# Chemistry for Isobar Separation behind SHIP*

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Recoil separators are powerful instruments for the isolation of desired nuclear reaction products. However, separation of ions of similar masses and isobaric nuclides is not possible at such a device without additional separation stages. One possibility for a second separation step is provided by chemistry. Two recoil separators at GSI are dedicated to superheavy element research – the velocity filter SHIP and the gas-filled separator TASCA. At gas-filled separators like TASCA, the coupling with chemistry setups is established[1]. In contrast, no vacuum separator has been used as a preseparator for chemical investigations so far. We have demonstrated that SHIP also can be combined with chemistry setups. Recently the in-situ formation of volatile metal carbonyl complexes was studied at TASCA [2,3]. Recoiling W, Re, Os, and Ir isotopes were thermalized in a CO containing atmosphere and formed volatile complexes. These complexes were transported in a gas jet over several meters to detection setups.

Short-lived Ta isotopes as well as Re and W isotopes were produced in the complete fusion reaction of $^{48}$Ca projectiles with a $^{133}$Cs$^{127}$I target at SHIP, in order to investigate the behaviour of Ta under comparable conditions. The Recoil Transfer Chamber (RTC), which was originally built for experiments at TASCA in the small image mode, was attached to SHIP. The chamber was separated from the high vacuum of SHIP by a 5.8-µm thick Mylar window supported by a honeycomb grid. The size of the RTC window was 3 cm × 4 cm. The chamber was cylindrical with an inner diameter of 3 cm. The depth of the RTC was 3 cm.

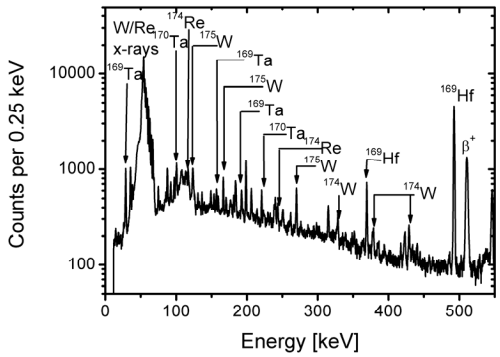


Figure 1: γ-spectrum of fusion products stopped in Al-foil behind SHIP.

In the first part of the experiment, an aluminium catcher foil was placed 5 mm behind the RTC window, where the recoiling ions were collected for 30 min. Within 2 min the foil was taken out of the RTC, placed in front of a γ detector, and measured for 10 min. Figure 1 shows a typical spectrum. γ-lines of $^{170,169}$Ta produced in the reaction $^{127}$I($^{48}$Ca, 5-6n) and $^{174}$Re produced in the reaction $^{133}$Cs($^{48}$Ca,7n) were observed. Furthermore $^{174,175}$W and $^{169,170}$Hf were identified. These are either produced in the ($^{48}$Ca,p xn)- reactions, or are decay products of the Re and Ta isotopes. In the second part of the experiment the catcher foils were removed, and the RTC was flushed with either a He/CO mixture or pure CO. The gases were purified by passing oxysorb and hydrosorb cartidges. The pressure in the RTC was kept at 600 hPa. The recoiling ions were thermalized in the RTC and all volatile compounds were transported in the gas stream out of the RTC through a 566 cm long capillary to a filter of activated charcoal. The volatile compounds adsorbed on the charcoal filter, which was monitored with the γ detector. Figure 2 shows a spectrum of the charcoal trap. Only W and Re isotopes were identified. No Ta and Hf isotopes were observed in the spectra.

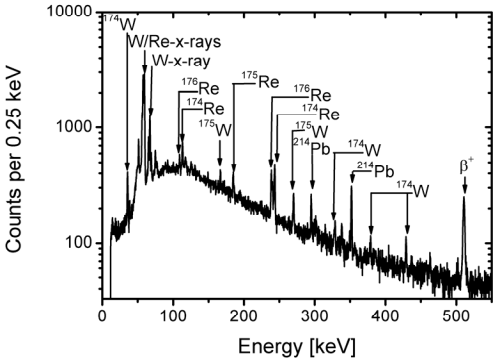


Figure 2: γ-spectrum of the charcoal filter. Pb γ-lines originate from the natural background.

This confirms former results that W and Re form volatile complexes in a CO atmosphere. However, Ta and Hf were not transported so that the formation of volatile complexes with CO was excluded. Gas phase carbonyl chemistry is therefore an appropriate tool to separate group 4 and 5 elements from group 6 and 7 elements and can thus be used for isobar separation.

## References

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