

An Indian-Australian research partnership

**Project Title:** **Modeling and Simulation of Laser Assisted Evaporation of Biological Specimens**

**Project Number** **IMURA0844**

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### 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	<b>Material Science/Engineering (including Nano, Metallurgy)</b>	1	<b>Advanced computational engineering, simulation and manufacture</b>
2	Energy, Green Chem, Chemistry, Catalysis, Reaction Eng	2	Infrastructure Engineering
3	<b>Math, CFD, Modelling, Manufacturing</b>	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	<b>Nanotechnology</b>
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

### *Define the problem*

In this project, we aim to understand the fundamentals of laser interaction with biological specimens in order to develop a multi-physics model of the process involving evaporation of the cells or tissues. The modeling work would mainly include the fundamentals of heat transfer, computational fluid dynamics and to some extent, physics of bio-materials. This fundamental process of laser-assisted evaporation finds application in many vital areas, including laser surgery, and laser-assisted atom probe tomography (APT). We specifically aim at developing models for use in laser-assisted APT and validate them using experiments. This research could potentially enhance the capability of APT for 3D chemical measurements of biological cells and tissues with near-atomic resolution.

## Project aims

1. To develop a multi-physics model of laser-assisted evaporation of biological tissues
2. To validate and interpret the models developed using experiments
3. To determine the optimal laser parameters for improved resolution in APT.

## Expected outcomes

1. Enabling the use of atom probe tomography (APT) for biological cells based on laser-assisted evaporation
2. Enhance the understanding of laser-assisted evaporation using computational models (MD simulations), which could enhance the understanding of laser-matter interaction of graphene and biological cells.
3. Publications in high impact journals and conferences

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

1. The research would lead to the development of a novel atom probe tomography (APT) for insulating materials based on laser-assisted evaporation. The technique would have wide applications in materials science and nanotechnology.
2. The project also deals with developing atomic scale simulations to capture the evaporation process involved in APT of biological cells. A significant part of the work would involve modeling & simulation.

## Capabilities and Degrees Required

### *Essential skills:*

Strong background in thermodynamics, heat transfer, basic physics, mathematical modeling and computational methods  
Computer programming in C/C++, Java or Fortran, MATLAB

### *Additional skills (not mandatory):*

Molecular simulations, Plasma Physics

### *Qualifications:*

B.Tech/M.tech in Mechanical Engineering, Materials Science and Engineering, Nanotechnology or Physics.

## 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.

1. Prof. Upendra Bhandarkar (Mechanical Engineering, IIT Bombay)
2. Prof. Jian Li (Monash Biomedicine Discovery Institute, Monash University)

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.

Computational fluid dynamics and mechanics, nanotechnology and nanoscience,  
Materials chemistry/science, Modeling and simulation