IITB-Monash Research Academy

An Indian-Australian research partnership

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| **Project Title:** | **Numerical Simulation of Selective Laser Melting --- an Emerging Additive Manufacturing Technique** |
| **Project Number** | **IMURA0487** |
| **Monash Main Supervisor** (Name, Email Id, Phone) | Wenyi Yan, wenyi.yan@monash.edu |
| **Monash Co-supervisor(s)** (Name, Email Id, Phone) | |
| **Monash Department:** | Department of Mechanical & Aerospace Engineering |
| **IITB Main Supervisor** (Name, Email Id, Phone) | Ramesh Singh, rsingh@iitb.ac.in, |
| **IITB Co-supervisor(s)** (Name, Email Id, Phone) | |
| **IITB Department**: | Department of Mechanical Engineering |

*Full name, Email*

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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

Additive Manufacturing, also known as '3D-printing', builds components from metal alloy powders or wires by selective laser or electron beam melting. It produces near-final-shape components directly from computer design files without the need for tooling, leading to material savings of up to 90%, production cost savings of up to 50% and reductions in lead-time from design to final component of up to 90%.

To implement this new manufacturing successfully, it is crucial to ensure the same properties of the 3D-printed components as those conventionally manufactured from bulk materials. Besides experimental study, computational simulation is an alternative and cost-effective method to evaluate and improve the mechanical properties of the 3D-printed components through accurately modelling the additive manufacturing process. Besides its significance in developing 3D-printing technology for metallic materials, to successfully simulate an additive manufacturing process is scientifically challenging due to the complicated physical process, which involves

laser heating, power melting and metallic liquid solidification. From this point of view, to numerically simulate an additive manufacturing process itself is a fundamental research project.

### Project aims

This PhD project focuses on selective laser melting, one of the most popular additive manufacturing technologies for metallic materials, which is operated in machines at Monash Centre for Additive Manufacturing, Monash University. The overall objective of this PhD study is to develop a reliable computational tool to successfully simulate the selective laser melting process. The developed numerical model will be validated by experimental tests.

### Expected outcomes

We expect to achieve the following results from this project:

- Development of a constitutive model to describe the material response due to selective laser melting.
- Implementing the developed constitutive model into a user subroutine of the commercial software package Abaqus so as to numerically simulate the selective laser melting process.
- Experimental study to validate the developed computational tool.
- Applying the developed computational tool to optimize the selective laser melting process for a given metallic power material.

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

Additive manufacturing is the cutting-edge technology for manufacturing. This PhD project will contribute to the development of selective laser melting, one of the most popular additive manufacturing techniques for metallic materials through developing an effective computational tool, which fits well within the Academy's Theme on advanced computational engineering and manufacturing.

A/Prof. Wenyi Yan, as a CI, is involved in a five-year Industry Transforming Research Hub project (IH130100008) for Transforming Australia's Manufacturing Industry through High Value Additive Manufacturing, led by Prof. Xinhua Wu of Materials Engineering Department at Monash University. Although computational simulation was not proposed in the hub project, the hub project can provide the resources to carry out the selective laser melting tests for this PhD project and this PhD project will assist the success of the hub project.

## Capabilities and Degrees Required

The PhD student should have a Masters by research degree in Mechanical, Aerospace or Civil Engineering. She/he should have sound knowledge on solid mechanics and have the experience on using the finite element method.

## Potential Collaborators

A/Prof. Wenyi Yan from Monash University and A/Prof. Ramesh Singh from IITB have been co-supervising three PhD students through IITB-Monash Academy with one completion. They are willing to co-supervise a PhD student on this project.

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

Finite element modelling, laser metal deposition, selective laser melting, metallo-thermo-mechanical modelling