Preparation of Gd and Cd targets at Texas A&M University

T. A. Werke, D. A. Mayorov, M. M. Frey, and C. M. Folden III

Accelerator-based experiments in the Heavy Elements Group have required the preparation of thin targets of lanthanide elements. Targets of $^{156,157,158,160}Gd_2O_3$ and ^{nat}CdO were prepared in the last year using the Molecular Plating (MP) technique [1,2]. The Gd_2O_3 samples were prepared by dissolving ~1 mg of Gd_2O_3 in 2 M HNO_3 and evaporating to dryness under Ar gas. Each sample was then reconstituted with 5-10 μL of 0.1 M HNO_3 and 10-12 mL of anhydrous isopropanol. The CdO samples were prepared via the same method except the starting material was ^{nat}Cd metal instead of the oxide. The body of the electroplating cell is made from PEEK [3]. A Pt disk was used as the anode, and a 2 μm Ti foil served as the cathode and the backing onto which the material was plated.

The deposition voltage was 600-700 V with a current density of ~2 mA/cm^2. Deposition times ranged from 30-60 min. After deposition, the targets were baked in air at 200 °C for 30-60 min to convert the material to the oxide. The resulting targets had thicknesses between 225-655 μg/cm^2 as determined by weighing. The plating efficiencies were between 50-100%. Gd_2O_3 targets were characterized using secondary ion mass spectrometry (SIMS) to determine isotopic enrichment. Results are summarized in Table I.

Table I. Deposition conditions and enrichments for various metal oxide targets.

Isotope	Voltage (V)	Time (min)	Thickness (μg/cm^2)	Isotopic Enrichment
$^{156}Gd_2O_3$	700	100	479	Not measured
$^{157}Gd_2O_3$	700	45	365	88.5 %
$^{158}Gd_2O_3$	700	40	655	91.8 %
$^{160}Gd_2O_3$	600	43	523	91.5 %
^{nat}CdO	700	30	363	N/A

Future beam experiments will use a rotating target wheel to allow for use of higher beam currents [4]. An electrochemical cell based on the designs of Haba *et al.* [5] has been constructed to make targets for the rotating wheel, and first results are reported here. A schematic of the cell is shown in Fig. 1. One arc-shaped target of $^{nat}Gd_2O_3$ has been fabricated as a proof-of-principle. The ^{nat}Gd sample was prepared as described above with enough isopropanol added to ensure the plating solution covered the entire arc.

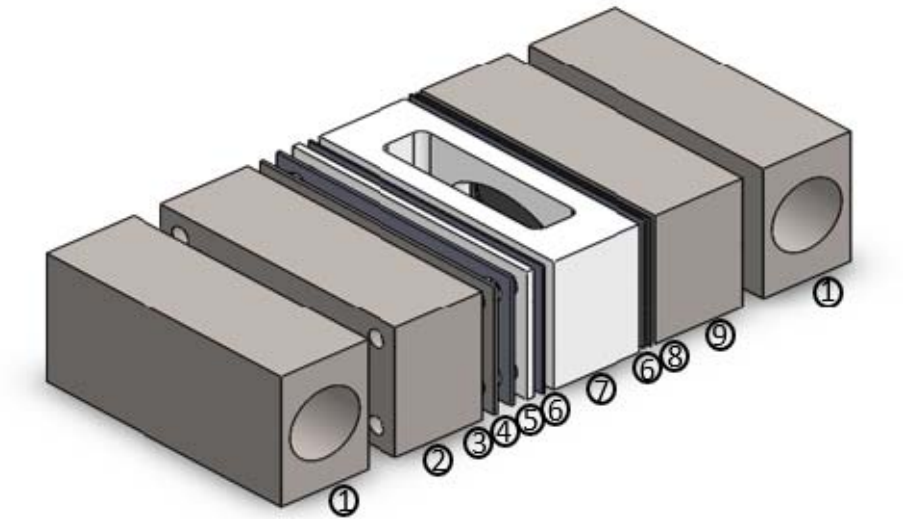

FIG. 1. Deposition cell for arc-shaped targets. (1) Ti Cooling Blocks, (2) Ti cathode, (3) Ti target frame, (4) 1.0 mm silicone seal, (5) 2.0 mm PEEK cover, (6) 0.6 mm silicon seal, (7) PEEK body, (8) 47 μm thick Pd anode, (9) Ti block.

The deposition was done for 60 min at 700 V. The resulting target is shown in Fig. 2. The thickness was 438 μg/cm^2 and the plating efficiency was 95%.

FIG. 2. Arc-shaped 438 μg/cm^2 $^{nat}Gd_2O_3$ target on 2 μm Ti backing.

[1] W. Parker and R. Falk, Nucl. Instrum. Methods **16**, 355 (1962).

[2] W. Parker *et al.*, Nucl. Instrum. Methods **26**, 61 (1964).

[3] D. Mayorov *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2012-2013), p. II-7

[4] D. Mayorov *et al.*, *Progress in Research*, Cyclotron Institute, Texas A&M University (2013-2014), p. IV-50.

[5] H. Haba *et al.*, TASCA05 Workshop, http://www-win.gsi.de/tasca05/