Abstract 026

A Solid ^{114m}In Target Prototype with Online Thermal Diffusion Activity Extraction- Work in Progress

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Introduction

A solid target system is under development for indium isotope production. Pure ^{114m}In ($T_{1/2}$=45 d, Eγ=190 keV, 15.6%) can be produced from proton irradiation on natural cadmium foils if the simultaneously produced ^{110}In-^{111}In activity is allowed to decay several days. ^{114m}In decays to ^{114}In ($T_{1/2}$=71.9 s, β^-=99.5%). This work focuses on ^{114m}In production/extraction.

Material and methods

A target holder was constructed to match a MC 17 Scanditronix cyclotron with a wide beam. The beam fits into a collimator of 40x10 mm^2. The foil holder is a 30° slanted cooling/heating block with a three side frame mounted to the beam strike side (fig 4). On this frame a 25 µm niobium foil is placed to create a water tight cavity, of some ml volume, between the niobium foil and cooling/heating block. In this cavity the cadmium foils are placed. The slanting gives a beam strike area of 40x20 mm^2. This area is cooled with a 1.5 mm thick, 3 l/min water film.
The system was loaded with natural cadmium foils and bombarded with 45 µA protons, under helium flush. After irradiation, the foils were heated to 280-310°C for 1 to 2 hours under argon flush in the cavity. The heating was performed with two heating elements (L=40 mm, ø=6.5 mm, P=160 W each) mounted symmetrically on the long sides to the beam strike area (fig 3). The temperature was measured, with two PT100 sensors (9.5x1.9x1.0 mm, -70…+500°C) mounted on the sides (fig 4), and displayed/controlled with two Shimaden RS32 controllers. The side temperatures were calibrated to the actual temperature under the cadmium foil with another PT 100 sensor.
The activity extraction was made with a thermal diffusion technique [1]. This technique is based on heating close to the melting point of cadmium (320°C). At this temperature, the produced indium isotopes (melting point 150°C) are diffusing in the cadmium matrix. Gradually over time, the indium atoms concentrate on the foil's surface and can then be etched off with a weak acid (0.05 M HCl). The acid was pumped in and out with a peristaltic pump.

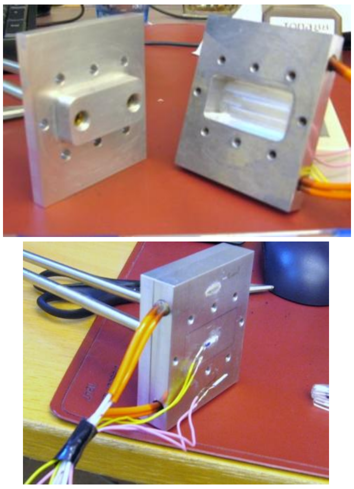

Fig 1. Target cooling/heating block back plate with water cooling in out and two heating elements.

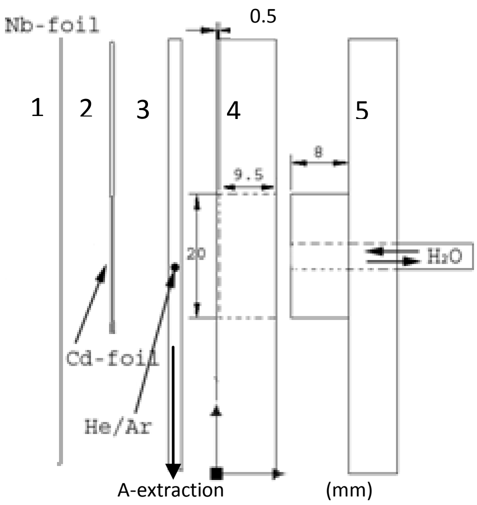

Fig 2. 1: 25 µm Nb foil, 2: Cd-foil-Al-fork (fig 4) 3: Outer frame with He/Ar in/out and a hole in the bottom for activity extraction, 4: back plate 0.5 mm back wall to cooling water, 5: water in/out plate.

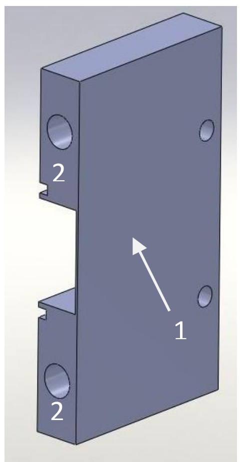

Fig 3. Cross section view of the back plate: 1: Beam strike area. 2: Heat element holes.

