BU MATCH FUNDED STUDENTSHIPS 2024 PROJECT DESCRIPTION

PROJECT TITLE
New electrolytes for safer lithium-ion batteries
PROJECT SUMMARY

Do you have a passion to develop the next generation batteries? Did you ever thought of making batteries that is safer, more efficient and can help achieving better performance for electric vehicles and energy storage application? If so, perhaps this fully funded PhD studentship is available for you. Bournemouth University is teaming with ambitious industrial partner, Arkimedes B.V. (The Netherlands), to develop new types of solid-electrolytes to build next generation solid state batteries. The project is multidisciplinary and covers aspects of chemistry, chemical engineering, physics and materials science. Main focus will be on developing novel synthesis method and while making the industrial processing easier. The synthesized electrolytes will be characterized using X-rays, SEM, electrochemical methods (impedance spectroscopy, cyclic voltammetry etc.) and tested in various half and full cell battery configurations to find compatible electrode materials.

More information regarding this project can be addressed to the lead supervisor Dr. Amor Abdelkader at aabdelkader@bournemouth.ac.uk

The PhD student will be embedded in the advanced materials lab at the Bournemouth University under the supervision of by Dr. Amor Abdelkader) and co-supervised by Remco van der Jagt and Dr. Deepak Singh at the Arkimedes (The Netherlands). The PhD student is expected to have secondment and frequent visit to industrial partner in the Netherlands, and will also have an opportunity to partaking experiments in the UK and abroad. The PhD candidate will receive extensive training in a range of state-of-the-art research techniques via course work, conferences and collaborations, which are directly applicable to a career in academia or industry.

The ideal candidate for the role will have received a First-class Honours degree in Materials Science, Chemistry, chemical engineering, or a related discipline. They will preferably have some experience with nanomaterials synthesis and lithium-ion batteries. Further requirements include:

- A Master Degree in Materials Science, Chemical Engineering, Chemistry or Physics (or equivalent), obtained within last 3 years.

- Strong academic credentials relevant to this PhD project. (i.e. good grades in electrochemistry, ceramic, solid state physics, material science, chemistry and/or related subjects, internship or master's thesis)

- Good communicating, writing and laboratory skills.

- Previous experience in working with Lithium batteries or battery materials, solid electrolyte will be preferred (yet not mandatory)

- Motivation letter (Max 2 pages), Detailed CV, (List of publication if available), Contact details of at least two referees.

- English proficiency is preferred to be at a high level as the PhD project will be at Bournemouth University (UK) and to ensure that the candidate is able to participate fully in English Doctoral Education courses and discussions.

- You are eager to learn, can think outside the box, strive for the better result and like to work in direct connection with industry partners.

ACADEMIC IMPACT

The success of the proposed project would give the possibility of the creation of a next-generation Li-ion battery electrolyte, which is more efficient and much safer to use in electric vehicles than the current liquid electrolyte. The project will also introduce a cost-effective technique for fabricating the new electrolyte that can enable large-scale production of energy storage. This would undoubtedly benefit interdisciplinary work and broaden the scientific portfolios of many research groups and individual scientists all over the world. The work is anticipated to generate high impact publications. It is also expected to be the first stage of a rather larger knowledge transfer project.

SOCIETAL IMPACT

The UK has set a legally binding target to reduce greenhouse gas emissions by 80% by 2050. To achieve this target, most of the R&M suggest using decarbonised electricity to meet many of the energy demands currently served by fossil fuels. This, combined with the increasing dependence on renewable energy and electrification of space heating, would lead to seasonal peaking of electricity demand for heat and variability of supply from intermittent generation. Energy storage systems are expected to play a major role in meeting the challenges of more variable supply and peak demand. The proposed project is concerned with developing electrode materials that could be scaled up for grid-scale electrochemical energy storage. Also, there is an increasing demand to provide improved lightweight energy storage devices for electric vehicles and portable electronic devices. The proposed project has a very high potential to provide a cost-effective, high-performance battery. Therefore, the impact of this project would be significant for society, the environment and the economy.

PGR DEVELOPMENT OPPORTUNITIES

The candidate will receive technical training in three major areas: (1) nanomaterials synthesis, (2) nanomaterials characterisation (3) electrochemical devices fabrication and characterisation. This training will be provided by the supervisory team and will form a routine part of the doctoral student's workload. Arkimedes BV in Delft will be acting as co-host and co-supervisor for this project to provide training specific to the production of electrolyte and solid-state batteries that the student must understand. A senior scientist from Arkimedes will join the supervisory team to ensure that the student is achieving the required training and guidance.

