

First successful chemistry-experiment behind TASCA –Electrodeposition of Os*

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Underpotential deposition has been shown by Hummrich [1] to be a suitable method for studying the chemical behaviour of the transactinides. For such investigations, the nuclide should have a half-life of at least 10 s. Thus, ²⁷⁰Hs ($T_{1/2} \sim 22$ s [2]) is a good candidate for electrochemical experiments. This report describes the first electrodeposition of short-lived isotopes of osmium, the lighter homologous element of hassium.

Os was produced in the reaction $^{nat}\text{Ce}(^{40}\text{Ar},x\text{n})$. The first experiments took place in cave X1 without pre-separation. The reaction products were transported via a He/KCl-jet from the recoil chamber, which was directly behind the target, to a direct catch (DC) apparatus and to the Automated Liquid Online Heavy Element Apparatus (ALOHA). DC samples were collected on glass fibre filters which were measured by γ -spectroscopy. No γ -lines of Os isotopes were visible in the spectra due to the high background of transfer products (see figure 1, top), which clearly demonstrates the need for a physical pre-separation [3] for such chemistry experiments. Behind TASCA [4], ¹⁷⁷Os and ¹⁷⁶Os were seen as the main products (see figure 1, bottom).

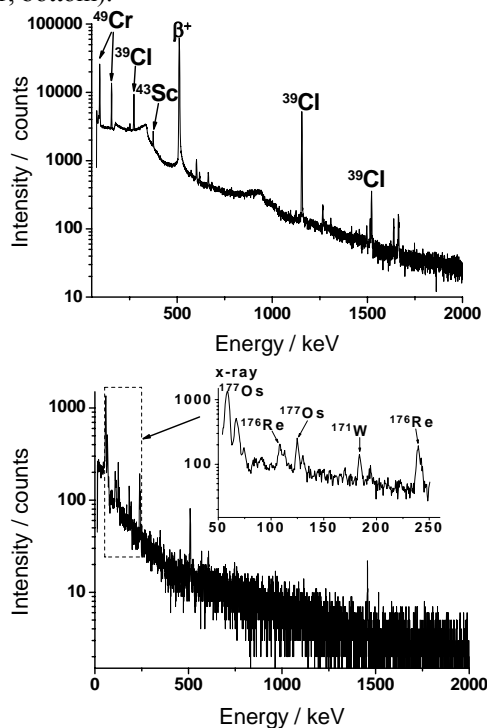


Figure 1: Comparison of the γ -spectra of a sample produced at X1 (top) and at TASCA (bottom).

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For the electrochemical studies, the KCl aerosol particles were transported from the HTM-RTC [5] to the radiochemistry laboratory and were deposited on a Ta plate in ALOHA [1]. After 2 min collection time, the sample was dissolved and flushed into the electrolytic cell with 1 ml 0.1 M HCl delivered by a syringe pump. After running the electrolysis for 2 min, the electrodes were measured with a γ detector. The electrolysis was repeated at various potentials vs. an Ag/AgCl reference electrode. Measurements with different electrode materials (Pd, Ni, and palladinated Ni) were performed. The data were analysed according to [6] as shown in figure 2. The $E_{50\%}$ -values, i.e., the potential, at which a deposition yield of 50% was observed, were +81 mV for Pd, +67 mV for palladinated Ni, and +10 mV for Ni, with uncertainties of ± 50 mV.

To gain information about the deposition kinetics, the electrode potential was kept constant at -800 mV vs. an Ag/AgCl electrode and the electrolysis duration were varied. At room temperature and non-optimal stirring conditions, half of the osmium was deposited on Pd electrodes within (48 ± 10) s and on Ni electrodes within (54 ± 10) s.

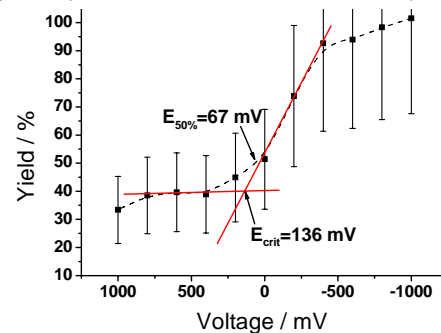


Figure 2: The critical potential on a palladinated Ni-electrode (the dashed line is drawn to guide the eye).

In another experiment with higher beam energy α -decaying ^{172,173}Os were produced and deposited on the Pd electrodes. Due to the small α -branch and the short half-lives (~ 20 s), only a few counts were detected. It could be shown, however, that it is possible to detect such short-lived nuclides by α spectrometry with an automated electrolytic cell after pre-separation with TASCA.

References

- [1] H. Hummrich, Doctoral thesis, U. Mainz, 2006.
- [2] J. Dvorak et al., Phys. Rev. Lett. **97** (2006) 242501.
- [3] Ch.E. Düllmann, Eur. Phys. J. D **45** (2007) 75.
- [4] M. Schädel et al., this report.
- [5] Ch.E. Düllmann et al., GSI Sci. Rep. 2006, p. 146.
- [6] F. Joliot, J. Chim. Phys. **27**, 119 (1930).