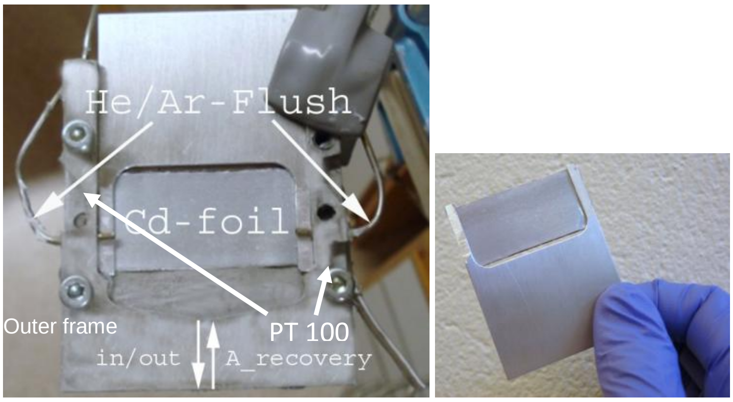

Fig 4. The foil is squeezed and stabilized into place under the flush tubes. This view is covered with a 25 µm Nb foil. HCl is pumped in/out from below, in the cavity between the back plate and the Nb-foil. The Cd-foils are mounted on an Al-fork with a silicone adhesive.

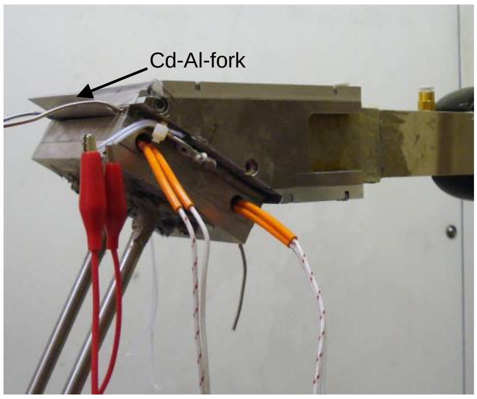

Fig 5: The target is loaded from its rear top simply by sliding down a Cd-Al-fork.

E_p on cadmium foils is ~12.3 MeV. 100 and 50 µm cadmium foils slanted 30° degrades 12.3 → 9.2 and 12.3 → 10.9 MeV. This correspond to theoretical ^{114m}In activity yields of 0.2 MBq/µAh and 0.08 MBq/µAh for natural[1] cadmium foils [2].

Preliminary Results

Low activity yields indicated that a great portion of the beam had missed the actual target, i.e. the cadmium foil. Activity yields will be presented at the conference when new irradiation has been performed. Separation yields on the other hand are valid and are given in table 1.

Table 1: Extraction yields were either measured with a Capintec CRC 120 dose calibrator or a HPGe detector. Etching time was 1-2 min.

Foil #	Thickness (µm)	Irradiation Time (min)	Heating time (min)	extraction (%)
1=T116	100	~6.3	128	41
2=T117	100	~6.8	120	54
3=T118	100	~6.8	60	44
4=T119	50	~6.7	120	41
5=T122	100	~7.0	60	40
6=T123	100	~6.8	120	49
7=T124	50	~6.7	120	56

Discussion

It was found that thermal diffusion extraction of indium from cadmium foils, which only requires temperatures around 300°C, is practically doable direct in the target without any dismounting of foils after irradiation. About 40-50% of produced activity could be extracted with heating times of 1-2 hours. Natural cadmium material for one target cost about 10 Euros.

Acknowledgements:

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References:

[1] Lundqvist. H. et al "Rapid Separation of ^{110}In from Enriched Cd Targets by Thermal Diffusion" *Appl Radiat. Isot.* Vol. 46, No. 9, pp. 859-863, 1995

[2] IAEA Recommended cross sections for ^{114}Cd(p,n)^{114m}In reaction (http://www-nds.iaea.org/radionuclides/cd4p4in0.html)

[1] The yields are calculated to correspond to the abundance of ^{114}Cd in natural Cd foil i.e. 28.73 %