

PhD Thesis Topic (Starting date: October 2023)

Title of the research topic	Sodium ionic conductors derived from sodium tetrathiophosphate Na₃PS₄.
Laboratory or Company	Laboratoire de Réactivité et Chimie des Solides (LRCS)
Laboratory Director	Mathieu MORCRETTE
Address, Country	15 rue Beaudelocque, 80039 Amiens Cedex
www Link	https://www.lrcs.u-picardie.fr/
PhD thesis Advisor(s)	Dr. Pierre GIBOT, Prof. Christian MASQUELIER
e-mail	p.gibot@u-picardie.fr , christian.masquelier@u-picardie.fr

Faced with the growing demand for energy, the development of mobile electricity, and the need to limit the consumption of fossil fuels, optimising the use of renewable energies and designing reliable and sustainable energy storage systems is obviousness. Currently, in terms of energy storage, lithium-ion battery technology covers most of the market needs (vehicles, telephones, laptops, etc.). These mature electrochemical devices are still the subject of research mainly focused on improving manufacturing processes and reducing manufacturing costs. Nevertheless, the safety of these devices is regularly called into question, particularly due to the use of flammable organic liquid electrolytes. As a result, academic laboratories and manufacturers have been directing their research towards the design of so-called all-solid-state batteries (ASSB) in which the liquid electrolyte is replaced by a solid material (oxides, sulphides or polymer). Increased safety, higher volumetric and mass energy densities, higher charging rates and autonomy are the promises of these new electrochemical devices, while at the same time considering the use of a metal anode.

The project will focus on all-solid batteries and, more specifically, on the development of a solid electrolytes capable of conducting sodium cationic species (Na⁺). The choice of working on sodium technology rather than lithium is explained in part by the lower criticality index of sodium (greater abundance, homogeneous distribution on the globe, etc.). To date, according to the literature, the most promising materials are oxides and sulphides. The sodium tetrathiophosphate sulphide Na₃PS₄, although sensitive to moisture, appears as a promising candidate owing to its superior conductivity, its low density and mechanical properties suitable for specific shaping. Na₃PS₄ is generally synthesised by means of solid-state chemistry methods (mechanochemistry or solid/solid reactions) which are energy- and time-consuming processes. The research topic proposed is to synthesise Na₃PS₄ – type solid electrolytes by solutions chemistry as a more competitive synthesis route that could allow more sustainable mass production. Partial substitutions will be investigated to improve the ionic conductivity and chemical stability of the Na₃PS₄ material. The formulation and assembly aspects of various electrode/solid-electrolyte/electrode systems (all solid-state batteries) will also be addressed.

Qualifications:

The candidate must have a MASTER 2 or Engineer degree in chemistry, electrochemistry or materials science. Knowledges on energy storage, materials and solution chemistry, crystal-chemistry, will be valuable.

Documents to provide:

- . CV and motivation letter
- . Marks and ranks of Master 1 and 2
- . The names and contact details of at least 2 reference persons

Application:

https://adum.fr/as/ed/voirproposition.pl?langue=&site=stsupjv&matricule_prop=48913