

On the production and chemical separation of Hs (element 108)

J. Dvorak¹, R. Krücken¹, F. Nebel¹, Z. Novackova¹, A. Türler¹, B. Wierczinski¹, A. Yakushev¹, W. Brühle², E. Jäger², E. Schimpf², M. Schädel², A. Semchenkov^{1,2}, A. Kuznetsov³, M. Chelnokov³, A. Yerebin³, Ch. E. Düllmann⁴, Y. Nagame⁵, K. Eberhardt⁶, P. Thörle⁶, R. Dressler⁷, Z. Qin^{2,8}, M. Wegrzecki⁹

¹TUM Garching; ²GSI Darmstadt; ³JINR Dubna; ⁴LBNL Berkeley and UC Berkeley; ⁵JAERI Tokai; ⁶Universität Mainz; ⁷PSI Villigen; ⁸IMP Lanzhou, ⁹ITE Warsaw

Chemical separation of Hs in the form of HsO₄ provides an excellent tool to study the formation reactions and nuclear structure of nuclei close to the deformed nuclear shells at Z=108 and N=162 due to a high overall efficiency and a very high purification factor. The first chemical identification of Hs as HsO₄ was performed by Düllmann et al. [1] at GSI in 2001. Seven decay chains were detected in a thermogradient detector and were attributed to the decay of ²⁶⁹Hs and ²⁷⁰Hs. Deposition temperatures of $-44 \pm 6^\circ\text{C}$ and $-82 \pm 7^\circ\text{C}$ and adsorption enthalpies of $-46 \pm 2 \text{ kJ/mol}$ and $-39 \pm 1 \text{ kJ/mol}$ were reported for HsO₄ and OsO₄, respectively.

Here we report on preliminary results of a recent Hs chemistry experiment performed at the GSI Darmstadt in December 2004. A rotating ²⁴⁸Cm target wheel consisting of three arc-shaped segments with a target thickness of 788, 743 and 244 μg/cm² on 15-μm Be backing foils was irradiated with ²⁶Mg⁵⁺ ions to produce Hs isotopes. The third segment contained 2 % in weight of ¹⁵²Gd (30% enrichment) for the simultaneous production of α-decaying Os isotopes. A total beam integral of 3.48×10^{18} ²⁶Mg particles was accumulated during 12 days: 1.46×10^{18} at E_{lab} = 145 MeV and 2.02×10^{18} at E_{lab} = 135 MeV in the middle of the target. The experimental setup (Fig. 1) was similar to the one described in [1]. Recoil products were thermalized in a He/O₂ (10% of O₂) gas mixture in a recoil chamber heated to 400°C. The chemical reaction was completed at 650-700°C in a quartz column directly connected to the exit of the recoil chamber. Volatile Hs and Os tetroxides were formed and transported with the gas flow at room temperature to a detector setup. Two different gas flow rates of 1.8 l/min and 1.5 l/min were applied. The transport time through a Teflon™ capillary, 8 m in length, with an inner diameter of 2 mm was less than 2 s. The new detection system COMPACT (Cryo On-line Multidetector for Physics And Chemistry of Transactinides) was used. A temperature gradient from +20°C to -142°C was established along the detector channel which consisted of 2×32 single

PIPS detectors (1×1 cm² in size). The distance between top and bottom arrays was 0.6 mm. The active detector surface covered 70% of the inner surface of the detector assembly. The overall efficiency of the experimental apparatus was about 50%. Decay chains detected in the 145-MeV run are presented in [2].

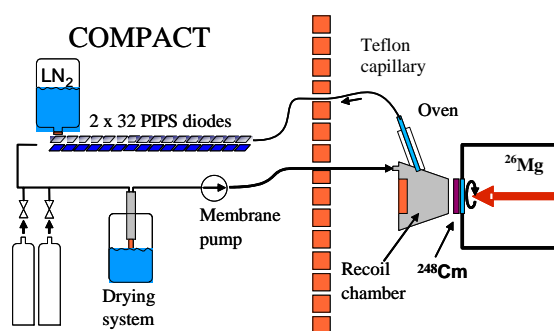


Fig. 1. Schematic of the experimental setup.

Figure 2 depicts the distribution of α-events with E_α = 4-5.1 MeV attributed to ^{172,173}Os along the detector as measured in the 145-MeV run. Seven events attributed to Hs isotopes are added to this plot (Fig. 2). The data are still being evaluated.

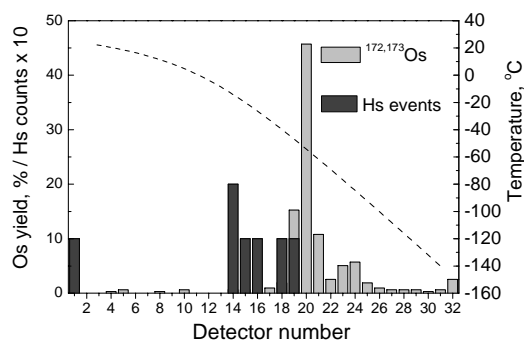


Fig. 2. Distribution of ^{172,173}Os and Hs isotopes in COMPACT.

References

- [1] Ch.E. Düllmann et al., Nature **418**, 859 (2002).
- [2] J. Dvorak et al., this Scientific Report, p.