# VAT Photopolymerization of Smart Structures with Highly Removable and Recyclable Supportable Polymers

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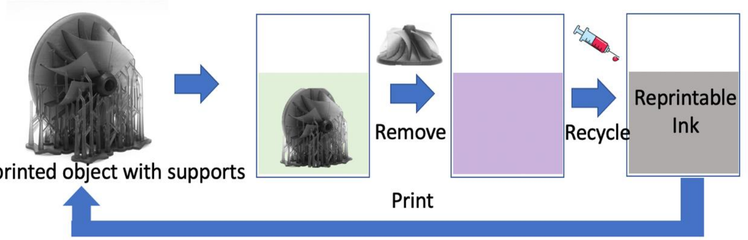
## Background

Current vat photopolymerization (VPP) technology can print there-dimensional (3D) objects with high precision and fast speed [1-2]. For complex computer-aided design (CAD) mega-structures, a significant amount of additional support structures is required in order to ensure the overhanging and free-hanging features can be fabricated [3-5]. However, internal support structures cannot be directly removed, and it is time-consuming to manually remove all the support structures. In addition, unexpected damage and undesired surface marks will be caused by the removal of the support structures [6-8]. Although some special materials, such as NaOH-soluble materials and wax, have been utilized to fabricate removable support structures, only certain types of printable material can be used and the removal process brings a lot of waste [6-8].

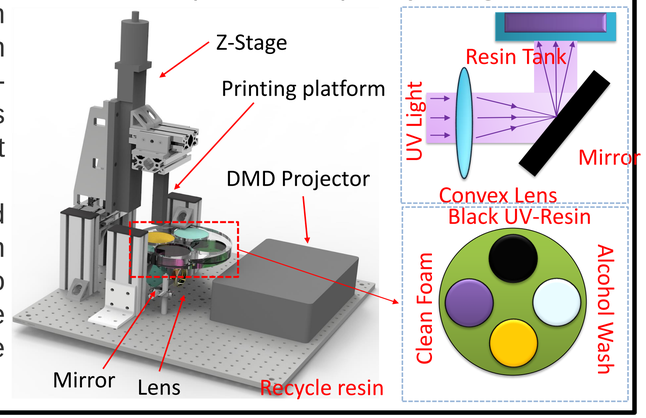

## Objectives

The objective of this project is to develop a novel vat photopolymerization process and print smart meta structures using highly removable and recyclable polymer as supports.

## Principle and method

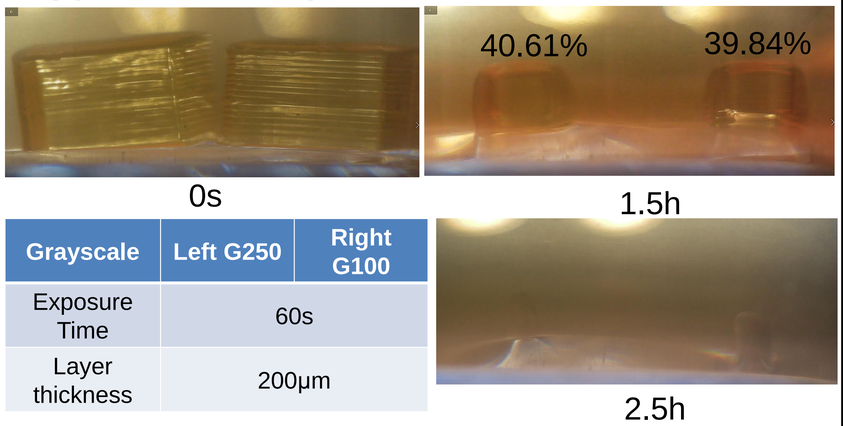
### Multi-material VPP

The multi-material VPP process was used to selectively cure a conventional acrylic-based UV resin and a recyclable thiol-ene photocurable material in a layer-by-layer manner to form high-resolution geometries and complex 3D shapes by using ultraviolet light of 405 nm wavelength. An recyclable thiol-ene resin was used to print supporting structures and acylate resin was used to print the structures in the same layer.




## Result and Discussion

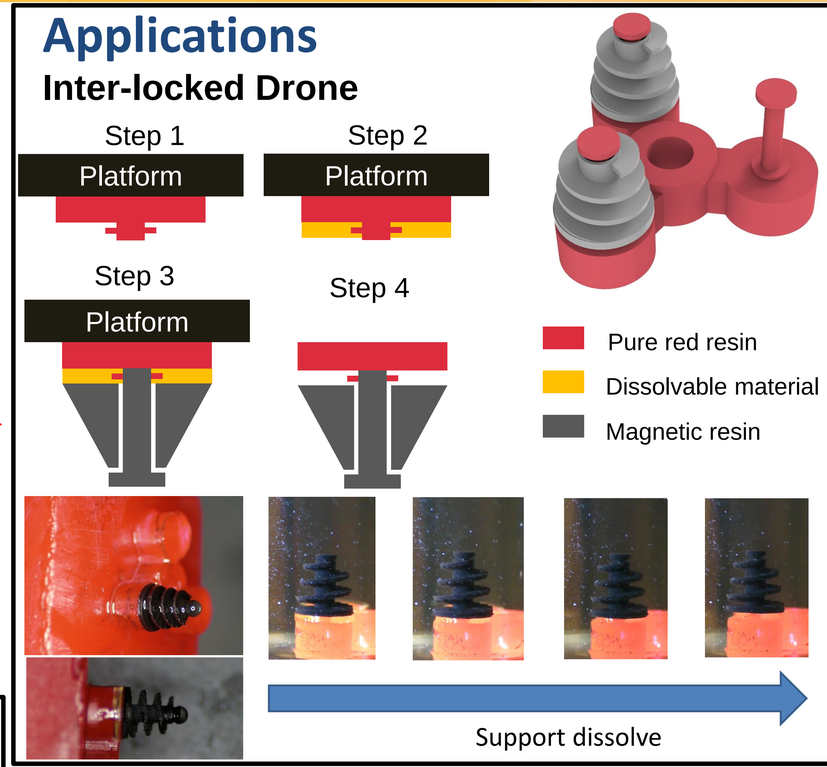
### Support dissolve process




| Grayscale | Left G250 | Right G100 |
|---|---|---|
| Exposure Time | 60s | |
| Layer thickness | 200µm | |

## Applications

### Inter-locked Drone




## Future work

1) Print more testcases using multi material VPP Process
2) Design support structures to recycle the supports more effectively

## Acknowledgement

**Thanks to the support of the FURI program**

**[1]** Alfarhan, S., Brown, J., Liu, B., Long, T., & Jin, K. (2022). Chemically recyclable crosslinked thiol-ene photopolymers via thiol-disulfide exchange reactions. *Journal of Polymer Science*.
[2] Joralmon, D., Alfarhan, S., Kim, S., Tang, T., Jin, K., & Li, X. (2022). Three-Dimensional Printing of Liquid Crystals with Thermal Sensing Capability via Multimaterial Vat Photopolymerization. *ACS Applied Polymer Materials*, *4*(4), 2951-2959.

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