IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**A highly efficient polysulfide-metal oxide composite electrode as polar host for lithium-sulphur batteries**	
Project Number	**IMURA0612**	
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Research Academy Themes:

Highlight which of the Academy's Theme(s) this project will address?

(*Feel free to nominate more than one. For more information, see www.iitbmonash.org)*

1. Advanced computational engineering, simulation and manufacture
2. Infrastructure Engineering
3. Clean Energy
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research

The research problem

Current Li-ion batteries are limited in their application due to capacity, temperature and stability issues. Achieving the stated goals of the project would allow the demonstration of viable Hybrid Electric Vehicle and Electric Vehicle batteries capable of satisfactory range performance in many city environments. Increasing the energy density and voltage Li-ion cells places extreme demands on all components of the device, particularly when required to operate over a wide range of temperatures and loads. Thus the key issue faced by this approach is the delivery of devices with improved stability and cycling lifetimes. The possibility of achieving high-energy, long-life storage batteries like Li−S cell, which can offer a 3−5-fold increase in energy density compared with conventional Li-ion cells, at lower cost.

Project aims

Despite significant recent advances in Li-S batteries, there are challenges to its wide-scale implementation. Upon sulfur reduction, intermediate soluble lithium polysulfides readily diffuse into the electrolyte, causing capacity fading and poor Coulombic efficiency in the cell. Porous carbons are typically used as sulfur hosts, but they do not adsorb the hydrophilic polysulphide intermediates or adhere well to Li_2S, resulting in distinct capacity fading.
In this project, a different strategy based on an inherently polar, high surface area metallic oxide cathode host will be used and hope it can mitigates polysulphide dissolution by forming an excellent interface with Li2S. Complementary we are going to use selected to Ionic Liquids as electrolyte to prevent further dissolution of polysulphur and improve the energy efficiency of the Li-S system.

Expected outcomes

- A novel metal-based MOF or porous metal oxides will be used for sulphur absorber.
- Demonstration of the new chemistry and how it can improve the cycling performance
- The study of the fundamental interactions between metal oxide building blocks and polysulfides
- Design new open cathode structured for Li−S battery chemistry.
- Understanding the Nature of Absorption/Adsorption in Nanoporous metal oxide frame work and Polysulfides

How will the project address the Goals of the above Themes?

NanoTechnology – The project will deliver the excellent Li-S with new class of advanced electrode materials.
Clean Energy – The advanced electrode will create superior energy storage devices for storing renewable energy such as solar and wind.

Capabilities and Degrees Required

- *Chemistry as major with sound knowledge in inorganic material synthesis, electrochemistry and solid-state chemistry*
- Chemical Engineering with relevant experience in materials synthesis and characterization are must

Materials Science with relevant experience in materials synthesis and characterization are must

Potential Collaborators

Please provide a few key words relating to this project to make it easier for the students to apply.

Nanotechnology, Metal oxide framework, sulfur composite, polysulfides confinement, long cycle life, lithium sulfur battery