SIMULATION AND EXPERIMENTAL VALIDATION OF METAL ADDITIVE MANUFACTURING PROCESSES ON PART-SCALE

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ABSTRACT

Additive Manufacturing (AM) of metals offers highest production flexibility and almost unlimited freedom of design. However, depending on the chosen process parameters, processing strategy and geometric design large thermal distortions as well as high residual stresses can result from the strongly localized energy input, which in combination with residual porosity might even induce cracking of the part during the production process. While predictive, physics-based modeling approaches would be highly desirable for systematic process and geometry optimization, the inherent multi-scale nature of these processes makes part-scale simulations with geometrically resolved heat source path very challenging. Apart from computational efficiency, also the aspects of constitutive modeling, taking into account the strongly inhomogeneous and anisotropic evolution of microstructure and material properties, and experimental model validation are critical for accurate thermo-mechanical predictions.

The purpose of this invited session is to provide a forum for discussion in the modeling and experimentation communities with application to metal AM. Contributions on the part-scale thermo-mechanical modeling of any relevant process (e.g., powder bed fusion of metals using an electron beam or laser beam, directed energy deposition, binder jetting, material droplet printing, etc.) are welcome. Topics of interest include, but are not limited to:

- Part-scale thermo-mechanical modeling and simulation of metal AM processes to predict residual stresses / strains, thermal distortion etc.
- Non-standard, adaptive temporal and spatial discretization strategies
- Efficient numerical schemes, solvers and algorithms (e.g., linear/nonlinear solvers, code parallelization techniques, etc.) tailored for part-scale AM simulation

- Reduced-order and phenomenological approaches for residual stress modeling
- Energy input agglomeration strategies (e.g., track/layer agglomeration)
- Thermo-mechanical material modeling (either directly on continuum level or microstructure-informed)
- Multiscale approaches considering several of the relevant time / length scales of the process
- Inverse approaches, e.g., for geometric compensation of part distortion
- Coupled process-part optimization for the design of functionally tailored / lightweight parts
- Experimental validation of simulations
- Experimental investigations on process monitoring and control
- Fundamental investigations on structure–process–property relations