MSc. Thesis Topic
(to start in February 2023)

Title of the research topic	Influence of the mixing parameters in the slurry and battery electrode microstructure
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Scientific Project: The manufacturing process step of dispersing the raw materials in a liquid phase to prepare a lithium-ion battery electrode slurry is the first step that drastically affects the following electrode fabrication process steps and the resulting cell performance. There are several parameters of the slurry preparation that can influence the final performance of the electrode. Among them, it has been demonstrated that an optimal temperature strengthened the slurry network and reduced its viscosity.[1] Furthermore, the variation in the slurry mixing process parameters could modify the particle interactions and homogenization of the active material dispersion.[2,3] Despite several studies reported so far, there is a lack of systematic study on how this process step parameters (such as the mixing speed and duration, the order of mixing of the corresponding constituents) affect the electrode microstructure and its associated electrochemical performance. In this MSc. project, we aim to study, in a systematic way, the effect of the mixing parameters on the dispersion of the particles and the rheological behaviour when preparing cathode NMC-based and anode graphite-based slurries for different slurry solid contents and formulations (i.e., weight ratios between active material, carbon additive, and binder). The impact of the slurry mixing parameters on the electrode performance will be also assessed. The results will be compared and will allow the optimization of a novel 3D-resolved computational model of the slurry mixing process that has been recently developed within the ARTISTIC project team (https://www.erc-artistic.eu/) in our laboratory. We also plan to implement the liquid-state slurry preparation knowledge we will acquire to facilitate the manufacturing of electrode slurries for solid-state battery electrodes.

Techniques used: rheometry, SEM, cycling testing by galvanostatic cycling with potential limitation, and granulometry.

Recent publications related to the topic:

(1) Hawley, W. B.; Li, J. Beneficial Rheological Properties of Lithium-Ion Battery Cathode Slurries from Elevated Mixing and Coating Temperatures. *J. Energy Storage* **2019**, *26*, 100994.

(2) Kuratani, K.; Ishibashi, K.; Komoda, Y.; Hidema, R.; Suzuki, H.; Kobayashi, H. Controlling of Dispersion State of Particles in Slurry and Electrochemical Properties of Electrodes. *J. Electrochem. Soc.* **2019**, *166*, A501–A506.

(3) Grießl, D.; Adam, A.; Huber, K.; Kwade, A. Effect of the Slurry Mixing Process on the Structural Properties of the Anode and the Resulting Fast-Charging Performance of the Lithium-Ion Battery Cell. *J. Electrochem. Soc.* **2022**, *169*, 020531.