Position Description

1. General Information

Name of the position	**Advanced battery electrolytes and Nuclear Magnetic Resonance spectroscopy**
Foreseen enrolment date	1 July 2024
Position is funded by	• COFUND, Marie Skłodowska-Curie Actions (MSCA), Horizon Europe, European Union • Centre National de la Recherche Scientifique (CNRS) • Deakin University
Research Host	Centre National de la Recherche Scientifique (CNRS)
PhD awarding institutions	Université d'Orléans & Deakin University
Locations	Primary: Orléans, France Secondary: Melbourne, Australia
Supervisors	Prof Michael Deschamps & Dr Elodie Salager (Orléans/CNRS) A/Prof Luke A. O'Dell & Prof Maria Forsyth (Deakin)
Group of discipline	Materials characterisation, battery electrolytes, magnetic resonance, electrochemistry, computational chemistry

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

Project 1: *Designing new solid polymer electrolytes for lithium batteries*
Solid electrolytes can solve the leakage and flammability issues associated with traditional carbonate-based liquid-state electrolytes, thereby potentially providing a safer alternative for lithium ion batteries and related technologies. However, in solid materials the ion transport is generally also slower than in liquids, and so new materials need to be developed with improved properties to solve this issue. In this project, novel block co-polymer electrolytes combining different functional components such as styrene (for mechanical strength) and cation or anionic groups (to promote dynamics and ionic transport) will be developed and studied with the aim of understanding their molecular-level structure, dynamics and interactions. A combination of nuclear magnetic resonance (NMR) spectroscopy, computational simulations and other complementary techniques will be used to understand the ion transport mechanisms and interactions present, thereby enabling the materials to be improved via tailoring of their chemistry and composition and subsequently tested inside a prototype cell. The candidate will gain expertise in advanced experimental and computational materials characterization methods and will work at two world-leading energy materials research groups. This project takes advantage of the host universities and industry partner's unique expertise and capabilities in

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polymerized ionic liquid synthesis (Solvionic), electrolyte design and characterization (Deakin University) and high-field NMR spectroscopy (Orleans/CEMHTI-CNRS).

Supervisors:

Prof Michaël Deschamps & Dr Elodie Salager (Orléans/CNRS)

A/Prof Luke A. O'Dell & Prof Maria Forsyth (Deakin)

Dr Sébastien Fantini (Solvionic)

Research Fields: Batteries and energy storage, materials characterization and modelling, polymer electrolytes, magnetic resonance spectroscopy

Project 2: *Measuring interactions in ionic liquid-based electrolytes using advanced NMR spectroscopy*

Ionic liquids, including their polymerized form, are highly promising in applications as battery electrolytes due to their tailorable properties, electrochemical stability and ability to dissolve high concentrations of metal salts. By adjusting their chemistry (e.g., by varying the cation organic groups or anion fluorination), we can potentially optimize their ion transport properties. However, this molecular design approach requires a detailed understanding of the structure and interactions present within the liquid, both in the bulk phase and at the interface with a solid (e.g. an electrode surface). In this project, advanced nuclear magnetic resonance (NMR) spectroscopy and other complementary methods will be used to study these interactions in detail, including the formation of solid electrolyte interphase products that form inside operational batteries and are crucial to their performance. This work will provide detailed information that will aid the design of the next generation of electrolyte systems. The candidate will gain expertise in advanced experimental and computational materials characterization methods and will work at two world-leading energy materials research groups. This project takes advantage of the host universities and industry partner's unique expertise and capabilities in ionic liquid development and synthesis (Solvionic), electrolyte design and characterization (Deakin University) and advanced NMR methods development (Orleans/CEMHTI-CNRS).

Supervisors:

Prof Michaël Deschamps & Dr Elodie Salager (Orléans/CNRS)

A/Prof Luke A. O'Dell & Prof Maria Forsyth (Deakin)

Dr Sébastien Fantini (Solvionic)

Research Fields: Batteries and energy storage, materials characterisation and modelling, ionic liquid electrolytes, magnetic resonance spectroscopy

Project 3: *Molecular level characterisation of novel ionic sodium battery electrolyte materials*

Sodium offers a cheaper and more abundant alternative to lithium for battery electrochemistry. However, while sodium has similar properties to lithium, it cannot be directly substituted into existing battery materials due to its larger size and different interactions with the host matrix. Thus, new materials such as electrolytes need to be designed specifically for this cation with the aim of promoting its transport properties. In this project, novel sodium electrolyte systems such as ionic liquids, polymers and plastic crystals will be studied using high-field nuclear magnetic resonance (NMR) spectroscopy, which can provide detailed information on structure, dynamics and ion interactions in these materials. In turn, this will inform the design of new and improved sodium battery electrolytes that will enable this cheaper and greener energy storage technology. The candidate will gain expertise in advanced experimental and computational materials characterisation methods and will work at two world-leading energy materials research groups. This project

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takes advantage of the host universities and industry partner's unique expertise and capabilities in battery electrolyte development and synthesis (Solvionic), sodium batteries and electrolyte characterisation (Deakin University) and high-field NMR spectroscopy (Orleans/CEMHTI-CNRS).
Supervisors: Prof Michaël Deschamps & Dr Elodie Salager (Orléans/CNRS) A/Prof Luke A. O'Dell & Prof Maria Forsyth (Deakin) Dr Sébastien Fantini (Solvionic)
Research Fields: Batteries and energy storage, materials characterisation and modelling, sodium electrolytes, magnetic resonance spectroscopy

3. Employment Benefits and Conditions

CNRS offers a 36-months full-time work contract (with the option to extend up to a maximum of 42 months). The total working hours per week is 38.5h.

The remuneration, in line with the European Commission rules for Marie Skłodowska-Curie grant holders, will consist of a gross annual salary of EUR 27,000. Of this amount, the estimated net salary to be perceived by the Researcher is EUR 1,750 per month. However, the definite amount to be received by the Researcher is subject to national tax legislation, approximatively 4.2% of the gross salary for a single person with no tax deduction.

Benefits include

- Becoming a Marie Skłodowska-Curie fellow and be entitled to join the Marie Curie Alumni Association.
- Access to all the necessary facilities and laboratories at Université d'Orléans and Deakin University.
- Tuition fees exemption 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 up to 12 months in Australia.
- 44 days paid holiday leave.
- French Social security coverage.
- Paid sick leaves according to Social Security rules and based on certificates signed by authorized health professionals.
- Parental leave: 14 weeks of paid maternity leave, 11 days of paid paternity leave.

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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 hold a Master's degree by research in a related area from a recognised tertiary institution.

Applicants should meet the English Language Entrance requirement of IELTS 6.5 with no band below 6 - for entrance into an Engineering Degree.

More information on Université d'Orléans' requirements

Visit the website: https://collegedoctoral-cvl.fr/as/ed/page.pl?page=procedures&site=CDCVL

Successful applicants will be required to submit an application on the CNRS enrolment platform https://emploi.cnrs.fr

More information on Deakin University's requirements

Visit the website: https://www.deakin.edu.au/research/research-degrees-and-PhD/research-applications

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