IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Solid-State Lithium–Sulfur Battery operating at low temperature for EV applications**
Project Number	**IMURA0856**

BASF We create chemistry

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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

Energy density and safety issues are of great concern in developing state-of-the-art lithium-ion batteries used for modern electronic vehicles and consumer electronics. A promising strategy to improve the energy density and safety are moving from the traditional intercalation chemistry to conversion chemistry i.e. Lithium–sulfur (Li–S) battery and use of solid state lithium ion conductor as electrolyte. It is well documented that the most efficient liquid electrolyte for the conventional Li–S batteries are lithium bis(trifluoromethanesulphonyl) imide salt dissolved in a mixture solvent of 1,3-dioxolane (DOL) and/or 1,2-dimethoxymethane (DME) with $LiNO_3$ as additive to passivate the Li metal anode. However, DOL and DME both have serious safety problems due to their intrinsic flammability and electrochemical instability. These problems including the dissolution of polysulfide's restricts Li-S chemistry to come to market.

Project aims

The main objective of this project is to develop a methodology to improve the solid-electrolyte interface and study the compatibility of electrolyte and cathode and anode. To reduce the interfacial resistance between S and the ion/electron conductive matrix due to the poor ionic/electronic conductivities of S and Li_2S, we propose the solid ion conductor nanoparticle-decorated carbon foam as cathode.

Moreover, the current work can be a step forward toward lower temperature operation of all solid-state Li-S battery due to the improved ionic and electronic conductivity.

Expected outcomes

The outcomes will include:

- *Development of a solid state lithium ion conductor-polymer composite blend*
- *A deeper understanding of the ion conduction mechanisms with temperature*
- *An understanding of compatibility of S cathode and composite electrolyte*
- *Low temperature (40 C) feasibility study of solid state Li-S battery*
- *All solid state batteries based on these materials and ready for scale up to pouch cells*

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

Clean Energy: The project will address the global need for inexpensive energy storage technology.

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

Monash – UCSD cooperation partners.
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Please provide a few key words relating to this project to make it easier for the students to apply.

Nanotechnology, Energy Storage