Preparation of Targets for the New GSI Rotating Wheel Target Assembly

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Electrodeposition is widely used for the preparation of lanthanide and actinide targets on metallic and non-metallic backing materials.[1] For heavy ion studies often Be is required as backing material. The deposition of lanthanide and actinide elements can be performed from an organic solution (usually isopropanol) with current densities of only a few mA/cm^2 and voltages up to 1200 V. The lanthanide or the actinide compound, normally the nitrate, is dissolved in a small volume (5-20 µl) of 0.1 N nitric acid and then mixed with 7 ml of the organic solvent. With this „Molecular Plating (MP)" technique target densities in the order of 1 mg/cm^2 are possible.
In order to prevent excessive heating of a stationary target at high beam currents as delivered from heavy-ion accelerators, a rotating wheel system with a multi-target device has been developed at GSI. Here, the rotation speed of the wheel is adapted to the pulse structure of the ion beam. The wheel rotates with a frequency of 2000 rpm in order to distribute each beam pulse evenly over one target segment.
A multi-target device consists of three banana-shaped segments. One segment is shown schematically in Fig. 1. The target area is 1.9 cm^2 per segment and the banana-shaped backing is mounted on a Al-frame prior to deposition.

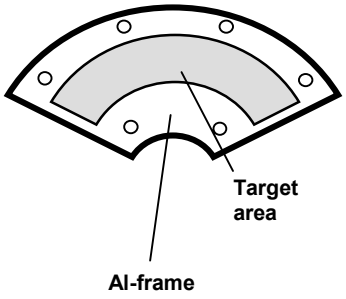

FIGURE 1. Schematic view of one of three segments for a rotating wheel target arrangement. The banana-shaped target covers an area of 1.9 cm^2 (per segment).

Table 1 summarizes the lanthanide and actinide targets produced in the last two years at the Institut für Kernchemie in Mainz for the new GSI rotating wheel target assembly. The ^{248}Cm targets have been used in a recent experiment at GSI to investigate the chemical properties of hassium (Z=108) [2]. Here, a 2.82 mg/cm^2 Be foil was used as backing material. The ^{248}Cm targets were irradiated with an intense $^{26}Mg^{5+}$-beam with an energy of 192.7 MeV applying beam currents up to 6.6 eµA. The ^{248}Cm target material was obtained by chemical separation from a ^{252}Cf-source [3]

Very often, prior to deposition, chemical separation procedures are required to ensure highest possible purity of the target material. This is of special importance in many HI-experiments, since HI-reactions with impurities like Pb have much higher cross sections compared to the HI-reaction of the target material itself. Furthermore, traces of Be present in recycled target material, prevent an effective deposition by molecular plating, and thus must be removed.
For this, the irradiated target material is dissolved in 2 N nitric acid from the Be backing foil and the solution is evaporated to dryness. The residue is dissolved in 2 ml of a nitric-acid/methanol mixture (1 N HNO_3/90 Vol% methanol). This solution is transferred to an anion-exchanger column (AIX; BIORAD AG 1X8) and the column is eluted with 4 x 2 ml of the methanolic solution at room temperature. Under these conditions, Be is completely removed from the column. In the next step the trivalent lanthanides or actinides are eluted with 1 N nitric acid. This procedure is repeated at least twice to get rid of all Be.

Table 1. Targets used in HI reaction experiments with the new GSI rotating wheel assembly.

Isotope	Backing	Thickness [µg/cm^2]	Method
Ba (nat)	Ti / 5 µm	400	MP
Ce (nat)	Ti / 5 µm	800	MP
Nd (nat)	Ti / 5 µm	800	MP
Gd (nat)	Be / 10 µm	1100	MP
Dy (nat)	Ti / 5 µm	800	MP
Er (nat)	Ti / 5 µm	800	MP
Yb (nat)	Ti / 6 µm	300	MP
U(nat)/Nd(nat)	Be / 10 µm	800	MP
Gd-152	Be / 10 µm	800	MP
#Cm-248	Be / 15 µm	240	MP
	Be / 15 µm	730	MP
	Be / 15 µm	690	MP

3 segments form a complete target device

Pb and other impurities are separated from lanthanide or actinide elements by means of a cation-exchanger column (CIX; Dowex 50WX8). 3 ml of a 0.5 N HCl solution are transferred to a CIX-column (150 x 4 mm) operated at 55^{0}C. The column is first washed with 8 x 2 ml 0.5 N HCl. Then Pb is eluted with 10 ml 1,5 N HCl and 5 ml 1.5 N HNO_3, whereas the trivalent lanthanides and actinides remain on the column. In a subsequent step, the lanthanides or the actinides are eluted with 15 ml 8 N HNO_3. This procedure is repeated with a smaller column (50 x 3 mm).

References:

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