Production cross sections of (*d,x*) reactions on natural irons†

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The method for obtaining accurate information of light-charged-particle-induced reaction cross sections has generated significant interest in the nuclear data community because these reactions are being increasingly used in nuclear medicine, accelerator and nuclear technology, and the testing of nuclear reaction theories. Recently, we investigated the production cross sections of deuteron-induced radionuclides from various target elements because measured data of the (*d,x*) processes are limited compared to those of (*p,x*) processes. A survey of existing literature shows that several investigations have been conducted for the ^{nat}Fe(*d,x*) reactions, leading to various applications. The formation of the ^{55}Co radionuclide via the ^{nat}Fe(*d,x*) reaction is useful in PET imaging procedures, especially for diagnosing slower metabolic processes[1]. It also plays an important role as a label for bleomycin in diagnostic nuclear medicine, and more recently, in some cardiac and cerebral studies. Several authors[2] successfully applied ^{55}Co as a PET imaging agent in studies of ischemic stroke for quantifying cerebrospinal fluid kinetics in the brain, and they suggested that its effective clinical use is limited up to 48 h because of the production of the ^{56}Co contaminant. ^{55}Co was also applied as a potential renal imaging agent through the dynamic PET imaging of animal renal functions[3]. Therefore, accurate determination of the production cross sections of the ^{nat}Fe(*d,x*)^{55}Co reaction is required because of its great importance in various practical applications, especially in nuclear medicine.

The objective of the present study was to report the latest cross sections of the ^{nat}Fe(*d,x*)$^{55,56,57,58g+m}$Co, ^{52g,54,56}Mn, ^{51}Cr, ^{59}Fe reactions that were measured with a high precision over the energy range of 2–24 MeV using the AVF cyclotron facility of the RIKEN RI Beam Factory, Wako, Japan. Details on the irradiation technique, radioactivity determination, and data evaluation procedures are available in Ref.[4]. A brief description of the model codes used in this work is also available elsewhere[4]. Owing to the space limitation of this report, we present only the ^{nat}Fe(*d,x*)^{55}Co cross sections and the deduced yield in Figs. 1 and 2, respectively. Measured cross sections with an overall uncertainty of about 12% are listed in Ref.[4]. The cross-sections were normalized by using the ^{nat}Ti(*d,x*)^{48}V monitor cross sections recommended by IAEA. Measured data were critically compared with the available literature data, and an overall good agreement was found. However, only partial agreements were obtained with the data extracted from the TENDL-2012 library based on the TALYS code. The deduced thick-target yields indicate that a low-energy (<13 MeV) cyclotron and a highly enriched ^{54}Fe target could be used to obtain the high purity product ^{55}Co, which is a long-lived positron emitter used in clinical applications.

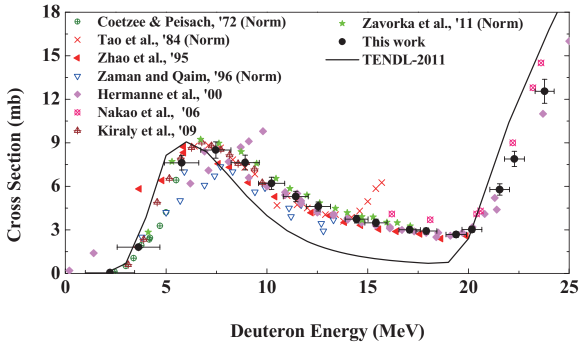

Fig. 1. Excitation function of the ^{nat}Fe(*d,x*)^{55}Co reaction.

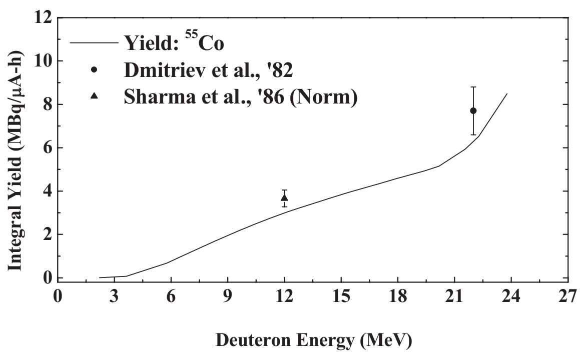

Fig. 2. Physical thick target yields for the ^{55}Co radionuclide.

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