NANOHOUR

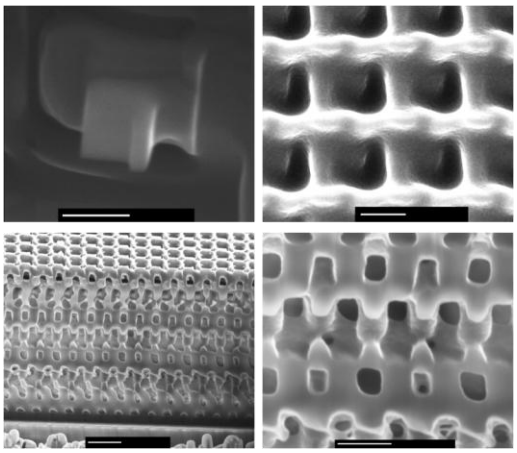
Wednesday, February 23, 2011 3:00 pm
Beckman Institute - Room 3269

Nanoindent Nanoimprint Lithography for the Fabrication of 3D Photonic Crystals

Andrew Gardner, Mechanical Science and Engineering

Graduate Student with Professor William King

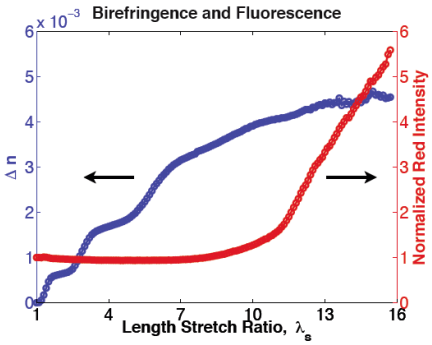
Photonic crystals are periodic optical nanostructures that can be used to control the propagation of electromagnetic waves. This talk describes the fabrication of three dimensional (3D) photonic crystals using a novel technique, nanoindent nanoimprint lithography (NINIL). NINIL is used to first fabricate a 3D phase mask in the surface of a photoreactive polymer through repeated indentation with a shaped diamond nanoindenter tip. Laser light passes through this indent array, or phase mask, creating a 3D distribution of light intensity in the substrate. This selectively develops the polymer and once developed a 3D structure with repeating nanoscale features is formed. This technique allows for the realization on a wide variety of complex 3D shapes at the nanometer scale which can be used as photonic crystals.



Towards Self-Sensing Polymers: Characterization of Mechanochemically Active Linear Polymers

Dr. Sharlotte Kramer, Materials Science and Engineering

Postdoctoral Research Associate with Professor Nancy Sottos



Representative birefringence (Δn) and fluorescence (red intensity normalized by first image red intensity) averaged over the gauge section of a PMA-SP-PMA tensile specimen vs. the length stretch ratio ($\lambda_s = L_{current}/L_o$), indicating a need for moderate polymer chain alignment (significant birefringence) before activation of the SP (increase in fluorescence).

Mechanophores are force-sensitive molecules that exhibit a chemical response to mechanical force and can be incorporated into polymer chains. Application of force to these polymers in turn can activate the mechanophore, producing an advantageous chemical response. One application might be fabricating polymers that are self-sensing, producing a localized color change or fluorescent signal in regions of high stress. We are characterizing the role of polymer chain alignment in mechanical activation of a color-changing mechanophore, spiropyran (SP), which undergoes a force-induced ring-opening reaction accompanied by fluorescence. Aligned polymer chains should transfer mechanical energy more efficiently to the mechanophore than randomly oriented chains. Our optical experimental setup combines photoelasticity to monitor the change in optical birefringence, which is related to chain alignment, and fluorescence imaging to determine the onset of mechanophore activation. The SP mechanophore is linked into the backbone of a linear solid elastomeric polymer, poly(methyl acrylate) (PMA). Since PMA is a time-dependent material that will not allow sequential phase-stepping photoelastic images, we have developed a method using di_raction gratings to split the photoelastic signal into four beams that can be captured by the same camera, allowing for four simultaneous phase-stepped images. These experiments elucidate the critical molecular orientation and macroscopic stress level required to activate the mechanophores, which are critical for the design of systems incorporating mechanochemically active polymers.

Coffee and cookies will be served

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