

# First results of the CALLISTO-experiment: Evidence for the formation of a hassate(VIII)

A. von Zweidorf<sup>1</sup>, R. Angert<sup>1</sup>, W. Bröchle<sup>1</sup>, S. Bürger<sup>2</sup>, K. Eberhardt<sup>2</sup>, R. Eichler<sup>1,3</sup>, H. Hummrich<sup>2</sup>, E. Jäger<sup>1</sup>, R. Jera<sup>2</sup>, H.-O. Kling<sup>2</sup>, J. V. Kratz<sup>2</sup>, U. Krille<sup>2</sup>, B. Kuczewski<sup>2</sup>, G. Langrock<sup>2</sup>, G. Lehr<sup>2</sup>, M. Mendel<sup>2</sup>, A. Nähler<sup>2</sup>, A. Peil<sup>2</sup>, V. Pershina<sup>1</sup>, U. Rieth<sup>2</sup>, M. Schädel<sup>1</sup>, B. Schausten<sup>1</sup>, E. Schimpf<sup>1</sup>, H.-J. Schött<sup>1</sup>, E. Stiel<sup>1</sup>, P. Thörle<sup>2</sup>, N. Trautmann<sup>2</sup>, K. Tsukada<sup>4</sup>, N. Wiehl<sup>2</sup>, G. Wirth<sup>1</sup>

<sup>1</sup>Gesellschaft für Schwerionenforschung, Darmstadt, <sup>2</sup>Institut für Kernchemie, Johannes Gutenberg-Universität Mainz, <sup>3</sup>now at PSI, Villigen, <sup>4</sup>JAERI, Tokai

In October/November 2002, after an intensive optimization of many experimental parameters, the CALLISTO-project finally led to a hassium chemistry experiment [1] at the UNILAC. Since it has been predicted, that hassium forms a volatile tetroxide [2], which was recently confirmed by C. Düllmann et al. [3], we decided to investigate this compound of hassium.

For the very volatile OsO<sub>4</sub>, it is known that it dissolves in strongly basic alkali hydroxide solutions thereby forming red, diamagnetic osmates(VIII) of stoichiometry [OsO<sub>4</sub>(OH)<sub>2</sub>]<sup>2-</sup>. In previous beamtimes, in which OsO<sub>4</sub> was produced in-situ directly behind the target [4], we demonstrated, that the volatile OsO<sub>4</sub> deposits effectively on NaOH surfaces from humid He gas.

This behaviour was used to design a continuously working system for the formation, transport, deposition and detection of OsO<sub>4</sub> and HsO<sub>4</sub> [1]. This system, which uses 4 computer-controlled valves and 4 detection arrays, each with 4 alpha-detectors [5], combines the advantages of a continuously operating system and adds the possibility to change the deposition material, a thin layer of NaOH on a plate of stainless steel, on a regular basis without interrupting the experiment. Changing the deposition material is necessary, as the deposition efficiency decreases with time [1].



Fig. 1: Rotating target wheel (Photo: W. Bröchle)

A rotating target wheel (Fig. 1), containing two <sup>248</sup>Cm-targets of 0.6 mg/cm<sup>2</sup> each and one <sup>152</sup>Gd-enriched-Gd-target, was irradiated with 1.18·10<sup>18</sup> <sup>26</sup>Mg beam particles at 144-149 MeV. In the second part of the beamtime, the <sup>152</sup>Gd-target segment was replaced with a <sup>248</sup>Cm/<sup>152</sup>Gd-hybrid target to enhance the hassium production. This target wheel was irradiated with a total amount of 1.64·10<sup>18</sup> particles at 142-150 MeV.

Os and Hs recoils, synthesized simultaneously, are stopped in a mixture of He and O<sub>2</sub> inside a recoil chamber especially designed for this purpose. This results in an in-situ formation of volatile oxides, which are carried out with the He-gas jet.

In our experiment, about 290 deposition plates were coated with NaOH and successfully used. The main part of the OsO<sub>4</sub> deposits in the first detection array. The distribution of the activity of OsO<sub>4</sub> in the detection system is shown in Fig. 2.

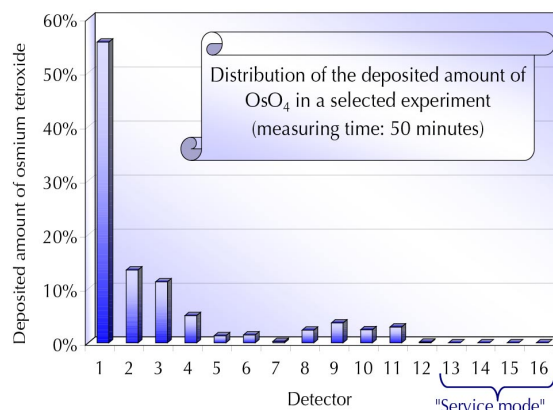
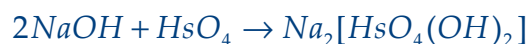


Fig. 2: Distribution of Os in the detection system

The data evaluation is in progress. A first and preliminary analysis shows  $\alpha$ - $\alpha$ -decay chains and  $\alpha$ -SF correlations which we tentatively attribute to the decay of Hs isotopes. For the first time, a chemical reaction has been performed with hassium tetroxide. Since the observed deposition of HsO<sub>4</sub> under the conditions of this CALLISTO set-up is only possible, if this volatile substance reacts with NaOH, we conclude, that HsO<sub>4</sub> reacted with NaOH. Since very similar properties for OsO<sub>4</sub> and HsO<sub>4</sub> can be expected [2], we suppose, that sodium dihydroxotetraoxohassate(VIII) was formed:



So, if the off-line analysis substantiates the above findings, for the first time in the history of element 108, a classical acid-base-reaction was successfully carried out one-atom-at-a-time using its tetroxide.

Besides it should be noted, that <sup>34m</sup>Cl has been produced as a byproduct in the target chamber. It was deposited on the alkaline surface too and was identified via  $\gamma$ -spectroscopy. Generally, the CALLISTO set-up may be able to investigate the chemistry of other volatile substances, which are able to react with reactive surfaces, too.

## References

- [1] A. von Zweidorf *et al.*, this GSI Scientific Report
- [2] V. Pershina *et al.*, J. Chem. Phys. **115** (2001), p. 792
- [3] C. Düllmann *et al.*, Nature, 418, (2002) 859
- [4] A. von Zweidorf *et al.*, GSI Scientific Report 2001, p. 181
- [5] Pictures are available at <http://www.callisto.ws>