3D-Printed Electroactive Hydrogel-Based Microgripper for Biomedical Applications

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Abstract

Hydrogels are made up of polymer network chains that are capable of absorbing and storing liquid, this feature makes them elastic and soft. Electroactive hydrogel-based (EAH) microgrippers are compact, biocompatible, adaptable, and they respond to stimuli; this exhibits a potential to be used in biomedical usage. Manufacturing these microgrippers was possible by using projection micro-stereolithography (PμSL). Their movement was studied in an aqueous environment.

Methodology

- Photosensitive resin recipe includes using a light stabilizer, photo initiator, acrylic acid as a monomer, and poly (ethylene glycol) diacrylate (PEGDA) as the cross-linking reagent.
- 3D-printing the samples via PμSL, an illustration to visualize the process is seen in figure 1.
- Soaking the samples 24hrs in ethanol, then in 0.05M phosphate-buffered saline (PBS) buffer solution for 24hrs.
- Applying 30V to the sample when it is submerged in the buffer solution for up to 2min to observe bending.

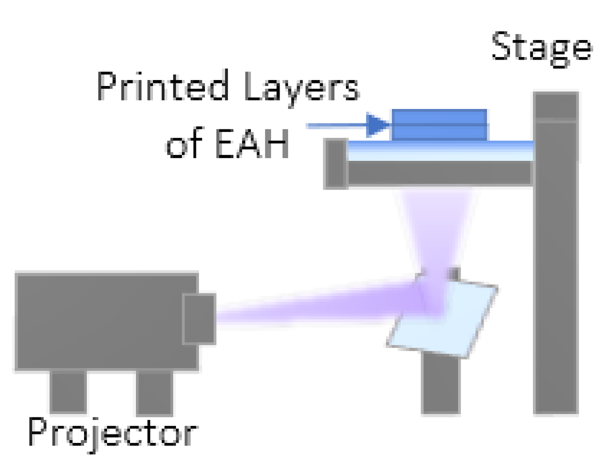

Figure 1. Drawing of the PμSL setup to 3D-print the EAH microgrippers, ultraviolet light is used to cure the resin layer by layer in the form of the sample.

Findings

To find the optimal curing time for the resin, preliminary tests were done in a 2D environment. These discoveries can be seen in figure 2. The samples showed continuous bending motion when electrical stimuli was applied. The bending rate was studied for the thickness of 500μm and 350μm and realized its maximum bending at 1min30s and 90s, respectively.

