Efficient Ion Sources for Radioactive Ion Beam Generation

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The degree of success of any radioactive ion beam facility can be measured in terms of the number of interesting short-lived isotopes that can be produced and accelerated with intensities adequate for nuclear astrophysics and nuclear physics research. For ISOL-based facilities, the intensities are dictated by the efficiency at which short-lived radioactive species can be expediently diffusion-released from solid-state or liquid-state targets; the speed at which such species can be effusively transported to the ion source; and the efficiency for ionizing the species of interest. Thus, delay times attributable to diffusion and effusive processes must be minimized in relation to the lifetimes of the species of interest and highly efficient ion sources must be chosen in order deliver useful intensities for experimental use. In this report, emphasis will be placed on issues related to selection and design of high-temperature, high-efficiency ion sources that have been successfully developed for use at the Holifield Radioactive Ion Beam Facility. Specific attention will be given to the design details, materials of construction, ion optics, operational parameters, thermal transport properties, emittances, and measured ionization efficiencies of ion sources designed to solve specific problems related to acceleration of RIBs at the Holifield Radioactive Ion Beam Facility. These sources include high temperature, electron impact ionization, surface-ionization, and ECR positive-polarity sources and high-temperature kinetic-ejection, surface-ionization and low-temperature, batch-mode, sputter-type negative-polarity sources.

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