

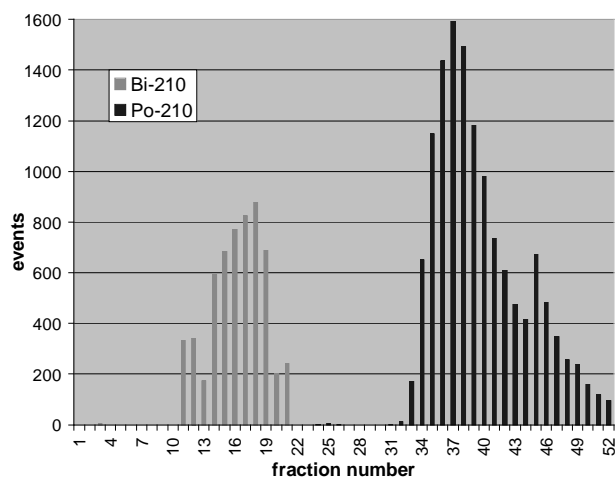
# Electrodeposition of Po-210 on various electrode materials

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For future investigation of the chemical properties of superheavy elements, the spontaneous electrodeposition of carrierfree polonium is being studied.

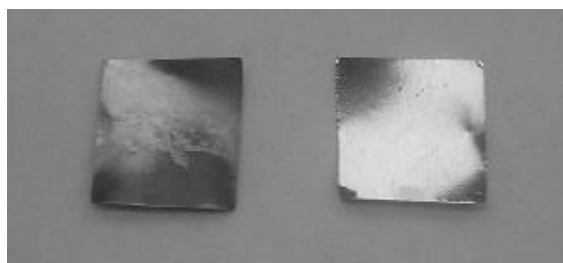
In a first preparatory step, the polonium tracer was produced at the Mainz TRIGA reactor by irradiating natural bismuth. After the Bi-210 ( $T_{1/2}=5d$ ) reached its radiochemical equilibrium with Po-210 ( $T_{1/2}=138d$ ) the elements were separated by anion-exchange chromatography using the Biorad AG MP-1 (100-200mesh) exchange resin [1]. A conc. HCl solution of the Bi-210/Po-210 was fed onto the exchange column ( $d=13mm$ ,  $h=50mm$ ). After elution of the Bi fraction with 100ml conc. HCl (flowrate 1.5ml/min), the carrierfree Po-210 could be eluted from the column with 300ml  $HNO_3$  (1:1) (flowrate 1.5ml/min) as shown in Fig.1.



**Fig.1 Elution of Bi-210 and Po-210 from the anion-exchange column AG MP-1.**

To get a Po-210 solution usable in electrochemical experiments, the fractions containing Po are evaporated to dryness and are dissolved in the desired solvent afterwards.

Reproducible results in electrochemical experiments can only be achieved by using electrodes with very clean surfaces. To get such electrodes, a procedure was established, where the electrodes (metal foils) are cleaned in a three-step process. First, the foils are washed in acetone to remove grease.

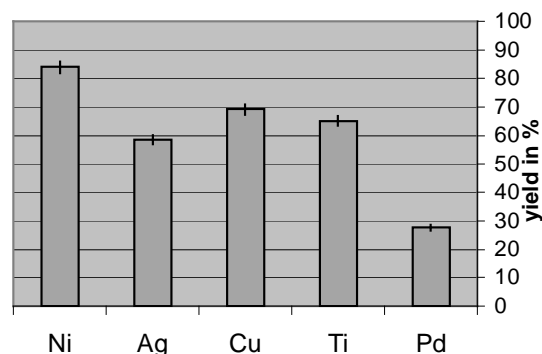


**Fig.2 Cu electrodes prior and after the surface cleaning.**

In a second step, the electrodes are heated under an argon/hydrogen (95:5) atmosphere at about 700K for 2 hours to remove oxide species from the surface. In a final step, the adsorbed layer of hydrogen is removed by a heat treatment at

400-500K under a pure argon atmosphere or by another heating process under vacuum conditions. Fig.2 illustrates the change in optical appearance of a copper-foil electrode prior and after the treatment.

Using a 0.1M  $HNO_3$  solution of Po-210, a first series of experiments on the spontaneous electrodeposition of Po has been performed. These experiments used Cu, Ag, Ti, Pd and Ni in form of 6x6mm foils as electrode materials. These foils were introduced into a small electrochemical cell with a volume of only 200 $\mu$ l [2]. After contacting the electrode with the Po-210 electrolyte, the reaction time was started. To assure a maximum ion motion towards the electrode, the cell was heated to 340K and treated with ultrasound. In these first experiments, a very long reaction time of 15min was chosen. At the end of the reaction, the electrode was removed from the cell and rinsed with water to stop all reactions. The determination of the amount of deposited Po was performed by alpha spectroscopy. Fig.3 shows the results for the various electrode materials.



**Fig.3 Deposition yields of Po-210 on metal foils.**

It can be noticed that the deposition of Po on a Pd electrode is very inefficient. This is in contradiction to a theoretical prediction by Eichler et al. [3]. As that prediction is only valid for a very low surface coverage of only a single monolayer, the degree of coverage was calculated using the experimental parameters (electrode surface area, activity of the electrolyte). The calculations resulted in a coverage of  $7 \cdot 10^{-6}\%$  which is well within the monolayer limit.

Because of the relatively good deposition results observed with Ni, Cu and Ag, future experiments will be performed using these materials. In the planned experiments, the first goal must be to reduce the deposition time by at least an order of magnitude. This has to be achieved with respect to the half lives of the superheavy elements which are to be investigated using this electrochemical technique.

## References

- [1] J. Korkisch, *Handbook of Ion Exchange Resins: Their Application to Inorganic Analytical Chemistry*, Volume VI, CRC Press, Boca Raton (1989)
- [2] U.Rieth et al., Institut für Kernchemie der Universität Mainz, *Jahresbericht 2001*, A12.
- [3] B. Eichler, J.V. Kratz, *Radiochim. Acta* **88**, 475 (2000).