Selection of Refractory Target-Materials and Design of High Efficiency Diffusion-Release Targets for Radioactive Ion Beam Applications

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Many of the reactions fundamentally important in nuclear physics and nuclear-astrophysics are inaccessible to experimental study using stable-beam/stable-target combinations and therefore can only be studied with accelerated radioactive ion beams (RIBs). As a consequence of worldwide interest in these research opportunities, facilities have either been constructed or are under construction for the production and acceleration of RIBs. Several of the facilities utilize the Isotope-Separator-on-Line (ISOL) technique. Experimentally useful RIBs are often difficult to generate by this technique, since they must be diffused from the interior of the target material, effusively transported to the ionization chamber of the source, ionized, extracted, mass-analyzed, and accelerated to research energies in a time-span commensurate with their lifetimes. The speeds at which these processes must take place, impose stringent requirements on the choice of the most appropriate refractory-target-material; on the design of fast diffusion-release targets; on the fabrication and optimization of fast vapor transport systems; and on the choice of the most efficient ion source for RIB generation. In this report, we define criteria for choosing target materials and for designing mechanically stable, short diffusion-length, highly permeable targets, and how vapor pressure, equilibrium concentration, and limiting temperature properties are used to make their selection. We illustrate the viability of the target design philosophy by providing diffusion-release and vapor transport data for a selected number of radioactive species from small diffusion-length, highly-permeable targets that have been successfully used for the generation of RIBs at the Holifield Radioactive Ion Beam Facility (HRIBF).

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