Nanopatterned Photo-responsive Hydrogels

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Motivation

Nanopatterned Hydrogels have enabled:

- Fabrication of combinatorial arrays
- Nanoscale sensors
- Micro- or nanofluidic devices
- Tissue engineering applications

Stimuli-responsive Hydrogels

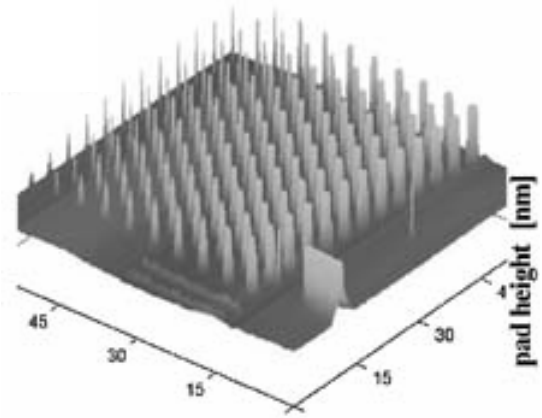
- Difficult to control
- Exponential complexity with increased-scale
- Required stimuli reduces application
- Current light-stimuli hydrogels are micron-scale

E-beam patterned bacteriorhodopsin-containing hydrogels

- Nanopatterned hydrogels are responsive to visible green-light
- Response depends on electron-dose and ionic strength
- Response is repeatable under cyclic light/dark exposure

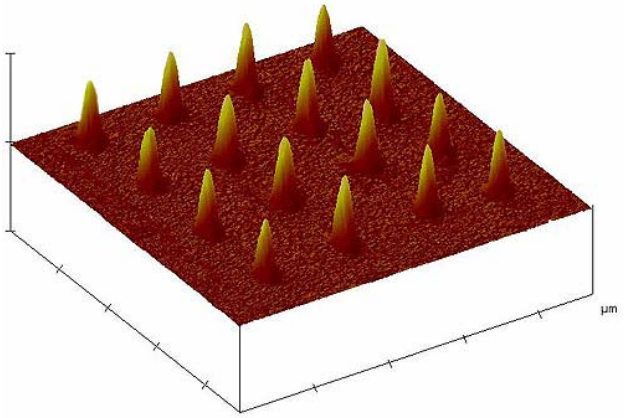
Can we make photo-responsive nanopatterned hydrogels comparable to current stimuli-responsive nanopatterned hydrogels?

