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# PHYSICAL PRESEPARATION FOR CHEMISTRY EXPERIMENTS: AN OVERVIEW AND AN EXAMPLE

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In recent years, the concept of physical preseparation of single atoms which are produced in nuclear fusion-evaporation reactions was introduced into the field of nuclear chemistry. Physical preseparation includes the following steps: (i) synthesis of the desired nuclear species in a heavy-ion-induced nuclear fusion reaction, (ii) separation of the evaporation residues from the unreacted beam and the majority of the transfer products in a physical recoil separator, (iii) extraction of these "preseparated" isotopes from the separator through a thin window, (iv) thermalization, e.g., in a gas-filled volume or a heated catcher, and (v) transport to the chemistry setup.

Among the most important advantages of this concept are the drastically reduced background of species that interfere with the unambiguous detection of single atoms (transfer products, products of the beam with various components of the target assembly or target impurities) as well as the beam plasma free conditions in the recoil chamber where the evaporation residues are thermalized.

A notable class of elements where this concept promises to allow significant progress is the one of the transactinide elements ( $Z \geq 104$ ). The Berkeley Gas-filled Separator (BGS) is the first device that was used as a preseparator for chemical studies of such elements. Studies of rutherfordium (Rf, element 104) with the automated liquid-liquid extraction system SISAK profited from the very low background of species whose decay is interfering with the unambiguous detection of the transactinides in the SISAK liquid scintillation counters. Another set of solvent extraction experiments (using different crown ethers as extractants) took advantage of the additional freedom that the chemist enjoys when using preseparated isotopes. Unlike in conventional experiments, where the main focus in the choice of the chemical system was dominated by the need of quantitative separation of the elements of the studied group from all other elements, a chemical system that probes the differences of the chemistry of the individual members of a given group can now be chosen. The physical separator provides an isolation of the selected elements.

As another exciting example of the new possibilities, studies of new compound classes in the gas phase will be discussed in some more detail. The mild conditions in the recoil chamber, without beam-induced plasma, allow for the direct introduction of organic and other thermally unstable compounds into this chamber. Thus, completely new compound classes of the transactinides, that were not previously accessible, can be investigated. These include, e.g., volatile metal complexes or organometallic compounds. First studies concentrated on volatile  $\beta$ -diketonates of the lighter homologs of Rf, hafnium (Hf) and zirconium (Zr). Hexafluoroacetylacetonate (hfa) was used as a ligand and the thermochemistry and kinetics of the reaction of hfa with Zr and Hf was investigated.

In a brief outlook, the main features of a new preseparator, the TransActinide Separator and Chemistry Apparatus (TASCA) which is currently under construction at GSI, will be presented.

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