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MICROSTRUCTURE EVOLUTION OF ALLOYS DURING ADDITIVE MANUFACTURING

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ABSTRACT

The microstructure of additively manufactured components is governed by the local processing conditions and largely determines their mechanical and functional properties. Layer-wise material deposition exposes the material to steep, rapidly changing temperature gradients, high cooling rates and repeated thermal cycling. As a consequence, solidification and solid-state phase transformations take place far from thermodynamic equilibrium, resulting in fine, often strongly textured and spatially heterogeneous microstructures. Predicting these microstructures requires models that capture nucleation and growth, epitaxy and competitive grain growth across remelted layers, solute segregation and non-equilibrium phases, as well as solid-state transformations, precipitation, recrystallization and grain coarsening during intrinsic and subsequent heat treatments.

This invited session brings together researchers who develop and apply models of microstructure evolution in additive manufacturing across length and time scales. Contributions are welcome on approaches including, but not limited to, phase-field, cellular automata, kinetic Monte Carlo and Potts, dendritic needle network and grain envelope models, CALPHAD-based thermodynamic and kinetic descriptions, mean-field precipitation models, and atomistic simulations providing material parameters. We particularly encourage work that couples microstructure models with thermal and melt pool simulations, links microstructure to properties (e.g. via crystal plasticity or homogenization), exploits data-driven and surrogate approaches, targets the deliberate tailoring of microstructures through process strategies, or validates predictions against in-situ and ex-situ experiments. All additive manufacturing processes and material classes are within scope.