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Nanoscale engineering of efficient photovoltaic conversion in quantum dot media[1] SERGEEV ANDREI, LI YANSHU, VAGIDOV NIZAMI, MITIN VLADIMIR, University at Buffalo, SABLON KIMBERLY, U.S. Army Research Laboratory, Adelphi, OKTYABRSKY SERGE, YAKIMOV MICHAEL, University at Albany — The main problem of photovoltaic nanomaterials for high efficiency conversion is enhanced recombination of photocarriers. Selective doping of quantum dot (QD) media allows for control of three-dimensional potential profile and adds more functionality and scalability to photovoltaic materials and structures. Optimization of the nanoscale barriers and reduction of wetting layer in a QD medium substantially suppress recombination processes and enhance itter-subband transitions, which provide electron extraction from QDs. We report that the optimized 1-μm InAs/GaAs QD media placed in 3-μm base GaAs p-n junction increases the short circuit current from 22.0 mA/cm^2 to 28 mA/cm^2. Spectral analysis of conversion processes shows that the IR sub-bangap photons and hot electrons created by high energy photons provide comparable contributions to photovoltaic conversion via charged QDs. The reduction of the wetting layer, which otherwise accumulates electrons, increases extraction of electrons from QDs due to interaction with hot electrons created by high energy photons. Nanoscale engineering of electron processes by charging of QDs provides wide possibilities for further suppression of recombination and thermalization losses in QD photovoltaic devices.

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