

An Indian-Australian research partnership

Project Title: **Focused Ion Beam (FIB) Fabrication of Novel 2D/3D Nanoscale Structures: Process Modeling and Applications**

Project Number **IMURA0463**

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IITB Department: **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)

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

Advances in micro-nanofabrication tools and techniques are pushing the structure size into nano-pico regime. Such micro/nano/pico structures carry potential in various applications like energy harvesting, opto-electronics, sensing, biomedical engineering etc. Conventional lithography techniques are widely used to fabricate microstructures commercially. This is mainly because of promising high throughput due to their parallel processing nature with the use of a mask. However, structures at nanolevel poses tremendous challenge on mask preparation and 3D structures are nearly impossible with such techniques.

The proposed research is based on Focused Ion Beam (FIB) process for nanofabrication and its application in creating novel nanostructures. Focused ion beam has evolved as a rapid prototyping of

microsystems owing to its one-step or maskless fabrication capability and high resolution. The aim of this study is to model ion-material interactions followed by rapid computation ion beam based material removal (milling or etching) and deposition, in order to create 2D/3D structures at micro- nanoscale. The methodology will be employed to fabricate masks towards functional nanostructures inspired by nature for diverse applications like anti-reflection, color filters, hydro-phobic surfaces, sensors etc.

Project aims

- 1) Investigation of ion-material interactions and ion induced damage to the materials
- 2) Process modelling and optimization of ion induced deposition for functional 3D structures
- 3) Experimental validation with designed prototypes 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 FIB process parameters for milling and deposition, which would lead to robust and accurate 2D/3D structure at micro/nanoscale.

Fabrication and performance validation of designed complex nanostructures particularly surface plasmon structures, with specific application in optics/photonics, 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 2D/3D 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 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.

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

Focused Ion Beam nanofabrication, process optimization, functional nanostructures