

**An Indian-Australian research partnership**

**Project Title:** Exploring the Surfactant-like Properties of Graphene/ Graphene-Oxide for Thermal Engineering of Emulsions

**Project Number** IMURA0295

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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](http://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**
*Define the problem*

Graphene- a 2D arrangement of carbon atoms has generated unprecedented research excitement. Partially oxidized Graphene-sheets possess hydrophilic surface groups such as carboxylic acid and epoxies, but also exhibit hydrophobicity from the remaining sp<sup>2</sup> domains. Most importantly, these nanosheets can be engineered to remain at the interface of hydrophobic/hydrophilic liquids, exhibit surfactant-like properties and may lead to the formation of emulsions. It is, however, not clear how the microstructure of the emulsion evolves with conditions such as concentration of the graphene sheets, degree of oxidation, pH, ionic concentration and hydrophobicity of the oil phase. Additional questions to be addressed are how the microstructure of the emulsions may affect the percolation threshold and subsequent rheological signatures and resultant thermal properties.

## Project aims

*Define the aims of the project*

- (i) Development of techniques for synthesis of Graphene/ Graphene-oxide emulsions in oil/water phases.
- (ii) Develop protocols for determination of microstructure of oil-in-water/water-in-oil emulsions with Graphene as a surfactant.
- (iii) Measurement of rheological properties and correlation with microstructure.
- (iv) Measurement of thermal conductivity of these emulsions and engineering with microstructural features.

## Expected outcomes

*Highlight the expected outcomes of the project*

Methods for formation of emulsions of graphene and oil/water interfaces.  
Improved understanding of behaviour of graphene nanoplatelets at oil/water interface through rheological measurements and microscopy.  
Methods for characterization of thermal conductivity as a function of graphene assembly and architecture.

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

*Describe how the project will address the goals of one or more of the 6 Themes listed above.*

The goals of progressing nanotechnology are achieved through development of novel techniques for synthesis of graphene and graphene oxide and their assembly process.  
The project also realises goals in energy given high thermal conductivity emulsions/fluids can have applications in mining or heat exchange processes. The knowledge can also be transferred in synthesizing novel architectures for battery and super-capacitor applications.

## Capabilities and Degrees Required

*List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.*

The students involved in this projects should possess backgrounds in:

- Chemical Engineering
- Chemistry
- Rheology