Electronic Supplementary Material (ESI) for Materials Advances.

Supporting Information

Additively manufactured thermosetting elastomer composites: Small changes in resin formulation lead to large changes in mechanical and viscoelastic properties

Ye Wang,[a] Ian M. McAninch,[c] Antoine P. Delarue,[b] Christopher J. Hansen,[b] E. Jason Robinette,[c] and Amy M. Peterson*[a]

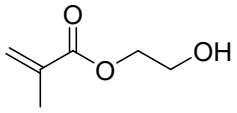
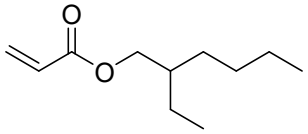
[a]*Department of Plastics Engineering, University of Massachusetts Lowell, Lowell, MA 01854, USA*

[b]*Department of Mechanical Engineering, University of Massachusetts Lowell, Lowell, MA 01854, USA*

[c]*Weapons and Materials Research Directorate, US Army Combat Capabilities Development Command-Army Research Laboratory, Aberdeen Proving Ground, MD 21005, USA*

Monomers added to the base resin system

Table S1. Descriptions of added monomers, molar percentage, short names, and corresponding chemical structures.

Product name	**Molar percentage (mol.%)**	**Short name**	**Chemical structure**
2-hydroxyethyl methacrylate	7.18	HEMA	
2-ethylhexyl acrylate	5.18	EHA	

Tensile testing

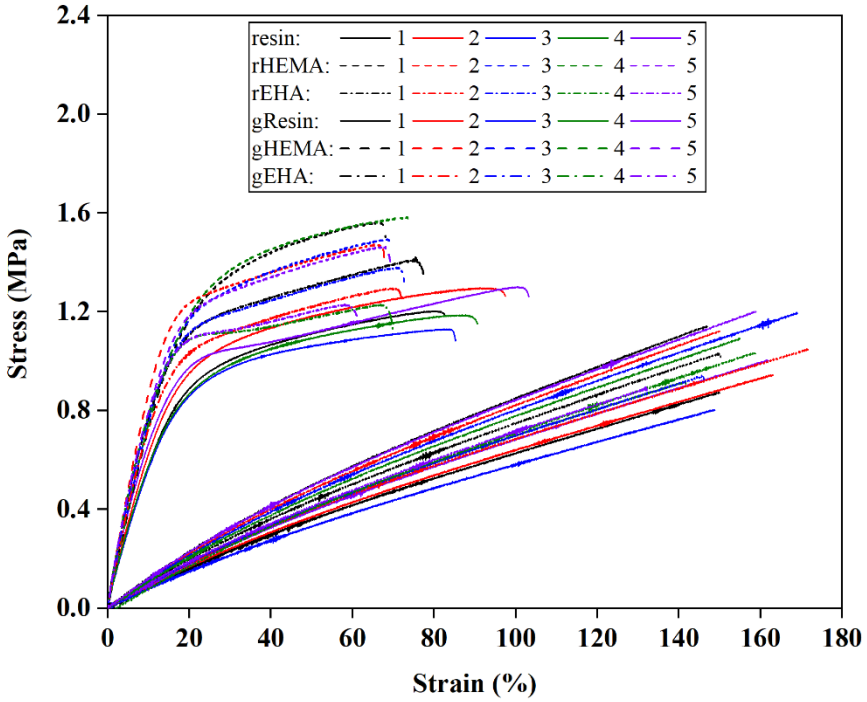


Figure S1. Stress-strain curves for neat and glass microsphere-filled samples from tensile testing.

Table S2. P-values for one-way ANOVA of given tensile properties for a given group.

Groups	Young's modulus	Elongation at break	Fracture/Ultimate Strength	Toughness
All conditions (Resin, rHEMA, rEHA, gResin, gHEMA, gEHA)	1.2×10^{-21}	5.9×10^{-16}	2.1×10^{-12}	0.06
Resin, rHEMA, rEHA	5.8×10^{-5}	0.67	0.01	0.06
gResin, gHEMA, gEHA	0.03	2.0×10^{-3}	1.4×10^{-3}	0.10
gHEMA, gEHA			2.5×10^{-3}	

Table S3. Summary of mechanical properties of printed neat and glass microsphere-filled samples. For each formulation, standard deviations are calculated based on the results from 5 samples.

