Biomimetic Self-templating Assembly and Applications

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Abstract

In nature, helical macromolecules such as collagen, chitin and cellulose are critical to the morphogenesis and functionality of various hierarchically structured materials. During morphogenesis, these chiral macromolecules are secreted and undergo self-templating assembly, a process whereby multiple kinetic factors influence the assembly of the incoming building blocks to produce non-equilibrium structures. A single macromolecule can form diverse functional structures when self-templated under different conditions. Collagen type I, for instance, forms transparent corneal tissues from orthogonally aligned nematic fibers, distinctively colored skin tissues from cholesteric phase fiber bundles, and mineralized tissues from hierarchically organized fibers. Nature's self-templated materials surpass the functional and structural complexity achievable by current top-down and bottom-up fabrication methods. However, self-templating has not been thoroughly explored for engineering synthetic materials.

In my seminar, I will demonstrate a facile biomimetic process to create functional nanomaterials utilizing chiral colloidal particles (M13 phage). A single-step process produces long-range-ordered, supramolecular films showing multiple levels of hierarchical organization and helical twist. Using the self-templating materials assembly processes, we have created various biomimetic supramolecular structures. The resulting materials show distinctive optical and photonic properties, functioning as chiral reflector/filters and structural color matrices. Through the genetic engineering of the M13 phages, I will also show how resulting materials can be utilized as functional nanomaterials for biomedical, biosensor and bioenergy applications[1-3].

References:

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Brief Bio: Professor Lee earned his B.S and M.S. from Korea University (Seoul) and his Ph.D. from the University of Texas at Austin. After a postdoctoral fellowship at Lawrence Berkeley National Lab, he joined a faculty position at UC Berkeley in 2006, was promoted to Associate Professor in 2011 with tenure. He is also Associate Director of the Center of Integrated Nanomechanical Systems at UCB and Scientist, LBNL Physical Bioscience Division. The Lee group uses chemical and biological approaches to create precisely defined nanomaterials, to investigate complex phenomena at their interfaces, and to develop novel, biomimetic, functional materials. Among other awards, Professor Lee is a UCB Presidential Chair Fellow, R&D 100 Award (2013) and an NSF CAREER awardee.