Fabricating Single Crystal Quantum Dot Solids.

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The combination of self-assembly and directed attachment of colloidal quantum dots (QDS) at fluid interfaces presents a scientifically interesting and technologically important research challenge. Remarkable strides have been made in epitaxially connecting the assembled dots to form atomically coherent quantum dot solids. Exploring the theoretically predicted properties of these structures presents an exciting scientific challenge. Sustained progress in this emerging class of quasi-2D materials depends critically on solving outstanding synthesis and processing roadblocks.
The working hypothesis of this project is that nucleation and growth processes can be rigorously controlled in small volumes of surface-patterned liquid droplets. Two principal goals of the project work are: (1) to establish fundamental principles that govern the formation of single crystal QDS in a confined liquid volume and (2) to understand and control the nature of the 'epitaxial bond' connecting the dots in the atomically coherent superlattice. Building on know-how from foundational studies of single component QDS, we will push our ability to fabricate systems with increasing complexity, in terms of both structure and composition. Students working on this project should grain proficiency in synthesis of colloidal nanocrystals and functional ligands and nanofabrication in a custom-made 3D printer. Students will also gain expertise in the following characterization techniques: small- and wide-angle x-ray diffraction, scanning electron microscopy (SEM), energy dispersive spectroscopy (EDX), transmission electron microscopy (TEM), and Fourier transform infrared spectroscopy (FTIR).