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Direct coupling of liquid-phase chemical setups for heaviest element studies to a recoil separator

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Liquid-phase chemical studies of transactinide elements ($Z \geq 104$), often referred to as "superheavy elements" (SHE), could so far be performed only for the first three SHEs rutherfordium, dubnium and seaborgium [1]. Such chemical experiments with accelerator-produced fusion-evaporation residues (EVR) are multi-step processes involving

1) Thermalization of a EVR in a pressurized gas atmosphere
2) Transport of the EVR to a chemistry setup via a gas-jet, seeded with aerosol particles
3) Dissolution of the aerosol particle (with the attached SHE)
4) Chemical separation and sample preparation
5) Detection of the nuclear decay

with each step having its own time budget and yield losses.

In order to reduce the background from by-products of the fusion reaction as much as possible, chemical experiments with SHE have recently often been carried out behind physical preseparators. However, due to decreasing production rates with increasing atomic number Z and the yield losses of the individual steps, it has not been possible to investigate elements beyond seaborgium directly in the liquid phase until now.

We have developed a new system suitable for enabling fast liquid-phase chemistry experiments, which provides access to study shorter-lived SHE isotopes than what is accessible with current techniques. By connecting this new "*vacuum to liquid transfer chamber (VLTC)"* [2] behind a physical preseparator such as TASCA, the SHEs to be investigated are guided from the low-pressure side of the separator directly into the liquid phase of a chemical experiment. This eliminates the first three steps of the above listing. Feasibility of this VLTC concept was demonstrated in offline residence time experiments and by experiments with $^{250/252}$Cf fission fragments. In combination with established systems such as AIDA, ARCA II or SISAK new experiments characterizing the chemical properties of SHEs can be envisaged. This holds even more for recently developed technologies, e.g., chemically selective alpha detectors [3]. With VLTC new and more efficient ways for liquid phase chemistry experiments of the heaviest elements can be explored in the future.

References

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