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## A generalized printing process window for preventing surface overcuring in volumetric additive manufacturing

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**A generalized printing process window for preventing surface overcuring in volumetric additive manufacturing**

*Running title:* Generalized process window for VAM

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**Supplementary File**

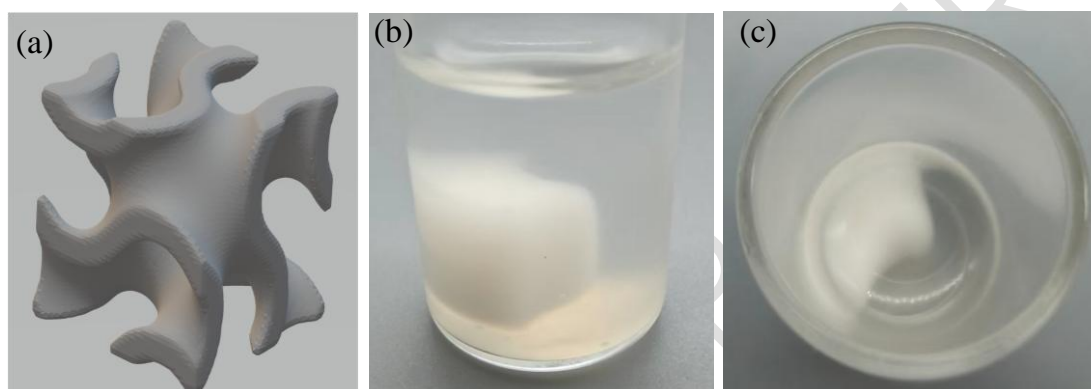


Figure S1. Demonstration of severe surface overcuring defect during the volumetric additive manufacturing of a complex geometry. (a) The target CAD model of a TPMS structure; (b, c) Photographs of the failed print (F5 ink,  $A \approx 1.23$ ,  $r \approx 3.5$  mm) from different viewing angles. As shown, the intricate structural features are completely obscured by the amorphous overcured resin adhering to the vat wall.

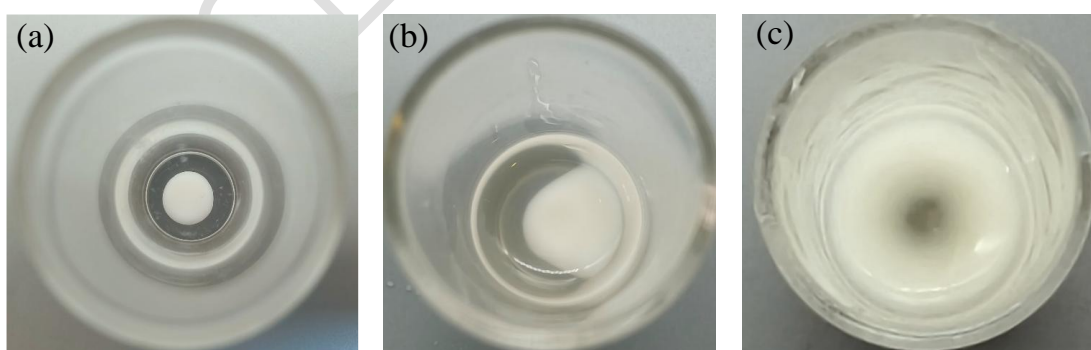


Figure S2. High-resolution photographs corresponding to the insets in Figure 2(a) of the main manuscript. These images detail the distinct morphological differences between (a) a successful volumetric print fabricated within the optimal process window, and (b, c) failed prints characterized by severe surface overcuring and subsequent vat wall adhesion.

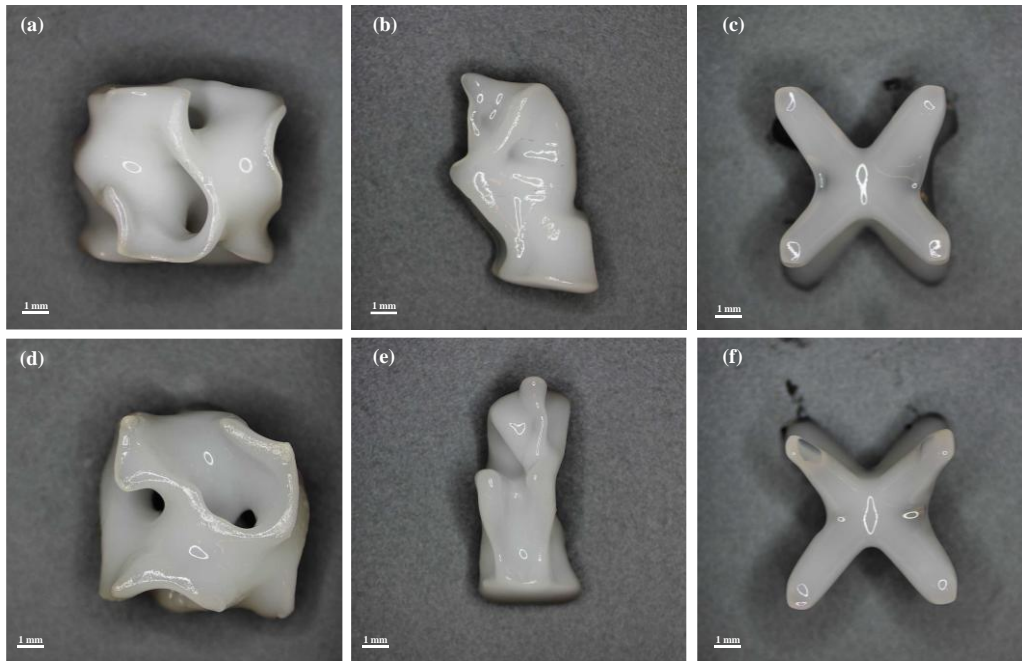


Figure S3. Photographs of the printed complex geometries (TPMS, Thinker, and BCC) from different viewing angles. Scale bars: 1 mm

