The deposition of ^{239}Pu on thin Ti backings by molecular plating

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Many transactinide elements can be produced in heavy ion fusion reactions with ^{244}Pu targets. For this, target thicknesses of 500 µg/cm² are required. Since ^{244}Pu is available only in very limited amounts, the target preparation technique should give high deposition yields. Easy and complete recovery of the target material is another prerequisite. Molecular plating (MP) is well suited for the preparation of lanthanide and actinide targets on metallic and non-metallic backing materials with deposition yields > 80 %. For the molecular plating the actinide material normally is used in its nitrate form, from which 10µl were dissolved in 16 ml isobutanolic solution. The electrodeposition cell consists of Polyetheretherketone (PEEK) and silicon seals.

The isotope ^{239}Pu is used to optimize the deposition parameters for Pu as well as to study the performance of Pu layers on thin Ti backings during irradiation with intense ^{22}Ne beams as applied at the UNILAC accelerator of the Gesellschaft für Schwerionenforschung (GSI). For the **T**rans-**A**ctinide **S**eparator and **C**hemical **A**pparatus TASCA at GSI a rotating target wheel assembly consisting of three banana shaped segments with an active target area of 1.74 cm² is used. Here, thin Ti foils (2 µm) serve as backing material.

In the initial deposition tests with very small amounts of ^{239}Pu (~ 10 kBq or < 5µg) serious adsorption losses occurred due to the special chemical nature of Pu. Pu appears in aqueous solution predominantly in the +IV and the +VI state, where especially Pu(IV) is known to form colloids and polyhydroxides in pH ranges > 1. These species tend to adsorb strongly onto glass and polymers like PEEK and silicon.

To circumvent these problems, the original Pu nitrate solution was fumed to dryness with 8 M perchloric acid to transfer the Pu into the higher oxidation state +VI, in order to suppress the formation of polynuclear Pu species. For further experiments, the Pu is kept in 8 M perchloric acid. Furthermore, different plastic and elastomeric materials were investigated with regard to their adsorption tendency for Pu. Here, equal samples of each material were contacted with 16 ml ^{239}Pu solution (11 kBq total), stirred and treated by ultrasound for 60 minutes. The amount of Pu adsorbed on the surface was measured by α-particle counting. As a result, PTFE shows the least adsorption and therefore was chosen as new cell material. Unfortunately, there was no alternative for the relatively high adsorbing silicon seals. With the new PTFE deposition cell, molecular plating experiments were performed with a total of 200 µg ^{239}Pu corresponding to a target thickness of 125 µg/cm². The first deposition still resulted in a loss of Pu due to adsorption of 27 %, whereas during the second procedure only 4 % of Pu was lost. In further depositions, a loss of material was not longer noticed. This effect leads to the suggestion that the surface of the deposition cell now was saturated with Pu since it was not cleaned between subsequent depositions. Then, the intake of Pu was increased to 1000 µg in order to obtain targets with approximately 500 µg/cm². Here the deposition yield ranged between 70 and 86 %. Table 1 shows all ^{239}Pu targets made in the PTFE cell.

Table 1: ^{239}Pu-targets made in new PTFE Cell

Target	Pu layer [µg/cm²]	Note
425Pu239	26	
414Pu239	108	
416Pu239	116	
417Pu239	476	backing ripped
419Pu239	423	
422Pu239	not determined	target peeled off

Figure 1 shows the picture of the target 416Pu239 and the corresponding alpha particle spectrum used for the determination of the target thickness.

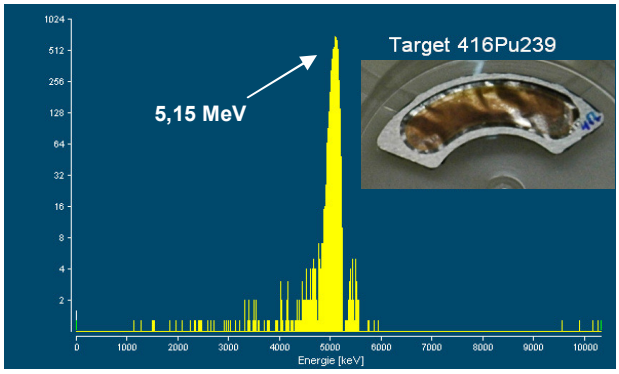

Figure 1: α-spectrum and picture of a target 416Pu239

Current experiments focus on the recovery of the adsorbed Pu by using a mixture of HCl/HF. Following this, a new amount of ^{239}Pu will be conditioned for deposition and three more segments will be prepared for further irradiation tests at GSI scheduled for April 2008.

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