

## Experimental and numerical study of the DLP 3D printed photopolymers

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Digital light processing (DLP) 3D printing is one of the innovative fabrication methods that builds 3D objects with complex geometry in a layer-by-layer fashion, via simultaneous in-plane photopolymerization [1]. This contribution proposes an experimental investigation of a commercial photopolymer resin followed by material modelling, system characterization and a finite element work that links process parameters with final mechanical properties.

We focus on the effect of the UV light intensity, temperature and frequency on the viscoelastic properties of the polymeric materials. Photo-DSC experiments are performed to investigate the curing reaction and modelling of the evolution of the degree of cure depending on the light intensity and temperature. The change in the degree of cure dependent viscoelastic properties is measured with UV rheometry and dynamic mechanical analysis (DMA). Time-temperature and time-cure superposition principles are applied to the experimental results. In addition, chemical shrinkage behaviour is captured as a function of the degree of cure by the high-precision balance setup. UV curing properties of the resin are assessed with the thickness measurement by optical tomography. As a result of our experimental studies, model equations are proposed to describe the material behaviour.

We present a modelling framework following the approach proposed by [2]. Here, the coupling effect of four relevant physical mechanisms will be taken into account: (i) distribution of UV light intensity in the medium, (ii) photopolymerization reaction, (iii) chemical shrinkage and (iv) evolution of the mechanical properties during the solidification process. A simulation methodology based on the finite element method is presented for the layer-wise application and curing of the material.

### REFERENCES

- [1] T. Rehbein, A. Lion, M. Johlitz and A. Constantinescu, *Polymer Testing*, 83, 106356, 2020.
- [2] D. Weisz-Patrault, *Additive Manufacturing*, 31, 100990, 2021.