Giant Polyhedra and Giant Surfactants based on Nano-atoms: Tuning from Crystals, to Frank-Kasper Phases, to Quasicrystals

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Seminar host: Xinwei Wang

Abstract
In order to create new functional materials for advanced technologies, both precise control over functionality and their hierarchical structures and orders are vital for obtaining the desired properties. Among all the giant molecules, giant polyhedra are a class of materials which are utilized by deliberately placing precisely functionalized polyhedral oligomeric silsesquioxane (POSS) and fullerene (C60) molecular nano-particles (MNPs) (so-called “nano-atoms”) at the vertices of a polyhedron. Giant surfactants are polymer tail-tethered “nano-atoms” where the two components have drastic chemical differences to impart amphiphilicity. These giant polyhedra and giant surfactants capture the essential structural features of their small-molecule counterparts in many ways but possess much larger sizes, and therefore they are recognized as size-amplified versions of those counterparts. One of the most illustrating examples is a series of novel giant tetrahedral and giant surfactants which possess precisely defined amphiphilic MNPs with different geometric combinations. When both geometrical and chemical symmetry are disrupted and these giant tetrahedra and surfactants are functionalized they become building blocks for hierarchical ordered structures. A range of ordered super-lattice structures of this class of materials: crystals, quasicrystals and Frank-Kasper phases have been investigated in the condensed bulk state and thin films, revealing the interconnections between soft matter and hard matter in sharing their common structures and fundamental behavior.

Professor Stephen Z. D. Cheng received his Ph.D. in Chemistry from Rensselaer Polytechnic Institute in 1985 with Professor Bernhard Wunderlich. Following a postdoctoral fellowship at RPI he joined the faculty in the Department of Polymer Science at the University of Akron in 1987. He served stints as Chairman of the Department of Polymer Science and Dean of the College of Polymer Science and Polymer Engineering and is currently the Frank C. Sullivan Distinguished Research Professor and Robert C. Musson & Trustees Professor. Dr. Cheng is also a Member of the National Academy of Engineering and received numerous awards and recognitions including the Presidential Young Investigator Award from NSF and White house, John Dillon Metal and Polymer Physics Prize of American Physical Society, Fellows of APS, AAAS, National Academy of Inventors and others. His research interests center on the condensed states in polymers, liquid crystals, surfactants and micelles, and focuses on the interactions, responses, dynamics, and structures of materials on varying length and time scales in which the material itself embodies the technology. His research activities include investigations of transition thermodynamics and kinetics in metastable states, ordered structures and morphologies, surface and interface structures in electronic and optical materials and advanced functional hybrid materials.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students. www.me.iastate.edu