Vol. 31 (2000) *ACTA PHYSICA POLONICA B* No 3

AN ESTIMATION OF THE PRODUCTION YIELD OF ^{111}In AND ^{123}I ISOTOPES USING THE ^{16}O INDUCED REACTION ON $^{\rm nat}$Ag

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(Received June 21, 1999)

The production of ^{111}In and ^{123}I isotopes has been studied, using ^{16}O induced reaction. The maximal cross section for the production of these isotopes was measured to be 168 μb and 187 μb for ^{111}In and ^{123}I, respectively, for a beam energy of about 70 MeV.

PACS numbers: 27.60.+j

The production cross section of the radionuclides ^{111}In and ^{123}I populated via the heavy-ion reaction ^{16}O + $^{\rm nat}$Ag at 80 MeV on the Warsaw Cyclotron has been studied. The target made of natural silver contains two stable isotopes ^{109}Ag and ^{107}Ag with abundances of 48.2% and 51.8%, respectively, giving the possibility to produce simultaneously both the ^{111}In and ^{123}I nuclides due to the expected reactions:

$$^{16}{\rm O} + ^{109}{\rm Ag} \rightarrow ^{125}{\rm Cs}^* \rightarrow pn + ^{123}{\rm Xe} \tag{1}$$

$$^{123}{\rm Xe} \underset{\beta^+,EC}{\longrightarrow} ^{123}{\rm I} \tag{2}$$

and

$$^{16}{\rm O} + ^{107}{\rm Ag} \rightarrow ^{12}{\rm C} + ^{111}{\rm In}\,. \tag{3}$$

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The second considered above reaction can be classified as an transfer reaction of the α particle and the estimation of the experimental cross section for such process is of special interest. The beam of ^{16}O ions was used to irradiate a stack of four Ag and Au targets (Fig. 1). The Au foils were applied to stop the reaction products created in the Ag foils. Due to the energy loss in the target stack the bombarding energy ranged from 80 down to 56 MeV. The energies of the projectiles were adjusted in such a way that the relative excitation functions could be measured in an energy range starting below the pertinent Coulomb barriers. Table I shows the irradiation conditions and the

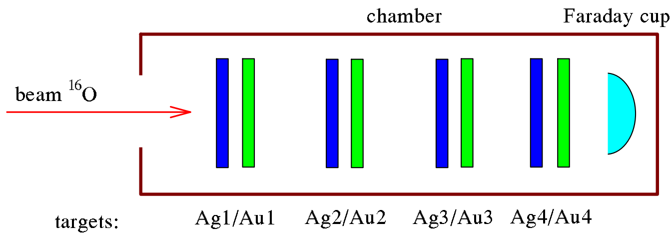

Fig. 1. Schematic presentation of the target chamber with the stack of the Ag and Au foils.

beam energies in the subsequent targets. The irradiation of the stack of foils was performed during 6.6 h with an integrated charge of 6.487×10^6 nC. The changes in the beam intensity were taken into account in order to estimate the fraction of nuclei decayed during the irradiation. The correction equal to 2.9% and 15% was obtained for ^{111}In and ^{123}I, respectively.

TABLE I

Experimental conditions for the measurements of the irradiated targets

Target	Target thickness [mg/cm^2]		Beam energy [MeV]	Relative detector efficiency	Distance [cm]	Photopeak efficiency [%] for γ lines [keV]		
	Ag	Au				159	171	245
1	2.78	1.23	80	15	5	2.4	2.3	1.7
2	3.2	1.23	72.1	17	5	2.3	2.1	1.5
3	3.16	1.1	64.3	60	10	1.3	1.3	1.1
4	3.2	1.1	56.0	20	10	0.8	0.8	0.6

Immediately after the irradiation the samples were taken to a low-background measurement room containing four HPGe detectors placed in a special background reducing selected Pb shields. The measurements were conducted for one week. Basing on a precise energy and efficiency calibrations with ^{152}Eu source the representative γ-lines and their half-lives belonging [1] to the ^{111}In and ^{123}I isotopes were determined. The measured intensities of the observed γ-lines were used for the estimation of the number of atoms created in the targets at the end of the irradiation. In Table II the weighted

TABLE II

Results for the ^{111}In and ^{123}I isotopes produced in ^{16}O beam interaction with ^{nat}Ag target.

Target	Beam energy	Number of nuclei [10^6]		Cross section [μb]	
	[MeV]	^{111}In	^{123}I	^{111}In	^{123}I
1	80	4.5±0.5	160±17	0.76±0.12	21.9±3.4
2	72.1	5.8±0.3	187±10	5.2±0.4	168±13
3	64.3	0.86±0.6	27.8±1.7	3.1±0.3	100±10
4	56.0	0.22±0.06	6.4±2.0	0.070±0.015	2.0±0.6

number of created nuclei (corrected for the decay during irradiation) and resulting measured cross section for the ^{111}In and ^{123}I production are shown. According to our knowledge the production cross section for the considered here radionuclides has not previously been investigated in the reaction with heavy ions. The obtained results are indicating a possibility to produce the radioisotopes ^{111}In and ^{123}I by the irradiation of natural Ag with ^{16}O ions.

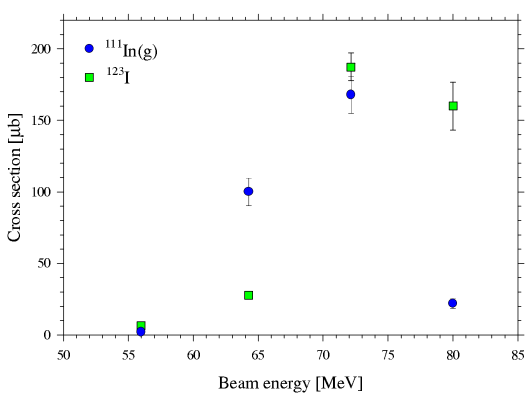

Fig. 2. The excitation functions measured in the ^{107}Ag(^{16}O,^{12}C)^{111}In and ^{109}Ag(^{16}O,$2p$)^{123}I reactions.

However, the maximal cross section for the production of these isotopes observed for an energy of about 70 MeV is equal only to 168 μb and 187 μb for ^{111}In and ^{123}I, respectively (Fig. 2). Perhaps, after an optimization of the reaction efficiency one could expect that it would be possible to obtain small, but sufficient for medical use amounts of these isotopes by means of extraction [2] of indium and iodine from silver target.

The authors would like to thank T. Inamura, R. Lieder, K. Siwek-Wilczyńska and J. Wilczyński for valuable discussions and critical reading of manuscript. Partial support of the Polish Committee for Scientific Research under grant KBN 2-PO3B-023-08 is also highly appreciated.

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