Master thesis proposal

February 10th – July 31st 2020

Title of the research topic	Formulation of aqueous-based slurries for lithium ion battery anodes (ERC-funded ARTISTIC Project)
Laboratory or Company	Laboratoire de Réactivité et Chimie des Solides (LRCS)
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Scientific Project: The general goal of the ERC-funded ARTISTIC project is the development of a multiscale modelling platform that rationalizes the formulation and fabrication process of Li-ion battery (LIB) composite electrodes (made of active material particles, carbon additive particles and binder) and the effect of the variables of the manufacturing process steps in the architecture and electrochemical operation of them. Within the project we have already studied organic NMP-based slurries for LIB cathodes, both at the experimental and simulation levels. Therefore, this MSc. thesis will be devoted to the formulation of aqueous-based slurries for LIB anodes. Overall, the MSc. thesis aims at studying **experimentally** the impact of the relative proportions in the slurry components (active materials, binder, elastomer, solvent) and the process variables (mixing order, mixing rate, temperature, etc.) on the coating process during the electrode manufacturing. The resulting electrodes properties will be defined by a complex relationship between the slurry properties and the coating and drying conditions.

We propose to study the formulation of graphite composite anodes, prepared with an aqueous-based binder. The **first objective** is to find the proper formulation conditions to get maximal active material mass loading with minimal material decomposition and final porosity. The density and viscodynamic/oscillatory rheological properties of the slurries will be systematically measured to evaluate the slurries stability and viscosimetry. The final electrodes will be characterized in terms of their porosity, density, morphology (scanning electron microscopy) and electrochemical performance. The **second objective** is to find inter-dependencies between the process parameters/materials properties and the final anode descriptors (such as porosity, active material mass loading, electrochemical performance).

Candidates should be MSc. students (M2) or engineer students, with excellent background in materials science or physical-chemistry, open-minded, dynamic and showing a strong motivation. Formulation and/or electrochemical skills will be a plus.

Techniques used:

- Slurry formulation equipment (prototyping facilities within LRCS: https://www.lrcs.u-picardie.fr/thematiques-transverses/plateforme-de-pretransfert/).
- Rheometer.
- Density meter.
- Scanning Electron Microscopy.
- Electrochemical techniques (galvanostatic charge/discharge cycles, electrochemical impedance spectroscopy).

Recent publications related to the topic:

1. A. C. Ngandjong, A. Rucci, M. Maiza, G. Shukla, J. Vazquez-Arenas, A. A. Franco; *The Journal of Physical Chemistry Letters* **2017** *8* (23) 5966-5972.
2. A. Rucci, A. C. Ngandjong, E. N. Primo, M. Maiza, A. A. Franco; *Electrochimica Acta* **2019** (312) 168-178.
3. A. Kraytsberg, Y. Ein-Eli; *Advanced Energy Materials* **2016** (6) 1600655.