

## Post-doctoral position (18 months)

### Structural investigation of ageing mechanisms in Si-based lithium-ion batteries by electron microscopy and FIB-SEM nano-tomography

A post-doctoral position is open at the Institute for Nanoscience and Cryogenics in Grenoble ([inac.cea.fr](http://inac.cea.fr)), a research institute depending both of the CEA and of the Université Grenoble Alpes (UGA). This position is offered in the framework of the H2020 project Sintbat ([www.sintbat.eu](http://www.sintbat.eu)) dedicated to the development of Si-based lithium-ion batteries with improved endurance. Our aim is to provide a better understanding of ageing mechanisms in composite electrodes by combining various techniques: electrochemical characterization, electron microscopy and spectroscopy analysis, RMN, and *in situ* and *operando* x-ray and neutrons scattering experiment. In the small team dedicated to this project, the postdoc will be in charge of the structural characterizations by (S)TEM (imagery, EELS and EDX spectroscopies) and FIB-SEM nano-tomography.

#### Context

Lithium ion batteries (LiBs) are widespread in many applications such as mobile phones, computers and electric vehicles. The usual anode material is graphite but silicon has recently appeared as a candidate for the next generation of LiBs: its energy density is about ten times higher ( $\sim 4000$  mAh/g) than that of graphite ( $\sim 330$  mAh/g), its discharge potential relative to  $\text{Li}^+/\text{Li}$  is low (improving the battery safety), its raw cost is very low and a dedicated industry already exists (micro-electronics). Although cycling performances have been greatly improved in the last years, the practical use of Si in LiBs has been hindered by limitations due to the mechanical failure of the electrode consecutive to the large volume changes upon rich lithiation. Different strategies have been proposed to minimize these effects:

- i) the use of **composite materials** by combining Si active particles with another active or inactive material;
- (ii) the use of **nanosized crystalline Si particles (Si NPs)** to accommodate large stress and strain without cracking;
- iii) the prelithiation to control the Solid Electrolyte Interphase (SEI) impact and compensate lithium trapping.

To date none of these strategies resulted in satisfactory cyclability.

#### Objectives

Our aim is to gain knowledge on the ageing mechanisms of Si-based lithium ion batteries to determine the limiting processes. We will combine for this purpose advanced characterization techniques (electron microscopy, RMN, *ex situ* and *operando* scattering techniques) to provide a comprehensive picture of structural and electrochemical evolutions of the Si-based electrodes, to quantify the impact of lithiation/delithiation processes on silicon nanoparticles, and to follow the SEI formation and evolution. This will be done on model materials (e.g. Silicon wafers), and on commercial composite materials. We expect to provide a detailed

understanding of complex mechanisms occurring during the charge and the discharge of the Lithium battery, which are critical for improving the performances of the device.

### **Hosting teams**

Within INAC, the postdoc will be based in the MEM laboratory (Modélisation et Exploration des Matériaux). This lab is part of the nanocharacterization platform of Minatec (PFNC), which has access to a large range of state-of-the-art facilities such as 6 TEMs (including two FEI Titan corrected microscopes), 5 SEMs and 3 dual-beam FIBs (including a new Zeiss Crossbeam 550), as well as a dedicated lab for specimen preparation. Our activity is mainly dedicated to nanoscale research (physics and chemistry of materials down to atomic scale) using advanced instrumentation.

### **Applicant profile**

The candidate should have a PhD in physics or in material science, with an expertise in electron microscopy and related spectroscopy techniques. Some experience on focused in beam microscopy and/or on the analysis of materials for energy storage would be appreciated. The candidate must be motivated to work in a multidisciplinary project, and interact with the electrochemists, chemists and physicists of INAC, as well as with our European academic and industrial partners.

**Application:** Please join a CV, a cover letter and one or two recommendation letters.

**Contact:** Dr. Pierre-Henri Jouneau - [pierre-henri.jouneau@cea.fr](mailto:pierre-henri.jouneau@cea.fr)