UV Didn't Start the Fire!

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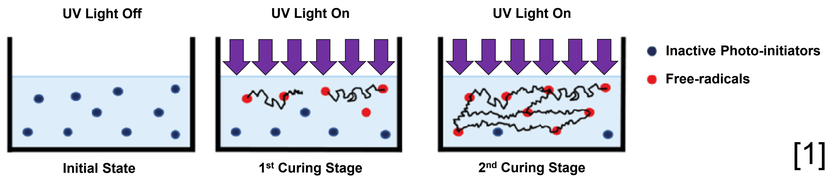
Abstract

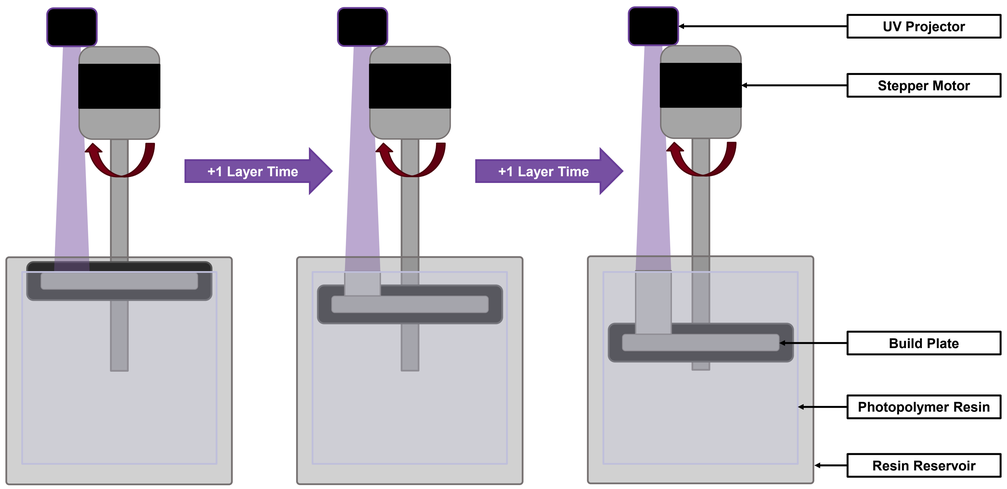
3D printing is a quickly moving field, on its way to being viable for mass manufacturing. A current roadblock to increasing print speed is the risk of overheating the resin and causing a fire. As an exothermic reaction, it is useful to characterize the effect of curing rate on the heat of photopolymerization. Curve fitting was used to correlate the temperature change to the duration of the print, and then the rate of temperature change during a print to the print speed. This showed a maximum temperature increase rate of 0.159±0.034°C/s, and a negative proportional relationship between print speed and temperature increase rate of -0.171±0.067°C/s^2.

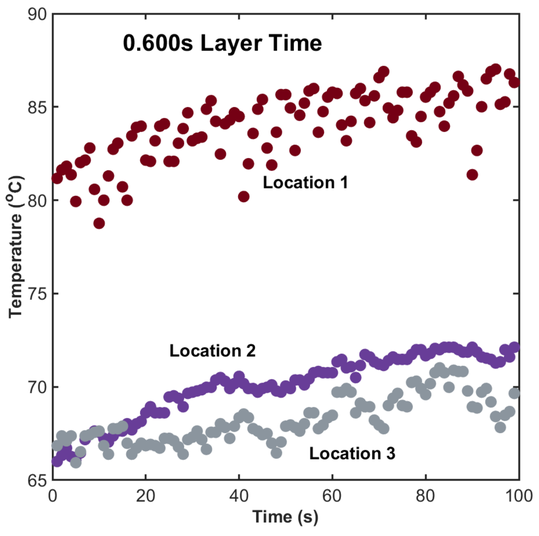
Background on Photopolymerization



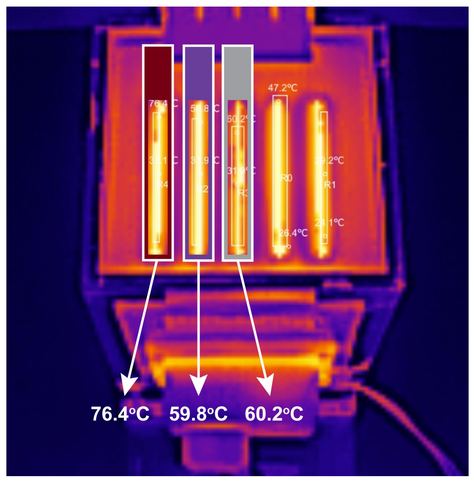
[1]