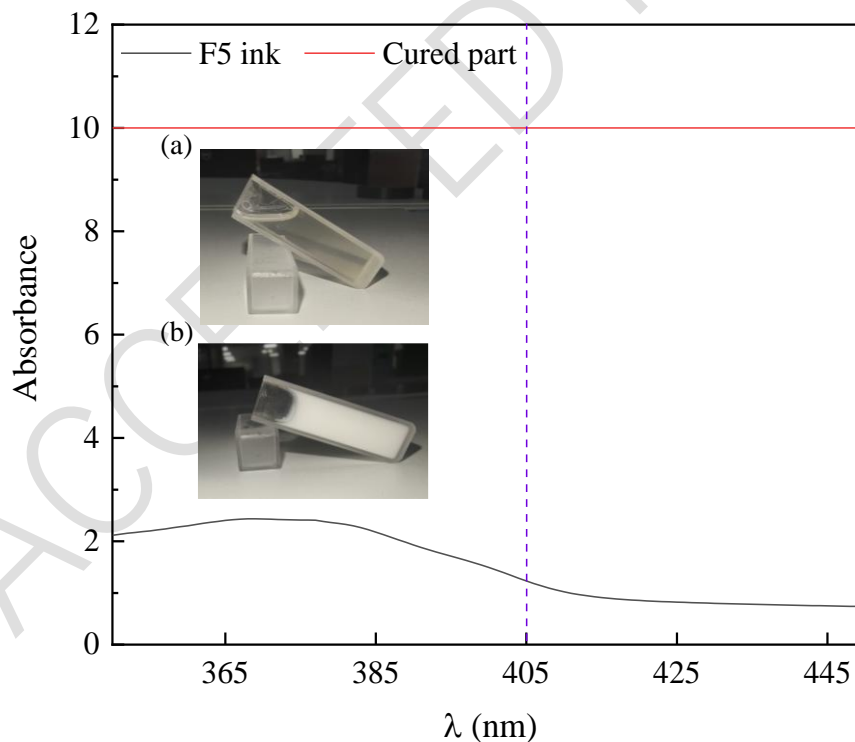


Figure S4. Comparative optical absorbance spectra of the F5 formulation in liquid and cured states (measured using standard 1 cm cuvettes via a Lambda 1050+ spectrophotometer). The transition from a liquid ink to a solid hydrogel induces a dramatic increase in absorbance to the instrumental limit ( $A \geq 10$ ), effectively rendering the cured part an optically opaque medium for multi-material overprinting. Insets (a) and (b) show photographs of the F5 ink before and after curing, respectively.

**Table S1.** Several references and their reported process parameters for VAM

<b>References</b>	<b>Ink</b>	<b>Absorbance</b>	<b>Inner radius of the vat</b>	<b>Maximum radius of the print</b>
Xie <i>et al.</i> (2023) <sup>[9]</sup>	Silk-based (bio)ink	~0.17	~6 mm	~3 mm
Behravesht <i>et al.</i> (2025) <sup>[7]</sup>	Resin from Anycubic	~0.77	~6 mm	~4 mm
Bernal <i>et al.</i> (2019) <sup>[12]</sup>	GelMA	~0.26	~8.9 mm	~7 mm
Kollep <i>et al.</i> (2022) <sup>[2]</sup>	Polysiloxane ceramic precursor	~0.8	~8.2 mm	~5 mm
Madrid-Wolff <i>et al.</i> <sup>[8]</sup>	Acrylic resin with TiO <sub>2</sub> nanoparticles	~0.58	~8 mm	~5 mm
Chen <i>et al.</i> (2024) <sup>[13]</sup>	Acrylic resin	~1.0	~10 mm	~5 mm
Ribezzi <i>et al.</i> (2023) <sup>[29]</sup>	GelMA	~0.2	~6.6 mm	~5.3 mm
Ribezzi <i>et al.</i> (2023) <sup>[29]</sup>	GelMA	~0.2	~6.6 mm	~4 mm (z≈2.2 mm)
Pellizzon <i>et al.</i> (2025) <sup>[27]</sup>	GelMA	~0.15	~8 mm	~5.8 mm (z≈2.6 mm)

**Table S2.** Measured dimensions of the printed structures.

Dimension (mm)	TPMS	Thinker	BCC
X	7.75±0.29 (7.5)	5.86±0.06 (6.0)	6.44±0.12 (6.5)
Y	7.65±0.34 (7.5)	3.86±0.06 (4.0)	6.62±0.12 (6.5)
Z	6.88±0.10 (7.0)	8.25±0.08 (8.0)	6.76±0.07 (6.5)
Wall thickness	0.62±0.11 (0.5)	-	1.38±0.13 (1.0)

Note: The values enclosed in parentheses represent the design dimensions of the printed parts, whereas the others represent the measured dimensions. All data were calculated using at least three samples.