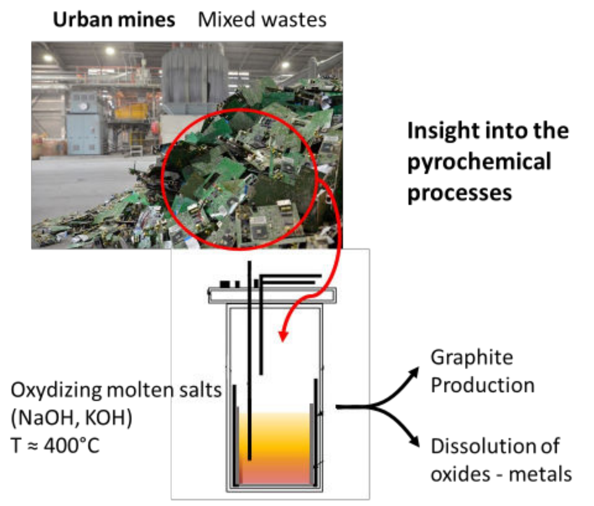
PhD

Recycling of rare earths by pyrochemical means: study of the mechanisms of degradation of materials and dissolution of metals

The thesis project revolves around the recycling of rare earths (RE) in a molten salt medium. Essential for the manufacture of many high-tech devices, their recycling remains difficult because of the small quantity of rare earths used in the finished products (<mg up to a few kg). The objective of the thesis is to decipher the reactions at work when mixed components (organic, oxides and metals) containing rare earths are introduced into baths of highly oxidizing molten salts, such as molten hydroxides. The studies will focus in a first phase on the identification of the dissolved species and the understanding of the mechanisms of dissolution. These questions are classically addressed by focusing on "pure" model compounds, an oxide of RE for example, and by analyzing the potential changes in oxidation state, crystal structure, chemical exchange, etc. which lead to solubilization. In the presence of mixtures of compounds, competitive reactions can occur, as surface passivation processes. The degradation of organic matter in the molten salts can indeed lead to the formation of graphite and amorphous carbon which can cover the particles of RE that we are trying to dissolve. The original approach of this project is not only to study a model compound, but also to characterize the surface and the morphology of the particles to be dissolved, by considering in particular the way in which the formation of parasitic deposits can modify the dissolution processes.

After a phase of selecting the optimal molten salt bath, the chemical transformations of the materials (transformation of the crystalline structure, modification of the degrees of oxidation), the morphological transformations (granulometry, structure of the interface) and the speciation of the ionic species dissolved in the bath will be studied using a combination of complementary analytical techniques. These will be in situ techniques such as electrochemistry and X-ray absorption and ex situ techniques (microscopy, X-ray diffraction, etc.). The characterization of the dissolution processes of rare earths in highly oxidizing molten salt baths will thus be able to direct towards selective recovery solutions.



The PhD candidate recruited will work as part of a team of researchers involved in the study of recycling processes using pyrochemistry and ionic liquids. In addition to the understanding of the materials recycling issue, she/he will gain expertise on pyrochemistry, electrochemistry and advanced characterization (SAXS, absorption X).

Candidate profile: Physico-chemist with an appetite for complex experimental challenges requiring specific developments. Solid basis in electrochemistry and spectroscopy are important for the proposed project. The candidate must be highly motivated, voluntary, curious and driving force behind the project.

How to apply: To apply, please send us a CV, a short letter explaining why you would like to join us, a document stating your master and licence qualifications and one or two reference persons (master professor or master supervisor) that we can contact. The initial deadline for the application is May 3rd 2023.

Period: October 2023 – September 2026. The PhD will take place in the PHENIX laboratory, located on the Pierre et Marie Curie Campus of Sorbonne Université.

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Sorbonne University is a world-class, research-intensive university bringing together a broad range of arts, humanities, social sciences, natural sciences, engineering and medicine. The scientific Pierre and Marie Curie campus was completely refurbished in 2016.

PHENIX is a laboratory at the interface between Chemistry, Physics and Materials Science with a long-standing expertise of colloidal systems, electrolytes and fluids under confinement. Its strength lies in a combination of experimental and modelling activities (numerical simulations). Several international projects and networks are in place in PHENIX, providing a rich and multinational environment.