Thermo-elastoplastic Simulation of Selective Laser Melting Processes with Multi-Level *hp*-Adaptive Finite Cell Method

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Key words: Finite Cell Method, Multiphysics, Applications.

ABSTRACT

Selective laser melting (SLM) has emerged as a very promising technique for creating highly complex and customized metal structures on the basis of digital models. It is achieved by successively joining layers of material of different shapes, where metal powder is fused together with the help of a laser. The overall process can be described as a coupled thermo-elastoplastic problem on an evolving domain. However, there are numerous challenges in simulating the SLM process, in order to compute the dimensional accuracy and the residual stresses of the end product.

One challenge is to create a transient geometric discretization (e.g. by finite elements) during the process. In order to tackle this, the Finite Cell Method (FCM) [1], a high-order immersed-boundary approach, is employed in our approach. Another challenge is that the phase change of the material takes place in a highly localized moving region around the laser, leading to strong gradients in temperature and mechanical stresses. Therefore, the discretization scheme should be able to adapt to the moving laser.

This contribution will present a multi-level *hp*-adaptive Finite Cell Method proposed by Zander et al. [2] being integrated in a multi-physics framework to simulate the thermo-mechanical process. Three-dimensional examples demonstrate capabilities and limitations of this new discretizational approach.

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