Effusive-Flow Characterization of Arbitrary Size and Geometry Target/Vapor Transport Systems: Radioactive Ion Beam Applications

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Time delays due to diffusion of radioactive species from solid or liquid target materials and their effusive-flow transport to the ion source can severely limit intensities of short-lived radioactive ion beams for nuclear physics and nuclear-astrophysics research applications. Diffusion times can be reduced by proper design or selection of short diffusion length, highly refractory, target materials and solving the diffusion equation for their release. However, effusive flow times are more difficult to assess. The characteristic time required for species to effusively travel through the target material to the ion source depends on the conduction path, chemical interactions between the species/target material and materials of construction as well as the physical size and geometry of the transport system. We have developed an ion-source-based apparatus for measuring the effusive-flow time for any gaseous or vapor-state species (chemically active or chemically inactive), independent of size and geometry and materials of construction of the transport system. The system utilizes a fast valve (1 ms closing time) to interrupt steady-state vapor flow to the ion source. The characteristic effusive flow time is then extricated from the exponentially decreasing mass analyzed ion beam intensity of the species in question. In this report, we describe the effusive flow apparatus and present characteristic time data derived from it use for noble gases and a selected number of electropositive and electronegative species.

1. Jean Bilheux and G. D. Alton, *Simulation of the effusive flow of reactive gases in tubular transport systems: Radioactive ion beam applications*, Nucl. Instrum. and Meth. B (in press).

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