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Laboratoire d'Electrochimie
et de Physico-chimie des Matériaux et des Interfaces
(UMR 5279)

LePMI
Grenoble - Chambéry

LEPMI
1130 rue de La Piscine – BP 75
38402 Saint Martin d'Hères Cedex
https://lepmi.grenoble-inp.fr/

FRANCE 2030 PROGRAMME DE RECHERCHE BATTERIES

Postdoctoral position: Investigating mechanical degradation in solid-state batteries

In the current context of increasing demand for electrical energy storage, the development of alternatives to Li-ion batteries is important. Li/S batteries offer highly promising features in terms of electrochemical performance, eco-efficient materials (free from critical raw materials), and cost. Unfortunately, this technology is not yet mature due to i) the solubility of polysulfides, which limits the system's reversibility, ii) slow reaction kinetics at the sulfur electrode, mainly due to the low electronic conductivities of both sulfur and Li_2S, and iii) the high reactivity of metallic lithium.
Replacing the liquid electrolyte with a solid electrolyte (ceramic or polymer) can address the issue of polysulfide solubility while also improving safety, by eliminating volatile components. However, the development of high-performance solid-state systems requires a large understanding and control of the interfaces, not only in terms of chemical and electrochemical reactivity, but also mechanical properties.
Indeed, ion and electron transport phenomena and their limitations in all-solid-state cathode, are strongly linked to the quality of the sulfur/electrolyte/carbon interfaces. During cycling, the electrode undergoes significant volume changes—over 80% between S_8 and Li_2S—which induce internal stresses and loss of contact, effects that remain poorly understood and rarely studied.

The primary objective of this postdoctoral project is to evaluate the mechanical stresses induced during cycling in all-solid-state systems (based on argyrodite and polymer electrolytes), and to identify the main driven force (rate, ratio of element composing the electrode, etc…). The electrodes obtained will be characterized using several physicochemical techniques (dilatometry, acoustic emission, mechanical measurements such as indentation), electrochemical testing, and imaging techniques. These analyses aim to correlate electrochemical performance with electrode microstructure and mechanical behavior, both before and during cycling.

Context :

This project is part of the PEPR "Li Metal Solid-State Batteries" program, known as LIMASSE**,** coordinated by the ANR under the France 2030 initiative. This highly ambitious project aims to develop all-solid-state batteries (inorganic, polymer-based, or hybrid) with lithium metal as the negative electrode. The project brings together 10 CNRS joint research units (UMRs) and CEA-

LITEN, forming a strong scientific consortium to address the key challenges hindering the development of solid-state battery technologies.

One of the strategies explored within LIMASSE is the use of sulfur as the positive electrode material, coupled with a solid electrolyte (Argyrodite or polymer), in the context of Li–S battery technology. It is within this framework that we are seeking a post-doctoral candidate to join the LEPMI laboratory in Grenoble, to work on the characterization of all-solid-state sulfur electrode in Li–S batteries.

This project will be carried out in close collaboration with all partners of the LIMASSE program, and more specifically with the LRCS (Amiens), indeed two PhD students (one at LEPMI, one at LRCS) are involved in Li-S technology in the LIMASSE project.

The candidate should hold a PhD in materials science and related field. Knowledge of electrochemistry, mechanics and battery technologies would be considered a strong asset.

Contacts : Fannie Alloin et Claire Villevieille – fannie.alloin@grenoble-inp.fr and claire.villevieille@grenoble-inp.fr

Location : Laboratoire LEPMI, Campus Universitaire de Saint Martin d'Hères