Abstract Submitted
for the MAR07 Meeting of
The American Physical Society

Carrier Multiplication in PbSe Quantum Dots ALBERTO FRANCESCHETTI, JOONHEE AN, ALEX ZUNGER, National Renewable Energy Laboratory — The efficiency of conventional solar cells is limited, because the energy of absorbed photons in excess of the band gap is converted to heat, instead of producing electron-hole pairs. Recently, efficient carrier multiplication has been observed in smiconductor quantum dots. In this process, a single, high-energy photon generates two or more electron-hole pairs, thus potentially increasing the efficiency of solar cells. Rather exotic mechanisms have been proposed to explain carrier multiplication in PbSe quantum dots. Using atomistic semi-emprical pseudopotential calculations, we show that the more conventional impact ionization mechanism - whereby a photogenerated electron-hole pair decays into a biexciton in a process driven by Coulomb interactions between the carriers - can explain both the rate (< 1 ps) and the energy threshold (~ 2.2 times the band gap) of carrier multiplication in Pbse quantum dots [1,2], without the need to invoke alternative mechanisms. The reason is that the density of biexciton states increases very rapidly with energy, thus making the rate of impact ionization faster than the rate of competing decay channels. [1] A. Franceschetti, J.M. An and A. Zunger, Nano Letters, 6, 2191 (2006). [2] J.M. An, A. Franceschetti and A. Zunger, Nano Letters, nl061684x (2006).

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Date submitted: 16 Nov 2006 Electronic form version 1.4