

# The electrochemical deposition of Hg on various metal electrodes

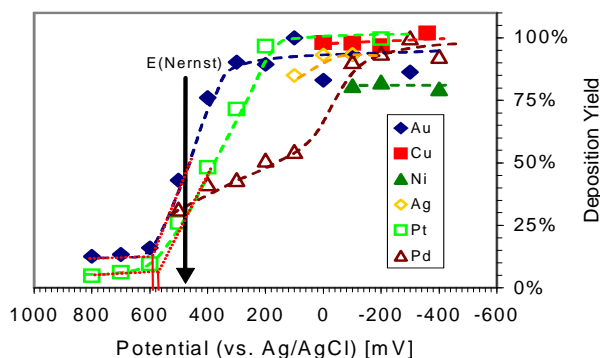
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Recently, attempts were undertaken to chemically characterize element 112 in gas phase experiments [1].

A different approach involves experiments in the liquid phase. If we assume that element 112 is a noble metal (like its homolog Hg), a separation by electrochemical deposition on a metal electrode should be possible. Furthermore, this would result in an ideal sample for  $\alpha$ -spectrometry.

In our experiments, we investigated the electrochemical deposition of Hg on various metal electrodes. A solution of  $\text{Hg}(\text{NO}_3)_2$  in 0.1M  $\text{HNO}_3$  was irradiated at the TRIGA reactor of the Mainz for 6h at a neutron flux of  $7 \cdot 10^{11}$  n/s/cm<sup>2</sup>. The isotope  $^{197g}\text{Hg}$  with a half live of 64,1h was produced with a specific activity of 70 kBq/mg, and its  $\gamma$ -line at 77 keV was evaluated in the experiments.



**Fig.1:** Electrodeposition yield vs. electrode potential for the deposition of  $^{197g}\text{Hg}$  on various metal electrodes. In the experiments with Ag, Au, and Cu, 0.1M  $\text{HNO}_3$  and with Pt, Pd, and Ni, 0.1M  $\text{HCl}$  was used as electrolyte

A heatable electrolysis cell with two working electrodes (total area 2 cm<sup>2</sup>), a Pt counter electrode and a Ag/AgCl reference electrode was used. The electrolyte volume of 1-2 ml was stirred with a high volume magnetic stirrer at 1000-1400 rpm. The total Hg concentration in each experiment was  $5 \cdot 10^{-6}$  mol/l. This was low enough, so that the deposition still took place in the sub-monolayer region. 0.1 M  $\text{HCl}$  and 0.1 M  $\text{HNO}_3$  were used as the electrolyte. The electrolysis time was 10 min. This should result in the maximum possible deposition for the given potential.

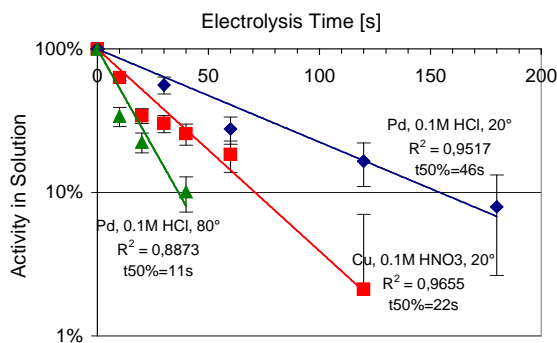
The electrodeposition yield was measured vs. the electrode potential (Fig. 1). The experiments, in which Ag, Cu, and Ni electrodes were used, were started at the potential that occurred when the electrode is immersed into the solution (rest potential). At the rest potential, no current is applied. An increase of the potential beyond this rest potential would lead to a dissolution of the electrodes. For the deposition of Hg on Pt and Au, a critical potential at which a significant deposition starts, was deduced. For Pd, no well defined critical potential was found. For Cu, Ni, and Ag, the deposition is already nearly complete at the rest potential (spontaneous deposition).

In table 1, the critical potentials are compared with  $E_{50\%}$ -values, which were calculated with a microscopic-macroscopic model proposed by Eichler and Kratz [2] using thermodynamic properties of Hg and of the electrode material.

**Table 1:** Critical potentials for the deposition of Hg on various metal electrodes compared with theoretically predicted  $E_{50\%}$ -values (all potentials vs. Ag/AgCl)

Electrode	$E_{\text{crit}}$ [mV]	$E_{50\%}$ calc.
Au	+ 600	+ 710
Ni	> +50	+ 660
Ag	> +100	+ 620
Cu	> -100	+ 630
Pt	+ 580	+ 970
Pd	-	+ 1140

The electrodeposition speed was investigated for the deposition on Pd (20° and 80°) and Cu electrodes. Fig. 2 shows the decrease in activity vs. the electrolysis time. The  $t_{50\%}$ -value is the time at which 50% of the activity is deposited. The electrodeposition seems to be faster on Cu electrodes than on Pd electrodes at room temperature. An increase in temperature lead to an increase in electrodeposition speed, in analogy to previous experiments with Pb [3].



**Fig.2:** Electrodeposition speed vs. electrolysis time for the deposition of  $^{197g}\text{Hg}$  on Pd and Cu. Electrolytic systems: Pd / 0.1M  $\text{HCl}$  / 20° / -500mV; Cu / 0.1M  $\text{HNO}_3$  / 20° / -300mV; Pd / 0.1M  $\text{HCl}$  / 80° / -500mV

The obtained results will be taken into account in a beam time at GSI, where carrier-free Hg isotopes are produced via the reaction of  $^{40}\text{Ar}$  with Sm. The transport of Hg with a KCl gas jet, the transfer into the liquid phase with the ALOHA system [4] and a subsequent electrodeposition will be investigated.

## References

- [1] S. Soverna et al, GSI, *Scientific Report* 2003, p. 187
- [2] B. Eichler, J.V. Kratz, *Radiochimica Acta* **88**, 475 (2000)
- [3] H. Hummrich et al., GSI, *Scientific Report* 2003, p. 199
- [4] H. Hummrich et al, *this report*