Measurements of Deuteron-induced Activation Cross Sections For Tantalum, Iron, Nickel and Vanadium in 33-40 MeV Region

Makoto Nakao[1], Kentaro Ochiai[1], Naoyoshi Kubota[1], Noriko S. Ishioka[2], and Takeo Nishitani[1]
[1] Department of Fusion Engineering Research, Japan Atomic Energy Research Institute
[2] Department of Ion-beam-applied Biology, Japan Atomic Energy Research Institute

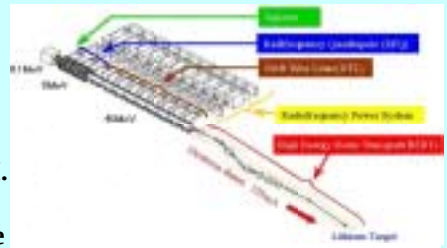
Introduction

The International Fusion Materials Irradiation Facility (IFMIF) is an accelerator-based D-Li neutron source designed to provide an intense neutron field for testing fusion materials. IFMIF is driven by two 40 MeV deuteron linear accelerator with 125 mA beam current. In the design of the IFMIF, long-term operation with a total facility availability of at least 70 % is conceived based on hands-on maintenance.

However, beam losses would occur activation of the structural materials along the beam transport lines and make hands-on maintenance difficult. Thus, the accurate estimation of the activities produced in the accelerator components and the selection of structural materials are important issues to determine the beam loss criteria for achieving the availability.

In this work, activation cross sections for deuteron-induced reactions on , Tantalum, Iron, Nickel and Vanadium were measured by using stacked-foil technique at the AVF cyclotron in the TIARA facility/JAERI.

Tantalum is candidate material for coating to protect the beam facing materials. Iron is used as the inner material of the drift tube. Nickel is the impurity of the steel and Vanadium is corrosion material.

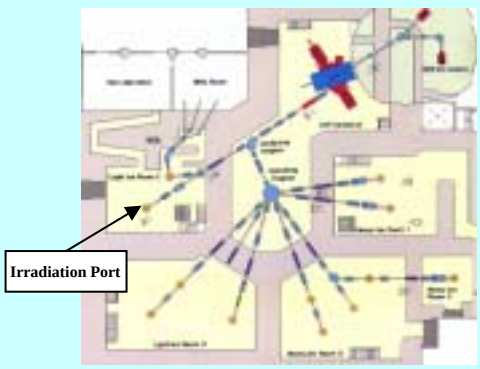


IFMIF

Experiment and Data Processing

Three kinds of stacked-foils consisting of aluminum, copper, and tungsten were irradiated with 41MeV deuteron beam (current= ~0.1 μA). The decayed gamma-rays emitted from the irradiated foils were measured by a HPGe detector and the induced activities were obtained. The energy degradation along the stacks and the effective deuteron energy were estimated by using the IRACM code. The number of deuteron incident on each stack was derived from the ^{65}Zn radioactivity using the cross sections for the ^{nat}Cu(d,x)^{65}Zn reaction reported by S. Takacs et al and the observed ^{65}Zn activities.

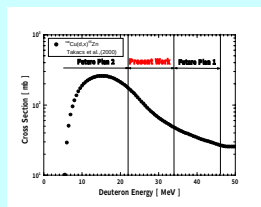
The elemental cross-sections were derived from the induced activities and the number of incident deuteron.



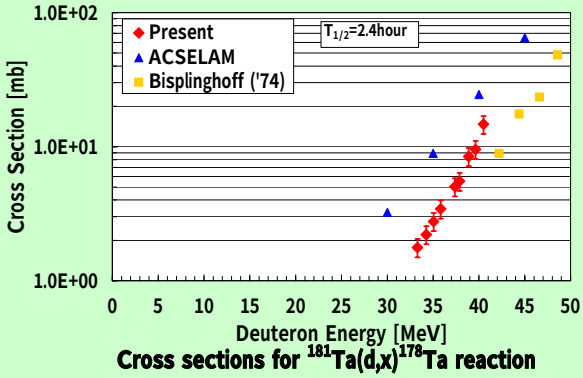
TIARA AVF-cyclotron

Data of Stacked-foils

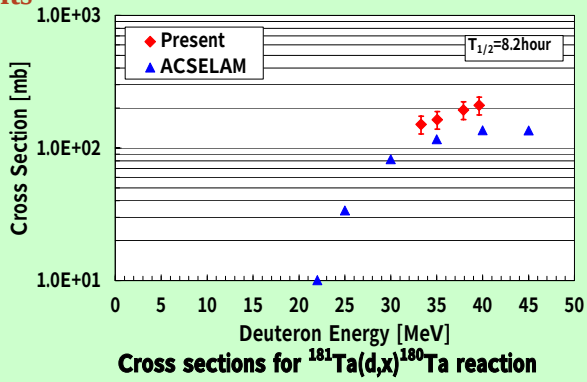
Foil	Thickness [mm]	Purity [%]
Ta	0.010	99.95
Fe	0.050	99.95
Ni	0.020	99+
V	0.025	99.7



