Investigation of alpha particle induced reactions on natural silver in the 40–50 MeV energy range[†]

F. Ditrói,[*1] S. Takács,[*1] H. Haba,[*2] Y. Komori,[*2] M. Aikawa,[*3] M. Saito,[*4] and T. Murata[*5]

Natural silver targets were irradiated using a 50 MeV alpha-particle beam in order to measure the activation cross sections of radioisotopes in the 40–50 MeV energy range. Among the radio-products, there are medically important isotopes such as ^{110m}In and ^{111}In.[1)] For optimizing the production of these radioisotopes and their purity and specific activity, the cross section data for every produced radioisotope are important. New data were measured in this energy range and the results of some previous measurements were confirmed. Physical yield curves were calculated using the new cross section data completed with the results from the literature.

The irradiation was performed on a dedicated beam line of the K70-MeV AVF cyclotron of the RIKEN RI Beam Factory by using an $E_\alpha = 50.7 \pm 0.3$ MeV beam. The ^{nat}Ti$(\alpha,x)^{51}$Cr reaction on titanium foils (Ti: 10.9 μm) was used as a monitor reaction to check and correct the beam intensity and energy degradation through the whole stack. The foils were ordered in groups in such a way that we could compensate or avoid the activity loss or excess activity due to the recoil effect of the radioisotope in question. The first 10 foils of the stack were silver. The Ag foils were arranged in one block, *i.e.* one after other, because for silver, we were interested in the high energy part (40–50 MeV range).

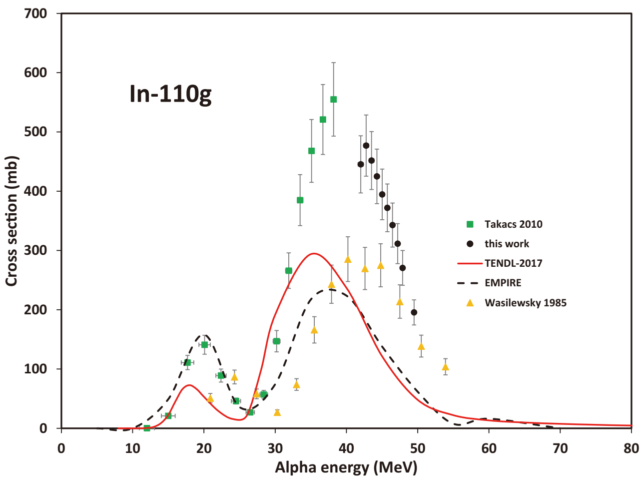

Fig. 1. Excitation function of the ^{nat}Ag(α,x) ^{110g}In reaction compared with the previous results and the results of the theoretical model code calculations.

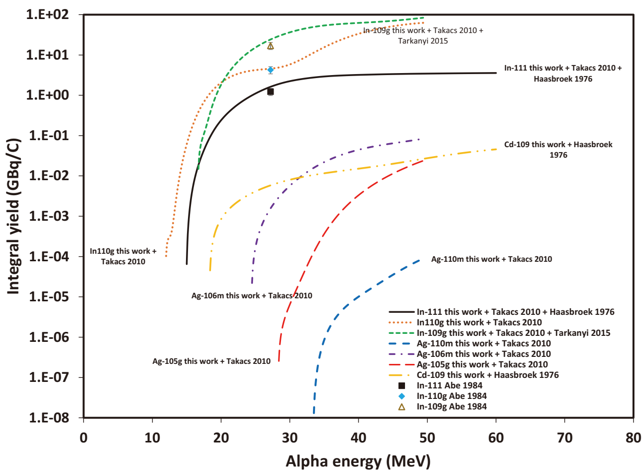

Fig. 2. Calculated physical yields from selected α-particle induced nuclear reactions on Ag compared with the literature data.

The excitation functions for ^{nat}Ag$(\alpha,\ x)^{111,110m,\ 110g,\ 109g\ 108g}$In, $^{111,\ 110m,\ 106m,\ 105g}$Ag and ^{109}Cd were measured in the energy range of 40–50 MeV (*e.g.* ^{110g}In in Fig. 1). The newly determined cross section data helped clarify the problems between the previous literature results. The cross section deduced for the production of ^{110g}In, ^{109g}In, ^{108g}In, ^{111}Ag, and ^{110g}Ag in most cases show a good continuation of the eventually existing literature data in a lower energy region. In the case of ^{111}In and ^{109}Cd, the agreement with the previous literature data is excellent. The results of the theoretical nuclear reaction model codes are not systematic and give only partly good estimations for several reactions. There are reactions, for which both (EMPIRE and TENDL) fail completely. Thick target physical yield curves were calculated from the measured cross sections (Fig. 2). The excitation functions for these calculations were constructed by using our new results combined with data from the literature. The literature values agree well with our results.

Among the possible industrial applications, the TLA[2)] method was demonstrated by using ^{106m}Ag, which is the best radioisotope for this purpose. It has been proved that by using ^{106m}Ag as a tracer, the wear measurement can be performed with actual parameters.

† Condensed from the article in Nucl. Instrum. Methods Phys. Res. B **436**, 119 (2018)

*1 Institute for Nuclear Research, HAS
*2 RIKEN Nishina Center
*3 Faculty of Science, Hokkaido University
*4 Graduate School of Biomed. Sci. and Eng., Hokkaido Univ.
*5 School of Science, Hokkaido University

References

1) F. Tárkányi *et al.*, Nucl. Instrum. Methods Phys. Res. B **351**, 6 (2015).
2) F. Ditrói *et al.*, IAEA TECDOC-924, 1997.