Overcoming Chemical Instability of PbSe Nanocrystal Quantum Dots Through Surface Ligand Engineering

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In the past a couple of decades, colloidal nanocrystal quantum dots (NQDs) have gained surprising interest due to intriguing properties derived from quantum confinement effect. Among the various class of NQDs, PbSe NQDs especially garnered the immense attention because of their narrow bulk band gap (0.26 eV), large exciton Bohr radius (46 nm), and IR-active energy gaps which can be adjusted over nearly entire solar spectrum. However, chemical instability of PbSe NQDs toward oxidation tackled the reliable applications. In this study, we developed highly simple and efficient strategies to prevent or retard the oxidation of PbSe NQDs. Surface ligand engineering with halides or other organic ligands carrying P-O- moieties leads to the dramatically enhanced air stability of PbSe NQDs. Absorption, photoluminescence, NMR, and XPS spectroscopic studies revealed that microscopic origin of the enhanced stability. Based on those understanding, we successfully fabricated PbSe NQD-based field effect transistors stably operating under ambient condition.