Current thermally-responsive nanopatterned hydrogels

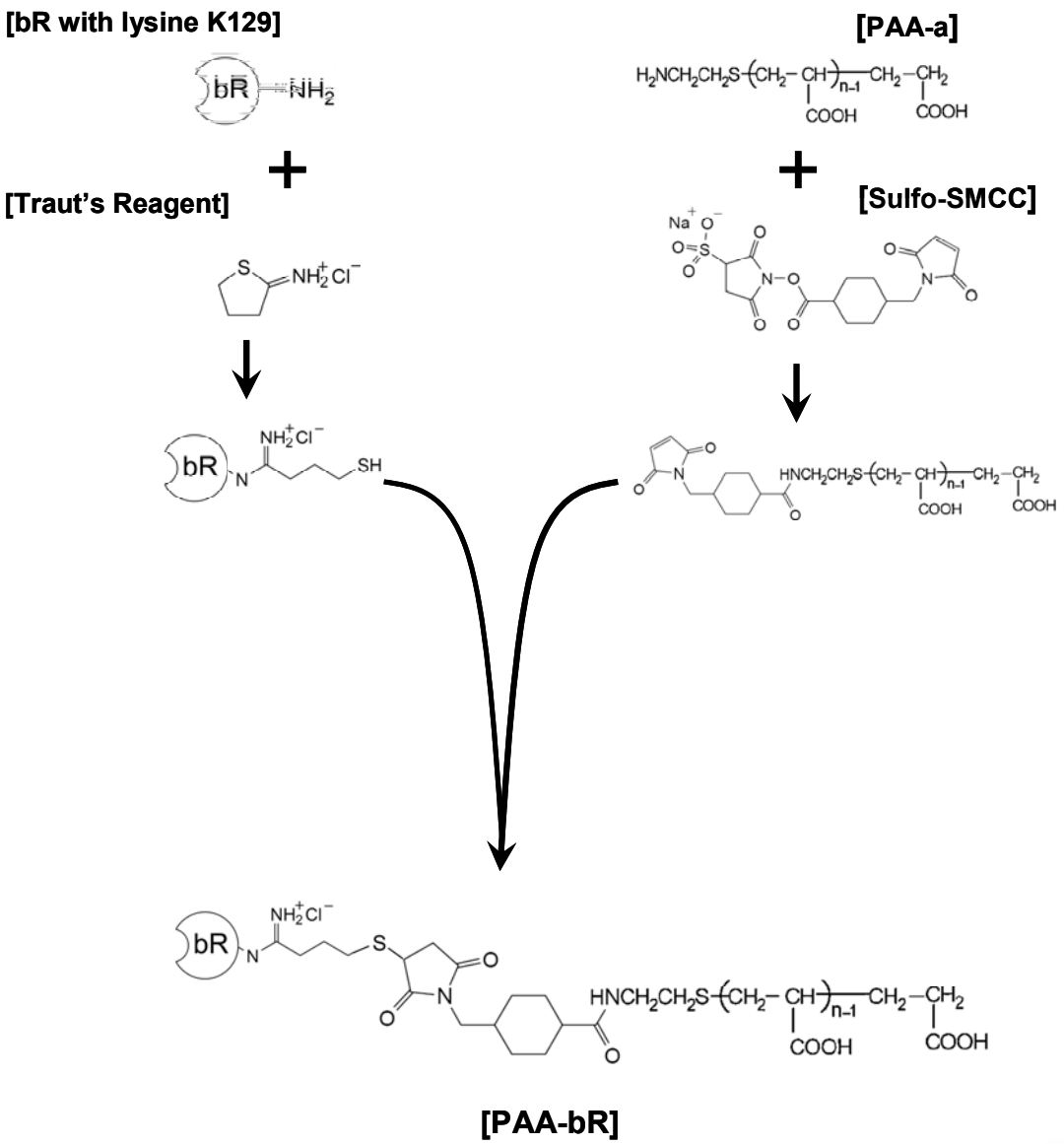


Karl-Friedrich Arndt, Technische Universität Dresden , Macromolecular Materials and Engineering, 2006

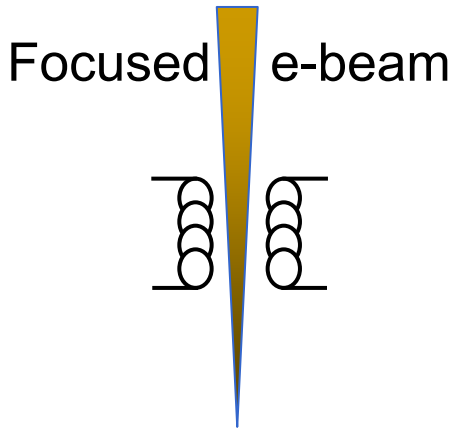
Model light-responsive nanopatterned hydrogels



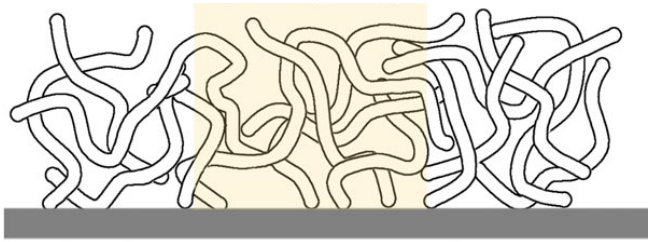
Synthesis of Poly (acrylic acid)-Bacteriorhodopsin Conjugate



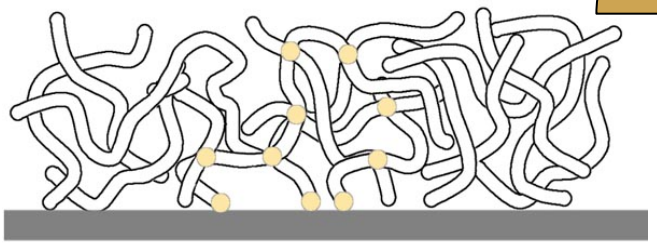
Electron Beam Patterning of Polymer Thin Film



