

Measurement of 40 MeV Deuteron Induced Reaction on Fe and Ta for Neutron Emission Spectrum and Activation Cross Section

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To improve the data accuracy of the neutron emission spectra and the activation cross section for the deuteron interaction with ^{nat}Ta and ^{nat}Fe which will be used as the structural materials in IFMIF(International Fusion Materials Irradiation Facility), we have measured the 1) differential thick target neutron yields from tantalum and iron targets bombarded by 40 MeV deuterons and the 2) excitation functions of activation cross sections for deuteron interaction with tantalum and iron up to 40 MeV, at the AVF cyclotron (K=110) facility of Tohoku University. The activation data were obtained with the stacked target technique and by detecting γ -rays with a high pure Ge detector.

The neutron spectra were measured at seven laboratory angles between 0- and 110-deg with the time-of-flight (TOF) method using a beam swinger system and a well collimated neutron flight channel, and obtained over the almost entire energy range of secondary neutrons using a two-gain method. In the neutron spectra, large peaks around 15 MeV appears in the case of 0-15 deg., and the spectra show very strong angular dependence.

The activation cross-sections were obtained for the $^{nat}\text{Fe}(d,x)^{51}\text{Cr}$, $^{nat}\text{Fe}(d,x)^{52}\text{Mn}$, $^{nat}\text{Fe}(d,x)^{56}\text{Co}$, $^{nat}\text{Fe}(d,x)^{57}\text{Co}$ and $^{nat}\text{Fe}(d,x)^{58}\text{Co}$ reactions, and are compared with other experimental data, the evaluated data by IAEA and calculations by a recent code TALYS. The present data is generally consistent with other experimental data. The TALYS results are similar to the experimental data in higher energy region, but much lower in magnitude in the lower energy region. The present data for the $^{nat}\text{Fe}(d,x)^{56}\text{Co}$, ^{57}Co and ^{58}Co reactions are consistent with other experimental data and evaluated data except for the TALYS results. To estimate radioactivity induced by deuterons, therefore, improvements will be required for cross-section calculation models or parameters in TALYS.