An extended meshfree Peridynamics correspondence framework to simulate extrusion based Additive Manufacturing processes

P. Hartmann*, **C. Weissenfels*** **and P. Wriggers***

* Institute of Continuum Mechanics
Leibniz Universität Hannover
Appelstrasse 11, 30167 Hannover, Germany
e-mail: hartmann@ikm.uni-hannover.de, web page: https://www.ikm.uni-hannover.de

ABSTRACT

To improve the functionality of cochlea implants patient specific Additive Manufacturing (AM) is desirable. Since a comprehensive understanding of the material behaviour (Room Temperature Vulcanisation medical grade silicon) during the printing process does not exist, a simulation driven support of patient specific implant development is necessary.

Therefore, a thermomechanical coupled large strain curing model, similar to [1], is developed. The developed model is able to exhibit curing specific characteristics as chemical shrinkage and the release of exothermal heat.

Since the considered extrusion based AM process comes along with large deformations and an extensive material spreading the classical FEM method does not appear to be optimal as numerical solution scheme. Thus, a meshfree framework of the Peridynamics correspondence formulation is introduced. In contrast to classical continuum mechanics in Peridynamics non-local particle interactions within a family $\mathcal{H}$ are considered and integro- instead of partial differential equations are solved [2]. To avoid zero-energy mode like oscillations the formulation is extended under the utilization of subfamilies and non-local sub-deformation gradients as proposed in [3].

The application of the developed local material model within the non-local Peridynamics framework then leads to local-non-local coupled equations for the equation of motion and heat conduction. In verification examples the capability of the developed framework to solve the multiphysical problem is shown.

Finally, the extrusion based AM process, including infrared laser radiation, is modelled within the developed framework and numerical results are presented. It appears that the framework is well suited for the prediction of the material behaviour during the AM process and should be extended to capture further physical effects such as wetting.

REFERENCES

[1] Landgraf R, Modellierung und Simulation der Aushärtung polymerer Werkstoffe, http://nbn-resolving.de/urn:nbn:de:bsz:ch1-qucosa-187720 , (2015).

[2] Silling, Stewart A and Epton, M and Weckner, O and Xu, J and Askari, E, Peridynamic states and constitutive modeling, *Journal of Elasticity*, Vol. **2**, pp. 151–184, (2007).

[3] Chowdhury, Shubhankar Roy and Roy, Pranesh and Roy, Debasish and Reddy, JN, A modified peridynamics correspondence principle: Removal of zero-energy deformation and other implications, *Computer Methods in Applied Mechanics and Engineering*, Vol. **346**, pp. 530–549, (2019).