FEI XL30 SEM-FEG

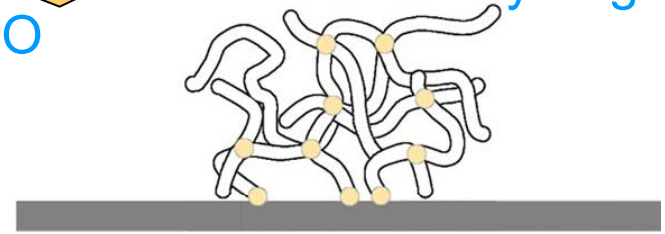


Spincoated thin polymer film

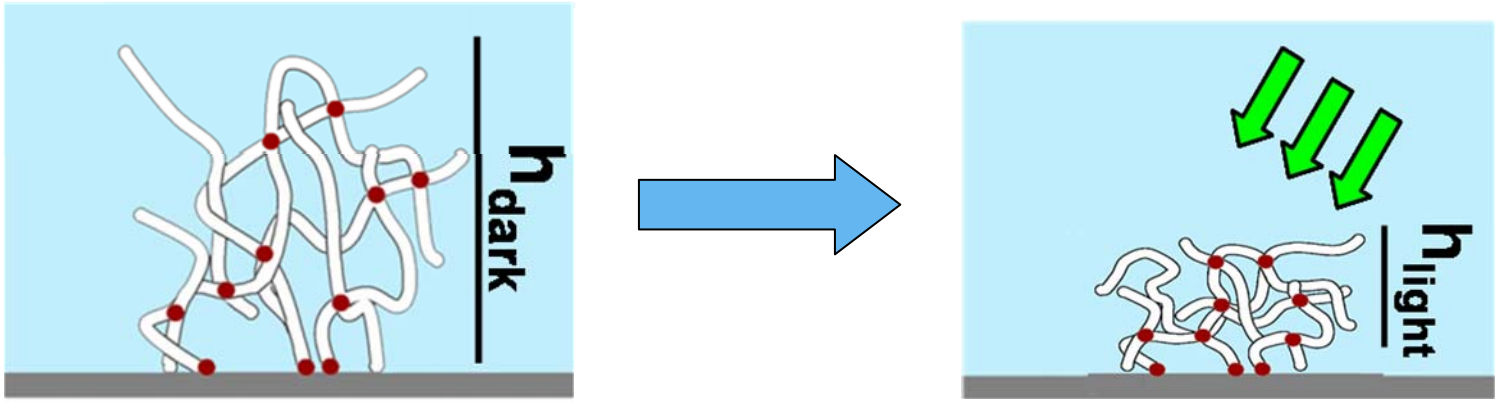


Develop in H_2O

Crosslinked hydrogel

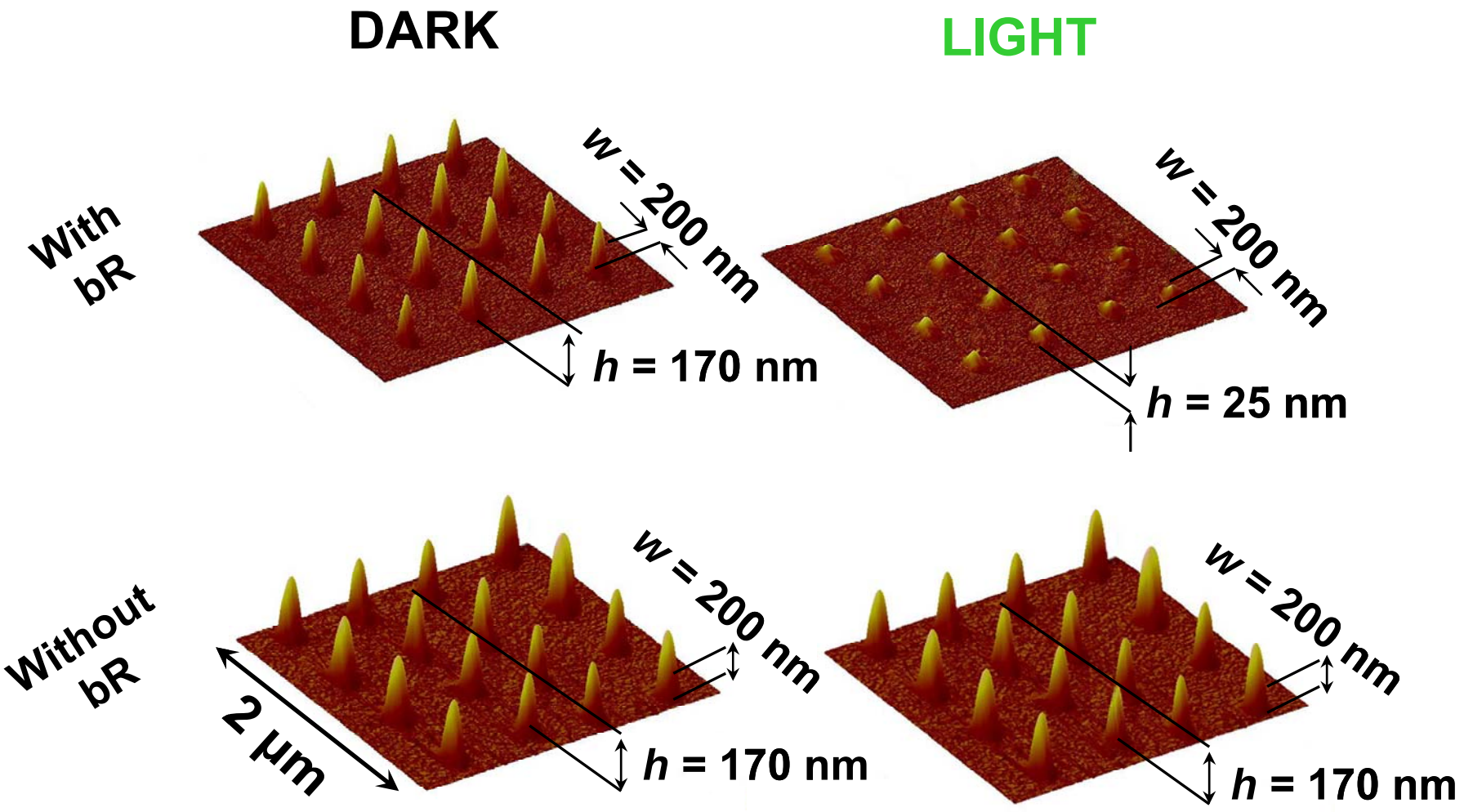


