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Controlled Crystallinity and Fundamental Coupling Interactions in Nanocrystals

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Metal and semiconductor nanocrystals show many unusual properties and functionalities, and can serve as model system to explore fundamental quantum and classical coupling interactions as well as building blocks of many practical applications. However, because of their small size, these nanoparticles typically exhibit different crystalline properties as compared with their bulk counterpart, and controlling crystallinity (and structural defects) within nanoparticles has posed significant technical challenges. In this talk, I will firstly apply silver metal nanoparticles as an example and present a novel chemical synthetic technique to achieve unprecedented crystallinity control at the nanoscale. This engineering of nanocrystallinity enables manipulation of intrinsic chemical functionalities, physical properties as well as nano-device performance [1]. For example, I will highlight that electron- phonon coupling constant can be significantly reduced by about four times and elastic modulus is increased ~40% in perfect single crystalline silver nanoparticles as compared with those in disordered twinned nanoparticles. One important application of metal nanoparticles is nanoscale sensors. I will thus demonstrate that performance of nanoparticles based molecular sensing devices can be optimized with three times improvement of *figure-of-merit* if perfect single crystalline nanoparticles are applied. Lastly, I will present our related studies on semiconductor nanocrystals as well as their hybrid heterostructures. These discussions should offer important implications for our understanding of the fundamental properties at nanoscale and potential applications of metal nanoparticles.

[1] Yun Tang and Min Ouyang, Nature Materials, 6, 754, 2007.