IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

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:

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

Research 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*
7	*Humanities and social sciences*
8	Design

The research problem

Define the problem

Laser assisted evaporation of biological tissues using high-power high-frequency lasers is a technique that has enabled novel analysis of biological specimens. For example, laser assisted atom probe tomography (APT) is now capable of offering 3D chemical measurements of biological cell and tissue with near atomic resolution. The optimal resolution mainly depends on the evaporation process, which is largely governed by the choice of laser parameters. A fundamental understanding of the laser assisted processes would be essential for the further development of various analytical techniques. Therefore, the aim of this project is to understand the influence of laser parameters on the evaporation process using multi-physics modelling and simulation and to determine the right set of operating parameters to generate optimal resolution using APT. A major part of the work would involve computational work related to laser-tissue interaction, along with some experimental work to validate the models developed.

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.*

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 programing in C/C++, Java or Fortran, MATLAB

Additional skills (not mandatory):
MD 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 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.
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, BioScience and Biomedical engineering, Modeling and simulation