NATIONAL ISOTOPE DEVELOPMENT CENTER

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The National Isotope Development Center (NIDC)

By Robert Atcher, NIDC Director

With the transition of the Isotope Production and Distribution for Research and Applications (IPDRA) Program from the Office of Nuclear Energy to the Office of Nuclear Physics in the Office of Science, the National Isotope Development Center (NIDC) was established. The NIDC is envisioned as a virtual center that fills a substantial operational role in the Isotope Program. The Executive management team consists of the Director and two Associate Directors. In December 2009, Robert Atcher was appointed the director with Wolfgang Runde and Mitch Ferren as the Associate Directors for Isotope Production and the Isotope Business Office, respectively.

The most familiar part of the NIDC is the Isotope Business Office (IBO), which remains based at Oak Ridge National Laboratory. Mitch Ferren is leading the activities of the IBO. The Isotope Business Office is responsible for the business-related interactions including handling inquiries about specific isotopes, generating quotations for interested customers, and handling purchase orders. The IBO is the point of contact for all inquiries for the program. They can be contacted by phone at (865) 574-6984 or by email at Isotopes@ornl.gov.

The NIDC also oversees isotope production. Wolfgang Runde is responsible for the planning and coordination of isotope production at National Laboratories, Universities, private industry and foreign isotope institutions. Managing the production schedules at the facilities in the IPDRA Program, interacting with major customers regarding isotope supply, contract negotiations, product specifications, production and shipping schedules, and expanding the production capabilities are part of the role of this Associate Director. Wolfgang Runde can be reached at (505) 231-0826 or via e-mail at runde@lanl.gov.

The third role of the NIDC is to consolidate the interactions regarding shipping, transportation and packaging. Jeff Shelton (ORNL) is responsible for these activities. His responsibilities include interactions with shipping contractors, freight forwarders, container manufacturers, and the production sites to ensure that the most efficient and cost effective means are being used to move shipments around the globe. Jeff Shelton can be contacted at (865) 576-6401 or sheltonjh@ornl.gov.

The National Isotope Development Center (NIDC), continued

The NIDC also provides support to DOE HQ on a variety of issues related to the isotope program. Examples are to identify expertise for technical questions related to isotope production or applications, or to assist in organizing meetings, workshops and other activities. This is a shared responsibility among the staff of the NIDC.

Finally, the last aspect of the program is communication. One obvious aspect is the publication of this newsletter. Another is an overhaul and expansion of the website devoted to the IBO and the Program. We expect to go live in the summer of 2011. Finally, it is to provide speakers for meetings, symposia on topics related to the program and the use of isotopes in industry, research and development. To date, this has been the responsibility of the director with assistance from members of the NIDC and IPDRA.

It is important to note that the responsibility for policy and budget in the IPDRA Program is solely the responsibility of the Program management in DOE HQ. The NIDC is tasked with implementing the Program. Questions regarding the issues related to budget, funding opportunities, and programmatic policy and direction should be addressed to Jehanne Gillo, Director, Facility and Project Management Division, Office of Nuclear Physics, DOE, by phone at 301-903-1455 or by email at jehanne.gillo@science.doe.gov.

Discovery of Element 117

Krzysztof Rykaczewski

Scientists used this heavy ion accelerator at the Flerov Laboratory of Nuclear Reactions in Dubna, Russia, to smash atoms together to create element 117.

The discovery of a new chemical element with atomic number Z=117 and further studies towards the extension of the Periodic Table of Elements were possible thanks to the unique production and separation capabilities of radioactive actinide materials at Oak Ridge National Laboratory(ORNL). The High Flux Isotope Reactor and Radiochemical Engineering Development Center at ORNL are the only facilities worldwide where the pure material of radioactive ^{249}Bk can be produced in quantities sufficient for the experiments on super heavy nuclei and new chemical elements. This capability is related to the ongoing program focused on the ^{252}Cf production and separation. Cf-252, ^{249}Bk and other heavy actinides are produced at ORNL through intense neutron irradiation of Cm and Am targets in the High Flux Isotope Reactor. The trans-curium products, including ^{249}Bk, are separated and purified at ORNL from the irradiated targets through a series of dissolution, extraction, precipitation, and ion-exchange processes. To facilitate the experiment on the new element Z=117, about 22 milligrams of ^{249}Bk having the ^{252}Cf contamination below 2 nanograms, were produced during ~ 250 days of neutron irradiations followed by three months of fission products decay and three months of chemical procedures.

