Title: Certification of Additive Manufacturing Processing Parameters through Physics-Based Predictive Simulation of Process-Defects-Microstructure

Research Team:

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Research Objectives:

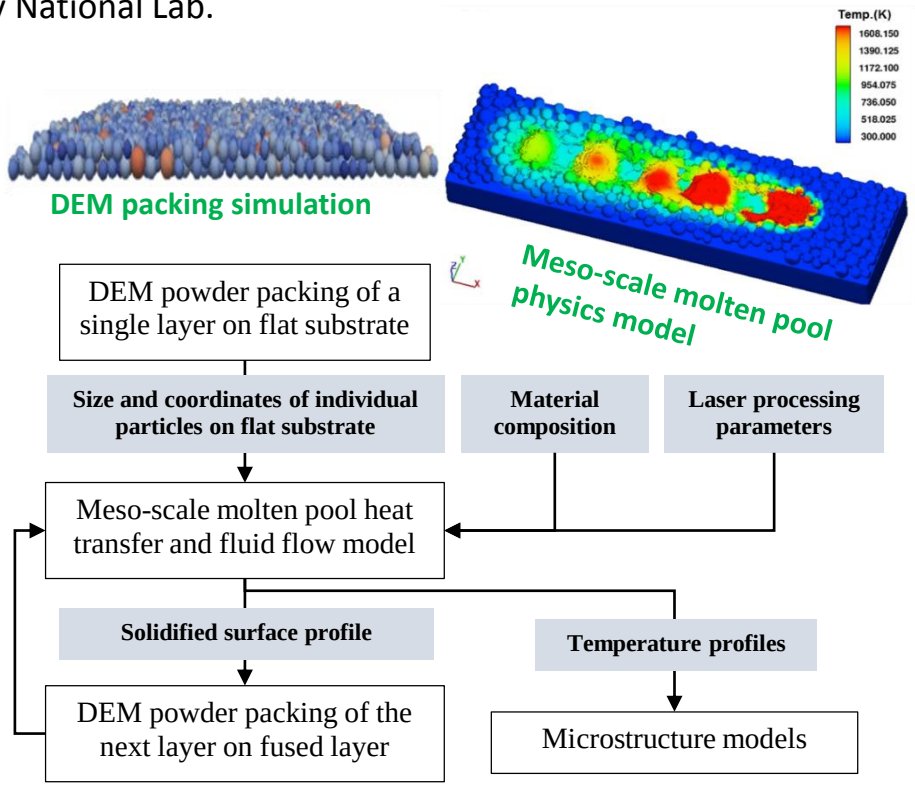
(1) Develop a new molten pool physics model capable of simulating multiple laser passes especially the evolution of defects. High-performance computing cluster will be utilized to speed up the simulation time.

(2) Develop a generalized CALPHAD + phase field framework that integrates processing variables, alloy composition and the resulting hierarchical microstructure.

(3) Validate the model predictions based on molten pool boundaries and microstructure of IN718 samples fabricated by Laser-Powder Bed Fusion Additive Manufacturing.

Approach:

Integration of two advanced physics-based, predictive models, one for molten pool fluid dynamics and the other for microstructure evolution, to develop a functional relationship between both the material composition and the AM processing parameters and resulting microstructure.



Flowchart illustrating the integration of physics-based models for AM certification.

Potential Impact:

- Significantly new capable for multiple laser passes, drastically improving the relevance of process-microstructure models to actual AM production scenario.
- Foundation to enable predictive modeling based approaches to certify both the L-PBF and allied AM processes as well as the resulting AM-manufactured flight hardware.