Proposition de stage de Master 2 au LRCS – Amiens
6 months starting in February 2021

Title of the research topic	LCO Based sintered electrode for High Energy density
Laboratory or Company	Laboratoire de Réactivité et de Chimie des Solides (LRCS) UPJV
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Scientific Project :

High energy electrodes have become particularly attractive over the past decades as a potential system for grid energy storage. Fabrication methods of high energy density electrodes could be divided into two main categories: those which tend to increase the mass loading of the electrodes by making them thicker [1-2] and those which aim to remove as many inactive components (e.g. current collectors, separators, binders, conductive additives) as possible [3-4]. Recently, **Spark Plasma Sintering** has been used to obtain (ultra)**thick electrodes** and all-monolithic electrodes/full cells as well as to synthesize electrode active materials [5-7]. Utilization of Spark Plasma Sintering and Hard Templating Approach allows quick and efficient electrode fabrication resulting in **free-standing electrodes** with **controlled porosity** and low tortuosity values. To resolve the main problem of (ultra)thick electrodes (that is ion diffusion limitations), various electrode architectures could be realized, such as porosity gradient electrodes (electrodes having layers of different levels of porosity), all-monolithic half/full cells with controlled interfaces, and (ultra)thick electrodes with controlled pore architectures. Improved electrode/cell architectures could result in enhanced ion transport properties thereby improving the electrode performance at higher C-rates and prolonging the battery cycle life. The project aims at developing different **electrode architectures** based on various active materials (primarily: $LiCoO_2$) by transferring the already existing thick electrode fabrication technology (based on SPS and templating approach) and modifying it based on the anticipated outcome. It will focus on the investigation of the influence of the starting materials, sintering protocols, and electrodes architectures on the electrode's final physical and electrochemical properties. Detailed surface, physico-(electro)chemical, and crystallographic analyses will be performed using various techniques present at the LRCS. The results will be put in perspective with electrochemical performances obtained in battery configuration.

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Techniques used:

SPS, Soft Chemistry, Pycnometry, XRD, SEM, Galvanostatic Cycling, EIS, BET

Recent publications related to the topic :

1.Sander, J. et al., Nat Energy 1, 16099 (2016). https://doi.org/10.1038/nenergy.2016.99
2.Billaud, J. et al., Nat Energy 1, 16097 (2016). https://doi.org/10.1038/nenergy.2016.97
3.Jin, J. et al. (2014). Journal of Power Sources. 272. 10.1016/j.jpowsour.2014.08.119.
4.Sunsun, C., et al., (2010), Adv. Mater., 22: E145-E149. doi:10.1002/adma.200904285
5.R. Elango, et al., Adv. Energy Mater. 2018, 8, 1703031
6.F. Lalère , et al. Journal of Power Sources 247 (2014) 975e980
7.Nadeina, A., Rozier, P. and Seznec, V. (2020),. Energy Technol., 8: 1901304. doi:10.1002/ente.201901304