

An Indian-Australian research partnership

**Project Title:** **Tuning the dimensions of 2D materials with nanoscale machining**

**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) **Chris Davies, chris.davies@monash.edu** *Full name, email*

**Monash Department:** **Mechanical and Aerospace Engineering**

**Monash ADRT**  
(Name,Email) **Emanuele Viterbo** *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) *Full name, Email*

**IITB Head of Dept**  
(Name, Email, Phone) **Bhalchandra Puranik, 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? <i>(Please nominate JUST <u>one</u>. For more information, see <a href="http://www.iitbmonash.org">www.iitbmonash.org</a>)</i>		Highlight which of the Academy's Theme(s) this project will address? <i>(Feel free to nominate more than one. For more information, see <a href="http://www.iitbmonash.org">www.iitbmonash.org</a>)</i>	
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 instruments have brought new ion species including He, O, and N which have unique capabilities to tune material surface at nanoscale. It is also now feasible to perform FIB based machining on 2D materials such as graphene, 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 an approach to machining on 2D materials at sub-100 nanometre resolution with focused ion beam of different ion species. Through investigating the particle interactions with target materials, we plan to develop prototype device and draft protocols to fabricating unprecedented 1D and 3D nanostructures. Preliminary results will be obtained with recursive refinement of computational studies and physical experiments on graphene, to foster ground-breaking applications which are previously infeasible.

## Expected outcomes

- Protocols for nanofabrication as required to modify the 2D materials (Graphene)
- 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 application like energy harvesting, clean energy, nanophotonics, 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 modelling
- 4) Exposure to experimental and characterization techniques in microfabrication domain will be an additional advantage

## Potential Collaborators

Please visit the IITB website [www.iitb.ac.in](http://www.iitb.ac.in) OR Monash Website [www.monash.edu](http://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.

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