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Exciton shelves for charge and energy transport in third-generation quantum-dot devices SAMUEL GOODMAN, VIVEK SINGH, HYUNWOO NOH, JOSEP CASAMADA, ANUSHREE CHATTERJEE, JENNIFER CHA, PRASHANT NAGPAL, University of Colorado Boulder — Quantum dots are semiconductor nanocrystallites with size-dependent quantum-confined energy levels. While they have been intensively investigated to utilize hot-carriers for photovoltaic applications, to bridge the mismatch between incident solar photons and finite bandgap of semiconductor photocells, efficient charge or exciton transport in quantum-dot films has proven challenging. Here we show development of new coupled conjugated molecular wires with "exciton shelves", or different energy levels, matched with the multiple energy levels of quantum dots. Using single nanoparticle and ensemble device measurements we show successful extraction and transport of both bandedge and high-energy charge carriers, and energy transport of excitons. We demonstrate using measurements of electronic density of states, that careful matching of energy states of quantum-dot with molecular wires is important, and any mismatch can generate midgap states leading to charge recombination and reduced efficiency. Therefore, these exciton-shelves and quantum dots can lead to development of next-generation photovoltaic and photodetection devices using simultaneous transport of bandedge and hot-carriers or energy transport of excitons in these nanostructured solution-processed films.

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