Computational Modelling of Metal Additive Manufacturing

Stefan Kollmannsberger* [1], Ali Özcan[1], Davide D'Angella [1,2], Massimo Carraturo [3], Philipp Kopp [1], Nils Zander [1], Alessandro Reali [2,3], Ferdinando Auricchio [3] and Ernst Rank [1,2]

[1] Chair for Computation in Engineering
Technische Universität München (TUM)
Arcistr. 21, 80333 Munich, Germany
www.cie.bgu.tum.de

[2] TUM Institute for Advanced Study

[3] Department of Civil Engineering and Architecture
Università degli Studi di Pavia
via Ferrata 3, 27100 Pavia, Italy
www.unipv.it/compmech

*stk@tum.de

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ABSTRACT

The numerical simulation of metal additive manufacturing bears numerous computational challenges. It is a thermo-mechanically coupled process in which material coefficients depend nonlinearly on the state of the material and the temperature. The energy input is highly localized which leads to strong temperature gradients and rapid changes of state in the material on growing computational domains. The large span of the involved spatial and the temporal scales call for highly efficient computational techniques. It is well known that *hp*-finite elements yield very accurate results for problems with strong gradients or even singular solutions. *hp*-finite elements are, therefore, an ideal candidate for the simulation of metal additive manufacturing.

In this contribution, we present a computational framework which was specifically designed to resolve moving singularities and sharp fronts [1]. Its core employs the multi-level *hp*-method for the resolution of strong gradients in the solution field [2]. This is complemented by a spatially hierarchic management of material coefficients in the spirit of the finite cell method [3]. We will discuss the computation of the metal additive manufacturing process and evaluate accuracy and efficiency of the presented computational approach by comparison to benchmark solutions.

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