	Young's Modulus (MPa)	Elongation at Break (%)	Fracture/Ultimate Strength (MPa)	Toughness (10^6·J/m^3)
Resin (neat)	0.8 ± 0.1	153.2 ± 9.1	0.92 ± 0.06	0.78 ± 0.01
rHEMA	0.9 ± 0.1	154.1 ± 9.5	1.00 ± 0.07	0.83 ± 0.13
rEHA	1.0 ± 0.1	159.1 ± 8.5	1.06 ± 0.04	0.93 ± 0.07
gResin	6.9 ± 0.6	92.2 ± 8.4	1.22 ± 0.07	0.92 ± 0.14
gHEMA	8.1 ± 0.7	71.2 ± 2.7	1.51 ± 0.06	0.85 ± 0.05
gEHA	7.7 ± 0.5	72.1 ± 5.9	1.31 ± 0.08	0.77 ± 0.09

Frequency Sweep DMA

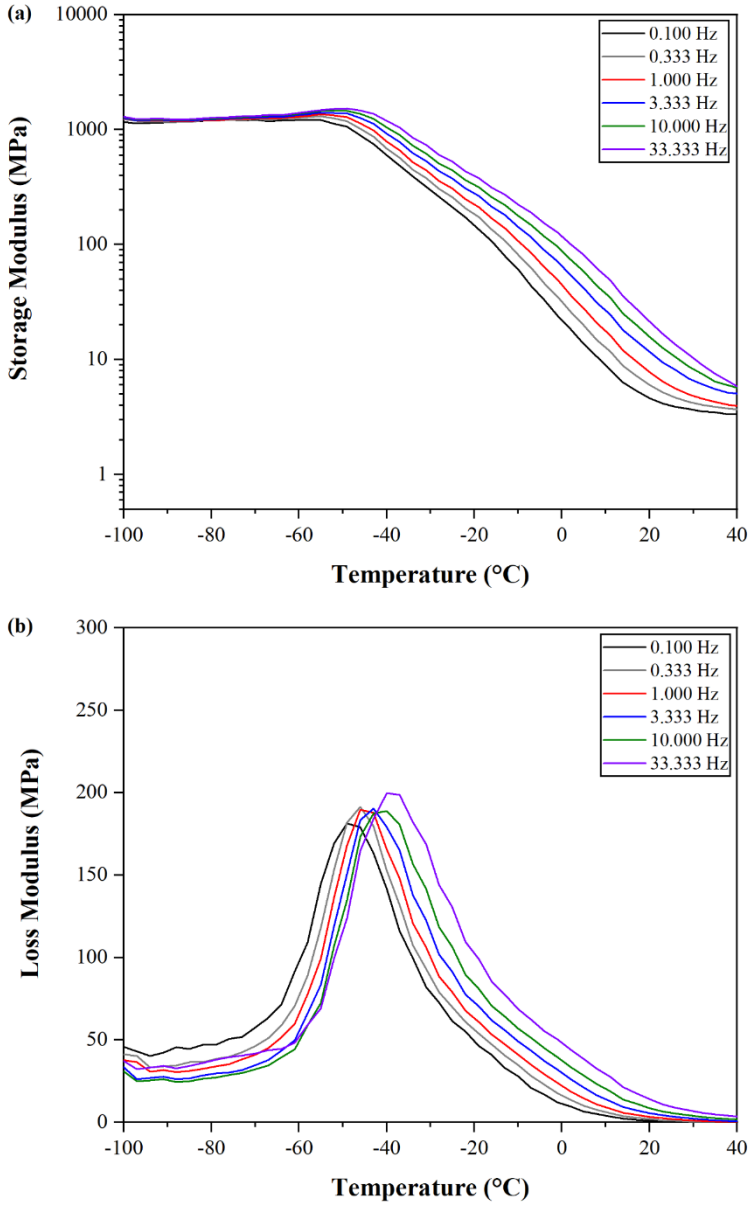


Figure S2. DMA frequency sweep results for printed base resin: (a) storage modulus. (b) loss modulus.

