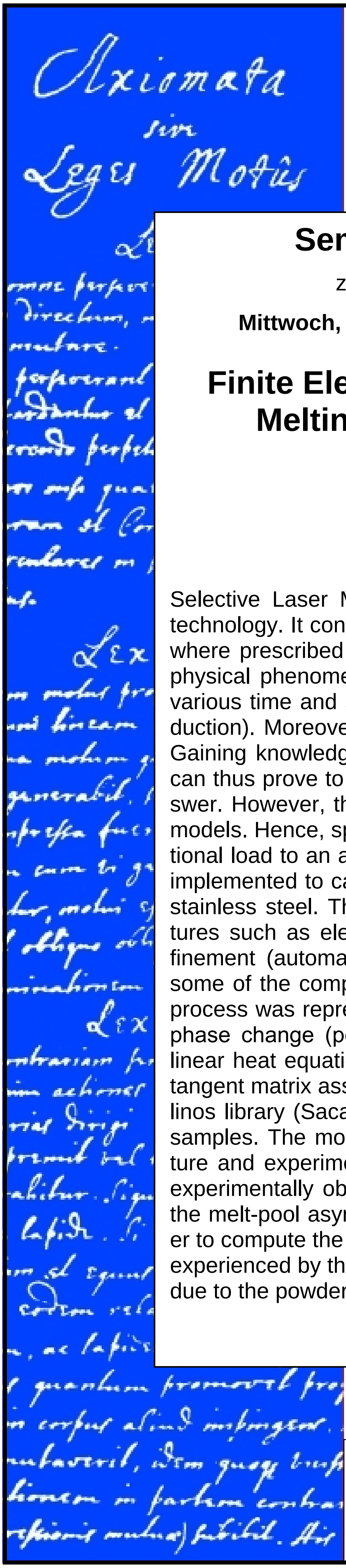

FRIEDRICH-ALEXANDER UNIVERSITÄT ERLANGEN-NÜRNBERG
TECHNISCHE FAKULTÄT

Seminar über Fragen der Mechanik

zu folgendem Vortrag wird herzlich eingeladen

Mittwoch, 12.07.2017, 10:15 Uhr, Egerlandstr. 5, Raum 0.044

Finite Element Modeling of the Selective Laser Melting Additive Manufacturing Process

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Selective Laser Melting (SLM) of metals is a recent additive manufacturing technology. It consists in moving a laser beam on top of a powder bed to melt it where prescribed to build the part layer by layer. This process involves many physical phenomena of various nature (thermal, mechanical, optical...) and of various time and space scale (e.g. powder particle interaction vs. thermal conduction). Moreover, the process has a lot of parameters that are user defined. Gaining knowledge and defining a processing window using experiments only can thus prove to be a cumbersome problem to which modeling may be an answer. However, the process characteristics give birth to computationally heavy models. Hence, specific methods have to be used in order to limit the computational load to an affordable level. A non-linear Finite Element Model (FEM) was implemented to calculate the thermal field throughout a part building by SLM in stainless steel. The open source C++ library deal.ii was used. It includes features such as element birth (for material addition modeling) and adaptive refinement (automatic computation of a finer mesh where needed) to address some of the computational issues. The powder and metal melting/solidification process was represented via a specific algorithm which includes an irreversible phase change (powder → consolidated material). The resolution of the non-linear heat equation was performed using the Newton-Raphson method with a tangent matrix assembled using the automatic differentiation package of the Trilinos library (Sacado). Computational experiments were performed on reduced samples. The model results are in good agreement with data from both literature and experiments in terms of temperature and melt pool geometry. Some experimentally observed phenomena were reproduced and explained such as the melt-pool asymmetry. Further developments will include a mechanical solver to compute the residual stress field created by the high thermal gradients experienced by the material during the SLM process, and the volume shrinkage due to the powder to consolidated material transformation.

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