Title

Light-Responsive Sacrificial Hydrogels for 3D Bioprinting Applications

Abstract

Three-dimensional (3D) bioprinting enables the fabrication of complex biological structures with spatial control over materials and cells. However, creating perfusable channel networks within these constructs remains a major challenge. Sacrificial hydrogels offer a promising solution by acting as temporary templates that can be removed after printing to form hollow structures.

This project focuses on the development of light-responsive sacrificial hydrogels that can be processed under mild conditions and selectively dissolved upon external stimulation. The material system can be tuned to function either as a support bath for embedded printing or as a printable sacrificial filament, enabling flexible fabrication strategies. The student will investigate how formulation and processing affect mechanical properties, printability, and removal behavior, and will demonstrate the fabrication of simple perfusable structures.

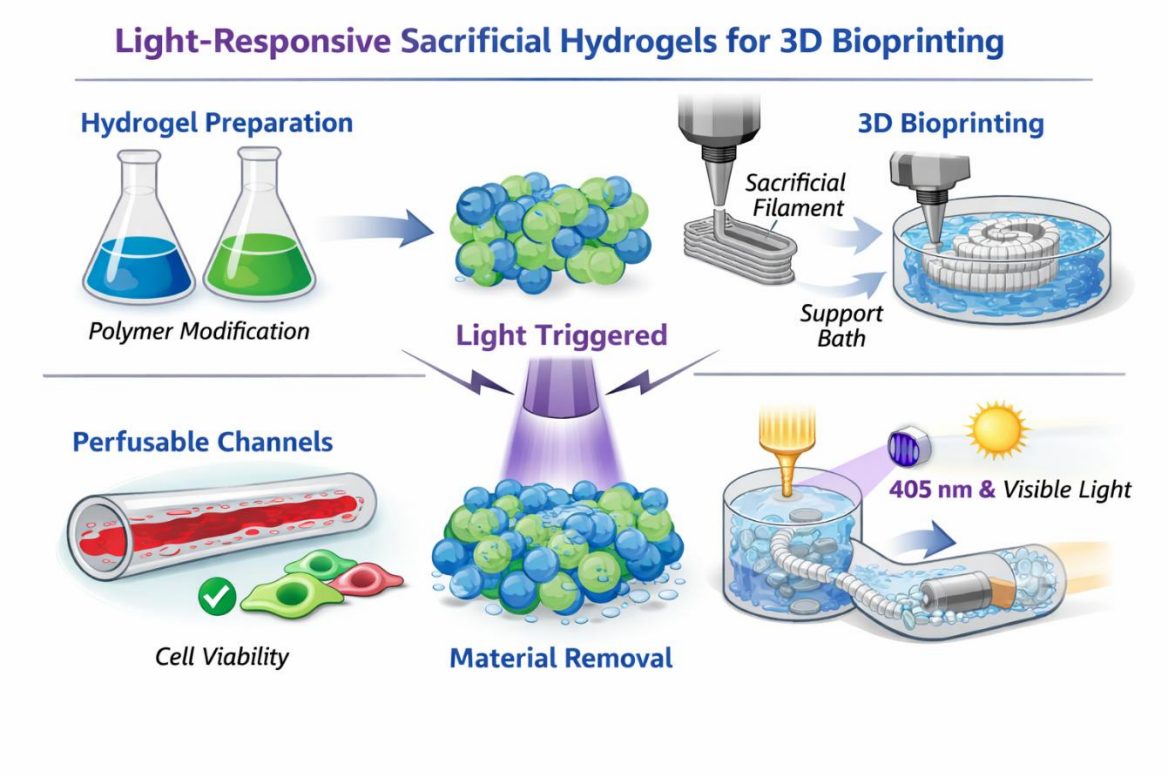
The objective of this project is to design and evaluate a tunable hydrogel system for use as a sacrificial material in 3D bioprinting. This includes understanding how material composition influences gel formation, mechanical behavior, and responsiveness to light-based triggering, as well as demonstrating its applicability in creating defined structures and channels.

Tasks

- Chemical preparation and modification of polymer-based hydrogels
- Formulation optimization to tune mechanical properties (soft vs. structured gels)
- Rheological characterization (viscosity, gel strength, recovery behavior)
- Development of support bath systems for embedded 3D printing
- Extrusion-based 3D printing experiments (filaments, simple structures)
- Evaluation of light-triggered material removal
- Fabrication of hollow channels and perfusion testing
- Basic biocompatibility assessment (cell viability assays)

Methods & Techniques

- Hydrogel synthesis and preparation
- Rheometry and mechanical testing
- 3D bioprinting (extrusion-based)
- Optical/light-based triggering experiments
- Microscopy and image analysis
- Cell culture and viability assays



Schematic illustration of a light-responsive sacrificial hydrogel system enabling 3D bioprinting and on-demand formation of perfusable channels via controlled light-triggered material removal.