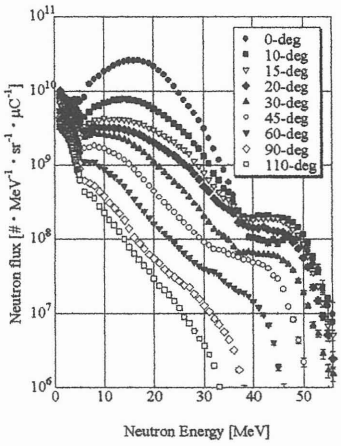

Fig.1. Thick target Li(d,n) spectrum.

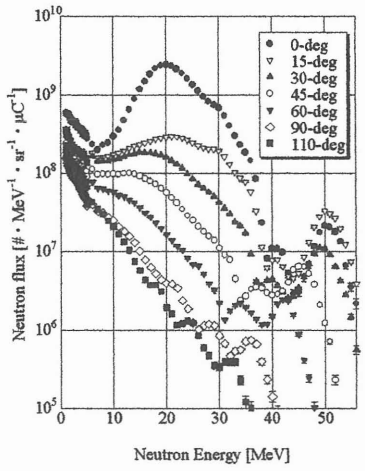

Fig.2 Thin target Li(d,n) spectrum.

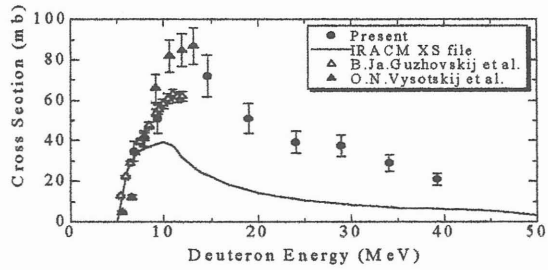

Fig.3 Li(d,x)^{7}Be cross-sections