

**PhD thesis offer**  
**Innovative and environmentally friendly manufacturing processes**  
**for lithium-ion batteries**

**Context and objectives.**

The objectives of **reducing greenhouse gas (GHG) emissions**, which are the subject of the Paris Agreement, require a significant increase of electricity derived from renewable sources in the global energy mix. In this context, energy storage will considerably increase and requires reliable, safe and efficient storage devices. Among these, 3<sup>rd</sup> generation **lithium-ion batteries** remain state-of-the-art technologies, allowing a high level of energy density, enjoy growing success, in line with the development of electric vehicle (EV) markets. To meet this growing demand, significant work is required on the manufacturing processes for the various battery components (electrodes, separators, collectors) as well as their assembly into cells.

The traditional methods of manufacturing the various components of a battery involve solvent-based processes, which are energy consuming and not very environmentally friendly. This thesis work aims to develop alternative methods of manufacturing by melt extrusion, more productive and environmentally responsible, and less energy consuming.

The work of the thesis will begin with the **choice of relevant materials and formulations** of the mixtures of active materials and polymer binders, as well as their **rheological characterization**. It will then focus on the optimization of the **manufacturing of the different components** of the battery and their assembly. Systematic microstructural studies will allow to highlight the effects of the different process parameters. Finally, the electrochemical performances of the battery (electronic and ionic conductions) will be evaluated and related to the microstructure generated by the process.

The thesis will take place in the **PIMM laboratory**, recognized for its expertise in various fields of materials science (processing, rheology, structure-properties relations), in close collaboration with **Arkema**, which develops materials for batteries and has a recognized expertise in their process.

**Key words.** Lithium-ion batteries, melt extrusion process, rheology of filled systems.

**Hosting research unit and working environment.** The thesis will take place at the PIMM laboratory (<https://pimm.artsetmetiers.fr/en>), located at ENSAM (151, Bd de l'Hôpital - Paris XIII), which is a joint research unit between ENSAM, CNRS, CNAM. It is financed by Hésam University in the framework of the **AMI project "Compétences et Métiers d'Avenir" École de la Batterie** (France 2030). The net monthly salary of the PhD student will be 2000 €.

**Skills and experience.** The candidate should hold a Master or Engineer degree in polymer sciences, physics or physical-chemistry of polymers obtained in 2023, and have a good knowledge of polymer processing. Knowledge in electrochemistry and batteries would be a plus. A good knowledge of English (written and spoken) is mandatory.

**Application.** Applications, composed of a CV, scores of master 1 and 2 or equivalent diploma, a letter of motivation and a letter of recommendation, should be sent, before **June 30<sup>th</sup>** to:

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