

Engineering and Physical Sciences Research Council Doctoral Landscape Award

PROJECT TITLE: Electrochemical lithium extraction

Lead Supervisor Details: Zhenyu Zhang

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Project details: Lithium-ion batteries are essential to achieving net zero by 2050, supporting electric vehicles, energy storage and the continued expansion of renewable energy. Rapid growth in battery manufacturing is driving demand for lithium, with UK battery manufacturers alone potentially requiring approximately 15,000 tonnes of lithium annually by 2030. Securing a sustainable and resilient lithium supply is therefore critical to the UK's future battery industry and clean-energy transition. Commercial lithium production is currently dominated by high-grade ores and salt-lake brines, using processes including evaporation, precipitation, solvent extraction and adsorption/desorption. These approaches can be energy- and water-intensive, have environmental impacts, and are geographically constrained. Electrochemical lithium extraction offers an alternative route that could recover lithium from lower-concentration brines without relying on slow evaporation processes.

Importantly, electrochemical systems can operate continuously and potentially be coupled directly with renewable electricity. This project will develop a lithium-selective membrane-based electrochemical extraction process for recovering lithium from complex brines. Unlike electrode-based lithium adsorption, where competing ions can cause slow kinetics and material degradation, lithium-ion-conducting ceramic membranes can selectively transport Li^+ while blocking other cations through differences in crystal chemistry and ion transport. NASICON-type and perovskite-type lithium-ion conductors have demonstrated this principle; however, significant challenges remain in achieving high Li^+ selectivity, rapid transport, long-term stability and high energy efficiency under realistic brine conditions.

The PhD will address these challenges through three interconnected objectives:

1. Solid-state lithium-ion conductors, used as electrolyte of all-solid-state batteries, will be systematically investigated to identify the mechanisms controlling conductivity and ion selectivity. Establish the relationship between membrane composition, microstructure, defects and grain-boundary chemistry and the selective transport of Li^+ in the presence of competing ions such as Na^+ , Mg^{2+} and Ca^{2+} .
2. Determine the mechanisms responsible for membrane degradation in aqueous and chemically complex brines and develop surface modification, coating and additive strategies to improve chemical stability without compromising lithium-ion transport. The effects of pH, ionic composition and operating conditions on membrane structure, transport and selectivity will be systematically established.

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3. Demonstrate the optimised membrane in an electrochemical lithium-extraction system and evaluate Li^+ transport, selectivity, extraction efficiency and stability under increasingly realistic brine conditions. The results will be used to establish materials design rules and performance limits for future scale-up and integration into sustainable lithium-recovery processes. Engagement with the emerging critical-minerals and geothermal sectors will help ensure that the research addresses practical resource and processing challenges.

The PhD will generate new knowledge in electrochemical materials and lithium-selective membranes while developing a potentially scalable, low-carbon approach to critical-mineral recovery. It will provide the student with interdisciplinary expertise across materials science, electrochemistry, energy systems and sustainable resource recovery, supporting future academic and industrial innovation in the UK's critical-minerals and clean-energy sectors.

Project specific entry requirements: Same to Exeter PhD entry criteria, with background in Chemistry, Materials etc.

Potential PhD programme of study: Engineering

Department: Engineering

Location: Penryn campus

Please direct project specific enquiries to: Zhenyu Zhang

Please ensure you read the entry requirements for the potential programme you are applying for.

To Apply for this project please click on the following link - [APPLY HERE](#)



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