THE DESIGN AND EVALUATION OF HIGH RELEASE EFFICIENCY COMPOSITE UC_2/RVCF FISSION TARGETS

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Efforts are presently underway at the HRIBF to develop new concept targets which combine short diffusion lengths, high permeabilities and controllable temperatures required for fast and efficient release of a wide range of RIB species for nuclear and astrophysics research. One concept is based on the use of low-density reticulated-vitreous-carbon-fiber (RVCF) to serve as the plating matrix for the target material as well as the thermal conduit for transport of heat, deposited in the matrix by the production beam, to a properly designed heat-sink. The low-density highly permeable structure of RVCF is well suited for deposition of controlled amounts of specified target materials and can be machined to the geometry appropriate for the application. Since neutron-rich nuclei are in strong demand for experimental use in nuclear physics and astrophysics, fission targets such as UC_2 and ThC_2 can be used to produce a broad range of these species. During this reporting period, specifications were written and a contract let with Babcock and Wilcox, McDermott Technologies of Lynchburg, Virginia, for the preparation of UC_2 targets for this purpose. Under this contract, the vendor coated 39 each, 16-mm diameter, 2-mm thick 2 x RVCF disks with thin layers (~14 μm) of $^{238}UC_2$. Following coating with UC_2, thirteen disks are required for 50 MeV proton beams from ORIC. Layers of UC_2 were deposited onto the RVCF by dipping the disks in a liquid slurry containing stoichimetric amounts of colloidal-carbon and UO_3 and then dried at low-temperature. The disks were then heated under vacuum at 1750 ^{o}C to form UC_2 according to the following carbo-thermic chemical reduction reaction

$$MO_x + (x + y)C = xCO + MC_y$$

where MO_x is the metal-oxide, C is carbon, and CO is carbon monoxide. The process was sequentially repeated to achieve the final thickness. Representative SEMs of the UC_2 depositions are shown elsewhere in this report. As noted, the UC_2/RVCF composite preserves the highly permeable attributes required of fast and efficient diffusion release targets. The final coating of UC_2 had an average density of ~1.0 g/cm^3 and an average thickness of ~14 μm. The C/U stoichimetric ratio for the targets was measured to be 1.85:1. Following coating, the targets were cycled from room temperature two times to 2000 ^{o}C to ensure the integrity of adherence to the RVCF and to convert the glassy carbon to ordinary carbon, thereby improving the thermal conductivity properties of the support structure. These targets have been tested on-line at the UNISOR facility and found to release very efficiently. Mass analyzed ion beam intensities extracted from the EBPIS are given elsewhere in this report. No attempt was made to measure all release products. Efficiencies are expected to improve when the ion source is carefully optimized for each species. The results of these preliminary investigations are very encouraging, suggesting that this concept can be adopted as an universal/general method for forming high efficiency release ISOL targets.

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