Improving Resolution and Printability of Photo-Printable GelMA-based Resins with comonomers and Light Absorbers

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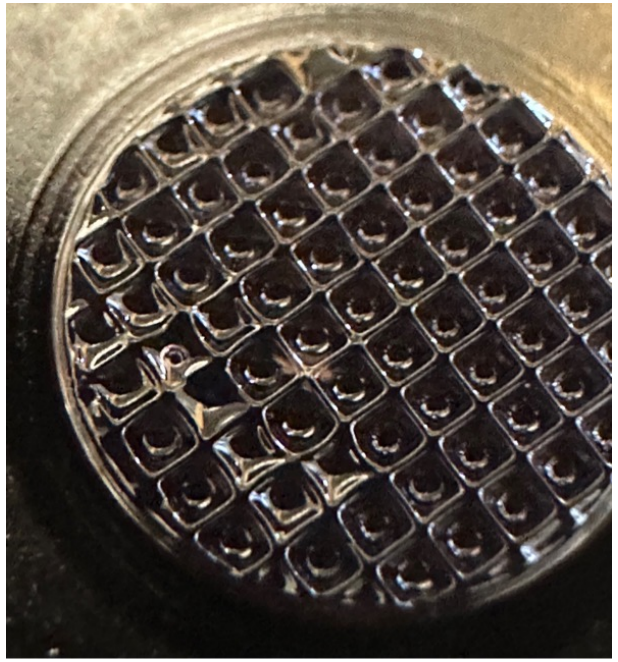
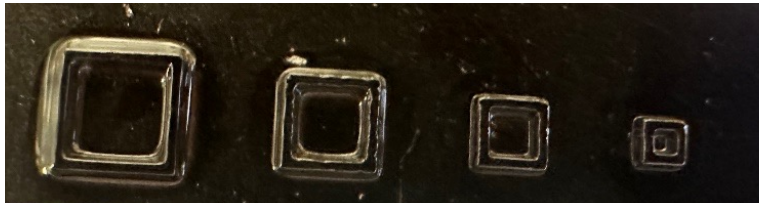
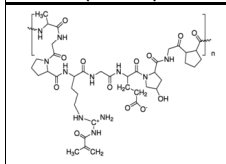
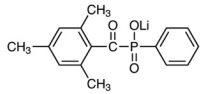
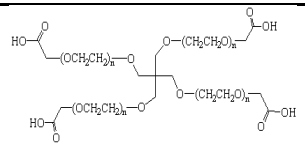
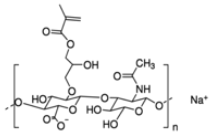
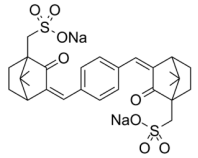
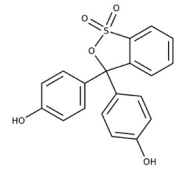
Image of printed scaffold:
Formulation F, 0.2mm strut; 0.8mm x 0.8mm Pore Array



3D Onshape Design: 0.6mm Strut 4mm x 4mm – 1mm x 1mm Pore Array

Image of printed part:
Formulation D, 4mm x 4mm – 1mm x 1mm Pore Array



GelMA 40% Methacrylate (5 wt%)	LAP (0.25 wt%)	4-arm PEG_{20k} AC (2.5 wt%)	$HAMA_{50k}$ (2.6 wt%)	Ecamsule (0.1 - 0.5 wt%)	Phenol Red dye (0.001365- 0.001403 wt%)
					
Monomer	Photo-initiator	Co-monomer	Co-monomer	Photo-absorber	Photo-absorber

How Does the Addition of Comonomers and Photoabsorbers Affect the Print Resolution and Printability of Photo-Printable GelMA-based Resin Hydrogels?

