Composite Nano-Lattices and Colloidal Crystals Enabled by 3D Nanoprinting

3D nanoprinting is a frontier for many fields, from micro-robotics to energy devices to medicine. Yet, current methods are generally limited to homogeneous polymers, metals or ceramics that lack the complexity of structural engineering materials. In addition, most efforts have focused on the fabrication of static structures, despite significant interest in active, programmable matter such as colloidal crystals that can transform into additional structures. First, I will present a novel two-photon lithography resin that is used to print nanocomposites, nanoporous carbon and nanostructured silk. The key ingredients in the resin are metallic nanoclusters that serve as both photoinitiators and inorganic precursors, and have pressure-dependent optical properties. Nanocomposite honeycomb, octet and shell-based lattices are fabricated that have a combination of high strength per weight, energy absorption and recoverability beyond other nano and micro-lattices due to a unique strain hardening behavior. In the second part of my talk, I will discuss the two-photon lithography of polyhedral colloidal microparticles that self-assemble into a 2D hcp crystal, and then undergoes a solid-solid phase transition into a quasi-diamond structure under a gravitational potential. Direct optical imaging of this phase transition reveals the single particle dynamics, including the role of particle rotation and crystalline defects, which is also explored using Monte Carlo simulations.

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