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INSTITUT FRANÇAIS
India

Job offer –Post-doctorate in Electrochemistry/Li-ion batteries

Research Project Short Title as Submitted to CEFIPRA: "Conductivity Tailored Scalable Gel-Li ion pouch cell battery with innovative functional carbon additives**"**
Principal Investigator contact: "Prof. Sylvain FRANGER, sylvain.franger@universite-paris-saclay.fr**",** Universite Paris-Saclay
Reference Number of the Job Offer: IFI_CEF_24_01

Project description

- **Keywords:** Li-ion battery, gel polymer electrolyte, conductive additive, electronic/ionic limitations, impedance spectroscopy

- **Context:**

  Lithium-ion batteries stand at the forefront of technology, maintaining dominance amidst ongoing research into alternatives. Their supremacy owes to remarkable qualities: high energy density, extended cycle life, heightened safety, and a consistent cost reduction trend. Performance hinges on materials for active and inactive components. Cathode laminates advance through tailored materials and coatings, boosting energy density and stability. Anode laminates prioritize volume changes, especially silicon-based anodes with nanostructures and coatings for prolonged cycling. Gel electrolytes evolve for safety and performance, balancing ionic conductivity and mechanical stability, a viable liquid electrolyte alternative. Gel polymer electrolytes find acceptance, including PAN, PEO, PVdF-HFP, PEG, PAM, and PVdF-HFP-TFE-based options. Blending polymers tailors electrolyte properties. Meticulous electrode laminate design ensures uniformity, heightening battery efficiency. Novel conductive additives like multilayer graphene enhance electronic conductivity and electrolyte reservoir capacity, promoting cyclic stability and battery longevity. Selecting and optimizing these components are pivotal for achieving higher energy density, swift charging, and secure battery operation across applications.

- **Abstract of the Research Project:**

  This study aims at developing an advanced lithium-ion gel battery system with functional electrode laminates. Incorporating in-house synthesized alternative conductive additives, the project aims to finely control electrolyte absorption and enhance long-range electronic conductivity within the electrode laminate. Notably, the utilization of high-aspect-ratio conductive additives, such as multilayer graphene, demonstrates sustained conductivity over prolonged charge and discharge cycles. The introduction of gel electrolytes contributes to heightened cell safety. Additionally, the project emphasizes the integration of a suitable cell management system in collaboration with an industrial partner. Through these efforts, the project aims to improve the efficiency and safely of lithium ion cells.

- **Scientific Objectives of the Project:**

  1. Develop functional carbon-based conductive additives to achieve: a) Uniform dispersion of conductive additives within the electrode laminate, b) Enhanced compatibility between gel polymer and active material.
  2. Optimize the morphology and concentration of multilayer graphene conductive additives to improve the quantity of electrolyte uptake in gel polymer, ultimately enhancing electrochemical performance.
  3. Fabricate lithium-ion gel polymer pouch cells with 300-500 mAh capacity using the following key aspects: a) Utilize Carbon Black-Multilayer Graphene-Lithium Nickel Manganese Cobalt oxide (CB-MLG-NMC) cathode laminates and Graphite-CB laminate, carbon coated Silicon-CB nanoparticles, b) Employ a gel-based electrolyte, known for high ionic conductivity and non-flammability, c) Develop pouch cells, d) Incorporate the battery management system (BMS) by an industry partner for real-time testing.

- **Methodology and Timeline of the Project:**

  The work to be done inside this project:

  1. Creation of Nanoscale Silicon-Carbon Composite Anode: This step targets enhancing Si-based anode materials by designing a nanoscale structure. This entails forming a small silicon core enveloped by a thin layer of conductive carbon, forming a composite. An elastic polymer electrolyte is introduced as an intermediary layer, addressing Si's expansion and contraction during charging cycles, improving anode stability and battery performance.
     (3 months)
  2. Incorporation of Gel Polymer Electrolytes: The planned cells will utilize gel polymer electrolytes to enhance cell safety and compatibility of functionalized conductive additives in both the cathode and Si-C anodes. The project centers on producing gel lithium-ion pouch cells using NMC-CB-MLG cathodes, gel electrolytes, and graphite-Si-CB anodes.
     (3 months)
  3. Measurement, through Electrochemical Impedance Spectroscopy (EIS), of the electrode and full cell performance. Determination of the main electronic/ionic limitations within the electrodes and full cell in order to improve the formulation, architecture of the final cell.
     (6 months)

Candidate profile

- Only Indian candidates or candidates with a research experience in India are eligible; French candidates are not eligible
- Applicants for post-doctorate must have a PhD degree (or be in the process of obtaining one)
- No competences in French language is required
- Candidate competences: chemistry, materials science, electrochemistry
- Candidate know-how: rigor, autonomy, report writing
- Expected starting date: **01/05/2024**

How to candidate ?

Documents to be provided :

i. A cover letter (reasons for the candidature, professional project …) max 2 pages
ii. A copy of the master's degree or a proof of the program followed (and expected date of end) OR A copy of the PhD degree or a proof of the PhD program followed (and expected date of defense) max 1 page
iii. A copy of results for previous scholarship (max 3 pages)
iv. International curriculum vitae (max 2 pages)
v. Two letters of recommendation: one from any Indian institution and one from the French institution planned to host the candidate –mandatory- (max 2 pages)
vi. All should be submitted within 1 pdf file of no more than 10 pages.

Applications should be submitted to the following email address: msi@ifindia.in mentioning the reference number of the Job offer clearly.

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Candidates are requested to contact the French scientific principal investigator of the project before submission. A recommendation letter from the scientific principal investigator is mandatory.

Benefits:

- Monthly allowance of 2400 euros for Post-Doc
- Travel allowance
- University fee
- Carte de séjour fee
- Campus France management fee
- Registration to the French social security scheme

Selection process:

Selection is made by a dedicated selection committee of at least 4 persons. Decisions will be transmitted by the Embassy of France to CEFIPRA. **No consideration will be given for candidates with no recommendation letter from the French institution.**

Criteria for applicants' selection:

Academic excellence

- Excellence of the Academic background, Academic records, Honors, Letters of support, Participation to international research projects, exchange programmes and conferences.

Motivation and qualities

- Academic maturity: appropriation of the thesis project (stakes and contexts) • Quality of the presentation (oral expression, skills for synthesis, English level) • Maturity of the professional project: capacity to project her/himself within five years in terms of career development.

About CEFIPRA:
Indo-French Center for the Promotion of Advanced Research (CEFIPRA/IFCPAR) is an Indian body which promotes scientific cooperation between France and India in advanced fields of Science and Technology. It is supported by the Department of Science and Technology, Government of India and the Ministry of Europe and Foreign Affairs of the French government.