Targets for “TRAKULA”*

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Within the TRAKULA project (**Tra**nsmutationsrelevante **k**ernphysikalische **U**ntersuchungen **l**anglebiger **A**ktinide) which requires large-area samples (≥ 40 cm^2) of $^{235,238}U$ and $^{239,242}Pu$ to calibrate fission chambers and to measure neutron-induced fission yields for transmutation studies [1], large area targets of ^{nat}U were prepared. Moreover, according to the need of targets for precise measurements of the half-life, $t_{1/2}$, of very long-lived α-particle emitters like ^{144}Nd ($t_{1/2} \approx 2 \cdot 10^{15}$ y), ^{nat}Nd samples with different surface properties were produced.

^{nat}U targets were prepared using 250-µm thick circular Ti backings with an area of 43 cm^2. The targets were prepared by Molecular Plating (MP) using $^{nat}UO_2(NO)_3 \cdot 6H_2O$. This salt was dissolved in 0.1M HNO_3 and 200 µl of this solution (5.7 mg of elemental U) were inserted inside the plating cell. This was then filled with 230 ml of isopropanol. ^{nat}Nd targets were prepared on two circular Ti backings with different surface roughness to investigate the influence of a different surface structure on the quality of the deposited layers. One was a 50-µm thick Ti foil with an average roughness of 20 nm, while the smoother one was a 300-µm thick Ti coated Si wafer with an average roughness of 10 nm. The deposition area of these samples was 9 cm^2 and for this reason a smaller volume cell was used. The MPs were realized using $^{nat}Nd(NO_3)_3 \cdot 6H_2O$. This salt was dissolved in 0.1M HNO_3 and 100 µl of this solution (containing 1.1 mg of elemental Nd) were inserted inside the plating cell. This was then filled with 1 ml of isopropanol and 34 ml of isobutanol. In both cases a constant current density of 0.6 mA/cm^2 was applied for the production of the targets. The deposition time was 3 hours. The solution was mixed via ultrasonic strirring. The temperature was kept constant (14°C) using water-cooling.

The deposition yield was determined by Neutron Activation Analysis (NAA) and γ-spectroscopy. The 106 keV γ-line resulting from the 23-min decay of ^{239}U into 2.4-d ^{239}Np was used to determine the U content in 2 ml samples of the supernatant solution taken before and after the deposition process. The 2 ml extracted from the deposition cell before the plating process were used as standard reference. This sample volume represents less than 1% of the total volume of solution inside the cell and corresponds to a negligible loss of material for the deposition (~ 50 µg of U from a total amount of 5.7 mg).

The evaluated deposition yield of the produced ^{nat}U targets was very high: (99.921±0.021)%. Gamma spectroscopy was used for the ^{nat}Nd targets after active MPs, (i.e. depositions realized using a radioactive tracer -^{147}Nd- inside the plating solution). The 91 keV γ-line of the β^--decaying ^{147}Nd was used as a reference during the γ-measurements of the standards and of the samples.

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The standards were obtained by soaking a filter paper with the same geometry as the targets with the tracer-containing solution. The evaluated deposition yield was very high in both cases: (95.6±2.7)% for the ^{nat}Nd target produced on the Ti foil, and (98.7±0.8)% for the ^{nat}Nd target produced on the Ti coated Si wafer.

The homogeneity of the radioactive targets was inspected by using Radiographic Imaging (RI), using a FUJIFILM FLA 7000.

Taking into account the different deposition areas, the obtained yields, and the homogeneities as evaluated in the RI investigations, the areal density of the produced ^{nat}U targets was (132±13) µg/cm^2. For the ^{nat}Nd target produced on the Ti foil it was (117±12) µg/cm^2, and for the ^{nat}Nd target produced on the Ti coated Si wafer it was (121±12) µg/cm^2.

The surface roughness of the ^{nat}Nd targets was investigated by using an Atomic Force Microscope (AFM) (MFP 3D, Asylum Research) in tapping mode. Fig. 1 a and b show the AFM image of the Nd target produced on the Ti foil (mean roughness 120 nm) (a), and on the Ti coated Si wafer (mean roughness 65 nm) (b). From these results follows that smoother backings lead to smoother layers.

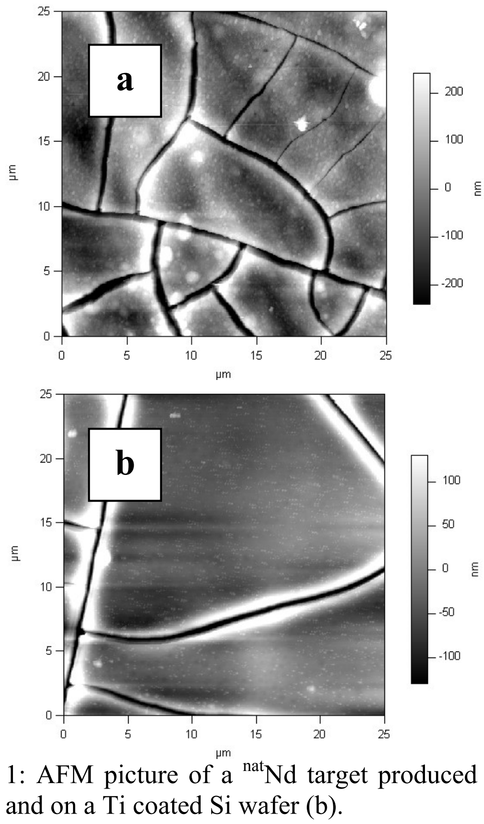

Figure 1: AFM picture of a ^{nat}Nd target produced on a Ti foil (a) and on a Ti coated Si wafer (b).

References

[1] A.Vascon et al., Nucl. Instrum. Meth. A **655** (2011) 72.