IITB-Monash Research Academy

An Indian-Australian research partnership

Indian Institute of Technology Bombay | MONASH University

Project Title:	**Advanced Electrode Materials by 2D Layered Materials Exfoliation**	
Project Number	**IMURA0490**	
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Monash Department:	Materials Engineering	
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IITB Department:	Department of Energy Science and Engineering	

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

Recently, layered transition metal di-chalcogenides have attracted a great attention due to their excellent mechanical properties as well as rich electrochemical properties. Thus, they have been used in energy conversion and storage devices, medicinal and electrical field. However, if such layered material can be well-exfoliated, its mechanical and electrochemical properties can be significantly increased due to the increased active surface area. Although several techniques have been adopted including mechanical exfoliation, electrochemical exfoliation, polymer assisted exfoliation as well as ionic liquid assisted exfoliation, these processes possesses inherent pros and cons. Ionic liquid and polymer assisted exfoliation methods are disadvantaged due to their scalability, high cost and non-environmentally nature. Electrochemical exfoliation has good yield but there is concern over safety issues and further modification is required to achieve scalable industrial process. Although mechanical exfoliation is scalable and environment friendly but the long sonication time is not energy efficient. Therefore, if chemically and mechanical exfoliation techniques are combined, the duration of sonication can be reduced. Hence, such a sonochemical process will be scalable, environment friendly, cost friendly as well as energy saving.

Project aims

Main objective of this project is to find out a scalable process of making exfoliated energy materials. The process should include features like

1) low cost process

2) environmental friendly

3) tunning the materials to achieve the best electrochemical performance

Expected outcomes

A low cost, scalable, environment friendly and efficient process will be developed.

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

NanoTechnology – The project will deliver the superior LIBs/NiBs 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

Prof. Doug McFarlane from Monash

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

Nanotechnology, exfoliation of 2D layered materials, advanced electrode materials, sodium ion battery