

Impact of QD stoichiometry on the electron transfer efficiency to a sensitized oxide

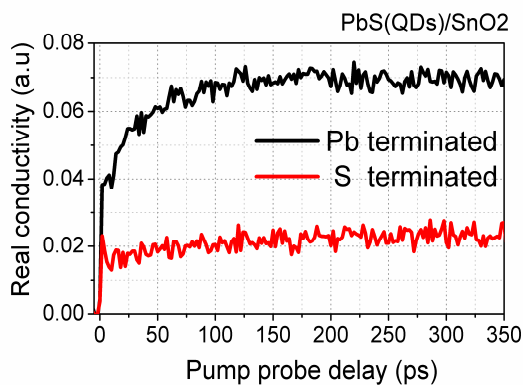
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Electron transfer (ET) between semiconductor quantum dots (QDs) and metal oxides nanoparticles is a key aspect process in novel sensitized solar cell architectures. Although the stoichiometry of a lead sulfide (PbS) bulk semiconductor is given by a 1:1 ratio, this picture doesn't necessarily hold when reducing its dimensionality – i.e. when dealing with nano particles (where the surface to volume ratio of the material is boosted). In this work, exploiting optical pump-THz probe measurements, we study the effect of QD stoichiometry on the ET efficiency on PbS QDs directly nucleated by SILAR onto an oxide matrix. PbS quantum dots terminated with a lead rich surface show an increase on the electron transfer efficiency of ~300% when compared with those terminated with a sulfur rich surface; identical 3-fold increase of photocurrent is corroborated in a batch of QD sensitized solar cells. Our results are in agreement with first principles calculations¹ predicting that sulphur terminated PbS QDs are expected to be densely populated with surface midgap states acting as recombination centres for the electrons. Similar effects are observed when the QDs are passivated by thiol based molecules.



3 fold improvement on the ET efficiency from Pb terminated PbS(QDs) to a SnO2 matrix.

¹ Donghun Kim et al. PRL 110, 196802 (2013)