

Feedback Control of Soft Materials

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Abstract

The assembly of nano- and micro-scale components into ordered structures forms the basis for tunable soft materials (e.g., colloids) capable of collecting solar energy for photovoltaics and for emerging applications in optical computing or metamaterials. However, a limiting factor in assembling microscopic components into ordered structures is the prevention of defects (e.g., grain boundaries, point defects) that form during self-assembly. As a result, there is a need to develop techniques capable of producing low-defect, single domain crystals.

This seminar discusses an approach to the self-assembly of ordered materials that relies on measurements in electric fields to inform open- and closed-loop control of colloids. Electric field transport mechanisms, like dielectrophoresis, drive the self-assembly of isotropic colloidal silica spheres into scalable two- and three-dimensional microstructures. Monte Carlo simulations compare well with experiments and demonstrate the microstructural evolution with applied electric field strength.

The introduction of anisotropic colloids (e.g., colloidal Janus rods) to electric fields enables new types of microstructures by using fabrication pathways that are analogous to open-loop control. Closed-loop control for the self-assembly of colloidal crystals is achieved using real-time image analysis as a sensor to compensate for system changes. A control algorithm is used to target the self-assembly of colloidal crystals based on their size or degree of hexagonal order so as to produce low-defect, single domain crystals.

The seminar concludes with an overview of future research plans and collaborations that will form the basis for addressing the challenge of engineering new materials using nanoscale components.

Biography

Jaime Javier Juárez is a NIH supported Institutional Research and Career Development (IRACDA) scholar at the University of New Mexico Center for Biomedical Engineering. Dr. Juárez received his B.S. degree from Stanford University and a M.S. degree from the University of Texas at San Antonio, both in mechanical engineering, and his Ph.D. in chemical and biomolecular engineering from the Johns Hopkins University. Dr. Juárez was also a postdoctoral research associate at the University of Illinois, Urbana-Champaign in materials science and engineering. His research expertise is primarily in complex fluid systems, with an emphasis on measuring forces that influence the self-assembly of colloidal crystals and the development of high-throughput bioanalytical instrumentation.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.

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