IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	Phase field simulation of microstructure formation during direct laser metal deposition	
Project Number	**IMURA0835**	
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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

Three-dimensional (3D) printing, or additive manufacturing, is a disruptive technology that is able to manufacture a component directly from a 3D computational model. Direct laser metal deposition (DLMD) is one of the major 3D printing techniques to produce or repair metallic components. Due to its superior freedom in deposition and a relatively narrow dilution and heat affected zone, DLMD has the potential of widespread applications in repair and restoration of aerospace, naval, automobile components, such as gas turbine blades, moulds and shafts.

The mechanical performance of a DLMD repaired/manufactured component is related to the microstructures, which depend on the DLMD processing parameters, which include laser power, laser beam spot size, powder feed rate. To understand and quantify the effect of the processing parameters on the formation of the microstructures can help design and optimize the mechanical properties and the quality of a DLMD manufactured component. The phase field approach has been proved to be an effective tool in the simulation of microstructure formulation during a thermal-dynamic metallurgical process.

Project aims

The project aims include:

1. Develop a phase field model to simulate the microstructure formation during a DLMD process
2. Valid the developed phase field model through comparison of simulated results and microscopic images
3. Parametrical examine the effect of the DLMD processing parameters on the microstructures
4. Correlate the mechanical performance/properties of a DLMD produced component with its microstructure

Expected outcomes

The expected outcomes include

1. A validated phase field model, which can correctly simulate the formation of microstructures during a DLMD process.
2. Based on the numerical study, an approach to control the microstructure through adjusting the DLMD processing parameters.
3. An approach to enhance the mechanical properties of DLMD manufactured component through optimising the microstructures.

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

Additive manufacturing (3D printing of metals) is considered as the next generation of manufacturing. This project focuses on an important additive manufacturing technique, direct laser metal deposition (DLMD). DLMD can be applied not only to directly print metallic components but also to repair metallic components. Therefore, this project addresses the theme of manufacturing. In addition, computational simulation will be applied as the main tool to simulate the formation of microstructures during a DLMD process. The relatively new method phase field numerical method will be applied. From this point of view, it is also about modelling and advanced computational engineering.

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 capabilities will be input into the online application form and students who opt for this project will be required to show that they can

demonstrate these capabilities.

The PhD student should have a solid knowledge on metallurgy and thermodynamics. He or she should also be good at computational simulations.

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.

We have identified the two IITB researchers.

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.

Smart manufacturing, metallurgy, modelling and simulation, computer simulation