Measurement of Alpha-induced Reaction Cross Sections for Cr Isotopes on Natural Ti

著者	Kikunaga H., Takamiya K., Ohtsuki T., Haba H.
journal or publication title	CYRIC annual report
volume	2014-2015
page range	49-51
year	2015
URL	http://hdl.handle.net/10097/00120745

V. 1. Measurement of Alpha-induced Reaction Cross Sections for Cr Isotopes on Natural Ti

Kikunaga H.[1]*, Takamiya K.*[2]*, Ohtsuki T.*[2]*, and Haba H.*[3]

[1]*Research Center for Electron Photon Science, Tohoku University*
[2]*Research Reactor Institute, Kyoto University*
[3]*RIKEN Nishina Center*

Introduction

Chromium is one of essential biotrace elements in some animals but also can be toxic in high concentrations. Understanding the behavior of chromium in animals, plants, and environment is important and influential on the various fields such as biological sciences. The radioactive tracer technique has been widely recognized as a powerful tool for behavior analysis of elements in trace amount. The isotopes ^{48}Cr (Half-life: 21.6 h), ^{49}Cr (42.3 min), and ^{51}Cr (27.7 d) have potential as radiotracers because of their suitable half-lives. In this work, the cross sections for the reactions ^{nat}Ti(α, X)^{48}Cr and ^{nat}Ti(α, X)^{49}Cr up to 75 MeV were measured to produce these isotopes efficiently and quantitatively.

Experimental

The excitation functions of these reactions were measured by the stacked-foil technique. The schematic diagram of the target stacks containing natural Ti (99.5% pure) and Al (99.9% pure) foils are illustrated in Figs. 1 (a) and (b). The target stacks shown in Figs. 1 (a) and (b) were irradiated for 30 min. with an α-particle beam delivered from the RIKEN K70 AVF Cyclotron and the model 680 Cyclotron at Cyclotron and Radioisotope Center (CYRIC), Tohoku University, respectively. The cyclotrons were operated at a beam energy of 50 MeV for RIKEN and 80 MeV for CYRIC with a mean current of around 0.4 μA.

After the irradiation, the target foils were enclosed in a polyethylene film separately and were subjected to γ-ray spectrometry using a high-purity germanium detector. The incident beam energy and flux were determined by activation of the monitor foil technique using the ^{nat}Ti(α, X)^{51}Cr and ^{27}Al(α, X)^{22,24}Na reactions. The reference data were obtained from the IAEA Reference Data[1]. The energy loss in each foil was calculated using the TRIM code[2].

Results

The cross sections for the $^{nat}Ti(\alpha, X)^{48}Cr$ and $^{nat}Ti(\alpha, X)^{49}Cr$ reaction obtained in this work are shown in Fig. 2. For comparison, the earlier experimental data[3–6] of the $^{nat}Ti(\alpha, X)^{48}Cr$ reaction and the values calculated using the Talys 1.6 code[7] with default parameters are shown in Fig. 3. The cross sections of ^{48}Cr obtained in this work is in good agreement with the earlier experimental data. The calculated values with the Talys code reproduce the experimental values of ^{48}Cr and ^{49}Cr with a reasonable accuracy although each peak position of the excitation functions is deviated slightly.

References

1) IAEA-Tecdoc-1211 2001 Charged particle cross section database for medical radioisotope production: diagnostic radioisotopes and monitor reactions (IAEA, Vienna, 2001).
2) Ziegler JF, et al., The stopping and range of ions in solids (Pergamon Press, New York, 1985).
3) Michel R, et al., *Radiochim Acta* **32** (1983) 173.
4) Weinreich R, et al., *Appl Radiat Isot* **31** (1980) 223.
5) Hermanne A, et al., *Nucl Instrum Meth* B **152** (1999) 187.
6) Peng X, et al., *Nucl Instrum Meth* B **140** (1998) 9.
7) Koning AJ, et al., ”TALYS-1.0”, *Proc Int Conf Nucl Data Sci Technol ND2007*, Nice, France, 2007-04 (EDP Sciences, 2008) p.211.