Discovery of Element 117, continued

The ^{249}Bk material was shipped in June 2009 to Russia for joint studies involving Oak Ridge, Livermore, Nashville and Las Vegas nuclear physicists and chemists. The ^{249}Bk targets were made by depositing berkelium oxide onto Ti foils at the Institute for Atomic Reactors (IAR, Dmitrovgrad, Russian Federation). The high-intensity ^{48}Ca irradiations were performed during 150 days at the Dubna Gas Filled Recoil Separator at the Joint Institute for Nuclear Research at Dubna (Russia). Six decay chains indicating the identification of two isotopes of new element Z=117, $^{294}(117)$ and $^{293}(117)$, were recorded [Oganessian et al., Phys.Rev. Lett. 104, 142502, 2010]. All together eleven new heaviest isotopes of elements 117, 115, 113, 111 (Rg), 109 (Mt), 107 (Bh) and 105(Db) were detected. The measured decay properties of new nuclei display a trend of increased stability with larger neutron number N. It demonstrates the critical role of nuclear shells and represents an experimental verification for the existence of the predicted island of enhanced stability for superheavy elements.

The program focused on the discoveries and studies of new heaviest elements and nuclei continues in US, Russia, Germany and Japan. These investigations require new target materials like ^{243}Am, ^{248}Cm and ^{249}Bk in multi-milligram quantities. Investments in trans-curium isotope production (HFIR, ORNL) are critical to secure a supply of unique radioactive target materials. Since the isotopes of new chemical elements like Z=120 are predicted to have half-lives around one microsecond, a new digital detection system has been developed at ORNL and University of Tennessee (Knoxville) allowing future experimental runs reaching these short-lived new nuclei. A particularly promising path towards the extension of the Periodic Table of Elements and the Chart of Nuclei and is based on the use of an intense ^{50}Ti beam on trans-actinide targets. For example, experiments with ^{50}Ti beams on the ^{249}Bk and ^{249}Cf targets have the potential to discover elements 119 and 120. These experiments will be attempted in Germany and Russia providing enough target materials can be produced at ORNL.

Californium-252 Production at ORNL's Radiochemical Engineering Development Center

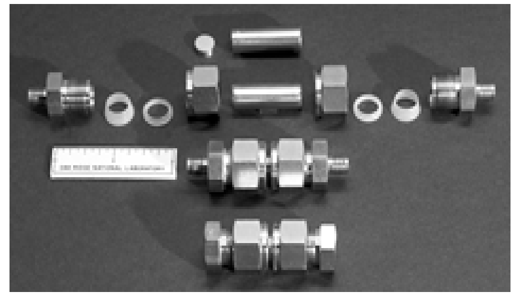
Julie Ezold

Over 50 years ago californium-252 (^{252}Cf, half-life 2.6 years) was recognized as a unique isotope. Since then, ^{252}Cf has been applied successfully in medical research, oil exploration, nuclear research, nuclear reactors, mining, cement manufacturing, defense, and national security. Californium-252 is a distinct neutron source that provides a highly concentrated flux and an extremely reliable neutron spectrum through spontaneous fission decay. Oak Ridge National Laboratory's (ORNL's) Radiochemical Engineering Development Center (REDC), the only ^{252}Cf production facility in the Western world, recovers ^{252}Cf and other heavy elements by fabricating curium targets, irradiating them in ORNL's High Flux Isotope Reactor (HFIR), and then processing them. REDC continues to make process improvements that have allowed for the uninterrupted supply of this versatile radioisotope and others.

