EFFICIENT PROCESS SIMULATION IN ADDITIVE MANUFACTURING: APPROXIMATION AND ACCELERATION STRATEGIES

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ABSTRACT

In additive manufacturing, many physical processes occur on very short time scales, while the overall manufacturing process takes hours or even days. Furthermore, some of the physical processes occur on spatial scales below a millimeter and still determine the outcome of an additive manufacturing process. For instance, in the laser powder bed fusion of metal, the melt pool width can be 200 µm, while modern multi-laser machines can manufacture parts with dimensions of a meter or more.

As a result, simulations of industrially relevant parts often require immense computational resources, must be restricted to specific regions or time intervals, or rely on strong model simplifications. The latter is one focus of this session. Instead of resolving the physical processes in detail, approximations are used to simulate the effects relevant to the application. Examples include layer-equivalent thermal simulations and inherent-strain-based methods.

Besides physical approximations, simulation times can also be reduced through numerical methods. Examples include adaptive mesh refinement to address the different spatial scales of the melt pool and the part, parallel computing, efficient solvers, and GPU acceleration.

Efficient process simulations often combine physical approximations and numerical acceleration.

This session aims to present and discuss these methods. We welcome contributions that:

- introduce new numerical acceleration or approximation methods,
- compare their computational cost and accuracy,
- investigate their limitations and applicability,
- apply these methods to practical engineering problems.

Contributions are welcome regardless of the additive manufacturing process or simulation method. This includes thermomechanical finite element simulations, finite difference methods, computational fluid dynamics, microstructure simulations, and more.