What we expect to see

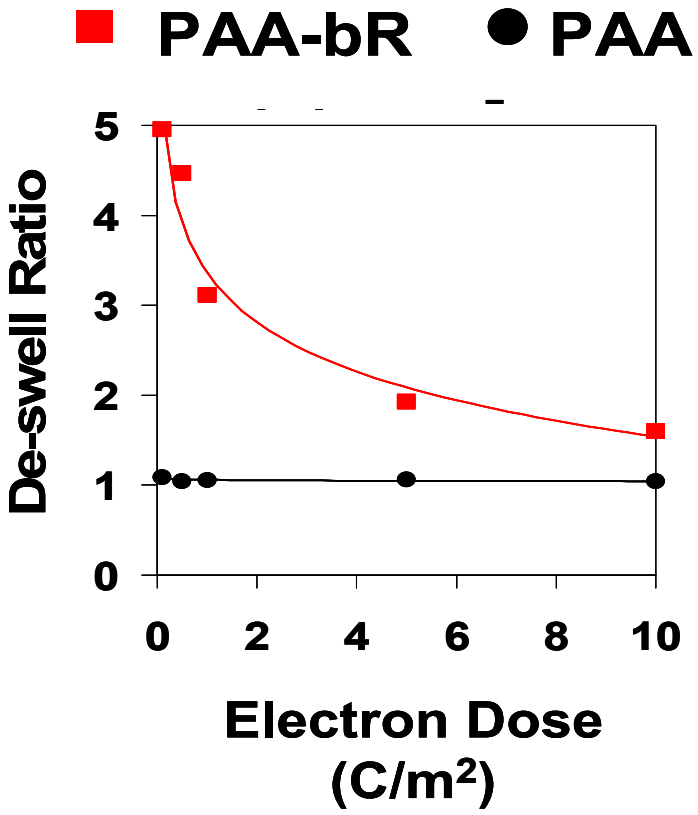


On exposure to visible green light

What the data looks like…



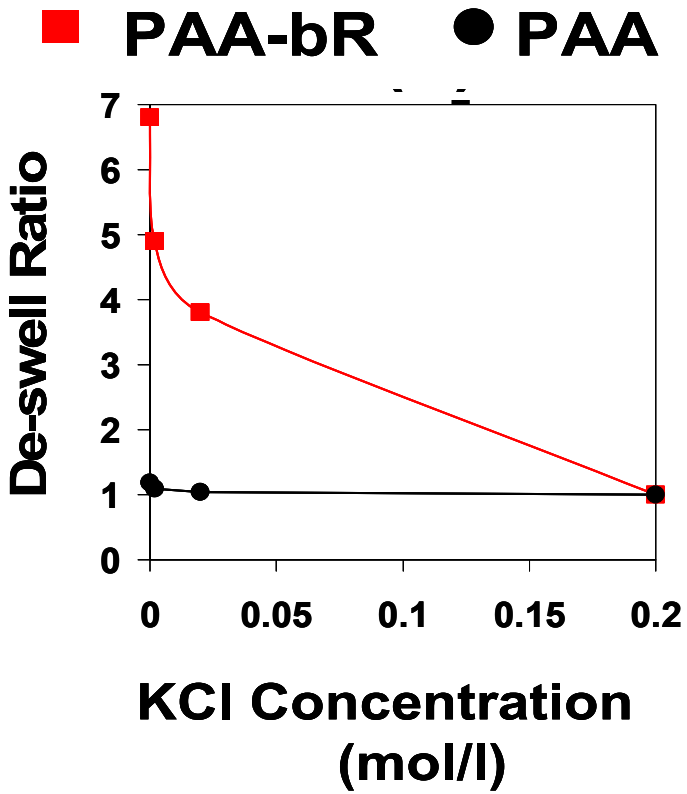
