

An Indian-Australian research partnership

Project Title: **Tuning the dimensions of 2D materials with nanoscale processing**
Project Number **IMURA0779**
Monash Main Supervisor

(Name, Email Id, Phone)

Jing Fu, jing.fu@monash.edu

Full name, Email
Monash Co-supervisor(s)

(Name, Email Id, Phone)

Monash Head of
Dept/Centre (Name, Email)

Michael Y. Wang, Michael.Y.Wang@monash.edu

Full name, email
Monash Department:

Mechanical and Aerospace Engineering

Monash ADRT

(Name, Email)

Timothy Scott

Full name, email
IITB Main Supervisor

(Name, Email Id, Phone)

Rakesh Mote

rakesh.mote@iitb.ac.in

Full name, Email
IITB Co-supervisor(s)

(Name, Email Id, Phone)

Mohammed Aslam,

aslam@phy.iitb.ac.in

Full name, Email
IITB Head of Dept

(Name, Email, Phone)

Sreedhara Seshadri,

head.me@iitb.ac.in

Full name, email
IITB Department:

Mechanical Engineering

Research Clusters:

Research Themes:

Highlight which of the Academy's CLUSTERS this project will address? (Please nominate JUST <u>one</u> . For more information, see www.iitbmonash.org)		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	Material Science/Engineering (including Nano, Metallurgy)	1	<u>Advanced computational engineering, simulation and manufacture</u>
2	Energy, Green Chem, Chemistry, Catalysis, Reaction Eng	2	Infrastructure Engineering
3	Math, CFD, Modelling, Manufacturing	3	Clean Energy
4	CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control	4	Water
5	Earth Sciences and Civil Engineering (Geo, Water, Climate)	5	<u>Nanotechnology</u>
6	Bio, Stem Cells, Bio Chem, Pharma, Food	6	Biotechnology and Stem Cell Research
7	Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng	7	Humanities and social sciences
8	HSS, Design, Management	8	Design

The research problem

Two-dimensional materials (e.g. graphene, etc.) have shown great promise for applications in many fields of both material and life sciences. Recent developments of focused ion beam (FIB) instruments have unique capabilities to manufacture novel products at nanoscale. It is also now feasible to perform FIB based machining on 2D materials such as graphene and graphene alike, to achieve dimensional reduction (1D) or increase (3D). However, lack in understanding of the fundamental physics involved limits the developments and repeatable applications.

Project aims

The aim of this project is to investigate both additive and subtractive modifications of 2D materials at sub-100 nanometre resolution with Focused Ion Beam (FIB) of different ion species. Through investigating the particle interactions with target materials, we plan to develop prototype devices and draft protocols to fabricate unprecedented 1D and 3D nanostructures. Preliminary results will be obtained with recursive refinement of computational studies and physical experiments on 2D materials, e.g. graphene or transition-metal dichalcogenide (TMD), to foster ground-breaking applications like engineered emissions, large quantum yields, etc., which are previously infeasible.

Expected outcomes

- Protocols for nanofabrication as required to modify the 2D materials (Graphene and graphene alike)
- Insights into fundamental interactions of different ion species (Ga, He, N, O) on 2D materials in FIB processing and underlying mechanisms
- Development of prototype devices using FIB processed 2D materials for applications like engineered emissions, large quantum yields, energy harvesting, clean energy, etc.

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

The project aims at modelling and optimizing nanofabrication processes for functional structures. Thus addresses the Theme 1. Further, the study is aimed at realization of complex micro/nanostructures with specific applications addressing the Theme 5.

Capabilities and Degrees Required

The interested candidates should have knowledge/skills in the following:

- 1) Mechanical/Manufacturing/Materials Engineering
- 2) Strong aptitude to take up interdisciplinary research
- 3) Skills in numerical/theoretical modeling
- 4) Exposure to experimental and characterization techniques in the microfabrication domain will be an additional advantage

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

Select up to **(4)** keywords from the Academy's approved keyword list (**available at <http://www.iitbmonash.org/becoming-a-research-supervisor/>**) relating to this project to make it easier for the students to apply.

Smart Manufacturing, Nanotechnology, Nanoscience, , Modelling and Simulation, BioScience, Bio Medical Engineering