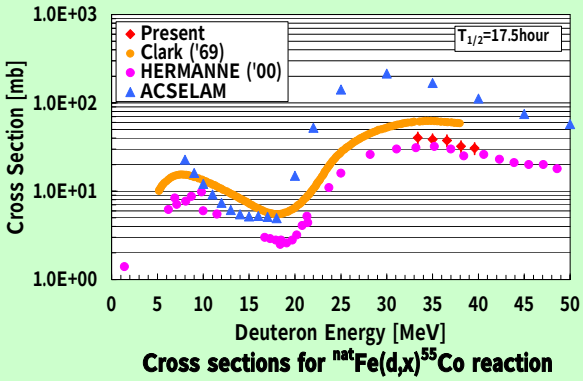
Results



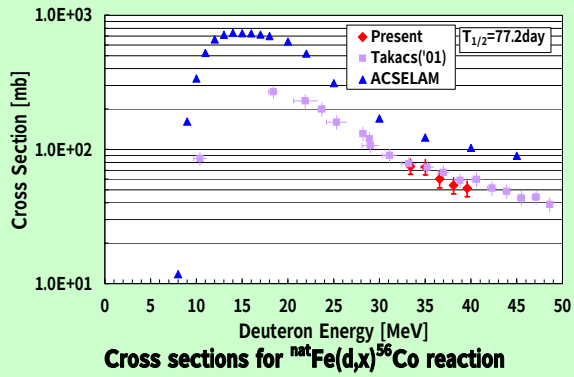
Cross sections for $^{181}Ta(d,x)^{178}Ta$ reaction



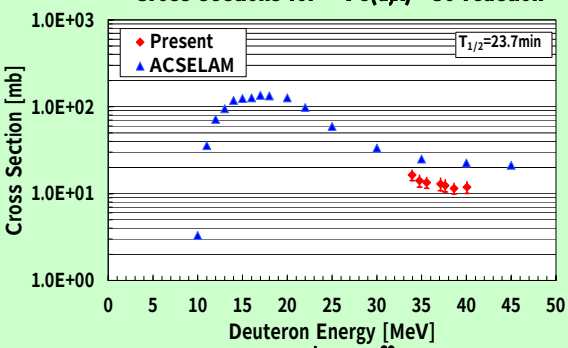
Cross sections for $^{181}Ta(d,x)^{180}Ta$ reaction



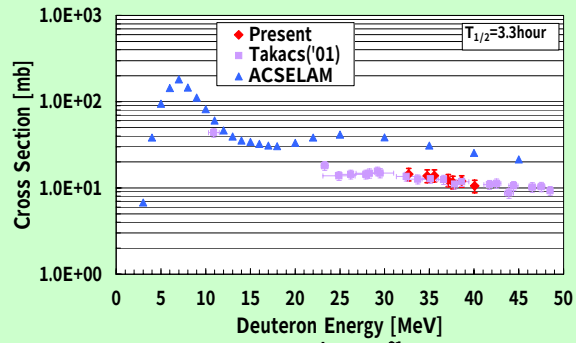
Cross sections for $^{nat}Fe(d,x)^{55}Co$ reaction



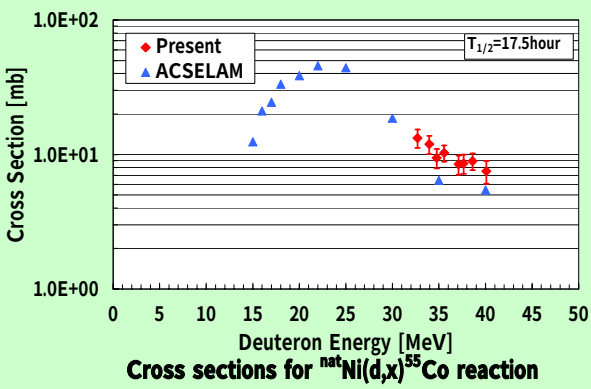
Cross sections for $^{nat}Fe(d,x)^{56}Co$ reaction



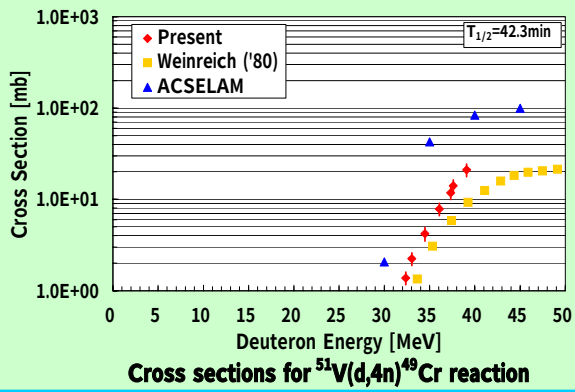
Cross sections for $^{nat}Ni(d,x)^{60}Cu$ reaction



Cross sections for $^{nat}Ni(d,x)^{61}Cu$ reaction



Cross sections for $^{nat}Ni(d,x)^{55}Co$ reaction



Cross sections for $^{51}V(d,4n)^{49}Cr$ reaction

Summary and future works

- The activation cross sections have been obtained for the reactions $^{181}Ta(d,x)^{178}Ta$, ^{180}Ta, $^{nat}Fe(d,x)^{55,56}Co$, $^{nat}Ni(d,x)$ $^{60,61}Cu$, ^{55}Co and $^{51}V(d,x)$ ^{49}Cr in 33-40 MeV region by a stacked-foil technique.
- The obtained results were compared with the other experimental ones and the data in the ACSELAM library.
- In the next experiment, we will perform the same kinds of measurement below 32MeV.