Size-Controlled Electron Transfer and Photocatalytic Activity of ZnO-Au Nanoparticle Composites

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An efficient photocatalyst should have the following characteristics:

- It should be able to trap solar energy efficiently, convert into charges, and should allow controlled transfer of those charges.

- Thiolate-protected gold nanoparticles (AuNPs) with diameters < 3 nm are stable, structurally well-characterized nanoparticles that exhibit size-dependent electrochemical and optical properties. One of the most interesting properties of these quantum-sized AuNPs is the ability to control the transfer of electrons into and out of the metallic core.

- The controllability of the electronic charging is a fundamental result of the ultrasmall capacitance (on the order of aF) of AuNPs.

- The size-dependent capacitance ($C_{AuNP}$) has been successfully modeled as a capacitance of metallic spheres with insulating dielectric layers

$$C_{AuNP} = 4\pi\varepsilon_0\varepsilon(r/d)(r + d)$$
AuNPs acts as an efficient quencher of photoexcited TiO$_2$ nanoparticles in the colloidal mixture of TiO$_2$ and AuNPs by accepting electrons from the conduction band of TiO$_2$ and the quenching process is controlled by the capacitance of AuNP.


In this paper…
Experimental Section

- Glutathione (GS)-protected AuNPs were synthesized using a modified Brust synthesis.

- AuNPs bearing carboxylic acid groups and ZnO nanoparticles were stirred together for 12 h to produce Zn-Au composites.
Result and discussion
Result and discussion
Result and discussion

Band edge emission

Surface related trap states
Result and discussion
Result and discussion
Electron transfer from photoexcited ZnO to Au NPs and the resulting photocatalytic activity can be controlled by the size of the mediating gold capacitor.

Unique charging properties of quantum-sized Au NPs can be utilized in the development of photocatalysts capable of selective reactions via the control of electron flow.
QD-quantum cluster composites can be used solar cell where QC will further enhance the charge separation.

Semiconductor-QC composites can act as a bifunctional sensor, it can sense both toxic metal ions and organic pollutants.
Thank You