Progress Report- FY2004

On-Line Measurements for RIA ISOL Beam Optimization
H. K. Carter, Principle Investigator

Accomplishments:

1. Hire post doctoral associate. This goal was modified in the award to: hire part time technician. This technician has been hired with his time being shared between this project (0.6 FTE) and Center of Excellence for RIB Studies for Stewardship (0.4 FTE). The technician has the mechanical and electronic skills to assist researchers in designing new and/or improved equipment for the UNISOR separator and will greatly extend the productivity of the UNISOR system. He is in the process of learning the separator's operating procedures, designing and installing an irradiation chamber for off-line release measurements, constructing the dedicated enclosure and improving the data acquisition system.

In addition, we have formed a collaboration of individuals at various laboratories with strong research interests in RIA targets/ion sources and expertise including: D.W. Stracener (ORNL), P. F. Mantica (NSCL), J. Nolen (ANL), W. Talbert (TechSource), U. Köster (ISOLDE), A. Kronenberg (Stewardship Center/ ORAU), J. D'Auria (Simon Fraser University).

Additional onsite manpower to this project is provided by A. Kronenberg, target/ion source postdoc with Center of Excellence for RIB Studies for Stewardship Science funded by NNSA through Rutgers/ORAU/UNIRIB. Other personnel supported in part are: E. H. Spejewski, consultant, W.H. Brantley, Furman University, and two Furman students, J. Stafford and A. Gaddis.

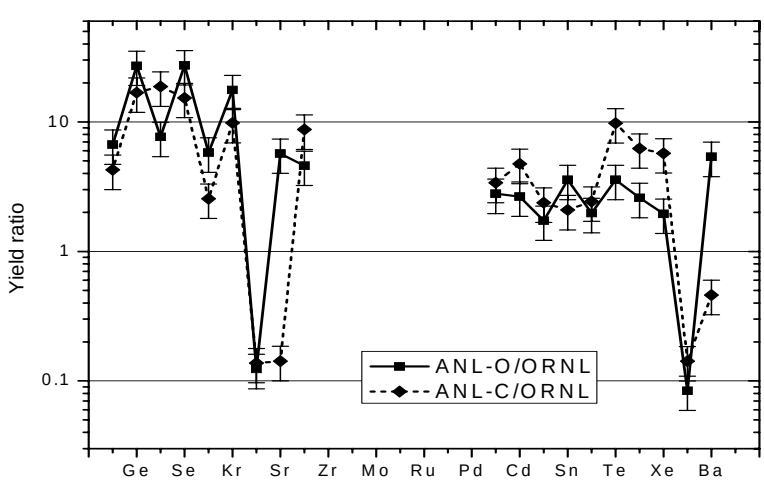
In order to establish stronger connections, the postdoc spent the entire month of August at CERN-ISOLDE (European Organization for Nuclear Research) in the target-ion source development group, working closely with Ulli Köster (TARGISOL/ISOLDE).
During this time he assisted in setting up new thermochromatography apparatus to measure absorption and desorption. Measurements were started on ^{48}V release from TiO_2 pressed powder pellet and single crystals with the former showing promise as a target material. In addition to the practical experiences gained the postdoc has established important connections with the TARGISOL community. These connections will provide important exchange of ideas and techniques between the RIA ISOL community and the community designing the EURISOL facility.

2. Design and construct dedicated target/ion source enclosure for target development. This additional enclosure will enable one experiment to be prepared while another is being conducted. We anticipate using the existing HRIBF target/ion source enclosure design with slight modifications including additional view ports and baffles which prevent contaminating off-line equipment. With the existing design we have the ability

to introduce gas into the system in order to form molecular sidebands. A dedicated system should be operational by mid October.

3. Design and construct improved current measuring system. The purpose here is to provide the ISOL development community with the release measuring capabilities (Kirchner Method) that were lost with the closing of the GSI separator. This capability is unique and very important to a thorough understanding of release properties of various materials from different matrices. The core capability exists at the UNISOR separator however the technician is studying methods to reduce the background current (noise) in the Faraday Cup. The new data acquisition system is being studied to provide faster response times. In addition, new software and hardware interfaces have been designed to provide reliable spectrum multiscaling over many samples for the yield measurements.

