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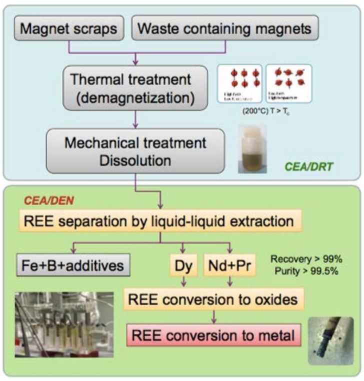
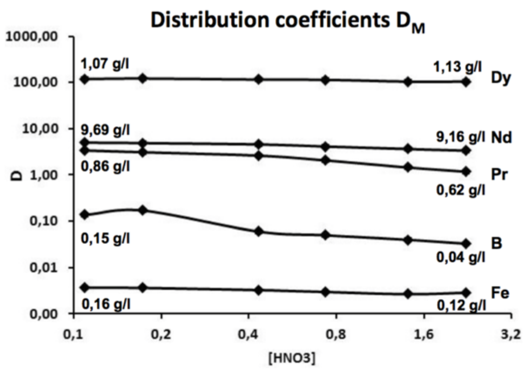
Rare earth elements (REE) have become essential for our modern economy, in relation to the development of new energy and communication technologies. Albeit being considered today as the most critical raw materials group with the highest supply risk, the recycling of REE from electronic waste and end-of-life products (permanent NdFeB magnets, Ni-MH batteries etc.) is almost inexistent.[1] Therefore, a large research effort is needed for over-coming the current scientific and technological barriers and improving the recycling efficiency. Innovative, eco-designed processes have to be developed, which require extensive R&D effort from basic research to technological developments.

The CEA has gained a world-class expertise in the field of separation processes by hydrometallurgy and pyrometallurgy, several solvent extraction processes being developed and industrially implemented for the nuclear fuel cycle. In this communication, an efficient combined hydro- and pyrometallurgical process aimed at REE recovery and separation from used NdFeB permanent magnets will be presented.[2] The process integrates the mechanical and physico-chemical treatment of NdFeB magnets, followed by a liquid-liquid solvent extraction step for the recovery and intra-separation of REE using a selective extractant with excellent affinity for heavy REE which are today the most expensive REE. Experimental liquid-liquid extraction and modeling data allowing the recovery of a 99.9% pure Dysprosium solution will be discussed in this paper. A subsequent pyrometallurgical treatment via molten chloride salt electrolysis allowed the isolation of pure Dy metal with 80% faradic yield. This is one of the first examples of an effective, closed-loop REE recovery and separation process, starting from magnet scrap down to individual pure REE as metals, which paves the way for future developments in the field.

Following this successful demonstration, a new project aimed at the separation of rare earths and nickel from Ni-MH batteries is currently being developed in our department, and preliminary results concerning the evaluation of new molecules for liquid-liquid extraction will be presented in this paper.





[1] K. Binnemans, *et al.*, Recycling of rare earths: a critical review. *Journal of Cleaner Production*, **2013**, *51*,1.

[2] M. Miguirditchian, *et al.*, **2014** : Procédés de récupération sélective de terres rares présentes dans les phases aqueuses acides issues du traitement d'aimants permanents usagés ou rebutés. *Patent application* 1459023.