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Electro-chemo-mechanical phenomena at the nanoscale in solid state ionic conductors by Atomic Force Microscopy (AFM)

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Abstract

Solid-state ionic conductors are essential components of the next generation of energy storage devices, such as lithium-ion batteries and supercapacitors. In this kind of materials conductivity is due to the motion of anions within the structure. Atomic force microscopy (AFM) is a scanning probe technique that uses a very sharp tip at the end of a microcantilever as a force sensor to provide valuable information at the nanoscale about physicochemical properties of a wide variety of systems [1].

In this project, the student will first learn about the fundamental principles of operation of solid-state ion batteries by standard electrochemical techniques such as voltammetry and charge-discharge cycles. Then he/she will use an AFM in an inert atmosphere to characterize at the nanoscale the electrical and mechanical properties of Li and Na ionic conductors, such as lithium lanthanum zirconium oxide LLZO ($Li_7La_3Zr_2O_{12}$) or NASICON ($Na_{1+x}Zr_2Si_xP_{3-x}O_{12}$). Finally, he/she will explore the possibility of using this technique to characterize the interfaces of solid-state batteries under operation conditions.

The *Nanoprobing Energy Materials* group is focus on the investigation of fundamental processes at the nanoscale of materials used in energy storage systems by AFM and other complementary techniques in collaboration such as X-ray photoelectron spectroscopy (XPS) or photoemission electron microscopy (PEEM). The student will benefit from the interaction with the international network funded under the OPERA HORIZON European Project coordinated by us [2].

References:
1. E. J. Fuller et al., Imaging phase segregation in nanoscale Li_xCoO_2 single particles, ACS Nano (2022)
2. https://horizon-opera.eu/