phD topic: Investigation of materials degradation for organic batteries by par cryo-electron microscopy and associated techniques. IDIOME

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Founding : financement établissement

Scientific domain : materials, energy stockage and conversion

Key Words: cryo-TEM, Li-ion/Na-ion batteries, degradation mechanism, organic materials

Subject description:

The constant growth of the world's population and the massive electrification of our daily lives are leading to an increased need for energy and the associated storage systems. This results in a high demand for limited mineral raw materials that could lead to a shortage. In this context, their substitution by organic compounds potentially derived from non-edible agro-resources, from "green" and more easily recyclable synthesis processes, is a promising alternative.

To date, many molecular organic or polymeric materials are capable of storing electrical energy abundantly over a wide range of potentials, thus paving the way for a complete organic battery with an output voltage of more than 2V and good energy density. Despite this, a striking observation is the lack of a commercial prototype on the market, which raises some questions about the veracity of the organic alternative and its effectiveness in storing electrical energy. These systems have many advantages including the versatility of the structures available. However, many questions remain about their reactivity and their degradation mode (formation of solid electrolyte interphase at the negative (SEI) or positive (CEI) electrode, amorphisation, ...). A thorough understanding of the electrochemical reactivity mechanisms of organic materials and in particular of the interfacial phenomena that occur between electrodes and electrolyte will allow major advances in the development of organic batteries. Few studies have been carried out to date to determine these phenomena, yet numerous analytical tools are available and have proved their worth, particularly in the context of investigations carried out on batteries made of inorganic compounds.

In this context, the IDIOME project aims to study the degradation mechanisms induced during the electrochemical cycling of model organic materials (Li-ion and Na-ion technology) and to make it possible to manufacture an all-organic battery of more than 2.5V and with a good capacity (200mAh.g-1 specific). It will be based on two complementary axes which are (i) the synthesis and electrochemical characterisation of model positive and negative organic electrode materials perfectly defined in size and morphology and (ii) their characterisation from a microstructural, structural and chemical point of view by cryo-electron microscopy at different cycling stages in order to investigate their evolution and to determine the possible degradations induced. The study of the mechanisms of electrochemical reactivity of the materials associated with the microstructural and chemical modifications determined will allow us to improve the understanding of the phenomena limiting the performance of the electrodes with a view to increase their reliability and their life span. This stage of understanding is essential for the design of viable prototypes that have less impact on the environment.

Skills / Requirements for the candidate:

The candidate must hold or be in the process of obtaining a Master 2 or equivalent degree in chemistry, electrochemistry or materials science. Knowledge in the field of batteries and/or characterisation techniques (electron microscopy, electrochemistry, etc.) will be appreciated.

Dossier de candidature :

1- **CV**
2- **Last degree grades**
3- **Master degree or equivalent**
4- **Recommandation letters**