RIB INJECTOR OPERATIONS

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A liquid germanium target was developed for the production of arsenic and gallium radioactive ion beams. The target consists of enriched ^{70}Ge contained in a graphite target cell having internal dimensions approximately 9-mm diameter by 4-mm thickness. Radioactive ion beams which have been produced by bombardment of the target with 42-MeV proton beams from ORIC are ^{69,70}As from ^{70}Ge(p,xn) reactions and ^{67}Ga from ^{70}Ge(p,α) reactions.

The first RIB experiment performed with this target was carried out in May-June 1997. At a proton-beam current of 4 μA, a maximum of 1.4 x 10^6 ions/s of ^{69}As beam were delivered to the experimental station. This corresponds to an overall efficiency of 6 x 10^{-5} which is within a factor of 2 of that expected on the basis of measurements made at the UNISOR test facility.

A second experiment was carried out in September 1997 with the intent of increasing the ORIC beam intensity and yield of the ^{69}As beam. A beam of ^{69}As was successfully transported to the Recoil Mass Separator, but the maximum beam intensity which could be achieved was only 10^5 ions/s for proton beam intensities up to about 6 μA. As the ORIC beam current was increased to 10 μA, the yield of ^{69}As decreased rapidly. Post-run examination of the target revealed that most of the Ge had been vaporized and deposited in the vapor transport tube connecting the target and ion source. A new target is now being designed to condense and recirculate the Ge and allow operation with higher ORIC beam currents. Following these experiments, the RIB development group concentrated its efforts on developing a ^{17}F beam.

The first high-intensity study of a fibrous alumina target for producing ^{17}F beams was carried out on the RIB Injector in March-April 1998 using a beam of 28-MeV deuterons from the ORIC. The maximum yield of $Al^{17}F^+$ observed was ~10^6 ions/s at a deuteron beam current of 4 μA which corresponds to a source efficiency of about 0.01%. Post-run examination revealed that the target material had suffered significant shrinkage and deterioration. A second high-intensity test of this target material was made in August 1998. In this test, the target thickness was increased and the deuteron beam current was limited to 2 μA to reduce target degradation. The yield of $Al^{17}F^+$ was ~10^6 ions/s, but after breakup of the AlF molecule and charge exchange, the yield of $^{17}F^-$ was only ~10^4 ions/s.

Approximately an order of magnitude improvement in breakup and charge-exchange efficiency for 40 keV AlF^+–>F^- has been achieved by increasing the Cs vapor charge-exchange cell temperature from 160°C to 200°C. This is consistent with a model in which the AlF^+ molecule is first dissociated and then the resulting atoms undergo subsequent charge-exchange collisions. Unfortunately, at 200°C the depletion rate of Cs is about 5 gm/day, resulting in 5 days of operation for a nominal 25-gm Cs load. Design modifications are currently underway to increase the recirculation performance of the charge-exchange cell. Alternative charge-exchange media have also been investigated. A 1-ugm/cm2 carbon foil mounted on wire mesh was found to have extremely poor efficiency. Na vapor was found to have an efficiency similar to that of Cs vapor. However, the required operating temperature of

400°C resulted in failure of a charge-exchange cell heater. In addition, for our application, Na is much more difficult to handle than Cs.

Studies of other metal-oxides having higher working temperatures have led to targets capable of withstanding higher deuteron beam currents. A major part of the development program for these target materials was the addition of a vapor feed system to provide a reliable source of aluminum or other metals to form metal-fluoride molecules.

Improvements continue to be made to the RIB injector system. A new water-cooled Danfysik power supply for the first-stage mass analyzer has replaced the air-cooled power supply. The motor-generator system has been completely overhauled. The generator bearings and the pillow block spherical bearings at the motor end of the drive shafts were all replaced after vibration analysis by Plant and Equipment Division personnel indicated bearing failure was in progress. The flange-mounted spherical bearings inside the east shield wall of C111N were replaced due to excessive movement of the shafts. The motors, generators, and shafts were aligned with a laser system. Two 3-1/2" mild steel shielding casks have been received to house each of the two Contamination Control Box(es) (CCB) of the Remote Handling System (RHS). An aluminum ion source vacuum enclosure has been successfully tested with a target-ion source at maximum operating temperature (with no internal heat shields) and nominal cathode emission.

In the immediate future, NaI (Tl) detectors will be installed near various Faraday cups along the RIB injector and after the tandem electrostatic accelerator. For short-lived isotopes producing only one energy gamma ray, e.g. ^{17}F, these detectors are an excellent alternative to tape systems for measuring the absolute intensity of a radioactive beam. Nonetheless, the beam line at the image slits of the second-stage mass separator will soon be reconfigured to accommodate a second tape system that is presently being fabricated at LSU. This tape system will allow the measurement of radioactive beams with longer half-lives and/or multiple energy gamma rays.

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