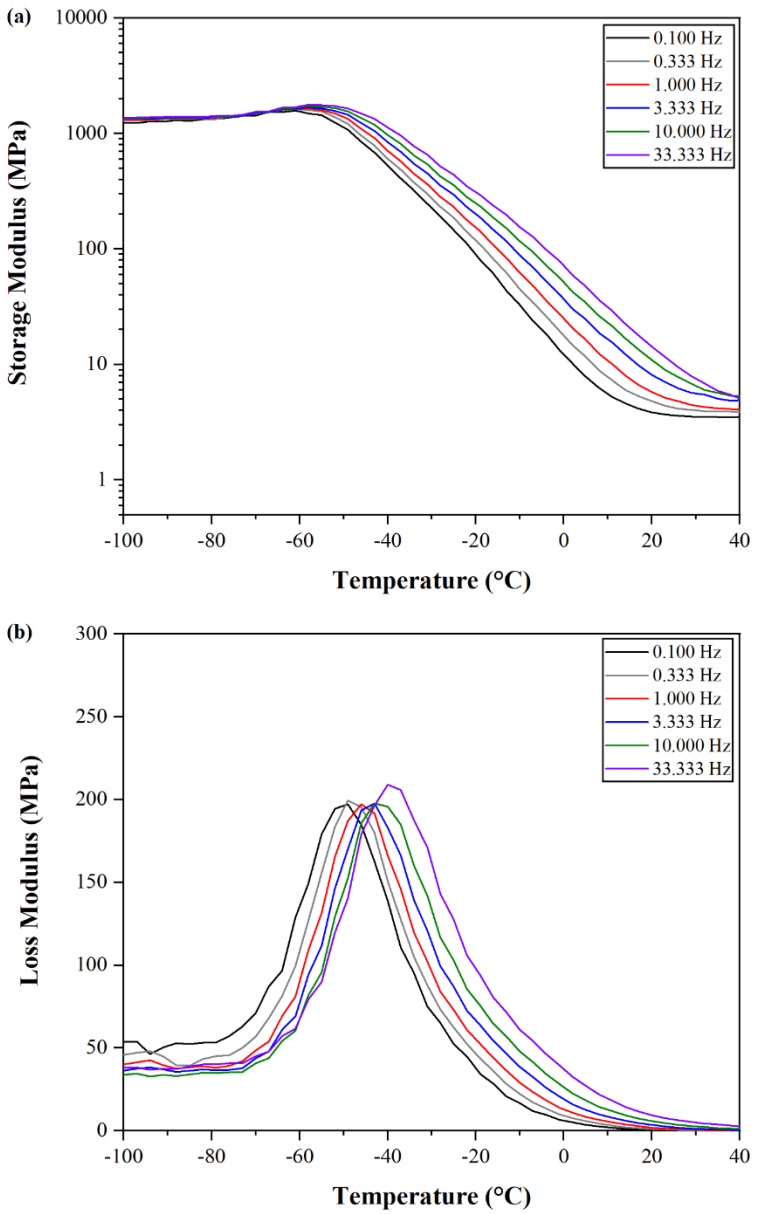


Figure S3. DMA frequency sweep results for printed formulated resin with HEMA: (a) storage modulus. (b) loss modulus.

