

## Background

In 2006, a new research group has been created at the SCK•CEN in order to focus more specifically on chemical issues relevant to the studies of materials. The integrated staff personnel has a long experience in many different fields of expertise such as radiochemistry (fuel cycles and radioisotopes), organic chemistry, electrochemistry (analytical techniques and corrosion) and sonochemistry. The previously running activities are now being reoriented according to a well-defined work programme.

## Objectives

Each research line that was previously running had specific objectives. Fuel cycle studies were axed on the partitioning of lanthanides and actinides in aqueous solutions. Support to corrosion studies was devoted to the development of a new method for the treatment of electrochemical noise data for the detection and the classification of local corrosion events. New objectives for the future put a strong accent on radioisotopes for the pharmaceutical industry as well as the use of non-aqueous chemistry as a tool for several applications among which the treatment and the separation of radioisotopes, analytical measurements as well as the chemical control of impurities in liquid metals.

## Principal results

### *Fuel cycle studies*

For several years, the SCK•CEN collaborated with the Japanese Institute of Research and Innovation (IRI) for the development of an advanced ion exchange process (ERIX= Electrolytic Reduction and Ion Exchange) for the reprocessing of spent nuclear fuels (FBR fuel), including waste partitioning. The overall treatment comprises 2 electro-reduction processes (elimination of  $\text{Pd}^{2+}$  and reduction of  $\text{U}^{6+}$  to  $\text{U}^{4+}$  and 4 succeeding column chromatographic separations in nitric acid solution to separate U/Pu and Np from the fission products, from the lanthanides, and from the minor actinides (Am and Cm). Besides, the literature was consulted on partitioning and transmutation. The conclusions are summarized in an open report [1].

### *Radioisotopes for the industry*

An initial exploratory study of the chemistry of lanthanum has been started up with the aim to extend the application to the chemistry of actinium [2]. The electro-crystallization of a lanthanum containing compound from a non-aqueous electrolyte has been carried out successfully on a platinum cathode. We are now in the process of further assessing the influence of the electrochemical input variables on the overall process (recovery yield, product purity and exact composition of the electro-crystallized compound).

### *Contribution to corrosion studies*

Electrochemical noise (ECN) is known to be related to the initiation and the propagation of local corrosion events. However, classical data treatment techniques like the Fourier Transform are not fully suited for the analysis of non linear and non steady-state data. We propose to make use of the Hilbert-Huang technique for the analysis of ECN data, thereby keeping track of the time variable while translating the signal into intrinsic mode frequencies to be related to the corrosion events. A preliminary code has been written and its application to available data reveals the feasibility of this approach [3].

### *Nano-materials*

In the framework of our research on nano-structured metallic alloys, the electro-deposition of electro-catalytic nickel nano-particles from a diluted Watt bath has been successfully achieved on a boron doped diamond electrode. Under the chosen experimental conditions, the diameter of the particles is  $(55 \pm 25)$  nm. Powerful 20 KHz ultrasonic waves were used to readily expel the deposited particles from the electrode without damaging the substrate. Further work should focus on the recovery of the nano-particles from their suspension in the electrolyte.

### Future work

The future work will be centred essentially on the production of radioisotopes for the pharmaceutical industry. Besides this main axis, dedicated support to other research activities is foreseen by making use of our expertise in non-aqueous chemistry.

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### Main references

- [1] K. Van Hecke, P. Goethals, "*Research on Advanced Aqueous Reprocessing of Spent Nuclear Fuel: Literature Study*", Open report BLG-1030 (July 2006)
- [2] K. Van Hecke, P. Goethals, A. Rahier, "*Reconditioning of Ac-227*", Restricted contract report R-4382 (September 2006)
- [3] A. Rahier, R. W. Bosch, "*Treatment of ECN data by the Hilbert-Huang transform*", Restricted contract report R-4291 (January 2006)