The goal of this work is to develop low cost and highly efficient hybrid solar cells based on semiconductor nanoparticles (NPs). Hybrid solar cells have been demonstrated to take advantages of both inorganic and organic semiconductors by employing simple soluble process. In order to improve the power conversion efficiency (PCE), the bulk heterojunction (BHJ) of cadmium selenide (CdSe) tetrapods (TPs) and poly (3-hexylthiophene) (P3HT) are introduced as an electron acceptor and donor, respectively.

The dimension of CdSe TPs and the 3D spatial distribution of CdSe TPs:P3HT photoactive blends are investigated to improve optical and electrical properties of photovoltaic devices. Hybrid solar cells having long-armed CdSe TPs and P3HT establish higher PCE of 1.12% when compared to device employing short-armed TPs of 0.80%. The device performance are improved by using longer armed CdSe TPs, which aids in better percolation connectivity and reduced charge hopping events, thus leading to better charge transport.

The device architecture is also examined to assist vertical phase separation. Improvement of vertical phase separation using CdSe TPs:P3HT photoactive blends is systematically manipulated by solution-processed interfacial layers, resulting in enhanced device performance. Multi-layered hybrid solar cells assist better light absorption, efficient charge carrier transport, and increase of the surface contact areas. To further control the improvement of the device performance, the effects of nano-scale morphology from solvents having different boiling point, the various shapes of semiconductor NPs, and the emergence of blending NPs are demonstrated. The formation of favorable 3D networks in photoactive layer is attributed to enhance the efficient charge transport by the optimized combination of semiconductor NPs in polymer matrix.

January 30, 2012; 1:00 PM; PSA 311