Heavy element targetry

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1. Introduction

It is of great interest to determine the chemical and physical properties of the transactinide elements (Z > 103). These studies can allow for assessment of the influence of relativistic effects on the properties of the heaviest elements, refinement of nuclear theory and to probe where the end of the periodic table may be [1].

The transactinide elements have such low cross sections (nb to fb) that they are produced on an atom-at-a-time basis. For elements produced an atom-at a-time (Z > 100) a thin target, 0.8 mg/cm^2, is necessary to allow for the fused nuclei to recoil out of the target and be collected. The target is typically bombarded with a beam intensity of approximately 3 x 10^{12} ions per second. This beam and target combination result in a production rate of a few atoms per minute (Rf and Db production) to an atom every week or lower (upper transactinide elements) [2,3,4].

2. Targetry

Currently, in the world there are very few facilities that have the capability to produce customized thin targets by means other than electrodeposition. One of the facilities with such capabilities is the Target Laboratory at Argonne National Laboratory (ANL), which has an electron beam gun evaporator, thermal evaporators, and a rolling system, in addition to electrodeposition techniques. Due to the need of the Heavy Elements Group at the Texas A&M University Cyclotron Institute a collaboration with the Target Laboratory at ANL has been established. To date 4- ~300 nm ^{nat}Ge foils on 3 μm Ti, 4- ~300 nm ^{nat}Gd foils on 3 μm Ti and 4 mixed targets with ~300 nm each of ^{nat}Ge and ^{nat}Gd on 1 μm Ti have been produced through this collaboration.

3. Rotating Target Wheel

Rotating target wheels are currently used at all 5 major transactinide accelerator facilities (LBNL, GSI, JINR, RIKEN, JAERI). The targets are typically an electrodeposited actinide with a backing of 1-5 μm ^{nat}Ti, are banana shaped, and rotate between 900-1700 rpm. The purpose of the banana shape is to maximize the amount of target exposed to the beam. The purpose of rotating a target is to assist in cooling the targets from long exposure to particle nanoamperes of heavy ion beam (typically ^{48}Ca). Recently, Texas A&M Cyclotron Institute has commissioned a similar rotating target wheel that can be used in the MARS spectrometer. The Cyclotron Institute rotating target wheel, while similar to those used at LBNL, GSI, JAEA, JINR and RIKEN had to be designed to rotate at pressures of 10^{-7} torr. LBNL, GSI, JINR and RIKEN all have separators where the pressure inside the target chamber is orders of magnitudes higher. In order to accommodate pressures of 10^{-7} torr a ferrorfluidic flange is employed.

In addition to this, a fiber optic system has been installed to pulse the beam when the beam would interact with the target frame. A picture of the new rotating target wheel can be seen in Fig. 1.

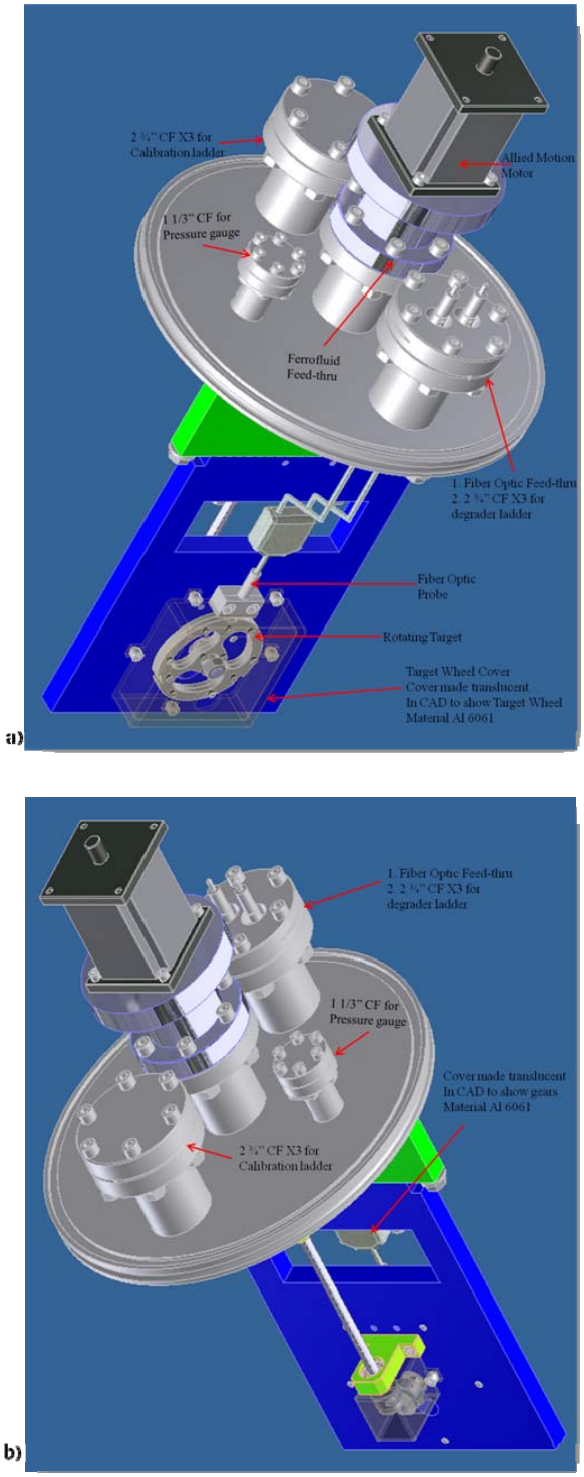

FIG. 1. Texas A&M Cyclotron Institute's Heavy Elements Group's new rotating target wheel. The rotating target wheel has been ordered from Ferrortec and is expected to be delivered in August of 2012.

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