JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Electrochemical Deposition - A Tool for Superheavy Element Chemistry?

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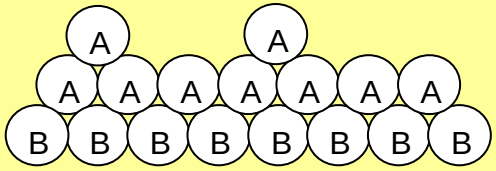
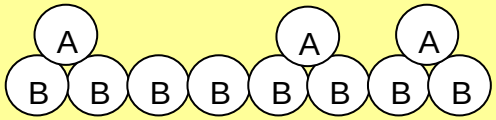
Why use Electrochemical Deposition?

- Nuclide separation and sample preparation for α-spectrometry in one step
- Electrochemical deposition of element 114 might be possible



$$E = E^0 + \frac{RT}{nF} \ln a_{ox}$$

Deposition of A on A → Deposition at Nernst potential

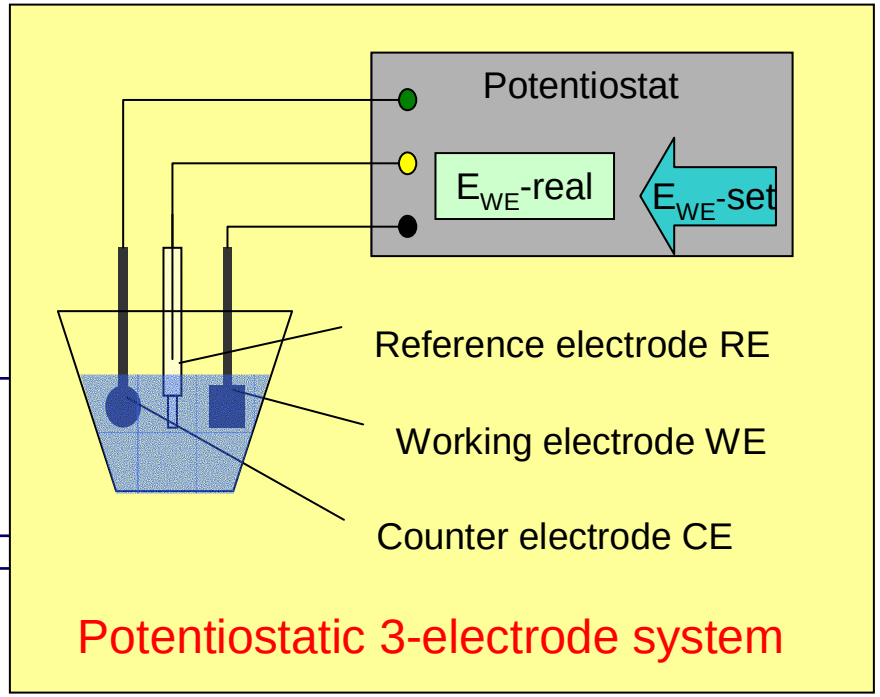


$$E_{50\%} = E^0 - \frac{\Delta\bar{H}(A-B) - T\Delta\bar{S}_{vib}}{nF} - \frac{RT}{nF} \ln \frac{A_m}{1000}$$

Deposition of A on B → underpotential deposition (UPD)

$E_{50\%}$ values for different metal combinations: B. Eichler, J.V. Kratz, Radiochim. Acta **88,** 475 (2000)