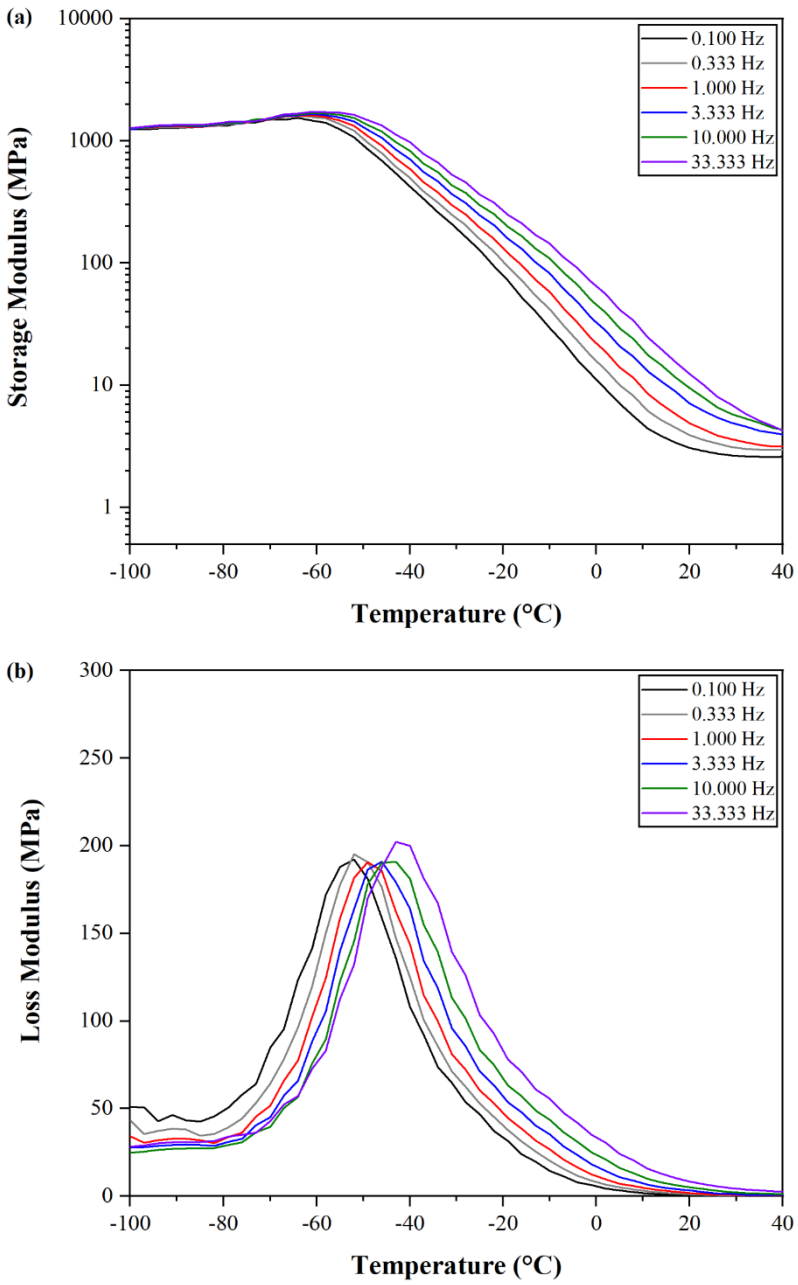


Figure S4. DMA frequency sweep results for printed formulated resin with EHA: (a) storage modulus. (b) loss modulus.

