Seminar über Fragen der Mechanik

zu folgendem Vortrag wird herzlich eingeladen

Dienstag, 07.02.2012, 14:15 Uhr, Egerlandstr. 5, Raum 0.044

Thermomechanical Modelling & Simulation of Electron Beam Melting

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In beam-based manufacturing methods, e.g. laser or electron beams, geometrically complex parts are built from powder layers of 20 to 100 micrometres. The energy of the beam fuses the powder in defined, locally-restricted points in the current layer to melt the powder into the already fused and recongealed material of the previous layers to construct the part layer-by-layer. Hence, such processes are called additive layer manufacturing or selective beam melting, as defined regions of the layer are melted. The issue here is that one has extreme temperatures and temperature gradients due to the very high energy of the beam. This results in residual stress, deformation and deterioration of the produced component and makes the process unfeasible for industrial production until recently.
The issues mentioned motivate the need to model the selective beam melting process. Precalculating the residual stress and deformation allows one to reduce them by adapting the parameters of the process like the intensity or the dwell of the beam. So modelling of the process enables for optimisation and the reliable production of complex parts.
It was begun to create a tool for modelling and simulating the selective beam melting of materials in powder form from a macroscopic point of view. Therefore in a first step a linear continuum mechanical model for small strains was developed to capture the transient thermoelastic behaviour of the selective beam melting process, what is the simulation of the interaction of the temperature and the displacement fields. A model for unsteady non-linear heat transfer was also developed to describe the high temperature gradients which cause strong non-linear effects in the real process. Moreover two solution algorithms for linear thermoelasticity, namely a monolithic one and a split one, were investigated. In the monolithic approach the thermoelastic problem was solved in one single step and in the split scheme the elastic and the thermal part were solved separately from each other to reduce the amount of computing time. The programming of the models was done using an open-source FEM library called deal.II and for the validation of the models several numerical examples were performed.

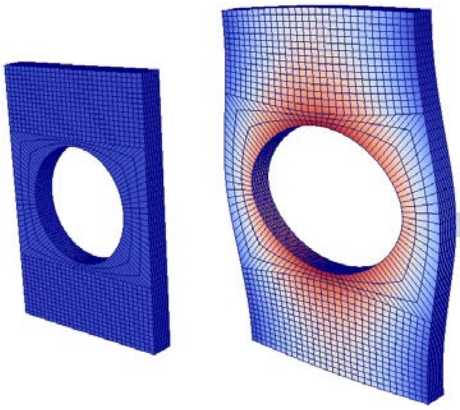

Fig. 1: Deformation due to thermal loading

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