Charge Transport in $SrTiO_3$:Rh and $BiVO_4$ Nanoparticle Photocatalysts for Z-scheme Water Splitting

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Solar-powered water splitting using nanoparticle photocatalyst suspensions is a promising route to economical, clean hydrogen production[1], [2]. In the Z-scheme approach, hydrogen and oxygen-evolving photocatalysts, such as $SrTiO_3$:Rh and $BiVO_4$, are coupled with a redox mediator to improve light absorption compared to single-photocatalyst systems[3]. A key step in the water-splitting process is the separation and transport of photo-excited electrons and holes to the photocatalyst surface. Here we characterize charge transport in individual $SrTiO_3$:Rh and $BiVO_4$ nanoparticles using a nanoprobe within a scanning electron microscope, and directly map internal electric fields with electron-beam induced current. Charge transport in $SrTiO_3$:Rh particles is limited by bulk defect states within the nanoparticle, in contrast to nearly Ohmic conduction in $BiVO_4$ nanoparticles. $SrTiO_3$:Rh particles contain insignificant built-in E fields, while $BiVO_4$ nanoparticles contain built-in E field between different facets of the nanoparticle which can efficiently separate e-h pairs. Inefficient charge transport and lack of built-in electric field explain why the H_2-evolving $SrTiO_3$:Rh nanoparticles are the limiting component within this Z-scheme system.

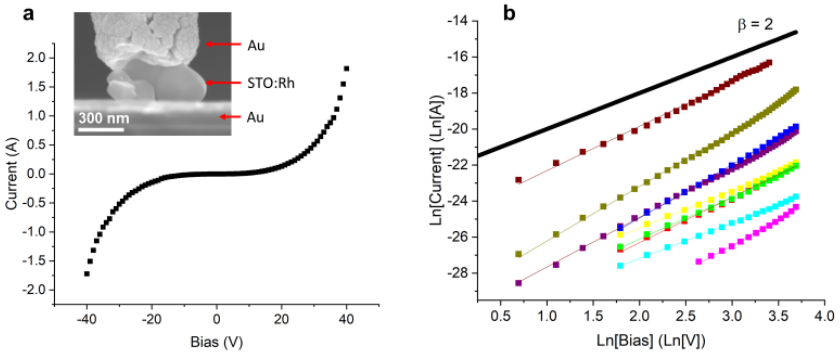

Figure 1: An individual STO:Rh nanoparticle with Pt co-catalysts is biased in situ within an SEM (a, inset). Transport data from 9 nanoparticles can be linearized on a log-log scale. The slope, β, of each I-V characteristic is near 2 (β=2 is plotted as a black line), in agreement with SCLC conduction.

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