

## PhD Thesis call

### Selective rare earth recycling from intermetallic compounds of NiMH batteries

The recycling rate of NiMH batteries is currently low. In addition, the existing processes are not sustainable because they use hazardous materials and are energy consuming.

NiMH batteries contain various valuable metals such as Co, Ni, Mn and mixtures of lanthanides (Ln) including La, Ce, Pr, Nd. Lanthanides are part of the rare earth elements, that are among the 20 critical metals established by the European Commission.

The present project proposes to develop new methods for separating these different elements, including the rare earth metals using ionic liquids. Extraction of lanthanides and separation from base metals using ionic liquids have gained significant interest in the recent years and promising results were reported in several works in the literature.

The main objective is to elaborate a full process for the recycling of NiMH batteries. The first step of crushing of batteries will use essentially already-known techniques and equipments already available in the industrial partner of the project, Recupyl. Research will be focusing on the separation of elements subsequent to the crushing of batteries. A first objective will be to recover all light metals (transition metals: Co, Ni, Mn, Fe) in a stream which will be further treated using separation processes available at Recupyl for Li batteries. Then, the second key step of the PhD will consist in recovering Ln metals using ionic liquids. Several strategies will be studied, such as selective precipitation, selective liquid-liquid extraction or any other mean that would be promising. Subsequently, recovery of pure metals will be investigated using electrochemical reduction or back extraction processes.

This work will be carried out in collaboration between a recycling company called Recupyl and the LEPMI lab. and will be financially supported with a PhD grant provided by the CEMAM labex.

### PhD profile

The PhD candidate will need to have a significant hydrometallurgical background, preferentially with a degree in chemical and electrochemical engineering. Because this project will require a close collaboration between Recupyl and LEPMI, the PhD student will work under the supervision of Farouk Tedjar and Eric Chaînet, director of research at LEPMI.

The PhD student will be working within Recupyl and LEPMI facilities. The research work realized at LEPMI will cover fundamental studies as the Recupyl will be oriented in a more engineering field for the different steps of separation, recovering and valorization.

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