Contribution ID: **70** Type: **Invited (In person)**

Development of nano-structured materials for ISOLDE targets

Wednesday 27 November 2024 10:05 (25 minutes)

The isotope separation on-line (ISOL) technique consists of on-line extraction, ionization, acceleration, and mass separation of radioisotopes produced in a target material irradiated by a high-energy particle beam. At CERN-ISOLDE, this technique is used to produce a broad variety of radioactive ion beams, enabling the study of exotic isotopes for research in nuclear physics, astrophysics, materials science, and medical applications.
The intensity of a radioactive ion beam at CERN-ISOLDE depends on multiple factors, including the primary beam intensity, target thickness, production cross-section for specific isotopes, as well as the efficiency of isotope extraction, ionization, and purification. To allow a reasonably fast release of the produced nuclei, the target should be tailored to optimize these parameters by selecting materials that are chemically and thermally stable under operational conditions and facilitate rapid diffusion and effusion rates of the elements of interest[1].
ISOLDE targets may be provided in the form of pressed pellets, loose powders, fibres, foils or molten metals, with the target material being carbides, metal/graphite mixtures, refractory metals, eutectic mixtures and oxides[1-2]. Traditionally bulk and micrometric materials have shown significant performance losses during the release process of more exotic radioisotopes, as challenges related to very short half-lives, low production efficiency and difficulties due to certain elements'refractory nature. The latter issue can be addressed by introducing a chemical reactant to enhance the release of the radioisotopes of interest as molecular beams and provide high-purity beams with less contamination compared to atomic beams[3]. The yields of short-lived isotopes can instead be improved by refining the microstructure of target materials as previous experiments at ISOLDE have demonstrated[4-5]. Optimizing these structural characteristics not only improves isotope release but also helps in maintaining the stability of the beam intensity over time[4], which is highly advantageous for users receiving the beam over extended periods of time, making the planning and execution of experimental campaigns more straightforward.
Exploring alternative compositions, testing novel material morphologies, and enhancing key material properties are crucial steps toward improving performance and overcoming current limitations in isotope production, providing stronger and more varied beams to users. In this work, we will examine the potential for employing new materials and nanostructures in ISOLDE target, discuss the challenges related to materials production and characterization, and present recent progress in the development of nanostructured target materials in ISOLDE's chemical laboratories.

Keywords: nanomaterials, porous materials, sintering, ion beam, isotope production, short-lived isotopes.

References:
1. J.P. Ramos, "Thick solid targets for the production and online release of radioisotopes: The importance of the material characteristics –A review", Nucl. Instrum. Meth. B 463 (2020) 201–210.
2. S. Chowdhury et al., "Uranium Carbide Fibers with Nano-Grains as starting Material for ISOL target", Nanomaterils B 12 (2020) 2458.
3. M. Au, "Production of actinide atomic and molecular ion beams at CERN-ISOLDE", PhD Thesis, CERN, Johannes Gutenberg University Mainz (2023).
4. J.P. Ramos et al., "Intense 31–35Ar beams produced with a nanostructured CaO target at ISOLDE", Nucl. Instrum. Meth. B 320 (2014) 83-88.
5. A. Gottberg, "Target materials for exotic ISOL beams", Nucl. Instrum. Meth. B 376 (2016) 8-15.

Author: BERLIN, Valentina (SY group)

Co-authors: SCHMIDT, Alexander; CREPIEUX, Bernard (CERN); SOBRAL DOS REIS, Edgar Miguel; FRANK, Isabel (CERN); LE, Line; GRASSER, Matthias Alexander; AU, Mia (CERN); ROTHE, Sebastian (CERN); USTA, Serdar; Dr STEGEMANN, Simon Thomas (CERN)

Presenter: BERLIN, Valentina (SY group)

Session Classification: Operation and developments I