

Hydride-based all solid state Li-ion and Na-ion batteries comprising novel surface-oxidized borohydrides electrolytes and metallic hydrides anodes

ICMPE



NICOLAS BAUDIN
INTERNSHIPS IN FRANCE INITIATIVE

Name of the hosting institution in France	CNRS/ICMPE (Institut de Chimie et des Matériaux Paris-Est) – UMR 7182
Name of the host laboratory / research team	Matter Hydrogen Interaction
Address	2-8, rue Henri Dunant - 94320 THIAIS-FRANCE
Web site	http://www.icmpe.cnrs.fr/
Name of the supervisor	Fermin Cuevas
Function	CNRS Research Director
Email	fermin.cuevas@icmpe.cnrs.fr
Phone number	+33 149 781 225

Internship offer

Topic of the internship (title)	Hydride-based all solid state Li-ion and Na-ion batteries comprising novel surface-oxidized borohydrides electrolytes and metallic hydrides anodes			
Proposed dates of the internship*	Start	2020-09-15	End	2020-12-15

* The supervisors have indicated the dates proposed are flexible and are able to be postponed subject to COVID-19 border closures.

Scientific and academic objectives of the internship (detailed description of the internship content, work expected from the intern and expected outcomes):

Research activities performed at ICMPE (France) on solid-state batteries (SSB) have demonstrated that hydrides are highly promising materials for this technology. Indeed, a full SSB was developed in which MgH₂-TiH₂ nanocomposite was used as anode, sulfur as cathode and LiBH₄ as solid electrolyte¹⁻². LiBH₄ was used as the solid electrolyte due to its good mechanical properties and high Li-ion conductivity of 10⁻³ S cm⁻¹ for the hexagonal polymorph at 120°C. Recent studies performed by MERLIN group at UNSW (Australia) have demonstrated that similar superionic properties are obtained near room temperature (35°C) when using surface oxidized borohydrides LiBH₄ and NaBH₄³.

The purpose of this internship at ICMPE (France) will be to study the chemical and thermal compatibility between metallic hydride electrodes and surface oxidized borohydrides electrolytes in Li-ion and Na-ion half-cell configurations.

[1] P. López-Aranguren, N. Berti, A. H. Dao, J. Zhang, F. Cuevas, M. Latroche, C. Jordy, "An all-solid-state Metal Hydride - Sulfur Lithium-ion battery", *J. Power Sources*, 357 (2017) 56-60 [2] M. Latroche, D. Blanchard, F. Cuevas, A. E. Kharbachi, B. C. Hauback, T. R. Jensen, P. E. d. Jongh, S. Kim, N. S. Nazer, P. Ngene, S. I. Orimo, D. B. Ravnbaek, V. A. Yartys, "Full-cell hydride-based solid-state Li batteries for energy storage", *Int. J. Hydrogen Energy*, 44 (2019) 7875-7887 [3] Xiaoxuan Luo, Aditya Rawal, Claudio Cazorla, Kondo-Francois Aguey-Zinsou, "Facile Self-forming Superionic Conductors Based on Complex Borohydrides Surface Oxidation" *Advanced Sustainable Systems* (2020) accepted.

Name of industrial partner	Naval Group S. A.	
Role of the industrial partner in the internship project	Naval Group has proposed a general topic that is "solid state batteries" while ICMPE laboratory has provided a detailed research project. Naval Group will visit the French lab during the project and will ask for a copy of the internship final report.	
Main contact at the French industrial partner	Dr Elise Deunf	
Function	Energy Advanced Technologies Specialist	
Email	elise.deunf@naval-group.com	
Main contact at the French industrial partner's branch in Australia	Dr Margaret Law	
Function	Chief Technical Officer, Naval Group Pacific	
Email	margaret.law@au.naval-group.com	
Is the internship project proposed in the framework of an existing collaboration with an Australian partner university?	Yes	
Name of the Australian partner institution	UNSW	
Outside of this ongoing collaboration, will applications coming from students of other eligible Australian universities be considered by the hosting institution in France?	No	

Expected profile of applicant

Level of study	PhD student
Discipline	Chemical Engineering
Required qualities, knowledge and skills	For this project combining the expertise of both laboratories in France and Australia to enable faster research output in terms of new batteries development. The applicant is expected to have strong skills in solid state electrolytes development as well as full battery assembly and characterization.
Other specific eligibility criteria	Communication will occur in English (a common practice in research laboratories). The student is not expected to be fluent in French.