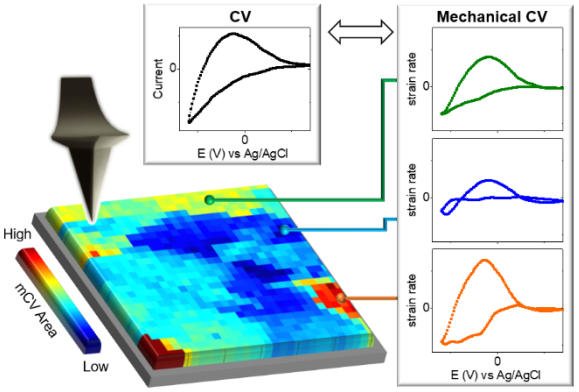
iemn
Institut d'électronique de microélectronique et de nanotechnologie
UMR CNRS 8520

Université de Lille

PhD Project: Charge Storage Mechanisms via *Operando* Atomic Force Microscopy (AFM) for Supercapacitor Applications

A fully funded 3 years PhD position in the field of fundamental characterizations for energy storage applications is available in the group of Jr. Prof. Wan-Yu TSAI at the Lille University (IEMN Lab).



About the research: To fulfill the increasing demand for portable electronic devices, advanced electrochemical energy storage technologies which store more energy at fast rates with low cost and long-term stability are required, making supercapacitors promising candidates. To achieve the high power and high energy density goal efficiently, fundamental understanding of the charge storage mechanisms at the solid/liquid interface at nanoscale is required.

About the project: To achieve fundamental understanding of the charge storage mechanisms, it is necessary to monitor the electrode materials' *intrinsic properties* during device operation. Thin film electrodes, typically used in the micro-devices (micro-supercapacitors or micro-batteries), are the perfect candidates for this task as it allows direct characterization of the electrode without interferences from additives and binders (common components in conventional battery electrodes). Atomic Force Microscopy (AFM) is a powerful technique which probes the materials' mechanical, electrical and electrochemical properties with nanometer and sometimes sub-nanometer spatial resolution. More importantly, it can operate during the device operation (*operando* mode in liquid environment) which reveals crucial real-time information during cycling. The PhD thesis will focus on investigating the charge storage mechanisms on thin film pseudo-supercapacitor electrodes with *operando* AFM and multiple other characterization techniques (XRD, SEM, TEM, Raman, UV/Vis Spectro-electrochemistry) have a nice overview of the material properties. The IEMN lab will host a new AFM in the glovebox in 2025. The candidate will first develop and validate the electrochemical AFM cell both outside and inside of glovebox for different types of electrolytes. He or she will then investigate the structure-properties correlation of the selected electrode/electrolyte system by combining electrochemical, mechanical and structural information.

What we offer: The successful candidate will have access to the Micro and Nano Fabrication Center (CMNF) and learn how to make thin film deposition, lithography, etching and all the way to micro-supercapacitors, The candidate will also have access to the Multi-Physics Characterization Platform (PCMP) and Chevreul Institute in Lille University, where he/she can characterize the micro-supercapacitors with a wide variety of techniques and experts in those techniques to guide them.

What we are looking for: Motivated students with a master degree (at the time of joining) from materials science, engineering, physics or chemistry are welcome. However, we are particularly interested in applications from students with a strong preference for hands-on experimental work, not shy of operating, optimizing complex experimental instruments. A strong curiosity that drives them to ask questions, seek answers, and explore new ideas is essential.

Funding for this position is open to **French and international applicants** and the 3 years studentship will **start as soon as possible** from September 2024. Enquiries and informal applications should include a C.V. and be addressed as soon as possible to Jr. Prof. Wan-Yu TSAI (wan-yu.tsai2@univ-lille.fr).