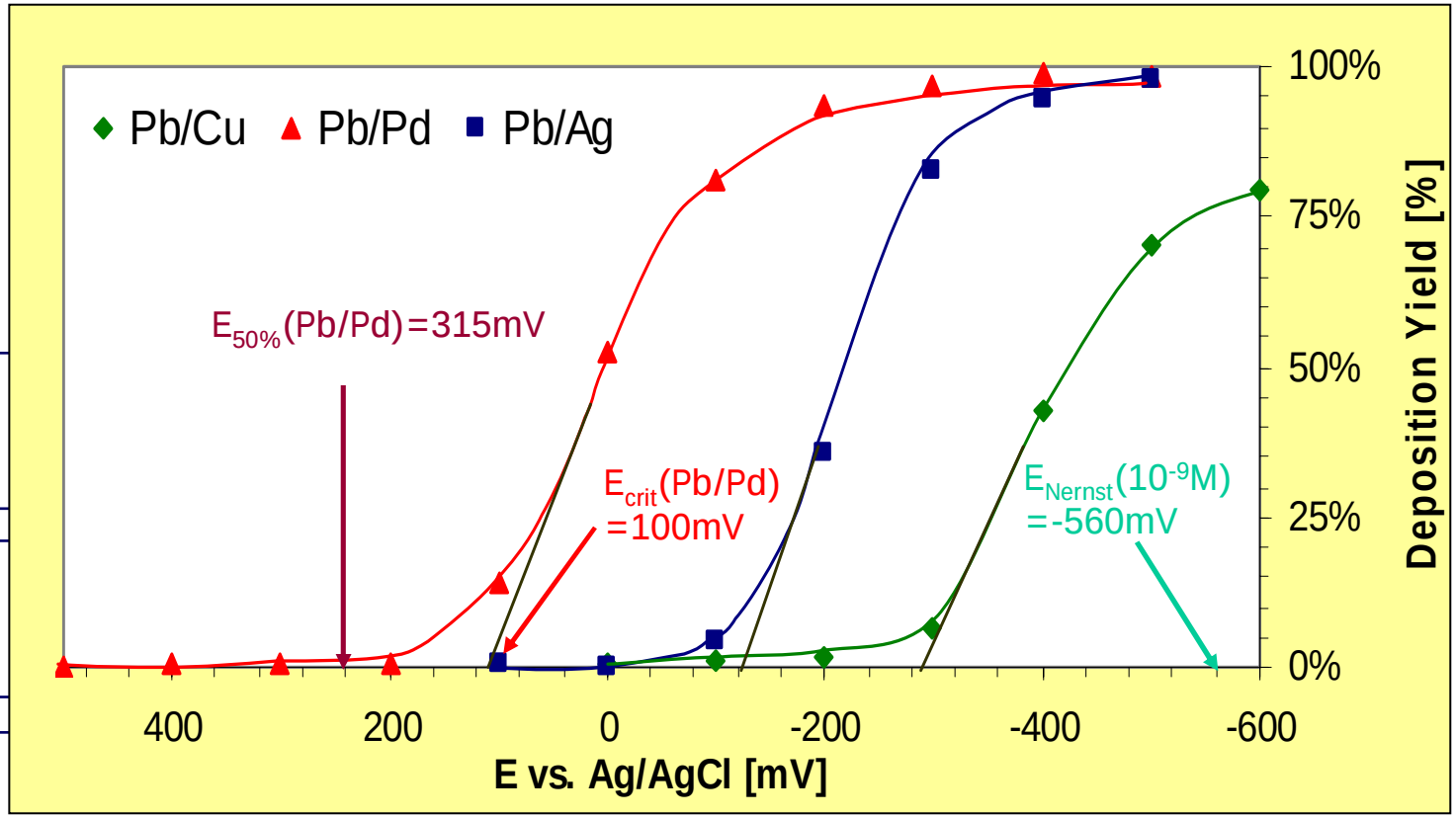
Experimental Setup



Potentiostatic 3-electrode system

- Experiments with ^{212}Pb, $T_{1/2}$=10,6h (Pb: homolog of element 114)
- Determination of UPD potentials
- Investigation of electrochemical deposition kinetics

Determination of Critical Potentials



Deposition of ^{212}Pb on Pd, Ag and Cu from 0.1 M $HClO_4$. Electrolyte Volume V=1mL, Electrode Area A=1cm², stirring at 600rpm. The tangents show the E_{crit} values.