SUPERVISORY TEAM	
First Supervisor	Dr. Amor Abdelkader
Additional Supervisors	Dr. Deepak Pratap Singh (external/ Arkimides B.V. , The Netherlands) Remco van der Jagt (External/ Arkimides B.V, The Netherlands)
Recent publications by supervisors relevant to this project	• Z. Sun, K. Xi, J. Chen, A. M. Abdelkader, M. Li, Y. Qin, S. Ding, Expanding the active charge carriers of polymer electrolytes in lithium-based batteries using an anion-hosting cathode. *Nature Communications*, 13(1), 1-11 (2022). • W. Wang, K. Xi, B. Li, H. Li, S. Liu, J. Wang, A. M Abdelkader, X. Gao, G. Li, Sustainable multipurpose separator directed against the shuttle effect of polysulfides for high-performance lithium–sulfur batteries. *Advanced Energy Materials*, 2200160 (2022) • Y. Zhong, Y. Su, P. Huang, Q. Jiang, Y. Lin, Wu H, A.M. Abdelkader AM, K. Xi, S. Chou, Polyoxometalate ionic sponge enabled dendrite-free and highly stable lithium metal anode. *Small Methods,* 2101613 (2022) • J. Wang, S. Yi, J. Liu, S. Sun, Y. Liu, D. Yang, K. Xi, ǁ G. Gao, A. M. Abdelkader, W. Yan, S. Ding, V. Kumar, Suppressing the Shuttle Effect and Dendrite Growth in Lithium-Sulfur Batteries, *ACS Nano*, 14, 9819 (2020) • C. R. Ratwani, S. Zhao, Y. Huang, M. Hadfield, A.R. Kamali, A. M. Abdelkader, Surface modification of transition metal dichalcogenide nanosheets for

	intrinsically self-healing hydrogels with enhanced mechanical properties. *Small*, 2207081(2023)F. Niranjala; K. Harikishan; H. F. C Robles; P. Ajayan, M. Ashokkumar, A. M. Abdelkader, Graphitic nanostructure integrated NiO composites for high-performance lithium-ion batteries, *Journal of Energy Storage*, 71, 108015 (2023) • Deepak Singh, et al. "Enhanced cycling and rate capability by epitaxially matched conductive cubic TiO coating on LiCoO2 cathode films." ACS Applied Energy Materials 4.5: 5024-5033. (2021) • Remco van der Jagt et al. Synthesis and Structure–Property Relationships of Polyimide Covalent Organic Frameworks for Carbon Dioxide Capture and (Aqueous) Sodium-Ion Batteries, Chemistry of Materials. 33, 3, p. 818-833 16 p. (2021) • Remco van der Jagt et al. Scalable Route to Electroactive and Light Active Perylene Diimide Dye Polymer Binder for Lithium-Ion Batteries, ACS Applied Energy Materials. 3, 3, p. 2271-2277. (2020)

INFORMAL ENQUIRIES

Please contact the lead supervisor on the following email for informal enquiries: aabdelkader@bournemouth.ac.uk

ELIGIBILITY CRITERIA

The BU PhD and MRes Studentships are open to UK, EU and International students.

Candidates for a PhD Studentship should demonstrate outstanding qualities and be motivated to complete a PhD in 4 years and must demonstrate:

- outstanding academic potential as measured normally by either a 1st class honours degree (or equivalent Grade Point Average (GPA) or a Master's degree with distinction or equivalent
- an IELTS (Academic) score of 6.5 minimum (with a minimum 6.0 in each component, or equivalent) for candidates for whom English is not their first language and this must be evidenced at point of application.

Candidates for an MRes Studentship should demonstrate outstanding qualities and be motivated to complete a MRes in 18 months and must demonstrate:

- outstanding academic potential as measured normally by an upper second class honours degree (or equivalent Grade Point Average (GPA)
- an IELTS (Academic) score of 6.5 minimum (with a minimum 6.0 in each component, or equivalent) for candidates for whom English is not their first language and this must be evidenced at point of application.

HOW TO APPLY

Please complete the online application form by **the deadline on the project webpage.**

Further information on the application process can be found at: www.bournemouth.ac.uk/studentships