Cross section measurements for proton induced reactions on ^{nat}Mo and ^{nat}Zr

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1. Introduction

Study of the excitation function of charged-particle induced reactions are of considerable importance for various practical applications such as thin layer activation, astrophysics, accelerator technology, medical radioisotope production, behavior of materials in particle irradiation and for the development of improved reaction theory. The charged-particle–induced reactions of Mo and Zr are important for the production of radioisotopes for medical purposes, nuclear reactor engineering as well as for other applications. The experimental results have been utilized in various fields through compilation in the EXFOR library [1] and also for the development of nuclear reaction data

Out of several established and potential candidates, the ^{99}Tc^{m} and its parent isotope ^{99}Mo are one of the most important medical radioisotopes. The production of ^{99}Mo which is the generator of ^{99}Tc^{m} hugely rely on the nuclear reactors. But nuclear reactors often face breakdown problems due to aged. Hence, it is necessary to produce the ^{99}Mo and ^{99}Tc^{m} radioisotopes by using an alternate method and one of the most promising methods is via proton-induced reaction on natural molybdenum. There is a great demand of highly accurate nuclear data of zirconium as it is one of the important structural materials in the design of the accelerator-driven sub-critical system (ADSs). Among different charged-particle induced reactions, proton induced reactions are of great interest for accelerator and ADSs. Zr is also a potential candidate for the production of some medical isotopes.

2. Experimental details

The Experiment was performed using BARC-TIFR Pelletron Linac Facility in Mumbai. The stack foil activation technique was used followed by off-line γ- ray spectroscopy. The irradiation and sample details are given in Table 1 and 2.

Table 1: Irradiation Details

Energy (MeV)	Current (nA)	Irradiation Time (hrs)
20	10	1
18	8	1
16	8	1.5
14	7	2

Table 2: Sample Details

Ep (MeV)	Stack	Sample	Area (cm x cm)	Thickness (mg/cm^2)
20	Cu11-Mo1	Cu11	1.01x1.06	10
		Mo1	1.56x1.48	10
18	Cu12-Mo2	Cu12	1.08x0.99	5
		Mo2	1.47x1.54	10
16	Cu13-Mo3	Cu13	1.06x1.16	5
		Mo3	1.48x1.49	10
14	Cu14-Mo4-Zr4	Cu14	1.00x1.09	5
		Mo4	1.47x1.55	10
		Zr4	1.09x1.08	10

Copper monitor was placed with every target. The proton beam degradation along the stack was calculated by SRIM code.

Each sample was counted by using pre-calibrated single crystal HPGe detector coupled to PC based multichannel analyzer. Three HPGe detectors were used to count the γ- ray activity of the irradiated samples, the first two detectors with relative efficiency of 30% and the third with 33%. All samples were mounted at 10 cm from the end cap of detector to avoid summing effect. The HPGe detectors were calibrated using standard ^{152}Eu source. The spectra were recorded using CAEN N6724 digitizer and analysed offline using CAMAC-based Linux Advanced

Multiparameter System (LAMPS) software [2]. The efficiency plots of the two detectors with relative efficiency ~30% are shown below:

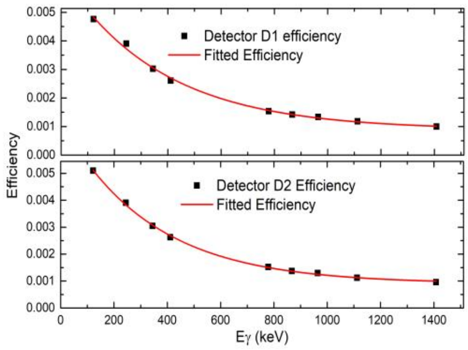


Fig. *1: Detector D1 and D2 efficiencies*

2.1. Half-Life tracking

Since there are multiple channels, half-life tracking was used to verify the source of the lines, wherever possible and the cross sections of only the identified lines will be calculated.

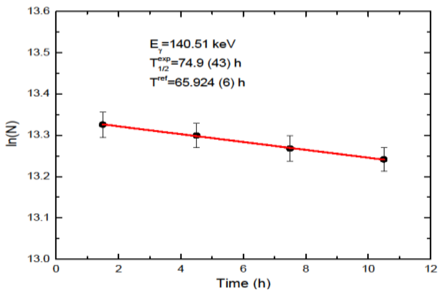


Fig. 2: Decay curve of E_γ= 140.51 keV of ^{99}Mo.

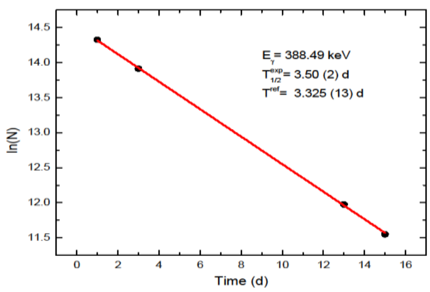


Fig. 3: Decay curve of E_γ= 388.49 keV of $^{87}Y^g$.

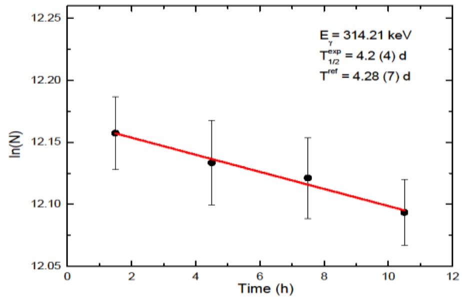


Fig. 4: Decay curve of E_γ =314.21 keV of $^{96}Tc^g$.

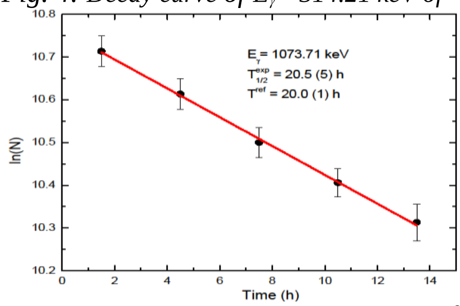
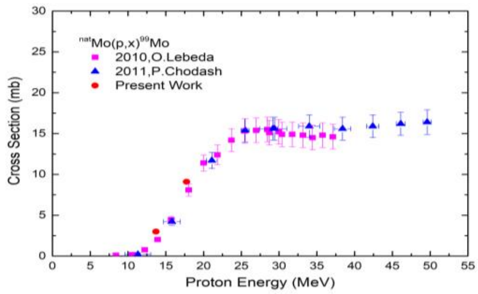


Fig. 5: Decay curve of E_γ =1073.71 keV of $^{95}Tc^g$.

3. Results

Preliminary result of ^{nat}Mo(p,x)^{99}Mo reaction cross sections at proton energies 13.70 and 17.75 MeV are given in Fig. 6. The analysis is in progress and the results will be discussed during the conference.



Acknowledgements

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References

[1] EXFOR database, https: // www- nds. iaea. org / exfor/exfor. html.
[2] http://www.tifr.res.in/~pell/lamps.html