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Thick targets for high-power ISOL facilities

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The future frontier of the ISOL technique is to increase the intensity of the Radioactive Isotope Beams (RIB) by many orders of magnitude in order to satisfy challenging experiments such as Rn-EDM, Fr-PNC… and in general for radiative proton-capture in nuclear astrophysics. In the On-Line Isotope Separation (ISOL) method, the isotopes are produced by nuclear interactions of light particles impinging onto a high-Z target material. The resulting products are stopped in the bulk of the thick target that is closely coupled to the ion source, allowing them to be quickly turned into an ion beam, which can be mass analyzed and transported efficiently to experiments. The main challenges in the ISOL method come from the fact that the reaction products are stopped in the bulk of the target material. To be released, the atoms have to diffuse out of the grain to the surface, then undergo the so-called effusion process, which is a series of desorption-absorption iterations, until reaching the ion source where the neutral atoms are ionized and extracted in the form of an ion beam. To obtain the highest overall efficiency for the release out of the target to the ion source, the targets are usually operated at the highest "acceptable" temperature.
The most direct method to increase the RIB intensity is to increase the driver beam intensity. At ISAC we have developed thick ISOL targets capable of withstanding high proton beam power by using composite target material and high power dissipating target container capable of dissipating 20 kW using radiative cooling. With these techniques we routinely operate refractory foil-targets and carbide targets between 35 and 50 kW incident beam power. The concepts and technical challenges of generating intense radioactive ion beams from ISOL target irradiated with high intensity proton beam are discussed.
Another method to increase RIB intensity is the use of indirect ISOL method, where secondary particle beam (n or γ) interacts with a fissile target material. The decoupling of the power deposition in the system composed of a converter and ISOL target allows the operation of the ISOL-target at much lower power while the converter can be cooled without affecting the target temperature and consequently the radioactive atoms overall release efficiency. While the indirect ISOL target method can reach several hundred kW to MW driver beam power, the RIBs hence produced are limited to mainly fission products.

Primary author: Dr BRICAULT, Pierre (TRIUMF)

Presenter: Dr BRICAULT, Pierre (TRIUMF)

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