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# Material modelling and mechanical behaviour of an SLA additively manufactured polymer

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Stereolithography (SLA) is an additive manufacturing process for polymers characterised by its high accuracy and homogeneous finished parts [1]. In engineering applications where such parts are used in load-carrying components, knowledge of their mechanical response, and how to model it numerically, is required.

Mechanical tests carried out on a commercial SLA polymer revealed an initial elastic behaviour followed by strain rate and pressure dependent yielding. The inelastic regime featured rapid strain hardening before ending with brittle fracture at a logarithmic strain between 0.4 and 0.5.

Motivated by the experimental results, a nonlinear hyper-viscoelastic constitutive model was implemented as a user model in an FE solver. The model uses the same framework as the Bergström-Boyce model [2], where two parallel hyperelastic springs describe the intermolecular resistance and orientational hardening of the polymer material respectively. Pressure and strain rate sensitive yield behaviour is captured with a nonlinear viscous dashpot in series with the intermolecular spring. A brittle fracture model is also incorporated. FE-simulations of the material tests show that the time and pressure dependent stress-strain prediction of the model agrees with the experimental results.

## REFERENCES

[1] Dizon, J. R. C., Espera, A. H., Chen, Q., & Advincula, R. C. (2018). Mechanical characterization of 3D-printed polymers. Additive Manufacturing. https://doi.org/10.1016/j.addma.2017.12.002

[2] Bergström, J. S., & Boyce, M. C. (1998). Constitutive modeling of the large strain time-dependent behavior of elastomers. Journal of the Mechanics and Physics of Solids, 46(5), 931–954. https://doi.org/10.1016/S0022-5096(97)00075-6