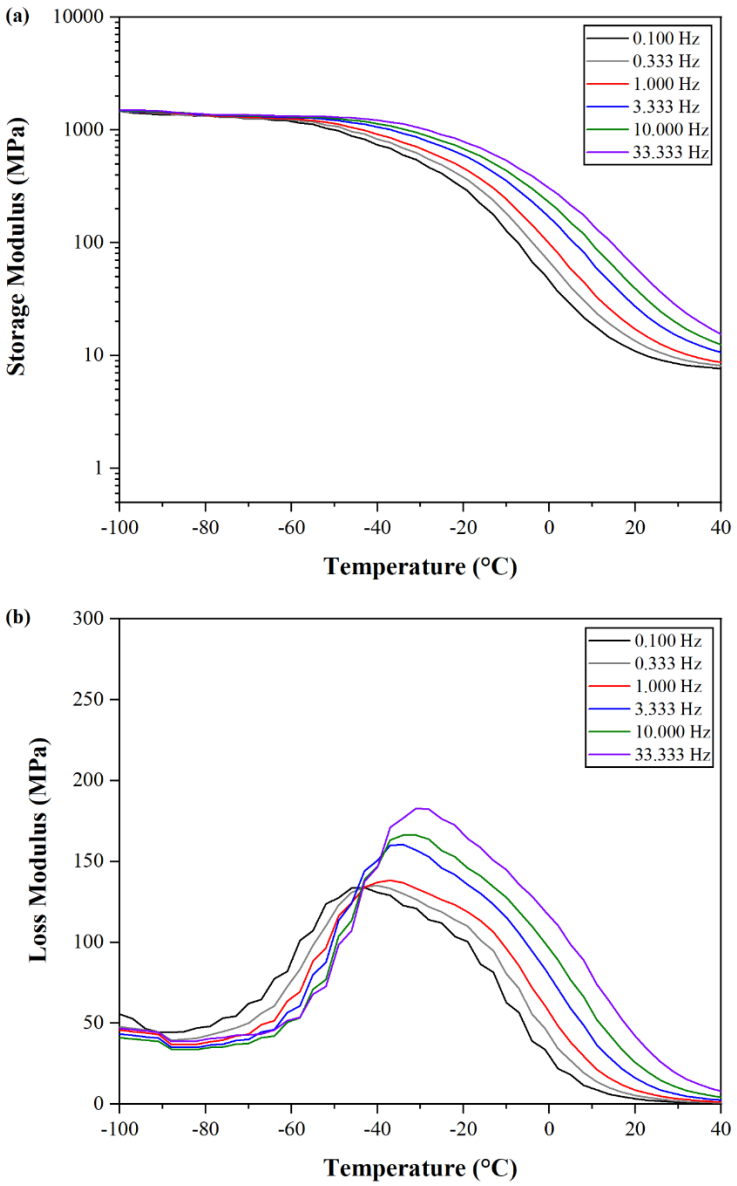


Figure S5. DMA frequency sweep results for printed base resin with glass microspheres: (a) storage modulus. (b) loss modulus.

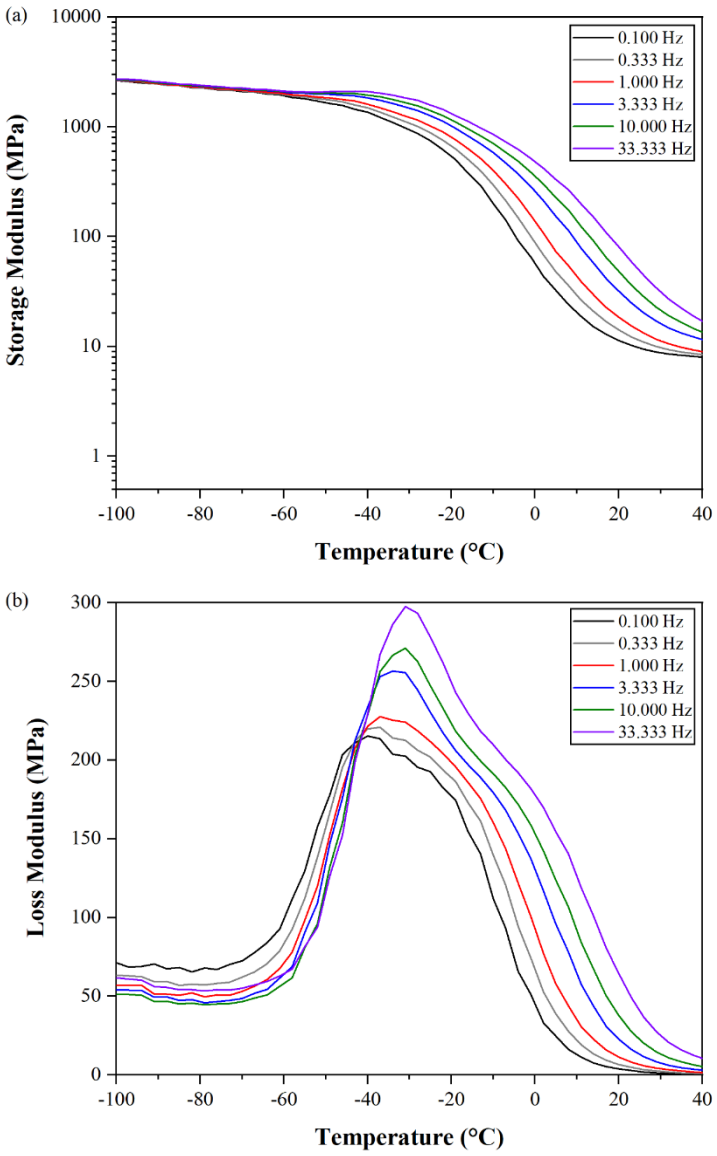


Figure S6. DMA frequency sweep results for printed formulated resin with HEMA and glass microspheres: (a) storage modulus. (b) loss modulus.

