Uranium and Thorium Targets for High Intensity Beams

Jerry Nolen

Physics Division, Argonne National Laboratory, Argonne, IL, 60439 USA
Nolen@ANL.gov

This talk will be an overview of the present status and results, as well as, current R&D projects and needs for further development of uranium and thorium targets for use with high power beams. Being the only naturally occurring target materials above bismuth, these two actinide elements are and will continue to be the work-horses as the targets for production of radioisotopes for basic and applied physics and chemistry, as well as, for certain important medical isotopes. Development of these targets is presently on-going at several laboratories around the world, with 13 contributions relevant to this topic at this workshop. A uranium oxide target was used in the first ISOL experiment in 1951 in Denmark, and both uranium and thorium have been used extensively at CERN/ISOLDE already for decades. Currently most development by the ISOL community is pushing for refractory carbides and oxides that can be used at high temperatures, have high density, good thermal conductivity, and are in a form that releases short-lived isotopes of many elements. For ISOL targets there are now two common configurations, one in which the target is irradiated directly by the primary beam, usually protons; and the other where uranium is used in a secondary target near a neutron converter where fission is induced by spallation or breakup neutrons. A goal for the future is to develop primary targets capable of extended use with beam power in the 100-kW range, and large mass secondary targets that will survive and effectively release isotopes with fission power in the 10-kW range. In general, uranium is the target of choice for the production of fission fragments either by the direct or 2-step configuration, while thorium will be the target of choice for many isotopes of elements in the Z=84-89 range that are effectively produced via the direct spallation mechanism. Some relatively long-lived isotopes produced by this mechanism are currently in demand for radio-therapeutic clinical trials. For these the isotopes there is a need for high specific activity since they will be separated from the primary targets chemically, and, hence, target design issues are quite different. These targets can be effectively cooled directly by liquids or gas with the figure of merit being the power density of the primary beam that can be accommodated. There is also a need for thin films of uranium and heavier actinides for use with intense beams of heavy ions to produce and study very heavy and superheavy elements via the heavy ion fusion reaction mechanism. The status and progress in this field will also be briefly reviewed.

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