4. Measure release properties of different Uranium carbide targets. Yields of approximately 20 different elements have been measured at HRIBF since 1998 at UNISOR and off of the HRIBF platform using ORNL prepared UC targets. During the past year yields using targets prepared at ANL have been measured. The targets were UC_x on a graphite fiber mesh (ORNL standard), pressed UC_x pellet from oxide (ANL(O)) and from carbide (ANL(C)). Experimental production rates were determined for each isotope by gamma-measurements on a tape station behind the mass separator. The data are normalized for beam intensity and target thickness. The figure shows a comparison of both types of ANL's targets to the ORNL target as the ratio of the yield for each element. The error bars shown are estimates of uncertainties in the experimental system. Although the data have substantial errors there are trends (decrease of yield with increasing Z and large drop at alkali and alkali earths) that need to be examined in detail. These data show the very important information to be learned if a detailed analysis and comparison is made of the yield data we are able to obtain at UNISOR and HRIBF. During the next year we anticipate more detailed analysis of these data and additional experiments, e.g. on higher density targets and other actinide compounds.

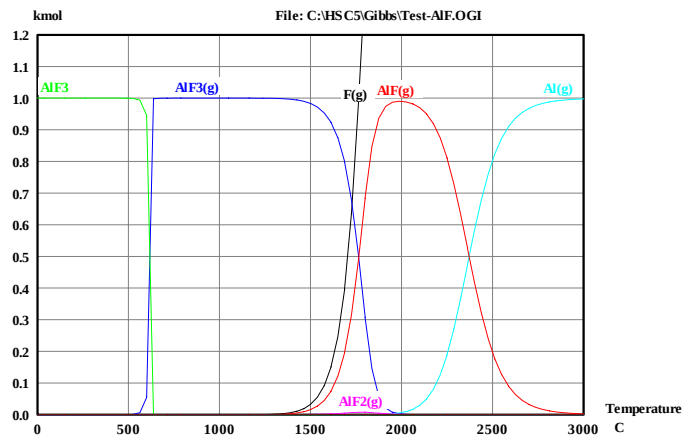


Comparison of target release as ratio of yield from ANL targets to ORNL target.

5. Study and test molecular sideband separation techniques: We have developed two important capabilities; one is the prediction of thermodynamic behavior of targets as well as chemical sidebands using the code and data base HSC (see figure). With this code we are able to predict thermal stability of target compounds and investigate molecular sideband formation depending on the temperature and pressure in the target-ion source system. Also, we have a database for binary alloys available, which is an important tool for target development and also for estimating the effusion through the target holder and transfer tube. It is known that As is delayed in its effusion to the ion source (sticking time on Ta is 1 minute/collision with the wall at 2000 ^{o}C). Therefore, the adsorption of As on Re will be measured at CERN and a transfer tube electroplated with Re is planned to be built.

With HSC, recent experiments with Al beam development at HRIBF using the AlF sideband can be interpreted. The figure shows that Al easily forms Fluoride species, which desorb faster from the target surface and do not interact with the surface of the target holder-transfer tube-ion source. Those compounds are volatile ((g)-gaseous) and, at the temperature of the ion source (2100 ^{o}C), the Al^{+} molecular sideband AlF^{+} is formed. Only by using this molecular sideband are Al beams are available.

Species diagram of Al and Fluorine calculated from HSC – "Chemical Reaction and Equilibrium Software with Extensive Thermodynamical Database" [University of Outokumpo, Pori, Finland, 2002].



Budget and Goals:

The funding was received in March 2004. We anticipate all funds to be utilized by March 2005. Four of the five goals will be completed by November 2004. The fifth goal, study molecular sidebands, will commence again (as well as UC release measurements) when beams become available to UNISOR in January 2005. We anticipate all goals to be fully completed by March, 2005.