

An Indian-Australian research partnership

**Project Title:** **Study of Ion Beam Interaction with Materials and Nanostructure Fabrication**

**Project Number** **IMURA0463(a)**

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Mechanical 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](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

The surface topography at micro, nano-scale strongly influences optical, electrical, and magnetic properties of materials, but 3D structures at nanolevel poses tremendous challenge on mask preparation and conventional lithography based techniques. Under the influence of focused or broad ion beam, self-organization of surface energies can lead to novel structures and morphologies, which is promising due to its high-throughput capability. However lack in control over structures limits their application.

The proposed research aims at studying ion beams and their interactions with materials. Based on energy levels and beam geometry, controlled ion beam irradiation is expected to significantly tune the surface morphology with characteristic topographical features. Our study will be aimed at understanding the detailed physics of surface structuring and surface reorganization through ion beam-material interactions leading to surface defects and consequently formation of characteristic surface morphology. The knowledge acquired for the interactions will be applied to create and to control the fabrication of novel 3D nanostructures.

## Project aims

- 1) Investigation of ion-material interactions and formation surface defects through experiments and simulations
- 2) Study of various irradiation conditions (like beam energy, defocusing, incidence), beam characteristics, substrate material and their role in surface self-organization and structuring
- 3) Experimental validation of proposed theoretical understanding of ion-material interactions to control formation of structures at micro and nano-scales and recursive refinement of simulation towards a high degree of feasible physical realization.

### **Expected outcomes**

A reliable modelling methodology will be developed for the prediction of optimized beam interactions and surface modification through structuring and self-organization which would lead to robust and accurate structure at micro/nanoscale.

Fabrication and performance validation of designed complex nanostructures particularly site specific surface plasmon structures, with applications in optics/photonics, bio-sensing, micro-fluidics.

### **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.