Response depends on electron-dose



Response displacement is dampened by:

- Electron dosage used for hydrogel fabrication

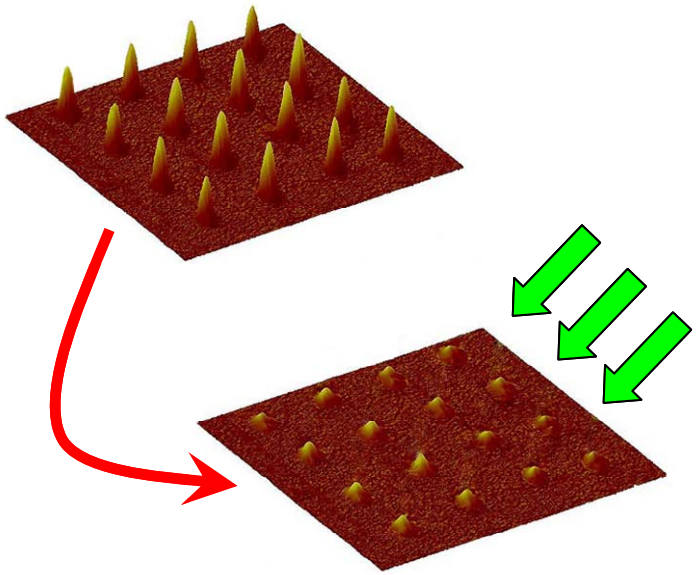
Response also depends on ionic conditions

