Structured PhD in Applied Mathematics (4-years full-time)

Project topic: Prediction of the plastic yielding of additively manufactured Steel 316L: Development and validation of a physics-informed mathematical model

Project supervisors: Dr. Doireann O'Kiely, Dr. Kyriakos Kourousis and Professor Michael Vynnycky.

Project location: MACSI, Department of Mathematics and Statistics, University of Limerick

Application deadline: 24 February 2023

Start date: Summer/Autumn 2023

PhD structure: This is a full-time 4-year structured PhD project based in the Mathematics Applications Consortium for Science and Industry (MACSI) in the Department of Mathematics and Statistics at University of Limerick, in collaboration with the Metal Plasticity & Additive Manufacturing Group in the School of Engineering. The funding includes a tax-free stipend (with fees paid) and expenses for computing equipment, conference travel and materials.

Research topic: The research topic is mathematical analysis of the elastoplasticity of steel parts produced via additive manufacturing. In laser powder bed fusion (PBF), which is a widely used metal additive manufacturing method, a thin layer of metal powder is spread across a surface, and parts of it are melted via laser. Another layer is added, and the process is repeated until a desired metal shape is created. Under mechanical loading, the metal part behaves elastically up to some yield threshold, beyond which it behaves plastically. A major complication for this process is that the yield surface typically exhibits anisotropy, even after heat treatment. This is attributed to the microstructural changes occurring from the layer-by-layer selective melting of metal powder.

The goal of this project is to develop a new model to accurately describe the initial and evolving yield surface of PBF Steel 316L. The model will bridge the existing gap between micro- and meso-structure characteristics and macro-scale plastic yield by incorporating parameters relying on measurable physical and mechanical properties. This will involve **design** and **manufacture** of steel parts (using a GE Concept Laser Mlab metal 3D printer owned by the School of Engineering), **experimental characterisation** (via mechanical testing), **data analysis**, and **development of a mathematical model.** The mathematical modelling will be a major component of the project, and will involve developing a mathematical description using **partial differential equations**, and then matching it to observed data.

Requirements: Applicants should have (or expect to attain prior to project start) at least a 2.1 honours degree or equivalent in applied mathematics physics, mechanical engineering or a closely-related discipline. Applicants must demonstrate proficiency in high-level mathematics and continuum mechanics. Applicants for whom English is a second language will be required to demonstrate their competence in the English language in line with University of Limerick requirements.

Funding notes: Stipend of €19,000 per year for four years (tax free) with fees paid and budget for travel and materials.

Application: Applicants should email Dr. Doireann O'Kiely (doireann.okiely@ul.ie) 24 February 2023 to apply with a 2-page CV and a short cover letter/statement of purpose (2-pages max) indicating how their skills align with the project. Please include "PhD Application" followed by your name in the subject line. The application CV should, at minimum, include the applicant's name, education institution, qualification stating overall grade/percentage (predicted grades are acceptable for those still studying) and contact details of two academic referees.

Informal queries can be made to doireann.okiely@ul.ie. Please include "PhD Query" followed by your name in the subject line.