The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5 – 9 June 2022, Oslo, Norway

Model order reduction applied to a transient heat transfer simulation of a Selective Laser Melting process

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Key Words: *Model order reduction, Selective laser melting, Non-linear heat transfer*

Among the different additive manufacturing processes comprising powder bed fusion, Selective Laser Melting (SLM) describes the process of which metal components of relatively simple to complex geometry are built incrementally, layer by layer, after being fused with a high-power laser beam. Because of the high heating and cooling rate occurring during the building process, the analysis of the residual stresses and distortion present in the material is of capital importance to validate the structure specifications. Thermo-mechanical simulation of the printing technique helps provide compelling information on the role played by the different parameters of the system during the building process [1,2]. However, the generation of such results requires heavy computational resources and is time-consuming.
The current work presents an implementation strategy to simulate the transient non-linear heat transfer system at a mesoscale level for these 3D printing processes. We demonstrate how a model order reduction approach, relying on the Energy Conserving Sampling and Weighting, can be employed to alleviate the high computational cost of these simulations [3]. The thermal results of the reduced order model are compared to the ones of the full order model.

Acknowledgement The work leading to this publication has been funded by the project "Procsima", which fits in the MacroModelMat(M3) research program, coordinated by Siemens (Siemens Digital Industries Software, Belgium) and funded by SIM (Strategic Initiative Materials in Flanders) and VLAIO (Flanders Innovation & Entrepreneurship Agency), as well as the KU Leuven research fund.

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