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Thermal modelling of selective beam melting processes using heterogeneous time step sizes

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In the context of powder bed based additive manufacturing complex part geometries are realised in a layer-by-layer fashion and the fusion of powdered material in locally defined regions by means of e.g. a laser or electron beam. Simulating these manufacturing processes from a macroscopic point of view may lead to computational expensive models, due to different scales in space and time, highly nonlinear material behaviour and methods to account for the layer wise built, i.e. dynamic growth of the computational domain. Aiming towards a reduction of the computational cost multiple numerical methods are therefore ought to be combined.

One approach in the context of Finite Element simulations is given by adaptive mesh refinement [3] and coarsening. This allows to locally refine the mesh where it is needed, e.g. in the region currently exposed to the beam, while keeping it relatively coarse in other regions. Yet the time step size of the model is constraint by the resolution of the beam path, which clearly limits the size of the problem under investigation. Within the present contribution we employ heterogeneous time step sizes to the arising thermal problem in different parts of the computational domain [2] in order to account for the distinct scales in time. In addition a line heat input model based on [1] is utilised to further lower the computational cost.

References

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