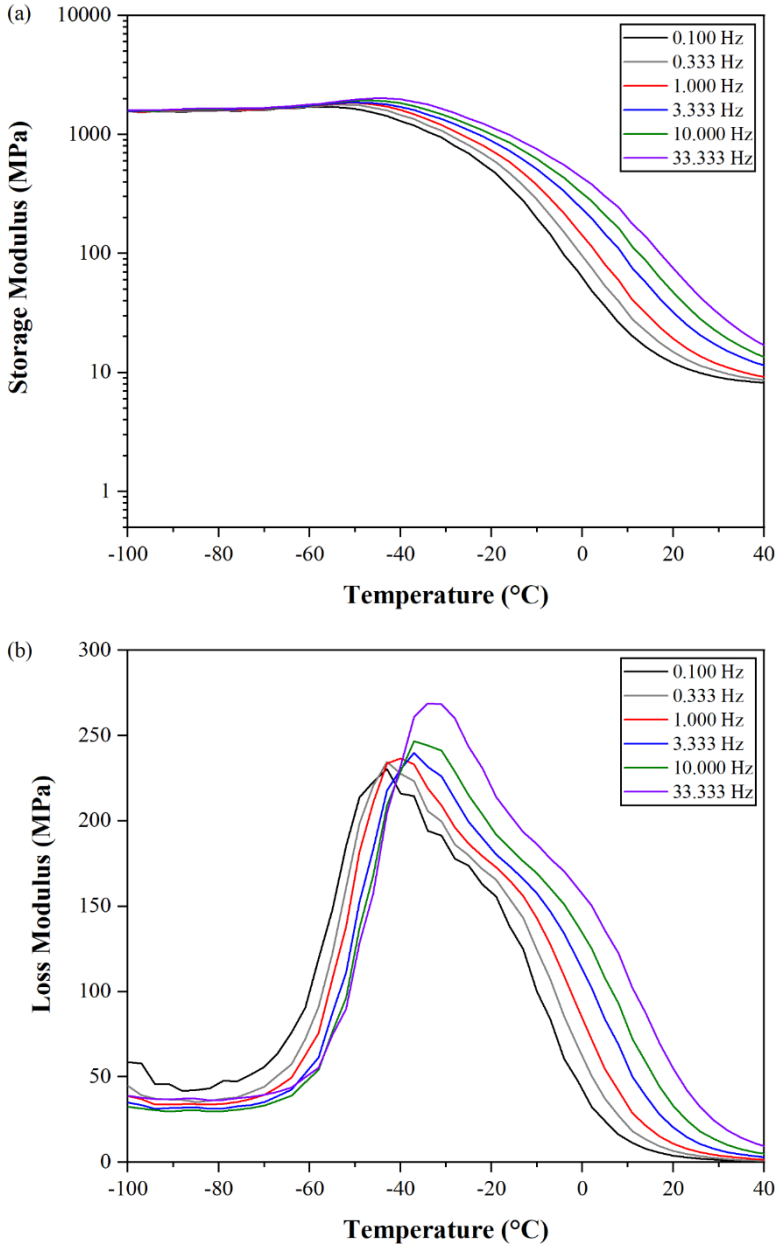


Figure S7. DMA frequency sweep results for printed formulated resin with EHA and glass microspheres: (a) storage modulus. (b) loss modulus.

Designs of printed structures

The resolution print design with vertical walls and trenches was inspired and created following previous work from Shah et al.[1]

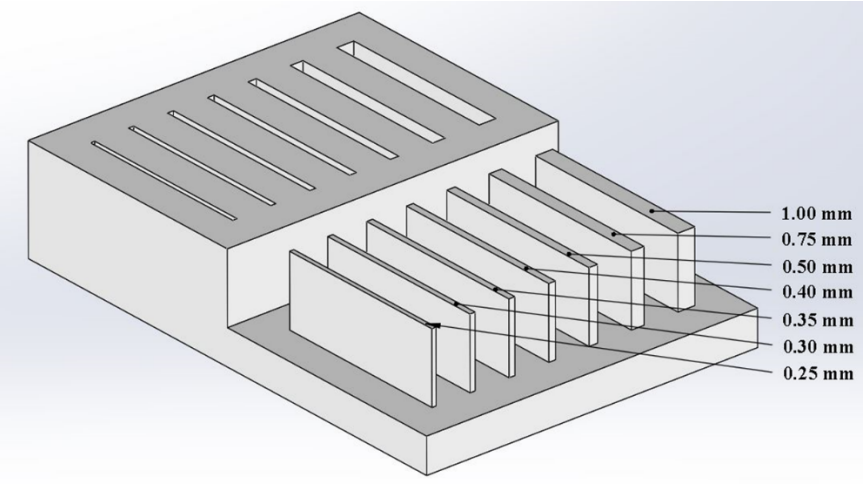


Figure S8. CAD file of resolution print with vertical walls and trenches.

