

Fabrication of lanthanide targets for nuclear reaction studies

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Thin targets are necessary in separator-based heavy-ion reaction studies to minimize the projectile energy uncertainty due to energy straggling, and to reduce the angular straggling of recoiling products, leading to higher particle transmission to the separator focal plane. Enriched Gd targets with thicknesses in the range 400 - 1000 $\mu\text{g}/\text{cm}^2$ have been prepared by molecular plating for use in a systematic study of fusion-evaporation reactions, focusing on factors affecting the de-excitation of the compound nucleus (see Ref. [1] for details). In molecular plating, a positively charged inorganic metal complex is plated onto a thin backing foil in electrical contact with a cathode by application of a high voltage (200 – 1200 V) to an anode. One distinguishing feature of molecular plating is the resulting chemical form of the target as metal oxide. Due to the high potential difference involved, the microliter volumes of the metal complex solution must be dissolved in excess organic solvent, commonly isopropanol or acetone, prior to plating.

Schematics of the plating cell used in the present work are shown in Fig. 1. The cell design is based on a design developed at Lawrence Berkeley National Laboratory, with minor modifications [2]. In

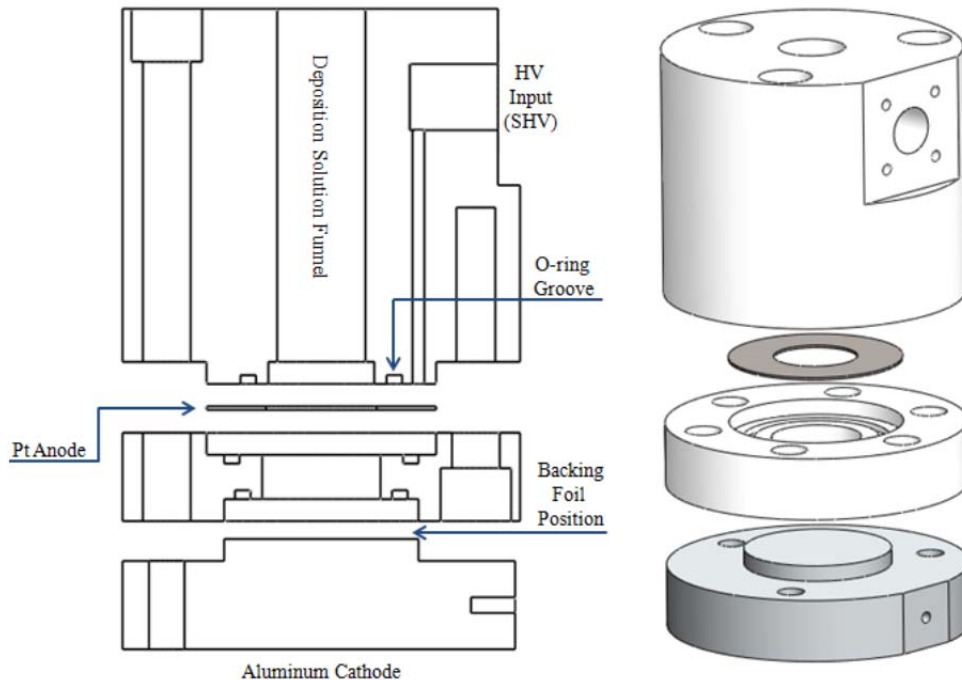


FIG. 1. Cross sectional and a 3-dimensional view of the molecular plating cell. The cell body and centerpiece need to have low electrical conductivity, low chemical absorption, and high chemical resistivity properties, criteria well accommodated by the polyether ether ketone (PEEK) plastic. The anode is a platinum washer. The cathode base is constructed of aluminum and contains a tap to attach wiring for circuit ground.

preparing the Gd targets, enriched oxide of the metal (starting material) was dissolved in dilute HNO_3 to prepare $\text{Gd}(\text{NO}_3)_3$, a water-soluble ionic salt. The resulting solution was dried under Ar gas to remove excess water. This eliminates a potential source of additional current, which may compromise the quality

of the target film due to bubbling (H_2 evolution) and/or heating of the cathode. The $Gd(NO_3)_3$ was dissolved in ≈ 10 mL of anhydrous isopropanol and 7 μ L of 0.1 M HNO_3 , yielding the deposition solution. This solution was injected into the cell funnel and plated at 800 V over 30 minutes onto a 2 μ m Ti backing (3/4" outer diameter) with current densities in the range of 3.5 - 5 mA/cm², followed by 40 minutes of drying of the film at 250° C. Target films on thin Al backings were also prepared. During the plating, the solution was continuously stirred. The final area of the target films was 2.27 cm².

Following the above procedure, a ≈ 1.0 mg/cm² $^{154}Gd_2O_3$ ($\approx 87\%$ by weight ^{154}Gd) target was prepared for separator-based work involving production studies of Po isotopes via fusion with ^{48}Ca . The target thickness was determined by α -particle energy loss measurements. The enrichment of the ^{154}Gd was $>99.8\%$, measured by Secondary Ion Mass Spectrometry at the Material Characterization Facility at Texas A&M University. In addition, targets of ^{nat}Ho and ^{208}Pb were also prepared utilizing the plating cell [3]. The presently described method provides capabilities for future production of lanthanide and actinide targets, with procedures available in literature [4-6].

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