Electron Transfer from Photoexcited Quantum Dots for Superbacteria Killing and Ammonia Production

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The use of nanoparticles (NPs) in biological applications has taken dynamically different phases. Efficient and relatively bleaching-free photoluminescence from semiconductor NPs was considered to make the materials suited for bio-imaging. While marginal progress persists, the fundamental question of electron transfer from NPs to biospecies poses both a challenge and an opportunity. The fertile opportunity space opens as we eye the biomedical applications, e.g., superbacterial killing for infected skin. In this talk, I will briefly discuss our strategy for the work on in vitro and in vivo studies of selective bacterial killing using NPs as photoelectron donor.

I will also share our progress on the nitrogen fixation in microorganisms to produce ammonia by incorporating quantum dots (QDs) into bacterial cells. The QDs generate and transfer photo-generated electrons to Component I, the catalytic site of nitrogenase, in Azotobacter vinelandii at an orders-of-magnitude higher rate. Light-driven control of QDs with large absorption cross-section will address the limitation of relatively low ammonia production rate in nitrogen-fixing bacteria.