Thermal Separation of Volatile Rare Isotopes from Irradiated Target Materials

Nuclear medicine research on radiotherapeutic methods like radioimmunotherapy, targeted alpha particle therapy and complementary imaging techniques are hampered by the limited availability of extremely rare and relatively short-lived isotopes such as $^{209,211}At$, ^{225}Ac, $^{223,224}Ra$, ^{213}Bi or ^{212}Pb. They can be produced by irradiating actinide targets with high-energy particles such as the intense 500 MeV proton beam from the world's largest cyclotron at TRIUMF. A wide range of radioisotopes is generated by this process. Separating and purifying isotopes of interest for nuclear medicine research is a challenge. Typically, a purely chemical separation is performed by dissolving the target including its radioactive inventory. An alterative to this method, which requires complex radiochemistry and produces a lot of radioactive waste, is to use thermal chromatography to separate species of varying volatility from an irradiated target. The investigation of thermodynamic and chemical properties that govern the diffusion and effusion of volatile species in this context offers opportunities for a number of thesis projects.

Interested graduate students will have the opportunity to obtain knowledge and receive training on the following subjects:

- Working in a controlled radiation area: The student will receive WHIMS, laboratory and radiation safety training and must obtain the status of a nuclear energy worker.
- Experimental setup: Includes design, assembly and integration of the components and the data acquisition system. The student will gain knowledge about vacuum systems, mass spectrometry and data processing.
- Measurements: The student will perform measurements and modifications of the experimental setup if necessary, learning how to organize, document and execute experiments independently and in a team.
- Online experiments: The goal of the project is to experiment with radioactive samples obtained from ion beam collections or irradiations. The candidate will learn about nuclear spectroscopy techniques and characterize rare isotope beams by their radioactive decay signatures.
- Data analysis: The candidate will have to put experimental results into a theoretical context, describing thermodynamics and chemistry with appropriate models and/or simulations.

Two specific thesis projects are offered:

1. Investigation of the thermal separation of astatine and radon isotopes from actinide targets.

The focus on this research project is ^{211}At, a promising candidate for cancer therapy, and its precursor ^{211}Rn. The release properties of astatine and radon from actinide targets as a function of temperature need to be investigated and understood. Developing an efficient method and designing a suitable apparatus to separate and/or trap these isotopes is the ultimate goal of the project.

2. Investigation of the thermal separation of radium and actinium isotopes.

^{223}Ra and ^{225}Ac are promising isotopes for cancer therapy. Radium and actinium become volatile only at very high temperatures. The main goal of this project is the development of a method for the efficient separation from refractory actinide targets, requiring the investigation of thermodynamic and chemical processes at high temperatures using a vacuum furnace.

For further information and inquiries, please contact

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