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Assembly of Dimer-Based Photonic Crystals

CHEKESHA M. LIDDELL WATSON, Department of Materials Science and Engineering, Cornell University

Recent advances in colloid synthesis to prepare monodisperse shape anisotropic particles provide the opportunity to address challenges related to structural diversity in ordered colloidal solids. In particular, computational simulations and mechanical models suggest that upon system densification nonspherical dimer colloids 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 variety of structures, both natural and synthetic. The materials 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 highlights our investigations of how particle shape programs the self-organization of colloidal structures. Methods including evaporation mediated assembly and confinement provide a platform to understand the formation of complex colloidal structures from non-spherical building blocks (silica-coated iron oxide, polystyrene, hollow silica shell). Optical property simulations for unconventional 2D and 3D structures with nonspherical particle bases will also be discussed.