Thermal Modeling of UC_2 and ZrO_2 Targets for 1 GeV Protons

Y. Liu, D. Bhowmick, G. D. Alton and J. R. Beene
Physics Division, Oak Ridge National Laboratory,[*] Oak Ridge, TN 37831-6368

The intensity of radioactive ion beams (RIB) produced by the isotope separator on-line (ISOL) technique depends on the production rate and the efficiency with which the radioactive species can be transported out of the target and formed into an ion beam. In order to maximize production rates and minimize transport delay times, targets that operate at the highest practical temperatures and production-beam powers are desirable. High-efficiency-release targets that simultaneously incorporate fast and efficient diffusion release properties have been successfully developed for the generation of useful radioactive ion beam intensities for nuclear physics and nuclear astrophysics research at the Holifield Radioactive Ion Beam Facility (HRIBF). Short diffusion lengths are achieved either by using thin fibrous materials as targets or by coating thin layers of selected target material onto low-density carbon fibers such as reticulated vitreous carbon fiber (RVCF) to form highly permeable composite targets. We have conducted a variety of simulations of 1 GeV protons incident on various low density, highly permeable targets in order to obtain the most uniform power deposition profile. The finite-element thermal analysis code ANSYS was used to model the generation and removal of primary beam deposited heat from these targets. Radiative cooling has been found to be the most effective heat removal means for low-density refractory targets. In this report, we present examples of calculated temperature distributions in UC_2 and ZrO_2 targets using parallel and converging incident 1 GeV proton beams and illustrate the affect of beam heating and radiative cooling on the temperature distributions within a number of fibrous and composite targets.

[*] Managed by UT-Battelle, LLC, for the U.S. Department of Energy under contract DE-AC05-00OR22725.