A novel technique for the production of robust actinide targets

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Accelerator experiments rely on various projectile and target combinations in order to extract key nuclear cross-section and structure information. The success of these experiments is highly influenced by the availability and the characteristics of targets with specific and well-defined properties. Especially relevant is the production of actinide targets which are typically rare in abundance and sometimes radioactive. Actinide targets are important for stockpile stewardship and nuclear science. In In this work, we have utilized solution combustion synthesis (SCS) in conjunction with electrospray deposition of chemically reactive layers that can be converted to actinide oxides by simple heat treatments, in order to produce actinide targets efficiently using the very minimum in starting materials. The produced targets are isotopically pure, cost efficient, reliable, robust, and highly uniform with controlled thicknesses and dimensions (Stewardship Science Academic Alliances Program Topic Research Area # 3: Radiochemistry). The actinides were provided by the Actinide Center of Excellence in Research in the Engineering College at the University of Notre Dame.

The initial steps consisted of the investigation of the different combinations of parameters that produced the best possible targets with respect to uniformity, thickness, and robustness. The surface treatment of both the aluminum and carbon substrates prior to spraying is where the investigation started, by determining the best treatment in order to have a thin target layer and not just droplets on the surface. Following that, the investigation turned to the parameters of the spraying itself (spraying time, uranium concentration in the solution, flow rate, heat treatment temperature) as well as the stability and robustness of the targets under irradiation with an argon beam (from 2×10^{16} to 1.3×10^{17} ions/cm^2). Through this investigation we can draw the following conclusions:

- The surface of our targets is smooth with minimum imperfections.
- The heat treatment temperature influences the crystal structure of the deposited layer. Higher temperatures result in Mg leaking from the substrate into the UO_2 layer, thus obstructing the crystallization of our layer and forming a MgO layer inside the UO_2 layer.
- The amount of U in the target linearly depends on the duration of the spraying, which allows the control of the thickness of the target by varying the spraying duration.
- The uranium amount in the targets does not change after the irradiation but there are significant structural changes when Mg is not present in the layer.

Finally, the robustness and purity of the targets was tested under a neutron beam, utilizing the neutron beam at the Los Alamos National Lab (LANL) and the DANCE detector array [1]. The target used was deposited on pure aluminum backing and was under the neutron beam for a total of 35 hours. After the data analysis, it was concluded that the targets are fairly robust with no impurities that would interfere with our measurements (Fig. 1).

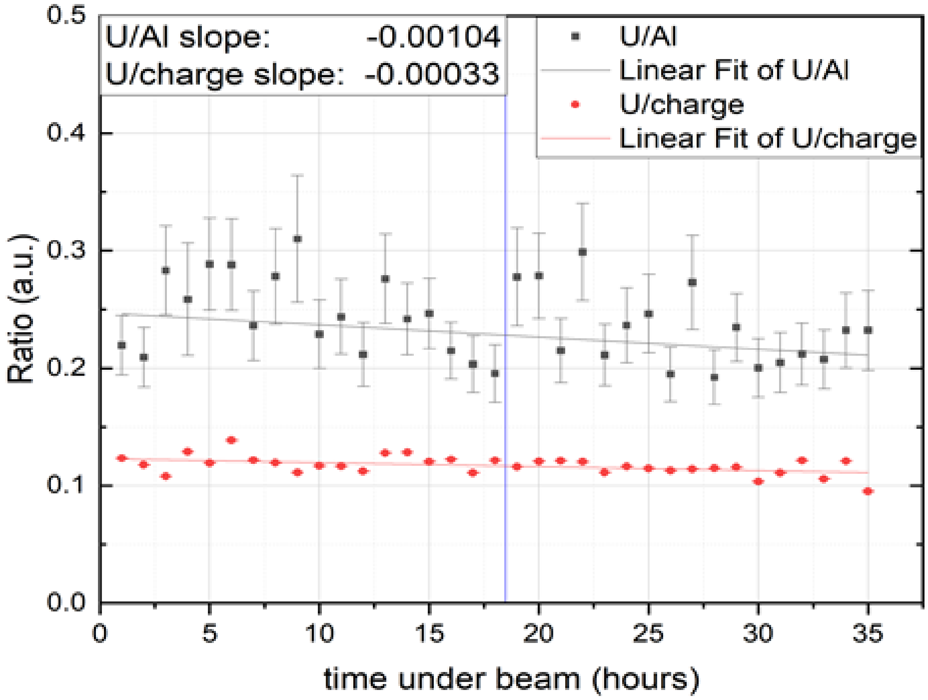

Fig. 1. The target's stability under the neutron beam.

Future work

We have started exploring the combustion properties of Eu as a surrogate for Am, which is going to be our next step in the actinide target production.

The final step would be a cross section measurement using the neutron beam at LANL as well as the neutron beam that is being developed at University of Notre Dame in the following months.

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