"BNC Distinguished Seminar"

January 29th, 2015 @ 3:00pm

BRK, ROOM 1001

Roger T. Bonnecaze

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Title: Unit Operations of Nanomanufacturing

Bio: Dr. Roger T. Bonnecaze is the William and Bettye Nowlin Chair of Engineering in the McKetta Department of Chemical Engineering and the co-Director of the NSF Engineering Research Center for Nanomanufacturing Systems for Mobile Computing and Energy Technologies (NASCENT) at The University of Texas at Austin. He received his B.S. ('85) from Cornell University and his M.S. ('87) and Ph.D. ('91) from the California Institute of Technology, all in chemical engineering. Between his M.S. and Ph.D., Dr. Bonnecaze was a project manager for Hydro Research Science working on environmental fluid mechanics and hydraulics issues. After his doctorate, Dr. Bonnecaze was a BP Post-Doctoral Fellow at the Department of Applied Mathematics and Theoretical Physics. He joined the faculty at The University of Texas in 1993. Dr. Bonnecaze's research interests include nanomanufacturing modeling and simulation and the rheology of complex fluids. He has won the NSF Young Investigator Award, David and Lucile Packard Foundation Fellowship, the AIChE Thomas Baron Award and numerous teaching awards. Dr. Bonnecaze is a Fellow of the American Physical Society, the American Institute of Chemical Engineers and the American Associate for the Advancement of Science.

Abstract: Flexible, scalable and cost-effective manufacturing of nano-enabled devices will require modular processes or unit operations that can be arranged in specific process flows for different devices. The utility of this approach is illustrated by its success in chemical manufacturing where a virtually limitless number of chemical products are made at any scale. Chemical plants are composed of unit operations, such as pumps, pipes, reactors and separators. These chemical unit operations are well-understood and simulation tools are available to design and explore production strategies *in silico* to mitigate risk and lower cost before construction of a production facility.

It is the dawning of the era of manufacturing of nano-enabled devices on rigid and flexible substrates with varying form factors. Like chemical plants, these nanomanufacturing facilities will be composed of unit operations that will involve 3D patterning and nanosculpting, direct nanoscale deposition of functional materials, nanometer and atomically thin film transfer, and directed self-assembly of nanoparticles and structured polymers, among other processes. We present an initial list of these unit operations and discuss the needs and opportunities for modeling and simulating them. We also present detailed results for unit operations and simulation tools for: 1) imprint lithography; 2) directed self-assembly of spherical and rectangular particles for bit patterned-media; 3) nanosculpting of multi-tiered patterns for spin-transfer torque RAM. These three examples illustrate the power of the unit operation concept coupled with simulation for the development and evaluation of nanomanufacturing systems.