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

# APPLICATION OF MODEL ORDER REDUCTION TO THE ANALYSIS OF POLYMER PROCESSING PROBLEMS

**Fabian Key[1*] and Stefanie Elgeti[2]**

[1] TU Wien, A-1040 Vienna, fabian.key@tuwien.ac.at
[2] TU Wien, A-1040 Vienna, stefanie.elgeti@tuwien.ac.at

**Key Words:** *Polymer Processing, Reduced Order Modeling, Finite Element Method.*

Polymer processing is concerned with the manufacturing of products based on a plastic raw material. More specifically, our interest lies on primary forming processes – like injection molding or extrusion – in which a molten plastic material is transformed into a new product of certain shape [1]. In order to achieve this in an efficient and economic manner, ensuring both a high process standard and a specified product quality are just as important as a minimal use of resources.

To that end, computer simulations used to either enhance the development of these processes with fast and accurate a-priori forecasts or even to control those processes during ongoing operation are a valuable tool. Different types of complexity may arise during the construction of the involved models, which need to be capable of covering all relevant effects while fulfilling the accuracy required for the analysis.

Especially the design and development phase may entail the assessment of various operating points, the optimization of process settings, or uncertainty regarding the quantities involved, resulting in many evaluations of the underlying models. Furthermore, the integration into an automatic control environment demands fast feedback from the simulation model. Thus, employing the original, high-fidelity models may easily exceed available resources or required feedback times. Here, the application of model order reduction (MOR) can provide a remedy. Based on the original model, a reduced model with decreased computational complexity is constructed, while keeping its accuracy in the desired range.

To speed up the analysis, which is originally based on the Finite Element Method (FEM) in this case, we explore the benefits of intrusive model order reduction techniques. The approach that will be presented makes use of Proper Orthogonal Decomposition (POD) where a subsequent Galerkin projection of the operators onto the constructed subspaces is performed. Eventually, the integration of the resulting reduced-order models (ROMs) in uncertainty quantification or control problems is demonstrated for different polymer processing applications.

## REFERENCES

[1] F. Zwicke and S. Elgeti, Inverse design based on nonlinear thermoelastic material models applied to injection molding. *Finite Elem. Anal. Des.*, Vol. **165**, pp. 65–76, 2019.