Colloidal quantum dots for electronics and optoelectronics

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Colloidal semiconductor quantum dots (QDs) are solution processable semiconductors that because of their remarkably broad absorption, large tunability, and high stability under ambient conditions are suitable for optoelectronic device fabrication. Recently, several authors have reported that using short ligands to assemble NCs thin films allows overcoming the dichotomy between quantum confinement and the necessity of electrical transport.

Electronic and optoelectronic devices can be fabricated from solution with these quantum dots solids. I will report about the activities of my group on quantum dots based solar cells, water splitting and field effect transistors. Power conversion efficiencies above 5% and fill factors of 60% under AM1.5 illumination are obtained with PbS QDs cross-linked with benzene-dithiols in a simple Schottky-like architecture [1, 2, 3]. This record efficiency demonstrates that even by using the simplest device architecture, accurate post-synthetic treatments result in substantial improvements in the performance. Field effect transistors showing bipolar characteristics and on/off ratio of 10^5 are fabricated on SiO_2 dielectric by controlling the QD quality and the fabrication environment [4]. By using ionic gels as gate we measure the bad-gap of the QD solid and correlated it with DFT simulations [5]. This gives an indication of delocalization of the electronic states over a large number of QDs. I will conclude giving an outlook of what we can expect from QDs solids in the future.

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