Position Description

1. General Information

Name of the position	**High pressure and Li-ion batteries**
Foreseen enrolment date	January 2025
Position is funded by	• COFUND, Marie Skłodowska-Curie Actions (MSCA), Horizon Europe, European Union • Université Claude Bernard Lyon 1 (UCBL) • University of New South Wales (UNSW)
Research Host	Université Claude Bernard Lyon 1
PhD awarding institutions:	University Université Claude Bernard Lyon 1 & University of New South Wales
Locations	Primary: Lyon, France Secondary: Sydney, Australia
Supervisors	Vittoria Pischedda (UCBL, ILM) Neeraj Sharma (UNSW)
Group of discipline	Physics, materials science, chemistry

2. Research topics (only one of these projects will be funded)

Project 1: Com*pressibility in zero/low thermal expansion materials*
Thermal expansion/contraction of materials can be a significant challenge in microscopic applications such as high precision instruments as well as a problem in large-scale applications like jet engines and buildings. These expansion coefficients need to be known and carefully monitored. Alternatively, materials that exhibit low or zero thermal expansion over a wide range of temperatures can be developed. Our team has recently worked on one such material. In addition, to the "zero" thermal expansion we have investigated the materials' response to pressure. The intention is to design and make an extremely stable material, stable in terms of volume and shape as a function of both temperature and pressure. This project focuses on the pressure aspect, to evaluate the pressure induced changes, compressibility, bulk modulus and phase transitions of low or zero thermal expansion materials. The student will systematically work through a range of materials, exploring the pressure-temperature phase diagram and may at the end of the project develop a low thermal and pressure stable material. The student will perform in situ XRD and Raman spectroscopy during compression decompression cycles in a diamond anvil cell or using a Paris-Edinburgh press. Subject to approval of a proposal, students will have the opportunity to participate to experiments at synchrotron or neutron large facility in Europe and/or Australia. We seek a student with a background in Physics/Material Science/Chemistry. Experience in high-pressure techniques, Raman spectroscopy and/or X-ray diffraction is advantageous.

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Supervisors: Prof. Vittoria Pischedda (UCBL, ILM); A/Prof. Neeraj Sharma (UNSW); Dr Jehan Kanga (Rux Energy)

Research Fields: Physics, Material science, Chemistry

Project 2: *The role of pressure in solid state batteries*

Lithium-ion batteries are ubiquitous in society finding use in mobile electronics, electric vehicles and grid-scale energy storage. As electrification of the world's transportation fleet continues these batteries will be more and more prevalent in society. One of the challenges of vehicle-based applications is safety, designing and using an inherently safe battery would further accelerate uptake. Solid state batteries are inherently safe as many of the thermal runaway mechanisms are either non-existent or do not occur in such batteries. Furthermore, use of an appropriate anode, Li metal, may mean a more energy dense battery. In solid state batteries, conductivity and interfacial resistance play a dramatic role in performance. This project is specifically targeting the role of applied pressure on a solid state battery (or part of such a battery). The physiochemical and electrochemical properties of solid state batteries will be examined as a function of pressure. Various compositions of electrodes and electrolytes will be examined. The ultimate goal would be to thorough atomic-level understanding of the role of pressure on device function. The student will study the sintering process of materials by means of high-pressure/temperature experiments performed with a unique High-Pressure Spark Plasma Sintering device (HP-SPS), developed at ILM. This HP-SPS device allows in situ synchrotron X-ray diffraction (XRD) during the sintering. The student will perform also in situ XRD and Raman spectroscopy during compression decompression cycles in a diamond anvil cell on the electrolyte and electrode compounds to obtain information on their structural and mechanical properties. Electrochemical tests such as ionic conductivity measurement, cyclic voltammetry will be performed additionally at UNSW to find out the optimal parameters for proper solid state battery cycling. Subject to approval of a proposal, students will have the opportunity to participate to experiments at the synchrotron.
We seek a student with a background in Physics/Material Science/Chemistry. Experience in electrochemical characterisation, high-pressure techniques, Raman spectroscopy and/or X-ray diffraction is advantageous.

