

Amplification in Light Energy Conversion at Q-CdTe Sensitized TiO₂ Photonic Crystal, Photoelectrochemical Stability in Se²⁻ Electrolyte, and Size-dependent Type II Q-CdTe/CdSe Formation

Ali S. Nehme, Fatima Haydous and Lara Halaoui

Abstract

“This study investigates the ability of Se²⁻ redox electrolyte to separate the photoholes and stabilize Q-CdTe quantum dot solar cell with a liquid junction. We examined the photophysical and photoelectrochemical behaviors of Q-CdTe in two sizes, green-emitting dots of 2.3-2.7 nm diameter and red-emitting dots of 4 nm diameter, in the presence of alkaline Se²⁻ electrolyte prepared under inert atmosphere. Photoelectrochemical, absorbance, emission and emission quenching measurements revealed the presence of size dependence in Se²⁻ surface binding to Q-CdTe, growth of type II Q-CdTe/CdSe, and stability in the photoelectrochemical cell. Emission quenching measurements show that Se²⁻ scavenges the Q-CdTe photohole, with mechanisms that depended on size and quencher concentration. Binding of Se²⁻ to green-emitting Q-CdTe occurred with a greater binding constant compared to the red-emitting dots, resulting in formation of type II Q-CdTe/CdSe at the smaller core indicated in red-shifted absorbance and emission spectra with incremental Se²⁻ addition at room temperature. Photoelectrochemical measurements acquired at Q-CdTe sensitized nc-TiO₂ and TiO₂ inverse opal with a stop band at 600 nm, 600-i-TiO₂-o, in Se²⁻ electrolyte confirmed this redox species ability to scavenge the photohole and to protect Q-CdTe against fast photoanodic dissolution, with greater stability observed for the larger dots. Gains in the photon-to-current conversion efficiency attributed to light trapping were measured at Q-CdTe sensitized 600-i-TiO₂-o relative to nc-TiO₂.” (copyright J. Phys. Chem. C, publications of the American Chemical Society. <http://dx.doi.org/10.1021/acs.jpcc.5b11478> (2016))