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MODELING LAYERLESS AND LAYER-BY-LAYER VAT PHOTOPOLYMERISATION

MARWAN AARAB[†*], JORIS J. C. REMMERS[†] AND JON SPANGENBERG[‡]

[†] Department of Mechanical Engineering, Eindhoven University of Technology
Eindhoven, The Netherlands
m.aarab@tue.nl

[‡] Department of Mechanical Engineering, Technical University of Denmark
Kgs. Lyngby, Denmark
josp@dtu.dk

[*] corresponding organiser

ABSTRACT

Vat photopolymerisation (VPP) is an additive manufacturing technique known for its excellent surface finish and high dimensional accuracy, and the family of VPP processes continues to grow. Processes can be distinguished by their light source: a scanned focused laser (0D), a screen or digital micromirror device with selectively switched pixels (2D), or a computed three-dimensional light field, as in tomographic, holographic and xolography-based volumetric printing (3D). Laser and projection-based systems build parts layer by layer, whereas volumetric systems cure the entire part in a single step [1].

In every variant, the final part results from tightly coupled physics: light propagation and scattering, reaction kinetics, species diffusion, heat generation, shrinkage and mechanical response [2]. These interactions produce defects that limit resolution and accuracy, and they affect the mechanical and optical quality of the part. For layerless processes the stakes are higher still. The geometry emerges entirely from a computed light dose, so the model becomes part of the process itself.

Numerical models provide both insight into these mechanisms and a route to optimising them. This session brings together researchers developing such models across the VPP spectrum. Topics include comprehensive multi-physics coupling, projection and dose optimisation, differentiable models and gradient-based inverse design, high-performance and reduced-order simulation, and machine-learning-assisted optimisation. Contributions on layer-based and volumetric processes are equally welcome, as are studies of resin chemistry, curing kinetics or part performance that inform either.

REFERENCES

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[2] Aarab M., Geers M. G. D., Remmers J. J. C., *High-performance coupled opto-chemical simulation of gradient-index light transport in vat photopolymerization*, Proc. SPIE 14082, 3D Printed Optics and Additive Photonic Manufacturing V, 2026.