Project Title: Rapid vascularization of polymer matrices using degradable templates

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Project Description: Degradable polymer templates including fibers and 3D printed architectures can be embedded inside a host matrix and later removed to create hollow microchannels that can be infiltrated with various functional fluids for bioinspired applications including self-healing, self-sensing, material regeneration and thermal homeostasis. The current process involves degrading poly (lactic) acid templates at 200 °C. This is time intensive and limited to high temperature resistant matrices. Our goal is to intelligently combine novel polymers and degradation triggers (thermal, chemical, radiative etc.) for making microvascular networks across different thermoplastic and low temperature cure thermoset matrices. Recently, thermal degradation of an embedded cyclic-poly(phthalaldehyde) (cPPA) fiber was achieved during an exothermic curing reaction of partially cured poly(dicyclopentadiene) (pDCPD) gels. This reaction (Frontal Ring Opening Metathesis Polymerization, or FROMP) results in the formation of microchannels inside a fully cured matrix in less than 3 minutes.

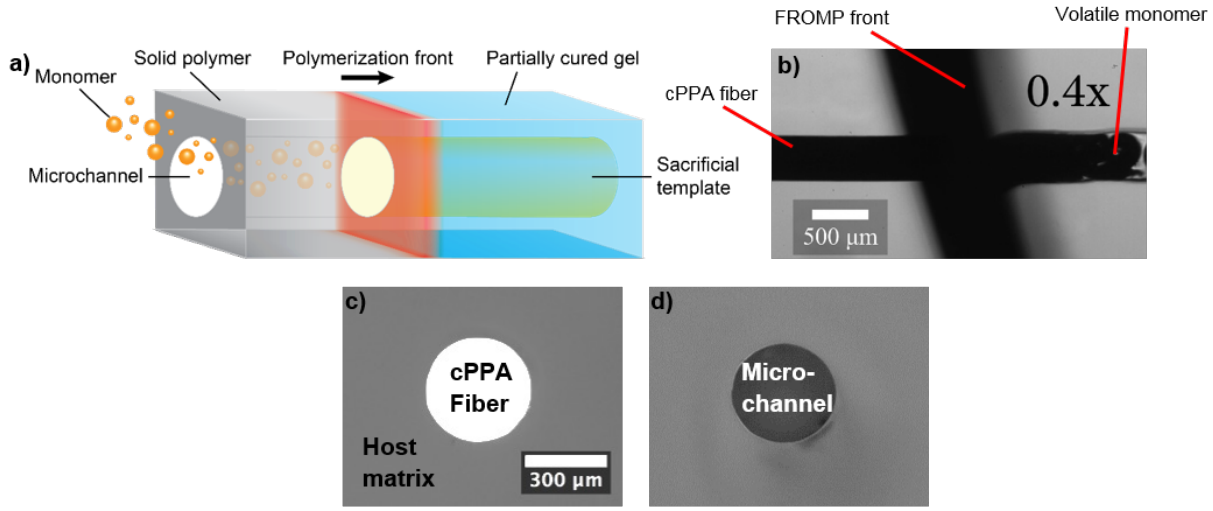

Figure 1. Rapid vascularization of poly(DCPD) matrix with embedded cPPA fiber. (a) Schematic and (b) video snapshot of cPPA fiber depolymerization in a rapidly curing matrix. Cross-section of poly(DCPD) matrix (c) before and (d) after FROMP

Student Background and Expected Research Activities: As an undergraduate student, you'll be assisting in synthesizing polymer matrices including cPPA and characterizing their degradation using various stimuli. Characterization experiments would include various thermal and spectroscopic methods including thermogravimetric analysis, mass spectrometry, UV-vis and Raman spectroscopy. The student will also be working with melt spinning and 3D printing equipment for templating the polymers into fibers and 3D printed networks. Mechanical and rheological properties of these polymers will also be tested for optimizing processing conditions during templating. The desired student would possess interest in organic chemistry, polymer processing and materials characterization. Laboratory experience is preferred, but the student will be trained thoroughly on all experimental procedures. The student will be expected to strictly follow the safety guidelines and procedures as instructed by the mentor. Strong communication skills are desired.

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References:

(1) Gergely, R. C. R. et al., *Adv. Funct. Mater.*, **2014**, 25.