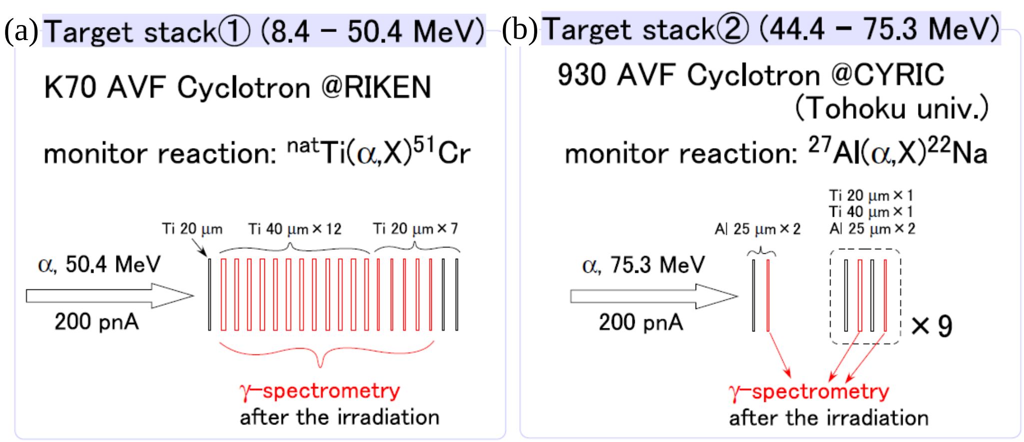

Figure 1. Schematic diagram of the target stacks for the measurement of the excitation function (a) from 8.4 to 50.4 MeV (b) from 44.4 to 75.3 MeV.

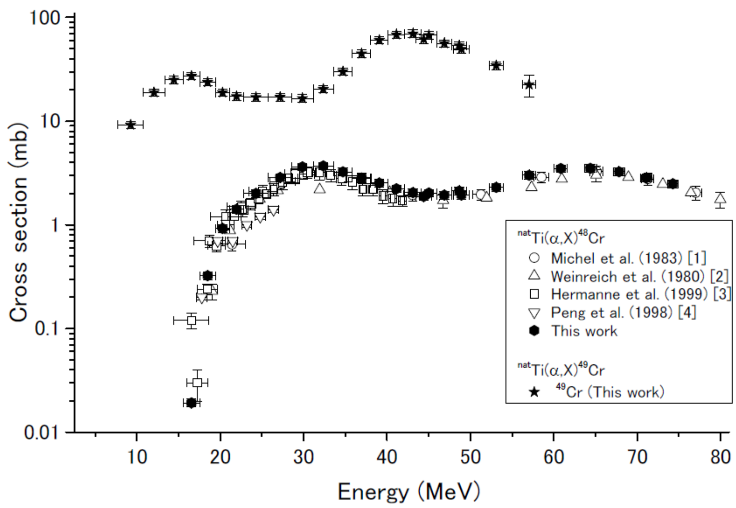

Figure 2. Cross section for the $^{nat}Ti(\alpha,X)^{48}Cr$ and $^{nat}Ti(\alpha,X)^{48}Cr$ reactions.

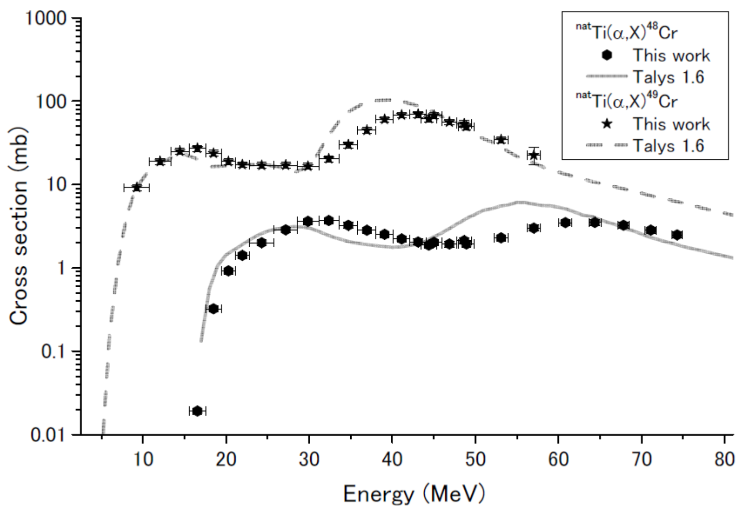

Figure 3. Comparison with the experimental data obtained and the calculated values.