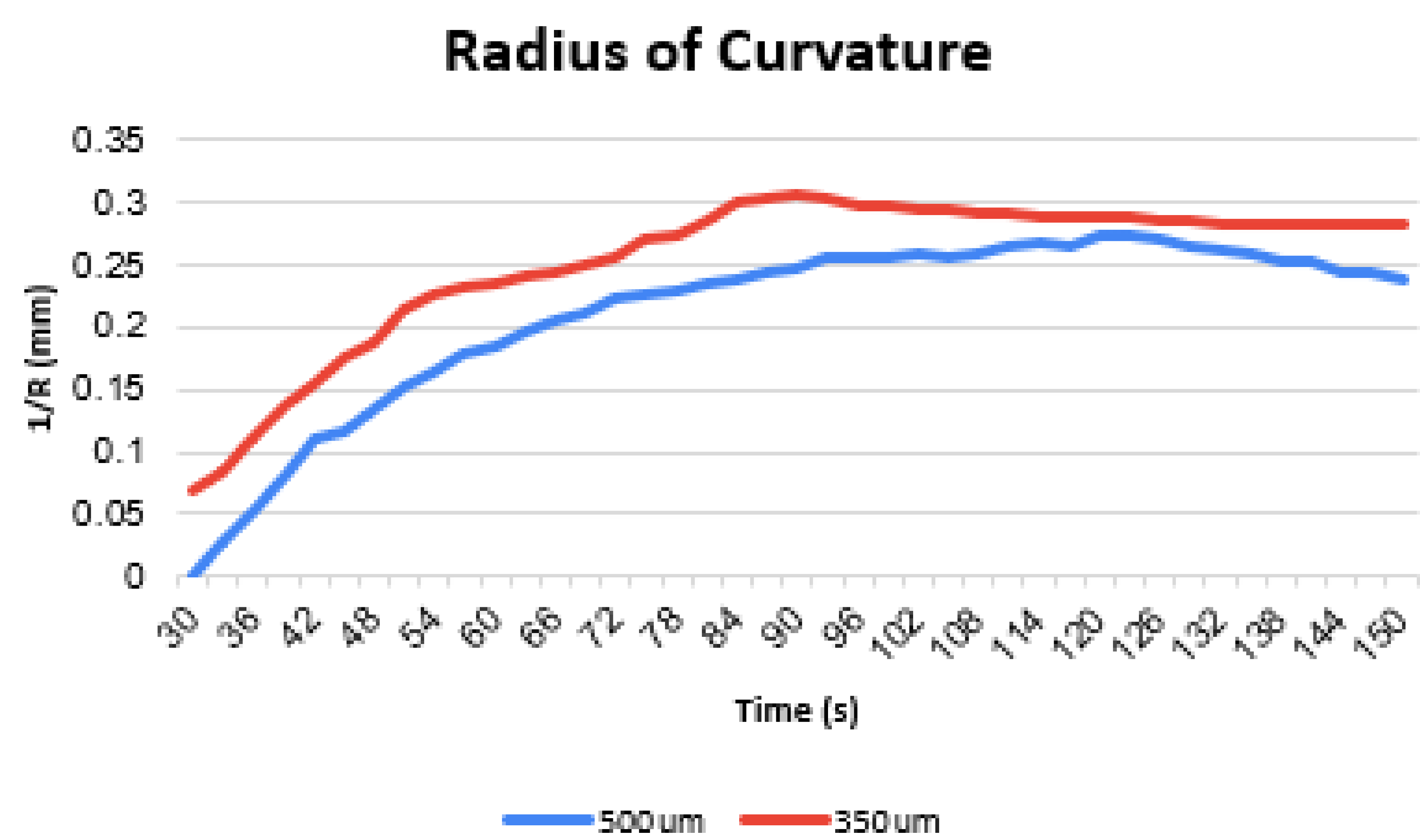

Figure 2. Graph above shows the radius of curvature found on the preliminary test done on the EAH beams that had 500μm and 350μm thickness.

Testing on the 3-finger EAH microgrippers was done in a 3D aqueous environment. The samples displayed continuous closing motion when the voltage was on. The 500μm and 350μm samples showed uninterrupted motion and maximum bending at 59s and 55s, respectively, as seen in figure 3A-D.

Findings Cont.

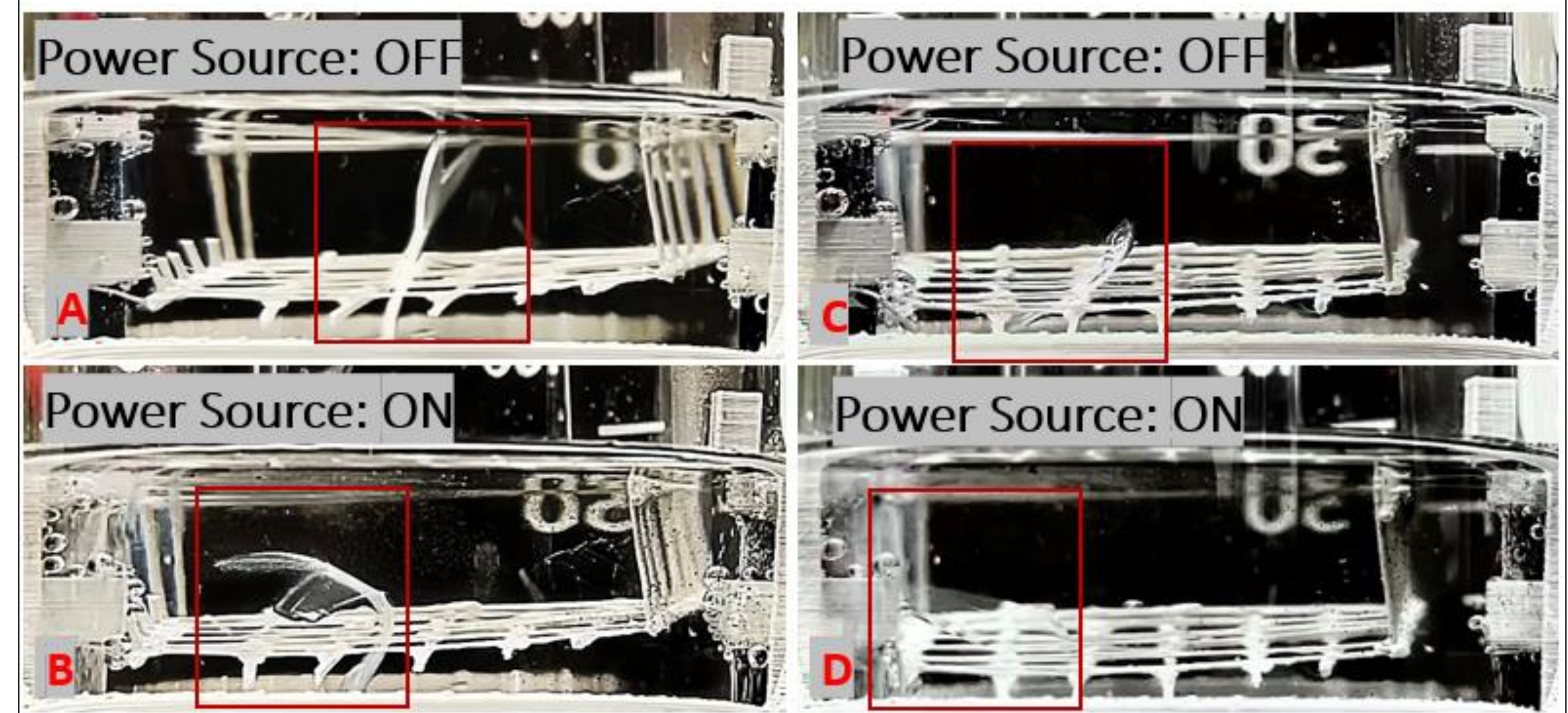

Figure 3. (A) 500μm microgripper in an OFF state, (B) 500μm microgripper in an ON state at 59 seconds with 30V applied, (C) 350μm microgripper in an OFF state, (D) 350μm microgripper in an ON state at 55 seconds with 30V applied.

The 350μm sample demonstrated a complete closing motion and went back to its original shape when the voltage was off.

Future Work

The next phase of this research entails:

- Analyzing other microgripper designs to observe and optimize their closing and opening capabilities.
- Exploring other resin recipes to produce a robust microgripper.
- Investigating its ability to hold a micro-object within the buffer solution.

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