^{244}Pu-targets for production of element 114 at TASCA

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Introduction: In a series of recent experiments at TASCA, production and decay as well as chemical properties of element 114 have been investigated using the ^{244}Pu(^{48}Ca,3/4n)-reaction leading to ^{288,289}114 [1,2]. Because the ^{244}Pu target material is available only in very limited amounts, the target preparation technique should give high yields. Easy and complete recovery of the target material is another pre-requisite [3]. Thus, we have chosen Molecular Plating (MP) onto 2 µm thin pinhole-free titanium foils as the target preparation technique. At TASCA, a rotating target wheel is used composed of three banana-shaped target segments with an active target area of 1.44 cm^2 each. The rotating target is confined in a nearly closed container in order to protect the beam line as well as the separator against contamination in the case that a target gets destroyed.

^{244}Pu target production and characterization: For the production of one target segment by MP about 1 mg of ^{244}Pu in the form of its nitrate is dissolved in a small volume (100-200 µl) of nitric acid in a Teflon™ beaker and mixed with a surplus of isopropanol (800 µl). The mixture is then transferred into the electrochemical deposition cell (EDC) made of Teflon™ which is subsequently filled up with isobutanol to a total volume of 16 ml [4]. MP is carried out by applying a voltage of 150-200 V at a maximum current density of about 1.2 mA/cm^2. After 5-6 hours plating time, deposition yields up to 90 % are achieved. The backing foils are produced by cold rolling at GSI [5]. They should be pinhole-free and are precleaned with isopropanol, 6 M hydrochloric acid and water. Prior to use, the foil integrity is checked by optical microscopy to ensure that the backing is pinhole-free. The average foil thickness is determined by weighing, whereas the homogeneity of the foil thickness is checked by α-particle energy-loss measurements. For a target backing foil with a nominal thickness of 2.2 µm deviations are in the order of ± 0.2 µm.

The target thickness is determined by two independent methods: (i) *α-particle spectroscopy*. After the deposition is completed, the target is dismounted from the EDC, dried under an infrared lamp and measured with a surface barrier α-detector at a distance of about 30 cm. (ii) The Pu-content of the solution in the EDC is determined by *Neutron Activation Analysis*. Subsequent to MP an aliquot of the supernatant solution in the EDC (1 ml) is irradiated for 2 h in the TRIGA Mainz research reactor with a thermal neutron flux of 7 x 10^{11} cm^{-2}s^{-1}. Here, 10.5 h-^{245}Pu is formed via the reaction ^{244}Pu(n,γ)^{245}Pu.
The Pu content of the irradiated solution is determined by means of γ-spectrometry using the prominent γ-lines resulting from the ^{245}Pu decay at 327 keV, 308 keV, and 560 keV, respectively [3]. Table 1 comprises all ^{244}Pu-targets produced for TASCA so far.

Table 1: ^{244}Pu-targets for TASCA

Target#	Thickness [µg/cm^2]
08-395	401
08-482	502
08-485	490
08-486	390
08-487	472
09-562	673
09-594	724
09-623	790
09-624	785

The homogeneity of the Pu-layer is checked with radiography [6] using a commercial radiographic imager (FLA 7000 from FUJIFILM Corp.). Figure 1 shows a picture of a target segment. Here, the brown layer indicates the Pu-oxide deposit. Also shown is a 3-dimensional plot of the activity distribution. With this technique it could be shown that the active target area is completely covered and, in addition, that Pu is homogeneously distributed over the entire target area. From this one can conclude that variations in target thickness are in the order of 15%.

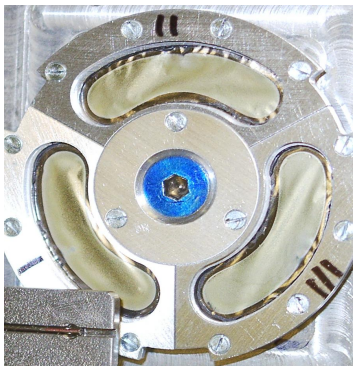

Figure 1: ^{244}Pu target wheel for TASCA as used for the production of element 114. The brown layer indicates the Pu-oxide deposit.

References

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