3D Printing & Imaging Setup

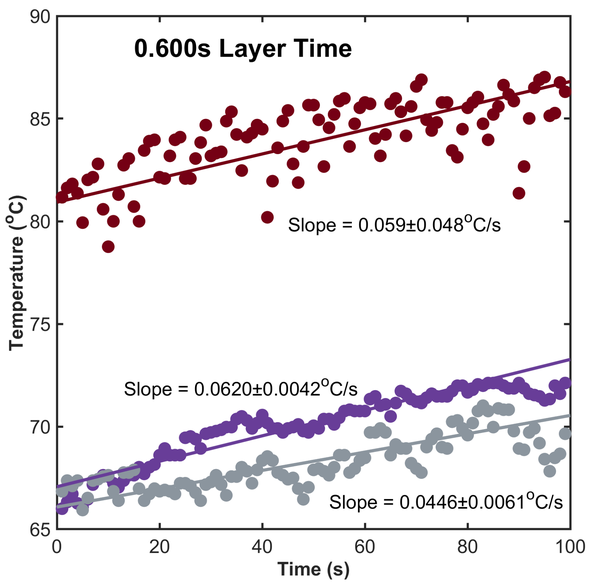


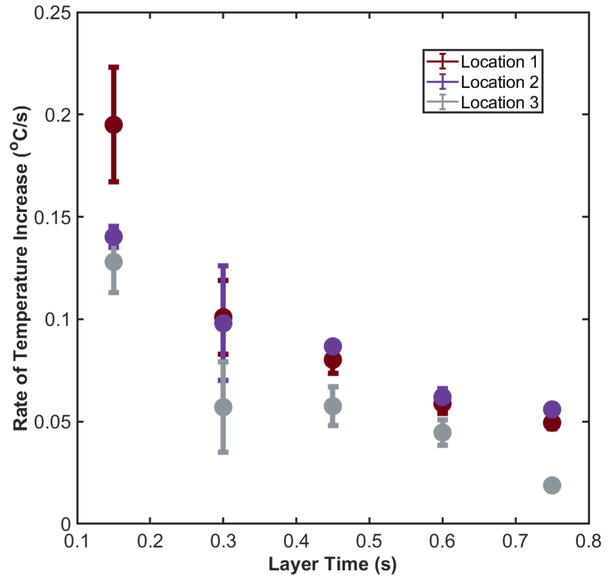


Thermal Camera View

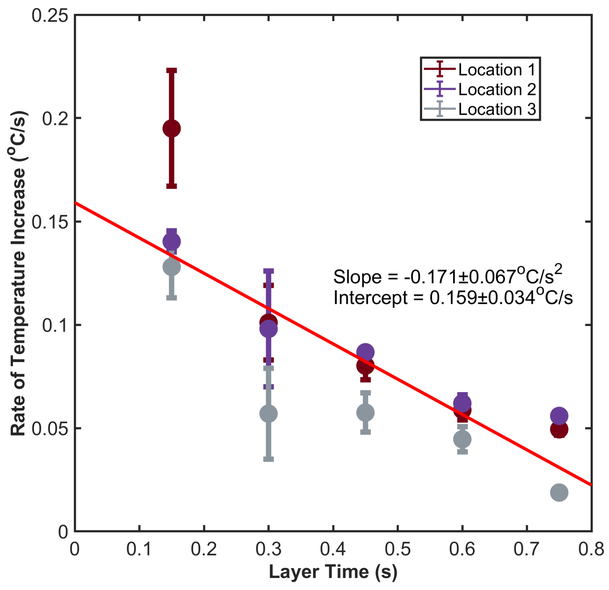


Thermal Imaging Results





Predictive Model



Conclusions

- The temperature of Photopolymer Resin increases linearly for the duration of a print.
- There is a negative proportional relationship between the Layer Time, or Print Speed, and the Rate of Temperature Increase for Photopolymer Resin.
- At continuous printing rate (i.e. 0 second Layer Time), the top layer of resin will heat up at a rate of 0.159 ± 0.034°C/s.
- It would be revealing to test ever-faster layer times to verify if the predictive model can make accurate predictions at the limit of 0 seconds layer time.

Acknowledgements

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References

[1] Brighenti, R., et al., "Multiphysics Modelling of the Mechanical Properties in Polymers Obtained via Photo-Induced Polymerization," Int J Adv Manuf Technol, **117**(1–2), pp. 481–499.
[2] D'Aveni, R., 2015, "The 3-D Printing Revolution," Harvard Business Review.

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