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Optimizing the in-situ production yield of transition metal carbonyls

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Despite the first synthesis of $Sg(CO)_6$ in 2014 by Even et al. being successful [1], also further experiments performed at RIKEN targeted at measuring thermodynamic properties of this new compound suffered from low formation rates for carbonyl complexes in general. In the mentioned measurement campaign performed in 2016, the post-separator yield was in the range of about 5-10% for $Sg(CO)_6$, the same for $W(CO)_6$ and only slightly higher (20%) for $Mo(CO)_6$, making the experiment analysis difficult due to low statistics for the observed number of events for the transactinide.

In order to overcome this problem, this works focuses on increasing the post-separator yield of $Mo(CO)_6$ in a model system called FORA, based on a down-scaled version of the RIKEN-setup used in 2016. The studied, short lived Mo-Isotopes are generated by the spontaneous fission process of a ^{252}Cf source and the yield of metal-carbonyls produced under various reaction conditions is monitored by trapping these volatile compounds on a charcoal-trap and monitoring their decay using γ-spectroscopy. Since additionally to Mo-Isotopes, the fission of ^{252}Cf also produces significant amounts of Tc, Ru and Rh, it was decided to extend our studies to those elements as well. A simple model was developed, that allows to calculate an absolute post-separator chemical yield for the synthesis of $Mo(CO)_6$, including a correction for the transportation time, that might differ between the model-system used here and an actual accelerator-based setup.

Using the mentioned setup, the dependency of the carbonyl-formation reaction on various parameters was investigated. Those parameters include pressure, gas mixture composition, kinetic energies of the recoiling isotopes, gas velocity, various impurities including H_2, O_2 and CH_4 as well as different purification columns and getters used to clean the applied gas mixtures. The results of those investigations will be presented. Further studies including the influence of temperature and H_2O will be performed in the near future.

References

[1] J. Even et al., Science, **345**, 6203 (2014)