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A Review of Chemically Selective Ion Sources for Radioisotope Production at ISOL Facilities

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Radioactive ion beam facilities produce radioisotopes for experiments that range from nuclear structure studies, astrophysics and medicine, to chemistry, biology or materials science. Following production, these exotic isotopes are ionized to enable acceleration into an ion beam for transportation, purification and delivery to experiments. There are some rather specific ion source requirements for radioactive ion beam production. Element selectivity is favoured over universality, efficiency typically dominates the desire to maximise ion currents and the ionization and extraction time should be minimized. Additionally, the emittance must be sufficiently low to facilitate the mass separation of the ion beam constituents and the transportation to experiments of the ions of interest.

To achieve this, multiple ion source types are employed, ranging from resonance ionization laser ion sources (RILIS) [1], to surface ion sources [2,3] and FEBIAD-type [4] arc discharge ion sources. Chemical selectivity can be achieved in FEBIAD and surface ion sources by tailoring component temperatures and/or materials [5,6]. RILIS offers chemical selectivity through ionization via sequential element unique atomic resonances. The laser atom-interaction region however, is typically a surface ion source, which can result in surface ionized isobaric contamination. To counter this, alternative laser atom interaction regions are being developed to offer enhanced chemical selectivity and experimental flexibility, these include repeller-ion guide-extraction systems [7] and coupling RILIS with FEBIAD-type ion sources [8]. The capabilities, applications and development prospects of these ion sources across ISOL-type radioactive ion beam facilities will be reviewed.

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