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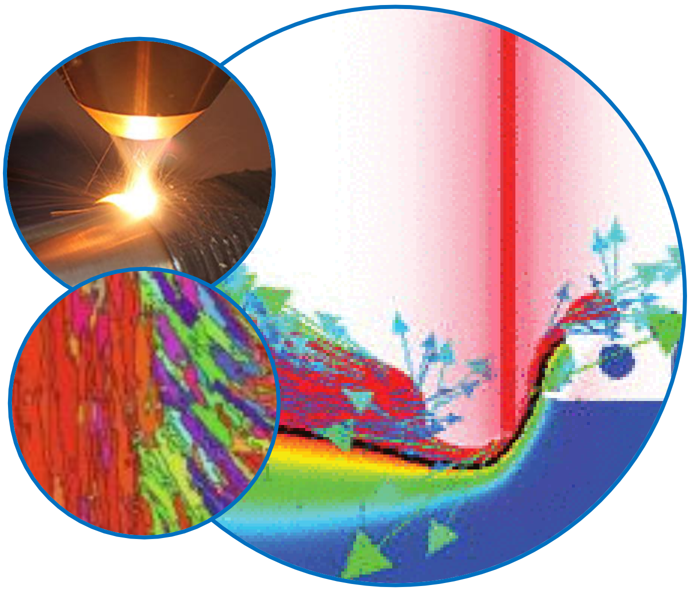
PhD Position – FutureNow Plus Scholarship

Development of Multi-Scale Models to Simulate the Laser-based Additive Manufacturing Process for Energy, Aerospace and Defence applications

Background

Laser metal deposition (LMD) is an additive manufacturing (AM) process that utilizes a laser beam to form a pool of liquid metal on the surface of metallic substrate into which metal powder is injected forming a deposit on the substrate after solidification. In comparison to powder-bed techniques, LMD allows for much higher deposition rate thus allowing building/repairing larger engineering structures. These make LMD process an attractive manufacturing/repair process for many energy, aerospace, and defence applications. Despite the major advantages of LMD process, there is, however, a continuous need to develop a full understanding of the process–structure–property relationships. The main emphasis is on the development of an in-depth understanding of the effects of a large number of process variables on the ongoing metallurgical processes (such as grain growth, segregation, defect formation, etc.), residual stresses, distortion which affect resulting mechanical properties – these are crucial for any in service applications. In-depth understanding of processes taking place during any AM manufacturing process would address a long-standing challenge to reduce component/repair failure due to the residual stress field, extensive distortion or microstructural defects. A multiscale physics-based modelling framework is required to elucidate the interrelationship between LMD/AM processing parameters and resulting microstructure governing properties of an additively-manufactured component or a repair.



Project

The current project will focus on the development of multi-scale models of the LMD process. To uncover the complex interdependencies between various LMD process parameters, we will first develop multiscale physics-based methodologies comprising of meso-scale models for predicting the resulting microstructure (grain size, texture, etc.) and its effects on mechanical properties, and macro-scale models that predict the residual stress field and distortion. We aim to utilize the phase-field mathematical framework to capture the solidification process and grain growth during the LMD process. These results will be then fed into the crystal plasticity models to capture microstructure-properties relationship. Finally, the validated predictions from the developed meso-scale models will serve as input for macro-scale models that predict the overall residual stress field, microstructure, and distortion. In developing these methodologies, it is important to establish the accuracy of developed numerical models by comparing predictions with experimental results using well-defined benchmark specimens – these will be prepared by the industrial partners. The long view goal of the project is to develop validated numerical models which can assist a large range of industries wishing to utilize AM process for building/repairs of engineering components. The developed models will help in understanding of the process–structure–property relationship and thus assist with the rapid optimisation of the LMD process for various applications.

Funding

This project is supported by ANSTO via FutureNow Plus scholarship and by DMTC (Defence Materials Technology Centre). The successful PhD candidate will be based at ANSTO at the Lucas Heights campus (Sydney), however, the student is expected to work collaboratively across all involved organisations. The student will receive a full FutureNow PhD scholarship of $35k/year, or a combination of $15k/year top-up and the Australian Government Research Training Program (RTP) stipend scholarship. Additional funding of $10k/year from ANSTO's FutureNow Plus is available for travel and consumables of the project. A background in materials engineering, mathematics, physics or mechanical engineering is welcome. We value diversity and encourage applications from all backgrounds to apply, however, this program is open to Australian citizens only. To enquire call (02) 9717 3488, and to apply, email your CV and transcript of your most recent or current degree to ondrej.muransky@ansto.gov.au