Carnegie Mellon

Materials Science and Engineering Seminar Series

Chekesha M. Liddell

Department of Materials Science and Engineering
Cornell University

"Nonspherical Colloid Self-Assembly Approaches to Diverse Symmetry Structures"

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Controlling light-matter interactions with materials structured at micron and submicron length scales has been predicted as the basis for enhancements in the performance of a range of technologies, including photovoltaics, sensors and solid state lighting devices. However, the types of thermodynamically stable structures from simple building blocks, such as colloidal spheres, are very limited. For example, face-centered cubic structures have been a staple as templates for mesoporous materials although the light-matter interaction in the structure is known to be relatively weak as compared to lower symmetry arrangements. Recent advances in colloid synthesis to prepare monodisperse shape- anisotropic particles provide the opportunity to address the challenge and produce a diverse range of ordered structures using simple secondary interactions. In particular, computational simulations and mechanical models suggest that upon system compression (densification) nonspherical dimer colloids should undergo disorder-order and order-order phase transitions to unconventional solid structures including, base-centered monoclinic crystals, degenerate aperiodic crystals, plastic crystal or rotator, etc. based on free energy minimization. The particle systems have notable analogy to molecular systems, where the shape of molecules and their packing density has been shown to critically influence structural phase behavior and lead to a rich diversity of structures, both natural and synthetic. The engineering challenges have been in attaining sufficiently monodisperse (size uniformity) colloidal building blocks, as well as the lack of understanding and control of self-assembly processes for non-spherical colloids.

This talk will highlight our investigations of how particle shape programs the self-organization of colloidal structures. A range of assembly methods including convective assembly and confinement provide a platform to understand the formation of complex colloidal structures from non-spherical building blocks. Optical property simulations for unconventional structures with nonspherical particle bases will also be discussed.

Chekesha Liddell received a Bachelor of Science in Chemistry with Highest Distinction from Spelman College (1999) and a Bachelor of Materials Engineering from Georgia Institute of Technology (1999). She was awarded the NASA Women in Science and Engineering Scholarship to support her undergraduate work. Liddell also held three internship appointments at NASA, Kennedy Space Center in the Cryogenics and External Tank Branch and the Microchemical Analysis Laboratories. She joined the Cornell University faculty in November of 2003, after receiving a Ph.D. in Materials Science and Engineering with a minor in Science and Technology Policy from Georgia Tech. Liddell's awards for scholarly achievement include the National Science Foundation PECASE, Presidential Early Career Award in Science and Engineering (2007), NSF CAREER Award (2006), Facilitating Academic Careers in Engineering and Sciences Career Initiation Grant, (2003); Office of Naval Research Graduate Fellowship (1999-2003); Georgia Tech President's Fellowship, (1999-2003); Facilitating Academic Careers in Engineering and Sciences Fellowship (1999-2003); NSBE, National Society of Black Engineers Fellow, (2000); Hertz Foundation Fellowship Grant, (1999); TMS materials society, J. Keith Brimacombe Presidential Scholarship, (1999); ASM Foundation Scholarship, ASM International Materials society, (1998); and the ASTM, American Society for Testing and Materials, Mary R. Norton Memorial Fellowship, (1999). Liddell is a member of Phi Beta Kappa, the American Chemical Society (ACS), the Materials Research Society (MRS), the Cornell Center for Materials Research (CCMR), the Cornell Center for Nanoscale Systems (CNS), the American Society for Engineering Education (ASEE), and the American Association for the Advancement of Science (AAAS).