Design and Development of a Transfer Cassette for Air-Sensitive Hazardous Materials in High Vacuum Ion Beam Systems

Pavlína Zavadilová, Jozef Dobrovodský, Pavol Noga, and Zoltán Száraz

Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Ulica Jána Bottu č. 2781/25, 917 24 Trnava, Slovakia

High vacuum ion beam systems require specialised sample handling solutions for air-sensitive hazardous materials that degrade upon atmospheric exposure. Due to the absence of airlocks in our experimental facilities, we encountered the problem of sample transfer from glovebox to chamber and inter-chamber movement. Since there are no commercial products that are compatible with our equipment, we had to develop our own solution for sample transfer. Comprehensive design and development of a transfer cassette system fulfils both safety and analytical requirements for ToF-ERDA (Time-of-Flight Elastic Recoil Detection Analysis).

The cassette introduced in this work was designed using Fusion 360 CAD software, building upon existing ToF-ERDA sample holder geometry to ensure system compatibility. Key design requirements included: maintaining inert atmosphere during transfer, ensuring high vacuum material compatibility and providing universal use without sample-specific modifications, opening and closing mechanism without additional electrical leads.

Material and sealing elements were optimised for ultra-high vacuum compatibility while preventing atmospheric contamination. The optimisation process focused on balancing compact dimensions, opening and closing mechanisms.

The resulting design provides a universal cassette system for safe transferring air-sensitive hazardous materials to high vacuum ion beam systems without compromising measurement quality. This solution extends the possibilities of analysis to materials that degrade when exposed to air in the field of thin film lithium batteries, hydrogen storage and energy materials development.

Funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I04-03-V02-00046