# Excitation functions of deuteron-induced reactions on natural nickel†

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Nickel (Ni) has been given priority over several other materials in a recent IAEA Coordinated Research Project on Nuclear Data Libraries for Advance Systems - Fusion Devices. Ni also can be used as a target material for the production of radionuclides by accelerators leading to medical and industrial applications. Co radionuclides such as $^{55,56,57}$Co found potential applications in medicine and other basic research fields due to their suitable decay characteristics [1]. $^{55}$Co found important applications in labelling bleomycin and in the studies of cerebral and cardiac problems via PET. $^{57}$Co plays a significant role as a calibration standard in γ-ray spectrometry and single photon emission computed tomography (SPECT) [2]. A detailed literature survey of experimental data via deuteron bombardment of nickel show large discrepancies among the previous data. More so, experimental data via the deuteron bombardment process are relatively scarce, leading to further need of enriching the database. In this article, new experimental cross-sections of several radionuclides were reported via deuteron irradiation of some stacked foils made from natural Ni. A well-established stacked foil activation technique combined with γ-ray spectrometry was employed to determine the cross-sections of the $^{nat}$Ni($d$,$x$)$^{55\text{-}58,60}$Co, $^{57}$Ni, $^{52g,54}$Mn, and $^{61}$Cu reactions for the deuteron energy range of 24 MeV down to the respective thresholds [3].

Using a water-cooled target holder that served as a Faraday cup, two stacks were irradiated for 2.00 h and 2.07 h, respectively, with a 24-MeV deuteron beam energy and about 200 nA beam current from the AVF cyclotron of RIKEN RI Beam Factory, Japan [3]. The beam intensity was determined from the activity of the Ti foil placed at the front of the stacks, and considered as a constant to deduce cross-sections for each foil in the stack. The $^{nat}$Ti($d$,$x$)$^{48}$V monitor reaction (σ = 217.54 mb at $E_d$ = 23.88 MeV) recommended by the IAEA [3] was adopted to evaluate the beam intensity.

The production cross-sections of $^{55\text{-}58,60}$Co, $^{57}$Ni, $^{52g,54}$Mn, and $^{61}$Cu radionuclides were reported in the tables and figures in Ref. [3], together with extensive reviews of EXFOR data base and also TENDL-2014. Owing to space, only excitation functions of $^{60m+g}$Co and $^{52g}$Mn are given here. Only two earlier studies reported the cross-sections of $^{60}$Co, and they are inconsistent with each other as shown in Fig. 1. The prediction by the Talys code extracted from TENDL-2014 database could not also give a good approximate of the excitation function of $^{60}$Co. A separate experiment based on the optimized experimental condition for $^{60}$Co may be helpful to obtain a more reliable excitation function of this radionuclide. Unlike proton production route, the production cross-sections of $^{52g}$Mn via deuteron irradiation was scarcely reported. The TENDL-2014 could not accurately predict the excitation function of this radionuclide.

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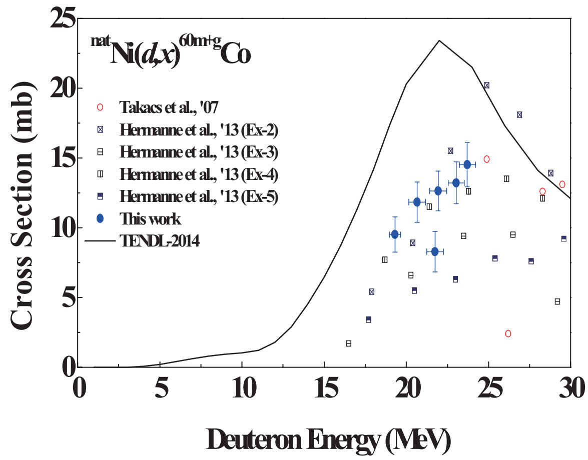


Fig. 1. Excitation function of the $^{nat}$Ni($d$,$x$)$^{60m+g}$Co reaction.

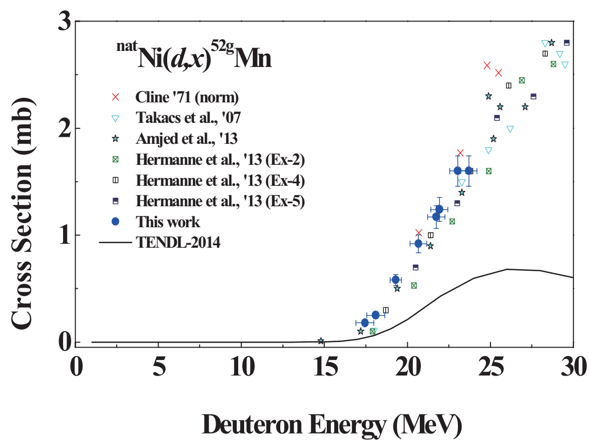


Fig. 2. Excitation function of the $^{nat}$Ni($d$,$x$)$^{52g}$Mn reaction.

References

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