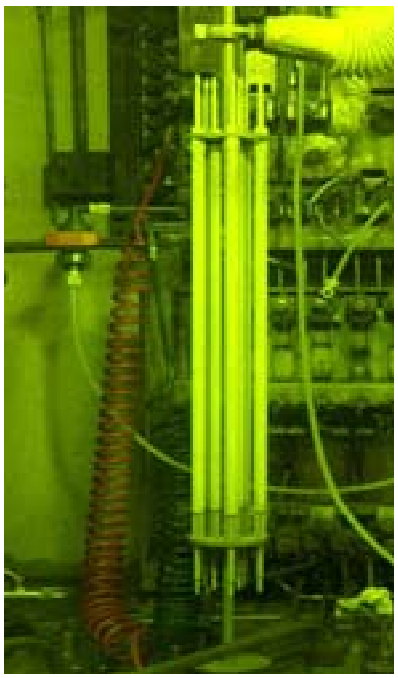
REDC hot cell

Since the 1960s the United States Government, through the Atomic Energy Commission and later the Department of Energy (DOE), has supplied ^{252}Cf to customers throughout the world. In 2008, however, the continued supply of ^{252}Cf was in question because the traditional program mechanisms for production and distribution were in a state of transition. During the transition, the IPDRA Program, working with ORNL, continued to successfully fulfill customer requests for ^{252}Cf. Using established production methods and creative process improvements, ORNL consolidated and distributed the residual ^{252}Cf stock from previous campaign material throughout 2008 and 2009. New material from Campaign 74 was processed in the spring of 2009, and additional curium targets were fabricated and placed into the HFIR in the spring of 2010.

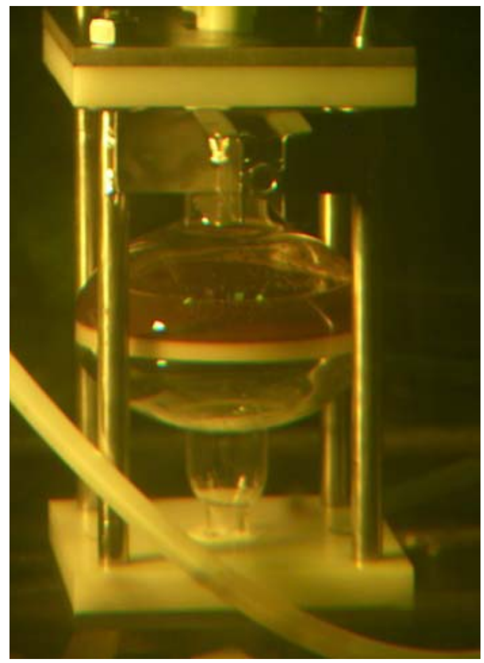
To bridge the gap between the remaining inventory of ^{252}Cf and the new Campaign 74 material, several "nut packages" loaded with californium from previous processing campaigns were identified that could be processed to provide an additional 10 mg of ^{252}Cf. A nut package is the container that holds purified californium loaded resin during transfer to the source fabrication facility. Small-scale experiments in a glove box were conducted to develop a process to consolidate and purify this material in a hot cell. Although, due to its age, this source of californium possessed a lower weight percentage of ^{252}Cf than typical material, it was acceptable for most industrial applications.



Nut package components



Seven irradiated Cm targets in hot cell



Actinide products (Bk, Cf, Es, and Fm) prior to separation and purification

The processing of Campaign 74 material began in the spring of 2009. Seven irradiated curium targets that had been in the HFIR for 11 cycles (~19 months) were dissolved. The aluminum and lanthanide fission products were separated from the actinides (americium, curium, berkelium, californium, einsteinium, and fermium), and the californium was further purified and loaded onto a cation resin for firing and transfer to the source production facility in nut packages. Approximately 220 mg of ^{252}Cf was produced from processing Campaign 74 material.

The recovered americium and curium were further processed into an oxide and blended with aluminum powder to produce the pellets for the next set of curium targets. These four targets were completed and inserted into HFIR in the spring of 2010.

The role of ^{252}Cf in a multitude of applications necessitates a reliable supply chain. As worldwide electrical power demands continue to rise, nuclear reactors will play an increasingly important role in the energy solution. As new nuclear power plants come on-line, the need for ^{252}Cf neutron start-up sources as well as sources for fuel rod scanners will increase. Developing countries looking to expand their capabilities and improve their infrastructure will rely on coal, cement, and mineral analyzers and oil well logging, all of which utilize ^{252}Cf sources. The increased use of californium necessitates the assurance that there will be a continual supply of ^{252}Cf. It is expected that the DOE Isotope Program and ORNL will continue to be a reliable supplier of ^{252}Cf.

For Further Information:

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