Electrochemical Deposition Kinetics

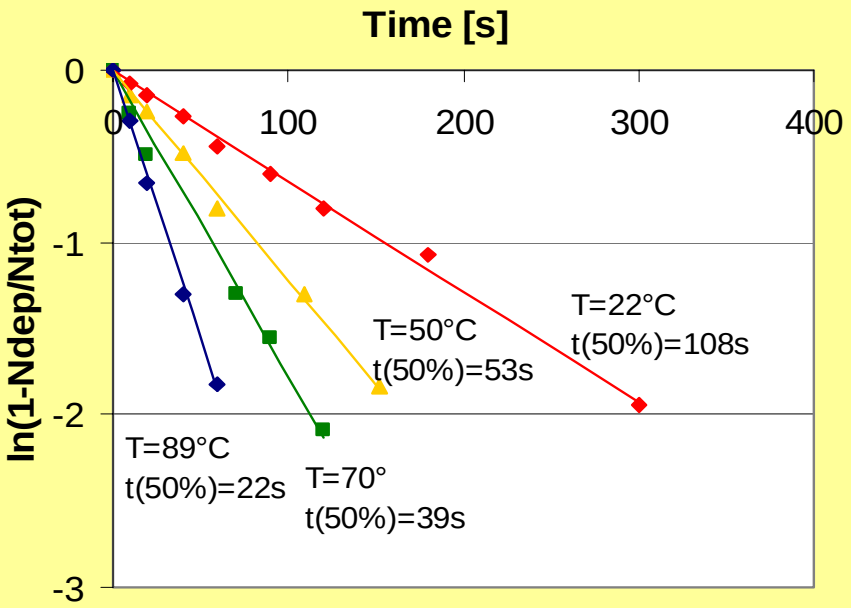
$$\frac{dN_{dep}}{dt} = \frac{D \cdot A}{\delta \cdot V}(kN_{tot} - N_{dep})$$

