DRF: Thesis SL-DRF-19-0850

RESEARCH FIELD

Soft matter and complex fluids / Physique de l'état condensé, chimie et nanosciences

TITLE

“Smart” Composite Membranes for Lithium-Metal-Polymer Batteries.

ABSTRACT

At the present stage, in the electrochemical device landscape, solid-state polymer lithium batteries offer an interesting compromise in terms of specific stored energy and power. Nevertheless, to achieve practical conduction they need to operate at relatively high temperature (80°C). This condition significantly hampers the performances of the system. The top-one priority of manufacturers in the field is to decrease the working temperature of their products. This project proposes a fundamental science approach targeting the delivery of a “proof of concept” polymer based lithium metal battery working at room temperature.

This ambitious goal will be achieved by taking advantage of i) the confinement of the electrolyte within composite Carbon NanoTube (CNT) membranes (Gibbs-Thomson effect), ii) one-dimensional (1D) ionic conductivity, and iii) the use of low molecular mass PEO (high mobility). The reduction of dimensionality will be obtained by using the quasi-perfect 1D topology offered by vertically aligned CNT forests.

The suppression of the electrical conductivity of the CNT is a critical aspect to use 1D CNT membranes as battery separators. Short PEO chains will be therefore grafted onto the CNT caps to achieve at once good ionic conduction at the CNT pore entrance and ensure electrical insulation of the CNT/electrode contact. Depending on the physico-chemical conditions on one side of the membrane (pH, temperature…), one can expect drastic changes in the conformation of the CNT-tips-grafted-polymer layer: from extended to mushroom conformation. Therefore, beyond the present project, such smart membranes could be turned into “nano-valves”, able to gate the flow between different media.

LOCATION

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Place: Saclay
Start date of the thesis: 01/10/2019

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