Master Thesis Topic
(February 13th – August 11th)

Title of the research topic	Sulphur-based solid electrolytes synthesis by means of a solution route
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Scientific Project:

Sodium-ion battery (SIB or NIB) is gaining interest in terms of electrochemical storage technology. However, this technology requires, like its Li-ion battery counterpart, the use of a highly flammable non-aqueous liquid electrolyte that can lead to safety issues. For the past 10 years, research has focused on the development of all-solid-state batteries (ASSBs), in which solid electrolytes replace liquid electrolytes, making these batteries safer.

Most of sulphur-based solid electrolytes materials are mostly synthesized at high temperatures or by mechanical alloying (ball-milling)[1,2]. More recently, the combination of shaking powders in a liquid medium has been suggested[3]. For the most of them, theses synthesis methods are energy and time consuming. As a result, more efficient and scalable routes are needed to meet industrial requirements. Therefore, it is essential to develop solution-based approaches for the synthesis of these materials. A remarkable advance on lithium-based solid electrolytes ($Li_xP_yS_z$) synthesis has been accomplished, in this sense[4].

Sodium-based solid electrolyte (Na_3PS_4) would be the targeted material because of their high ionic conductivity compared to other solid electrolytes. Recent works on its synthesis in liquid medium have been published[5,6]. The goal of this internship would be to investigate this new route by varying some experimental parameters such as precursors and solvents to evaluate the impact on the microstructure and electrochemical properties.

Techniques used:

. Gloves boxes/dry room . X-ray diffraction . Raman, Infra-red spectroscopies . Scanning electron microscopy . Impedance measurements . Electrochemical cycling

Recent publications related to the topic:

1. Tachez M., Malugani J., Mercier R., Guy R. Solid State Ionics 14 (1984) 181-185.
2. Seino Y., Ota T., Takada K., Hayashi A., Tatsumisago M. Energy Environ. Sci. 7 (2014) 627.
3. Phuc N.H.H., Morikawa K., Mitsuhiro T., Muto H., Matsuda A., Ionics 23 (2017) 2061-2067.
4. M. Ghidiu, J. Ruhl, S.P. Culver, W.G. Zeier, J. Mater. Chem. A 7 (2019) 17735-17753.
5. Uematsu, Solid State Ionics 320 (2018) 33–37.
6. Wan, ACS Appl. Mater. Interfaces 10 (2018) 12300-12304.

Documents to provide:

. CV and motivation letter