CNMS DISCOVERY SEMINAR SERIES

Thursday, March 8, 2012
4:00 pm
Iran Thomas Auditorium, 8600

Systematic theory-guided nano-engineering of molecular order, lattice dimensionality, and viscoelastic properties of organic electro-active materials

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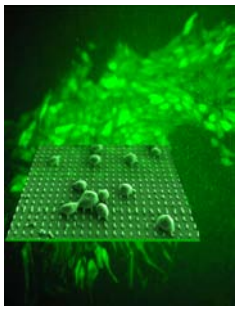

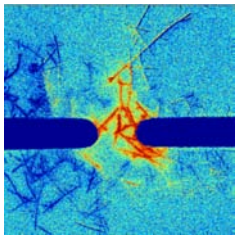

Abstract:
Mulit-scale theoretical (quantum and statistical mechanical) methods are used to guide the nano-engineering of organic electro-optic materials with controlled molecular order (e.g., lattice dimensionality) and dynamics (e.g., viscoelasticity). New techniques for the characterization of the molecular order and dynamics of soft matter materials are introduced and new experimental data permit definition of lattice dimensionality including fractional dimensionality. Lattice dimensionality is systematically varied from 3-D to 1-D and molecular cooperativity is varied from a few nanometers to nearly a micron. Control of lattice dimensionality had led to dramatic enhancement of optical nonlinearity. The molecular template that is developed for enhancement of electro-optic activity is also relevant to the optimization of the properties of soft matter electronic, photonic, and optoelectronic materials.

New, high performance organic electro-optic materials are integrated with nanophotonic silicon, silicon nitride, plasmonic, and metamaterial device structures. These nanophotonics structures permit enhancement of electromagnetic field intensities further enhancing observed nonlinear optical phenomena (electro-optic modulation, optical rectification, and difference frequency generation). Improved optical nonlinearity permits millivolt electro-optic signal transduction and optical switching and to microwatt all-optical modulation with 10 THz bandwidth. The device concepts demonstrated for electro-optic activity are also relevant to solar cell, light emitting device, and photorefractive device optimization.

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