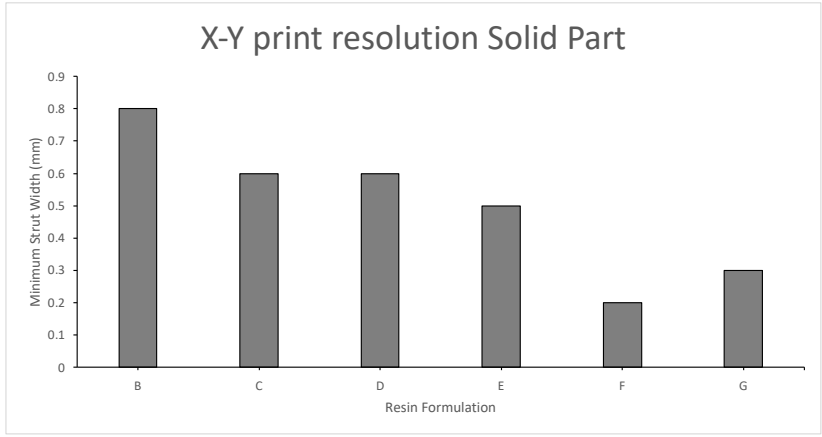
The Importance of the Research Question

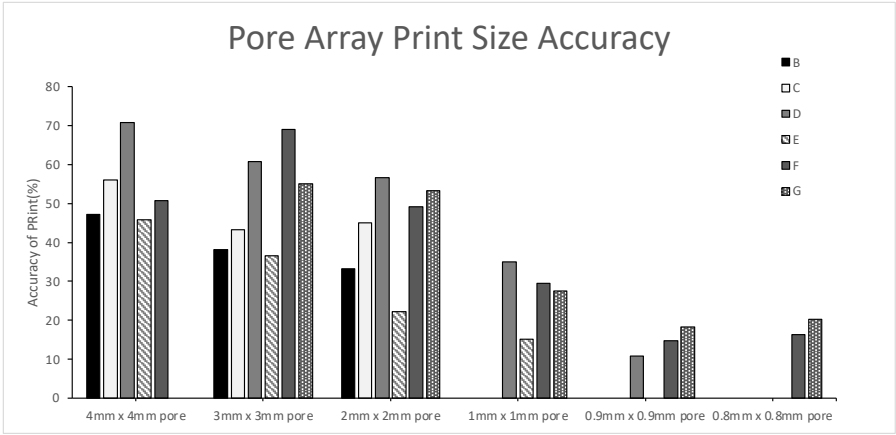
- Glioblastoma is a very aggressive type of brain cancer, and current post-surgery treatment options often lead to tumor regrowth.
- Neural Stem Cells (NSC) tend to migrate towards glial tumor cells in the brain, which could increase the effectiveness of future treatments if they contained therapeutic drugs.
- GelMA hydrogel scaffolds provide an environment for Therapeutic Neural Stem Cells (tNSC) to live and could be implanted into the glioblastoma post surgery resection cavity, with the degradation of the scaffold releasing the tNSC.
- The resolution of the pores of the scaffold are important, since the amount of surface area affects the degradation speed of the scaffold and the controlled release of tNSC.

Results:

- The addition of the photo absorber Phenol Red added in the form of DMEM to the resin formulations resulted in an improved print resolution.
- The addition of comonomers further improved print resolution, with HAMA (Hyaluronic Acid Methacryate, 50kDa) increasing print resolution more than four-arm PEGAC (Polyethylene glycol diacrylate, 20kDa)
- Due to the presence of slight overcuring, smaller pore sizes resulted in decrease pore resolution accuracy.

Formulation list			
Identifier	Formulation	DC	α
A	5 wt% GelMA, 0.25% LAP in H_2O	18.29	0.00147
B	5 wt% GelMA, 0.25% LAP, 0.5% Ecamsule in H_2O	249.687	0.00274
C	5 wt % GelMA, 0.25% LAP, in DMEM	23.619	0.00355
D	5% GelMa, 2.5% 4-arm PEG 20k AC, 0.25% LAP in DMEM	8.221	0.00319
E	5% GelMA, 2.5% 4-arm PEG 20k AC, 0.25% LAP, 0.1% Ecamsule in DMEM	31.414	0.00150
F	5% GelMA, 2.6% HAMA 50k, 0.25% LAP in DMEM	12.1443	0.00127
G	5% GelMA, 2.6% HAMA 50k, 0.25% LAP, 0.1% Ecamsule, in DMEM	11.693	0.00164





Importance to Scholarly Audience

This experiment provides more information on the diversity of biodegradable GelMA-based hydrogels, specifically the print measurements of different struts and pores to design scaffolds resolvable pores for a wide variety of resin formulations. It also highlights a connection of the inclusion of comonomers and photoabsorbers to allow for smaller prints and improved print resolution.

Importance to General Audience

This information allows for further design on novel glioblastoma post surgery treatments, which could greatly improve patient outcomes. It can also be important to better understand the possible uses of hydrogel scaffolds for a wide range of stem cell therapies and possibly tissue engineering.