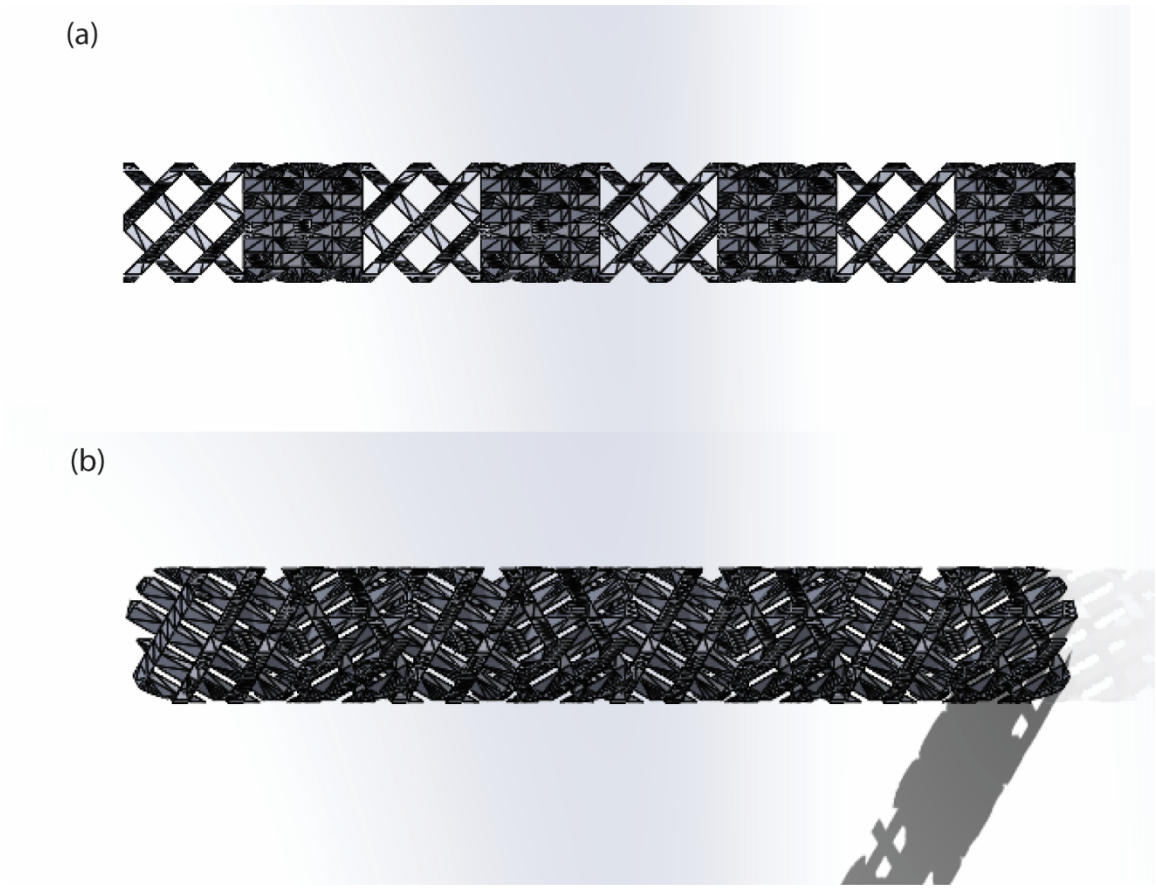


Figure S9. CAD file of mixing element. (a) side view; (b) isometric view.

(1) Shah, D. M.; Morris, J.; Plaisted, T. A.; Amirkhizi, A. V.; Hansen, C. J. Highly Filled Resins for DLP-Based Printing of Low Density, High Modulus Materials. *Addit. Manuf.* **2021**, *37* (August 2020), 101736. https://doi.org/10.1016/j.addma.2020.101736.