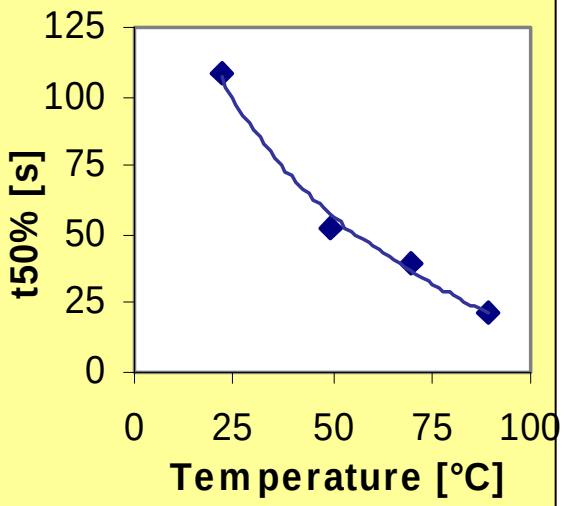
for k = 1 $\rightarrow$

$$\ln(1 - \frac{N_{dep}}{N_{tot}}) = -\frac{D \cdot A}{V \cdot \delta} \cdot t$$

F. Joliot, J. Chim. Phys. **27,** 119 (1930)

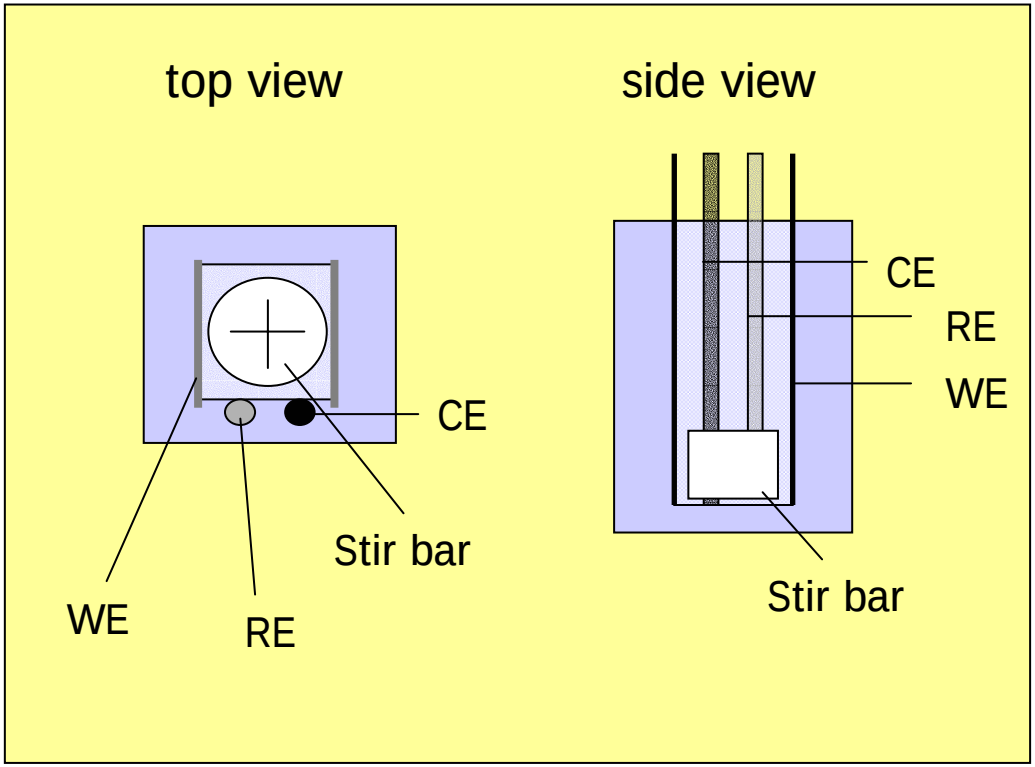
$t_{50\%}$ = time for deposition of 50 %





Temperature dependence of the electrodeposition of Pb on Pd from 0.1 M $HClO_4$. E_{WE}=-500mV, V=1 ml, A_{WE}=1 cm², stirring at 600 rpm.

Fast Electrodeposition Cell



$t_{50\%}$ = 5s for the deposition of Pb on Pd from 0.1M $HClO_4$,
A = 2cm² and V = 400µl at 90°.
Stirring with high volume magnetic stirrer at 1400rpm.

