Impact of coating on cathode materials for all solid batteries: Multiscale study and performance evaluation (IMHOTEP)

Context:

To meet new environmental challenges (reducing greenhouse gas emissions, improving air quality, etc.), increasingly stringent standards are being introduced at national and European level. In particular, they are encouraging automakers to invest more in low-emission technologies, including electric vehicles. Thus, by 2050, the aim to achieve carbon neutrality will be reflected in the electrification of transport, as well as in the development of renewable energies (solar, wind, etc.). Energy storage systems (batteries) are therefore becoming essential components in this transition, helping to regulate the availability of electricity supplied by renewable energies and improving the range of electric vehicles. Among the new technologies under development, all-solid-state batteries are of interest in terms of increased energy density and safety. However, this technology currently has some limitations, including interfacial reactions between the active material and the solid electrolyte. The strategy of performing coatings around the active material to protect it without hindering the transport of lithium ions is a strategic avenue for improving the performance of these systems. However, the protection and degradation mechanisms of this protective layer during operation are poorly understood, and detailed characterization is essential.

Aim:

The IMHOTEP thesis project aims to study the degradation mechanisms induced during electrochemical cycling of oxide cathode active materials coated with a buffer layer. It will focus on three complementary areas: (i) the synthesis and electrochemical characterization (electrochemical impedance spectroscopy or EIS, electrochemistry) of oxide-coated positive electrode materials, (ii) transmission electron microscopy characterization at different stages of cycling in solid electrolyte media to study their evolution and determine possible induced degradation, and (iii) their study in complete all-solid systems by "operando" scanning electron microscopy with comparison with conventional systems. The study of the electrochemical reactivity mechanisms of the materials associated with the microstructural and chemical modifications determined will thus enable us to improve our understanding of the phenomena limiting the performance of electrodes, with a view to maximizing their reliability and life cycle. This understanding is essential for the design of viable prototypes.

Prerequisites :

We are searching a motivated candidate with solid knowledge in materials chemistry (from synthesis to chemical and electrochemical characterization). In addition, candidates with prior knowledge in electron microscopies and electrochemistry will be preferred.

Fluency in English is essential, as candidates will be required to write manuscripts and communicate research results in English. Prior knowledge in French will be appreciated.

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Required document: CV (1 page), cover letter (1 page max), recommendation letters (ideally from 2 reference persons which contact details must be provided).

PhD starting date: October 2024, length: 36 months, Localization: LRCS (CNRS UMR 7314) in Amiens, France