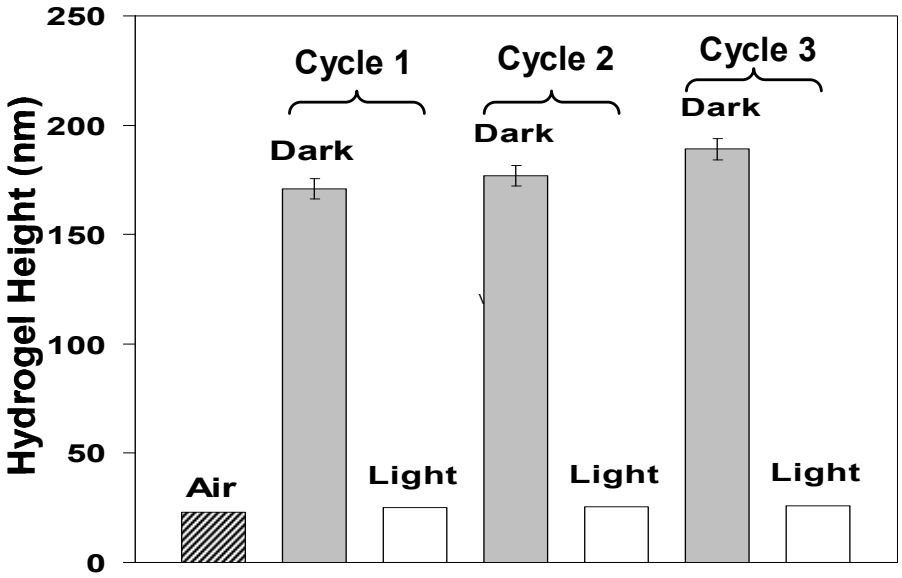


Response displacement is also dampened by:

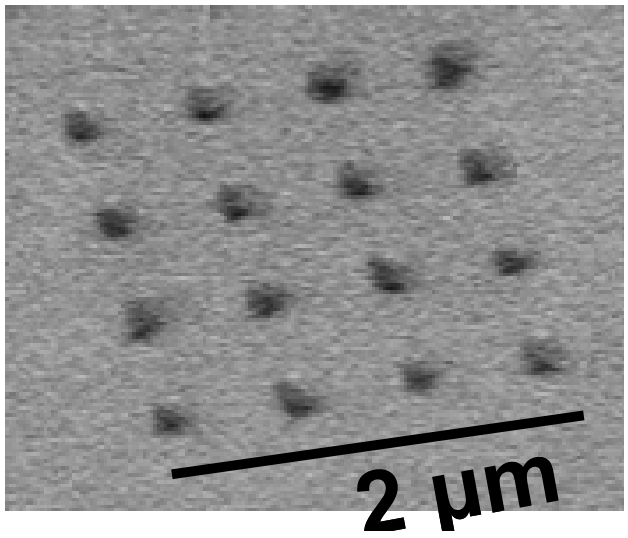
- Salt concentration of environment

Response is repeatable under cyclic light/dark exposure

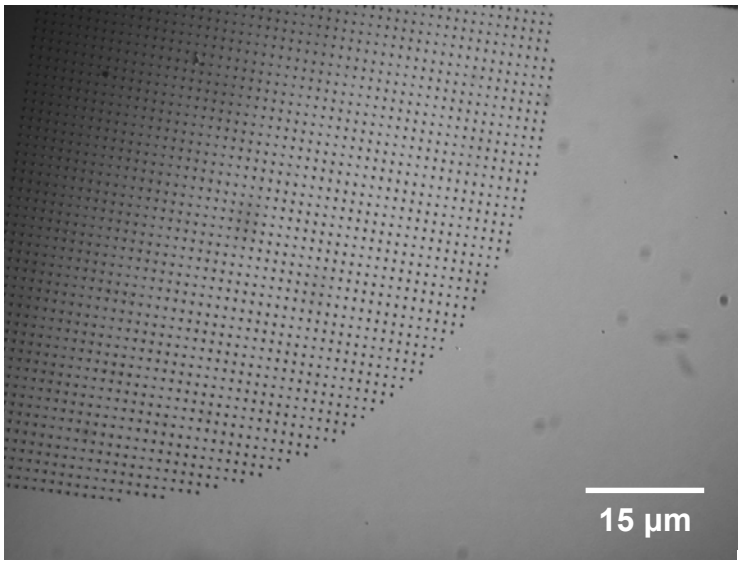




Arbitrary patterning of PAA-bR Hydrogels



SEM image of a 4x4 hydrogel dot array



Optical image of a large array with a diameter of 100 µm

Conclusions

- Bacteriorhodopsin-containing hydrogels can be nanopatterned via e-beam and are responsive to visible green light

- Response characteristics are determined by electron-dose used in patterning, as well as environmental ionic strength

- Response is repeatable and arbitrary patterns can be formed

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