IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	**Transport phenomena during droplet deposition on a solid substrate**	
Project Number	**IMURA0361**	
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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

The objective of this project is to understand the transport phenomena associated with impact and evaporation of microliter and nanoliter droplets on a solid surface. The physics during the droplet impact on a solid surface is characterized by complex and coupled transport phenomena: fluid dynamics in the presence of a severely deforming liquid-gas surface, wetting line motion and convective and conductive heat transfer.

There are many open questions in this framework—impact of droplets of non-Newtonian fluids, dielectric fluids, surfactant laden fluids, multicomponent fluids; wetting at three phase contact line for a drop/thin-film on a nanostructured patterned surface, impact, sliding and rolling of droplets on inclined planes and impact of a molten metal drop with a moving freezing front inside the droplet. An finite-element, in-house numerical solver will be developed to simulate the droplet impact and evaporation. This numerical model solves for fluid flow, heat transfer, mass-transport, wetting at three-phase contact line, colloidal particles concentration, Marangoni stresses at liquid-gas interface and electrostatic forces on particles in axisymmetric cylindrical geometry for the impact and evaporation/freezing of a droplet on a solid substrate. The governing equations are discretized by finite element method in Lagrangian coordinates, which accurately describes liquid-gas interface. The numerical predications will be compared with respective in-house and published experimental data. This research will significantly improve and innovate industrial applications associated with droplet deposition such as manufacturing of bio-assays, inkjet printing, spray cooling etc.

Project aims

The aims of this project are the following:

- Understand, control and enhance transport phenomena during droplet deposition.
- To develop an in-house finite element solver for the transport phenomena during droplet deposition.
- Develop experiments for validation of the numerical model.

Expected outcomes

We expect the following outcomes from this project

- Significant advances in the understanding of transport phenomena during droplet deposition.
- A state-of-the-art, three-dimensional, finite element solver for droplet deposition.
- Quality Ph.D. graduate with ability and skills to understand and model complex interfacial flows.

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

The target of the project is to develop a computational model which will help in understanding the physics of droplet deposition and industrial applications associated with nanotechnology, for example, manufacturing of bio-assays, inkjet printing etc. Thus, this project will help to address the goals of the two themes, namely, Advanced computational engineering, simulation and manufacture; and Nanotechnology.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These

The student for this project will require the following skills

- Sound background in fluid mechanics, heat transfer and numerical methods.
- Experience with computer programming preferably with FORTRAN. If not, a willingness to learn is essential.
- Exposure to finite element method is preferable.
- Good written and communication skills