

Publication

Anthracene Diphosphate Ligands for CdSe Quantum Dots; Molecular Design for Efficient Upconversion

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Quantum dot (QD)-sensitized photon upconversion follows a multi-step energy transfer process from the QD to transmitter ligand to a soluble annihilator. Using a novel 10-R-anthracene-1,8-diphosphoric acid (R = octyl, 2-hexyldecyl, phenyl) ligand with high binding affinity for CdSe QD surfaces, we demonstrate a photon upconversion process that is limited by the transmitter to annihilator transfer efficiency. Using ¹H NMR spectroscopy, we demonstrate that these bidentate diphosphate ligands rapidly and irreversibly displace two carboxylate ligands. These ligands mediate energy transfer from the photoexcited QDs to a triplet annihilator (1,10-diphenylanthracene), producing overall photon upconversion quantum efficiencies as high as 17%, the highest for QDs with no shells. Transient absorption spectroscopy shows that the anthracene dihydrogen phosphate (ADP) ligand supports a 3.4 fold longer triplet state lifetime compared to 9-anthracene carboxylic acid (299.9 ± 9.5 vs 88.2 ± 2.1 μs), increasing the probability of energy transfer.

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