Computational Modelling and Simulation of Part-Scale Metal Additive Manufacturing

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ABSTRACT

Additive Manufacturing (AM) is increasingly recognized as a transformative technology for fabricating complex components with enhanced performance and design flexibility. Processes such as Wire Arc Additive Manufacturing (WAAM), Directed Energy Deposition (DED), and Laser Powder Bed Fusion (LPBF) involve strongly coupled thermal, mechanical, and metallurgical phenomena across multiple spatial and temporal scales, posing significant challenges for modelling, simulation, and process control.

This Invited Session aims to highlight recent developments in computational modelling, experimental characterization, and data-driven approaches for the analysis and optimization of metal AM processes. The focus is on advancing predictive capabilities at the part and component scales, enabling improved process understanding, reliability, and performance of additively manufactured structures.

The session seeks to bring together researchers and practitioners from academia and industry to exchange ideas on robust and efficient simulation strategies, as well as their integration with experimental and monitoring techniques.

Topics of interest include, but are not limited to:

• Advanced numerical methods for part-scale process simulation.

• Efficient time integration and discretization techniques for large-scale AM problems.

• Reduced-order modelling and surrogate-based approaches.

• Multi-physics and multi-scale frameworks for capturing process–structure–property relationships.

• Thermo-mechanical and microstructural material modelling.

• Simulation and mitigation of residual stresses, distortion, and defects.

• Integration of simulation with in-situ monitoring and experimental validation.

• Data-driven and machine learning methods for process control and optimization.

• Design and optimization of scanning strategies and process parameters.

Contributions addressing different AM technologies (e.g., LPBF, DED, WAAM) and material systems are welcome. This session aims to provide a platform for discussing emerging trends and fostering collaboration toward the development of reliable, high-fidelity simulation tools that support the broader industrial adoption and certification of additive manufacturing.