Interferences from Polonium Isotopes

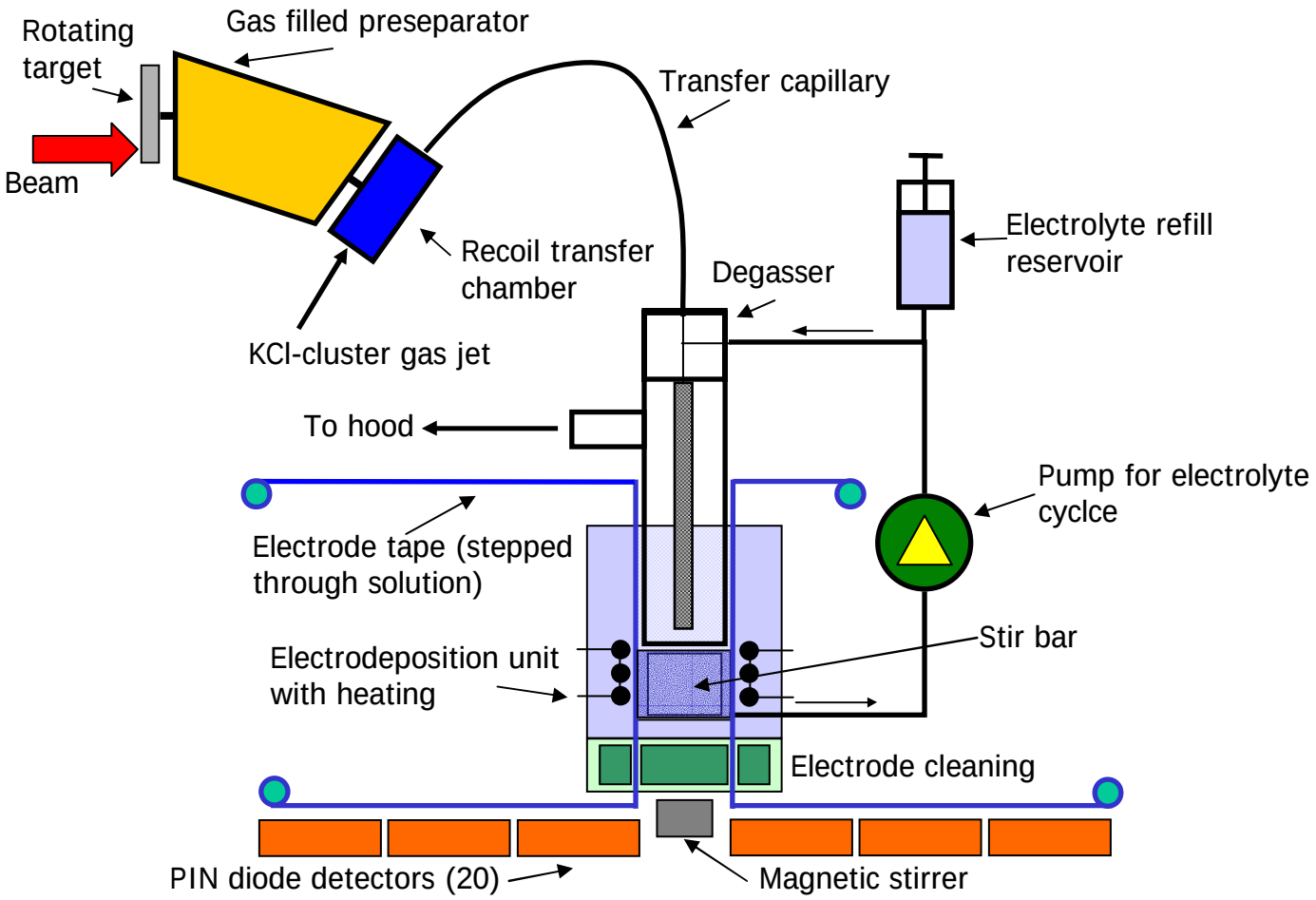
Po-isotopes in SHE chemistry

Isotope	$T_{1/2}$	E_α [MeV]
^{211m}Po	25,2 s	7,28; 8,88
^{211g}Po	516 ms	7,45
^{212m}Po	45,1 s	11,65
^{212g}Po	0,3 µs	8,78
^{213}Po	4,2 µs	8,38
^{214}Po	164 µs	7,69
^{215}Po	1,8 ms	7,39
^{216}Po	145 ms	6,78
^{217}Po	1,5 s	6,54
^{218}Po	186 s	6,00

- Rn isotopes partially removed in a degasser, but Po decay products may reach the electro-deposition unit
- Po is electrodeposited spontaneously*
- Presumably, a gas-filled preseparator will be mandatory

*U. Rieth, Institut für Kernchemie, University of Mainz, Annual Report 2002

Coupling Gas Jet - Electrodeposition Cell



Summary and Outlook

Present:

- E_{crit}-values for the deposition of Pb from different electrolytic systems were determined
- A fast electrodeposition cell was developed: $t_{50\%}$ = 5s for the deposition of Pb on Pd from 0.1 M $HClO_4$ at 90 °C

Future:

- Construction of the mini degasser
- Coupling of gas-jet, degasser and electrodeposition cell, test in a $^{110}Pd(^{80}Kr,5n)^{185}Pb$ beamtime at GSI
- Coupling with gas-filled separator and development of a fully automated electrodeposition and detection device