NANOHOUR

Wednesday, March 9, 2011 3:00 pm
Beckman Institute - Room 3269

Enmeshment of optical phase and material morphology in nanophotonics illustrated by sculptured thin films and holographic photonic crystals

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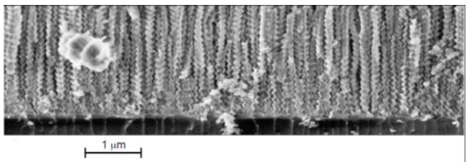
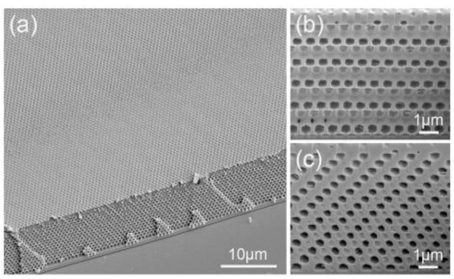




Optical phase and material morphology are intermeshed on the nanoscale. Sculptured thin films (STFs) and holographic photonic crystals (HPCs) demonstrate this enmeshment. STFs are assemblages of parallel bent and twisted nanowires whose morphology is engineered during physical vapor deposition. When a STF consists of helical nanowires with fixed pitch and sufficient length, the resulting chiral STF exhibits a circular-polarization-dependent photonic bandgap. HPCs are materials possessing periodic variation in their refractive indexes whose morphologies are engineered by recording an optical interference pattern in photoresist. The interference pattern can be generated either by several overlapping laser beams arranged via free-space optics, or by diffraction caused by a phase mask imprinted on the photoresist surface. These two material types are complementary in the following sense: a STF's morphology largely determines its optical function, while the optical function of the fabrication optics largely determines a HPC's morphology. An optically thick STF can differentiate between incident ultrashort optical pulses possessing identical envelopes but different carrier phases; the envelopes of the reflected pulses are different depending on the incident pulses' carrier phases. This effect establishes a link between material morphology and optical phase. The interference pattern determining a HPC's morphology depends on the relative phases of the constituent optical beams, whether created via free-space optics or a phase mask. This effect establishes a link between optical phase and material morphology.

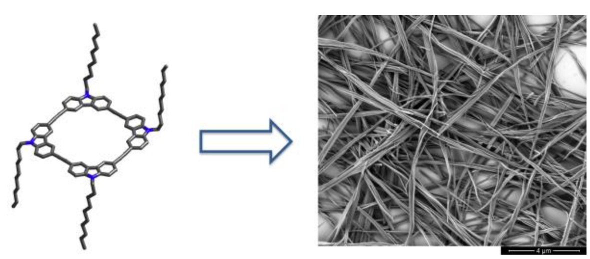
Figure 1: A chiral sculptured thin film (scanning electron micrograph; adapted from [1]).
Figure 2: A holographic photonic crystal showing (a) top surface and cross section and (b, c) cross sections (scanning electron micrographs; adapted from [2]).

[1] A. Lakhtakia and J. B. Geddes III, "Nanotechnology for optics is a phase-length-time sandwich," Opt. Eng. 43, 2410 (2004).
[2] Y. C. Chen, J. B. Geddes III, J. T. Lee, P. V. Braun, and P. Wiltzius, "Holographically fabricated photonic crystals with large reflectance,"

Carbazole-Based Arylene Ethynylene Macrocycles: Synthesis via Alkyne Metathesis, Organic Nanofibril Formation and Explosives Sensing

Dr. Dustin Gross, Chemistry

Postdoctoral Research Associate with Professor Jeffrey Moore



Arylene-ethynylene macrocycles (AEMs) are an interesting class of molecules due to their ability to self-assemble into multi-dimensional supramolecular nanostructures. To date the vast majority of AEMs have been synthesized using kinetically controlled processes, which are typically low yielding and generally require high-dilution conditions. Recently we reported the thermodynamically controlled macrocyclization of arylene ethynylene monomers at room temperature using a highly active molybdenum alkylidyne catalyst. Using this method we have synthesized a library of AEMs. Of which, carbazole-based macrocycles have been fabricated into fluorescent nanofibers. These novel one-dimensional nanostructures possess long-range exciton diffusion due to, presumably, extended intermolecular π-π electronic interactions. Upon exposure of nitro-based explosives to a thin film of the nanofibers the fluorescence is quenched due to photo-induced electron transfer. These materials may have potential applications in sensor devices for on-site explosives monitoring.

Coffee and cookies will be served

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