Introducing Environmentally Responsive Hydrogel Nanocomposites for Biomedical Applications Synthesized Via PCμCP

Hariharsudhan D. Chirra, J. Zach Hilt
Department of Chemical and Materials Engineering, University of Kentucky, Lexington, KY 40506

INTRODUCTION

Devices that are spatially functionalized with smart hydrogels, especially at the micro- and nanoscale, are of high interest in the diagnostic and therapeutic fields. Using nanocomposites, hydrogels can be tailored to exhibit synergistic effects of the component inside the crosslinked matrix along with the hydrogel’s responsive property. Further expanding their potential applications in the biomedical field, the goal of this project was to develop novel methods to fabricate precise 3-D patterned smart hydrogels to devices (e.g., silicon, gold) followed by the integration of nanoparticles to the hydrogel matrix.

Specifically, polymerization controlled by micromincontact printing (PCμCP) was applied to synthesize a controlled array of environmentally responsive hydrogels over surfaces followed by in-situ precipitation of nanoparticles. These methods enable the fabrication of device platforms harnessing the unique utilities of hydrogels, such as diagnostic and therapeutic devices, microarrays, and micro-/nano-devices.

RESEARCH OBJECTIVES

- Controlled synthesis of smart hydrogels over gold
- XY control using micromincontact printing (μCP)
- Environmentally responsive tunable smart hydrogels
- Responsive studies to external stimuli
- Environmental responsive studies for biomedical applications

EXPERIMENTAL METHODS

In-situ Precipitated Responsive Nanocomposites

METHODS

CP are treated with hydrophilic prepolymer solution, which is then UV-photopolymerized.

RESULTS AND DISCUSSION

Controlled Hydrogel Growth via ATRP

Environmental Responsive Hydrogels

In-situ Precipitated Gold Nanoparticles (GNP) in a Hydrogel Matrix

CONCLUSIONS

- Precise XY control at the microscale was achieved using micromincontact printing (μCP).
- To control the hydrogel’s mechanical properties, atom transfer radical polymerization was used.
- Crosslinker parameters (e.g., crosslinker MW and amounts) were used to control the response behavior of the hydrogel.
- The thickness of the hydrogels grown via ATRP respond instantaneously and can be used for point of care applications.
- Gold nanoparticles were loaded into hydrogel microstructures using in-situ precipitation.

- Environmentally responsive tunable smart hydrogels synthesized via PCμCP can potentially be used for 'instantaneous' biomedical applications at the micro- and nanoscale.

Reference: