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Understanding mechanical fractures in solid state batteries using ultrasound techniques (collaboration between LEPMI laboratory and ICGM, Montpellier)

Keywords: Solid state battery, electrochemistry, ultrasounds, material science

Offer description

Meeting rising energy needs and reducing fossil fuel use has driven research into solid-state batteries (SSBs). Since the first commercialization of Li-ion batteries by Sony in the early 1990s, substantial progress has been made in enhancing energy and power density[1]. However, this technology is now approaching intrinsic limitations, constrained by safety concerns and the difficulty of replacing graphite negative electrodes with lithium metal. Unlike conventional Li-ion batteries that rely on a liquid electrolyte, SSBs employ a solid electrolyte, providing multiple benefits over liquid-based systems. They can offer higher energy density (based on Li metal usage), longer cycling life, and greater environmental friendliness, making them promising for applications from electronics to electric vehicles[2]. Among solid electrolytes, thiophosphates, represent one of the most promising materials for safer and higher-energy batteries due to their scalability and ease of synthesis. Nevertheless, their successful implementation requires a deeper understanding of densification as well as their mechanical ability during cycling.

Indeed, during cycling, electrode materials are "breathing", meaning that during lithiation/delithiation, the lattice parameters of the active materials are changing leading to stress/strain on the solid matrix, that deserves proper investigation. We propose here to "listen" the fracture by using ultrasound/acoustic emission to prove solid state batteries. The work proposed here will be incremental understanding first the sound emitted by the solid electrolyte alone during compression/decompression, followed by the investigation of the composite electrode. *In fine*, full solid-state batteries will be investigated and the electrochemical behaviour and performance will be correlated to the ultrasound signal record and visual morphological evolution (SEM, tomography) shedding light on mechanical fractures in solid state batteries. This monitoring will be carried out on the electrolyte as function of the pression applied and will be extended to that of composite electrodes based on graphite and graphite/silicon mixtures where ratio and nature will be varied.

Location: LEPMI laboratory on Grenoble university campus, FRANCE
This internship will be carried out in collaboration with the ICGM, with regular discussions on the results, and additional characterizations may be carried out in Montpellier.

Goals

- Preparation of home-made solid-state batteries (in Ar-filled glovebox)
- Recording ultrasounds/acoustic emission on solid state batteries
- Solid state batteries assembly and electrochemical performance
- SEM/EDS and X-ray tomography characterisation
- Data treatment and interpretation

Student profile: background in chemistry and/or material science, knowledge on electrochemistry or energy storage thematic is an asset.

Duration: 5 – 6 months **Starting date**: February 2026

To apply to this master thesis please send your CV and motivation letter to Claire Villevieille (claire.villevieille@grenoble-inp.fr) and to Laure Monconduit (laure.monconduit@umontpellier.fr)