

Preparation of ^{249}Cf targets from pre-used material

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For the synthesis of the new element with atomic number $Z = 120$, the fusion reaction of ^{50}Ti with ^{249}Cf was studied at the gas-filled recoil separator TASCA [1]. Pre-used ^{249}Cf , originating from the decay of ^{249}Bk , was provided by the Lawrence Berkeley National Laboratory to produce suitable targets.

The chemical form of the delivered ^{249}Cf was either the oxide, chloride or the nitrate. In a first step the material was dissolved in 8 M HCl. The ^{249}Cf solution contained Al, Fe, Pb and Ti as impurities. In a first purification step the anion-exchanger BioRad AG MP-1M was applied to remove Al and Fe from the solution. In the second step a cation exchange column with DOWEX 50WX8 was used for the removal of Pb and Ti. Over both purification steps the Cf recovery was almost 100 %.

A rotating target wheel assembly was used, which was previously tested to accept high beam intensities up to 2 μA (particle). Molecular plating (MP) [2] was employed for the preparation of ^{249}Cf layers on $\sim 2.2\text{-}\mu\text{m}$ thick Ti backing foils produced by cold rolling at GSI.

The average foil thickness was determined by weighing, whereas the homogeneity of the foil thickness was checked by α -particle energy-loss measurements over 5 positions per foil. The standard deviation of the foil thickness varied between 0.03 and 0.14 μm .

The deposition parameters for Cf were optimized in experiments with Gd. This also included MP with ^{153}Gd -tracer to verify the homogeneity of the Gd layer using a commercial radiographic imager [3] (FLA 7000 from FUJIFILM Corp.).

The first step in the MP of Cf was the conversion of the Cf chloride into the nitrate by evaporation to dryness and re-dissolution in 8 M HNO_3 . An aliquot of the Cf-solution with about 3 mg of ^{249}Cf (455 MBq) was evaporated to dryness in a TeflonTM beaker. The green residue was re-dissolved in a small volume (100 μl) of 0.1 M HNO_3 . The solution was transferred into an electrochemical deposition cell (EDC) made of PEEK. The beaker was washed with 3 x 300 μl isopropanol, which was also transferred to the EDC. The EDC was filled up to a volume of 52 ml with isobutanol. For the mixing during the deposition process an ultrasonic stirrer was used [3]. For the MP of ^{249}Cf with a surface of 6 cm^2 a voltage of 200 – 600 V at a maximum current density of about 0.3 mA/cm^2 was applied. The deposition time was 4 – 5 hours. The deposition yield exceeded 90 %. Fig. 1 shows one of the produced target segments.

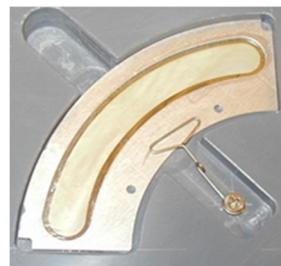


Figure 1: Cf target-segment

Prior to the production of $\sim 0.5\text{-mg}/\text{cm}^2$ thick ^{249}Cf targets, a thin ^{249}Cf target was prepared. With this target we tested the deposition parameters. Before the deposition, and in 1-h steps during the MP process, 10 μl aliquots of the ^{249}Cf -solution were evaporated to dryness for α -particle spectroscopy. With these measurements the decreasing Cf content in the solution during the deposition was determined as well as the deposition yield.

As a method for the yield determination, γ spectroscopy was used. For this, the thin ^{249}Cf target served as a reference sample. The distance from the target to the γ detector was about 3 m, the dead time was 5%. The data confirmed a thickness of $\sim 0.5\text{-mg}/\text{cm}^2$, and the final analysis of the thickness values, including measurements performed after the element 120 experiment [1], is in progress.

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