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Extrusion based Additive Manufacturing Processes within a Meshfree framework

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To improve the functionality of silicone based medical implants, a patient specific Additive Manufacturing (AM) is sought. Medical silicon is comprised of a two-component curing system with a high initial viscosity. As a consequence, an extrusion based AM process must be applied.

For a deeper understanding of the material behaviour during the AM process, the simulation of the extrusion and the subsequently applied heat curing is necessary.

Therefore, a thermodynamically consistent large strain curing framework is formulated. It is based on the multiplicative decomposition of the deformation gradient into a mechanical, thermal and chemical part, cf. [1], and the approximation of a thermochemical free energy function on behalf of a theoretical consideration of differential scanning calorimetric measurements, cf. [2].

For the numerical approximation the Optimal Transportation Meshfree (OTM) method, first introduced in [3], is applied. It is capable of capturing large deformations during the extrusion without any remeshing and theoretically allows an automatic merging of extruded material layers

It was found that the formulated large strain curing model exhibits the typical curing behavior of shrinkage and the release of heat. Additionally, the material motion during the 3D printing performs as expected. After the extrusion the material approaches the printing plate and sticks, while the extruder continues its translation.

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