Supervisors: Prof. Vittoria Pischedda (UCBL, ILM); A/Prof. Neeraj Sharma (UNSW); Dr Jehan Kanga (Rux Energy)

Research Fields: Physics, Material science, Chemistry

Project 3: *Biomass carbon derived anodes for durable Li-ion batteries*

Energy storage is one of the key challenges in the energy transition from non-renewable to renewable sources. The erratic nature of solar or wind energy conversion is an issue, especially for local automotive production. Another challenge is the next generation of electric vehicles that require high-capacity storage and short charging time. One solution is the Li-ion battery, which is easy to use, partially recyclable and could become increasingly cost-effective. However, the current technology based on graphitic electrodes is not yet able to meet the requirements (high capacity and fast charge) and there is a growing demand for Li-ion quality graphite or alternatives. The objective of this research project is to study, by applying pressure, the stability and properties of materials that are of potential interest as a new generation of anodes in batteries, such as fluorinated graphites. To do this, we will replace pristine commercial graphite with biomass carbon derived and carbon-neutral or carbon-negative "green" materials to find market-competitive alternatives to carbon pricing (e.g., carbon tax or emission permits). The student will investigate at ILM, France, the impact of pressure on biomass-derived carbons or recycled carbon materials to design more durable, higher-performance lithium-ion battery anodes. The student will perform in situ high-pressure/temperature experiments using XRD and Raman spectroscopy during compression decompression cycles in a diamond anvil cell or in large Paris-Edinburgh press. The electrochemical tests will be performed at UNSW, Australia. We seek a student with a background in Physics/Material Science/Chemistry. Experience in electrochemical characterisation, high-pressure techniques, electrochemical characterisation, Raman spectroscopy and/or X-ray diffraction is advantageous.

Supervisors: Prof. Vittoria Pischedda (UCBL, ILM); A/Prof. Neeraj Sharma (UNSW); Dr Jehan Kanga (Rux Energy)

Research Fields: Physics, Material science, Chemistry

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3. Employment Benefits and Conditions

The Université Claude Bernard Lyon 1 offers a 36-months full-time work contract (with the option to extend up to a maximum of 42 months). The total number of worked hours per week is 37h30.

The remuneration, in line with the European Commission rules for Marie Skłodowska-Curie grant holders, will consist of an estimated gross annual salary of 28,080.00 EUR. Of this amount, the estimated net salary to be perceived by the Researcher is 1,870.00 EUR per month. However, the definite amount to be received by the Researcher is subject to national tax legislation.

Benefits include

- Becoming a Marie Skłodowska-Curie fellow and be invited to join the Marie Curie Alumni Association.
- Access to both universities educational resources, as well as ILM/CETHIL and UNSW research facilities and laboratories.
- Tuition fee waiver at both PhD awarding institutions.
- Yearly travel allowance to cover flights and accommodation for participating in AUFRANDE events.
- 10,000 EUR allowance to cover flights and living expenses for 12 months in Australia.
- 47 days paid holiday leave.
- Sick leave.
- Parental leave.

4. PhD enrolment

Successful candidates for this position will be enrolled by the following institutions and must comply with their specific entry requirements, in addition to AUFRANDE's conditions. Applicants must have a bac+5 diploma or equivalent (Master 2 in France) with a substantial research component and demonstrated capacity for timely completion of a high-quality research thesis.

If English is not your first language, you will be required to provide evidence your English language proficiency. Note that your English test needs to be completed no more than two years before your enrolment. The English language test scores requirements can be found here: https://www.unsw.edu.au/study/how-to-apply/english-language-requirements

More information on UCBL's requirements

More information: https://phd-physics.universite-lyon.fr/ed-52-phast/site-francais/navigation/pendant-la-these/inscriptions-reinscriptions/ and https://edmega.universite-lyon.fr/modalites-d-inscription-en-these-dans-l-ed-80532.kjsp?RH=1517326141045&RF=1517327603142

More information on UNSW's requirements

More information: https://research.unsw.edu.au/higher-degree-research-programs

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