

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

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J. Phys. Chem. Lett. **2011**, 2, 2840–2845

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Date: 05/11/11

Introduction

- 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

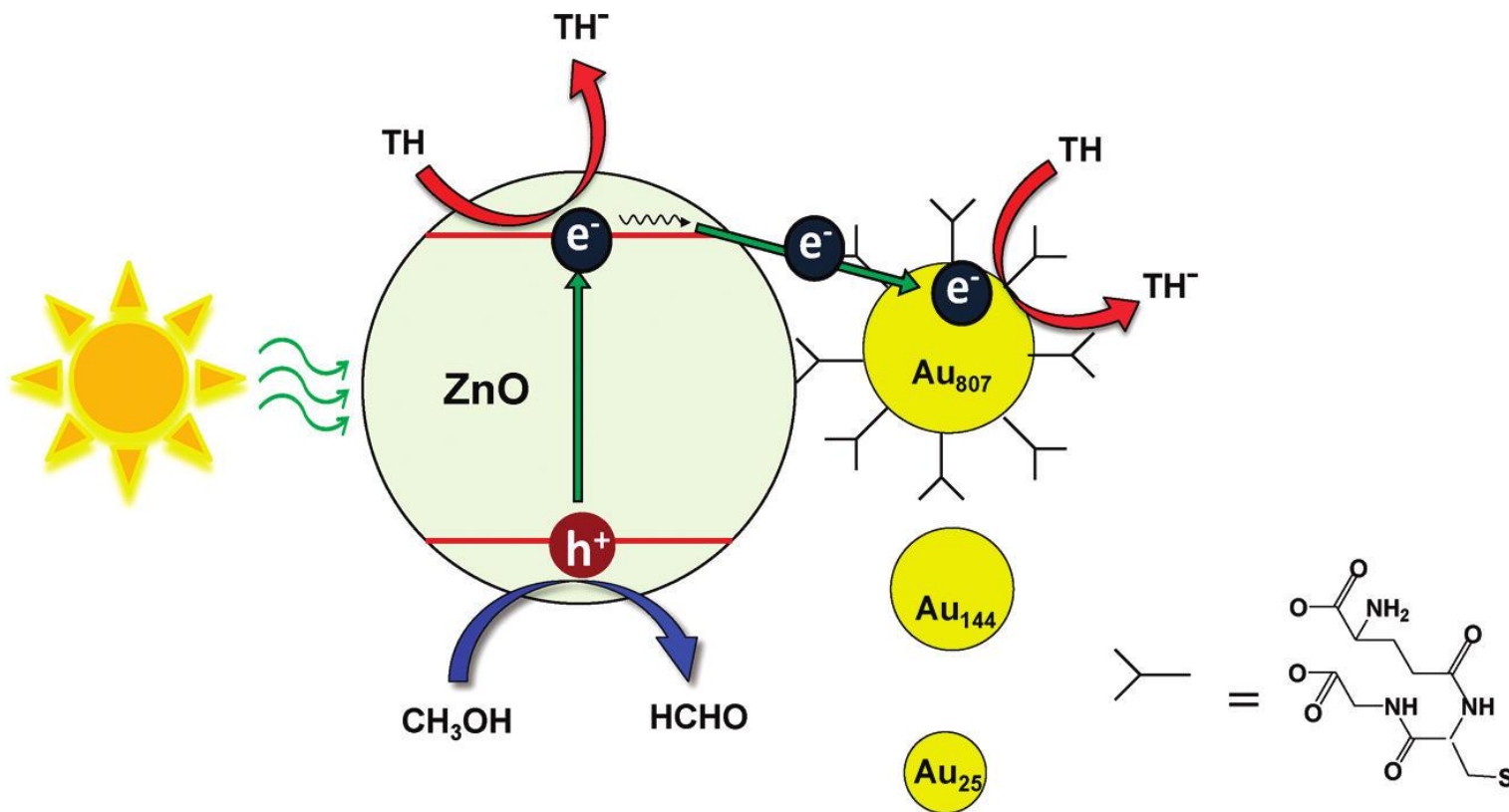
$$C_{\text{AuNP}} = 4\pi\epsilon_0\epsilon(r/d)(r + d)$$

Previous literature report...

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.

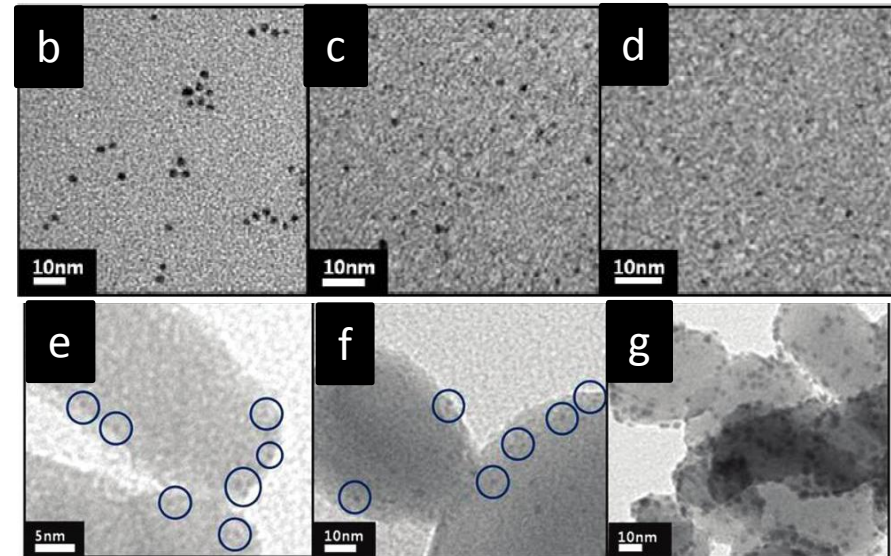
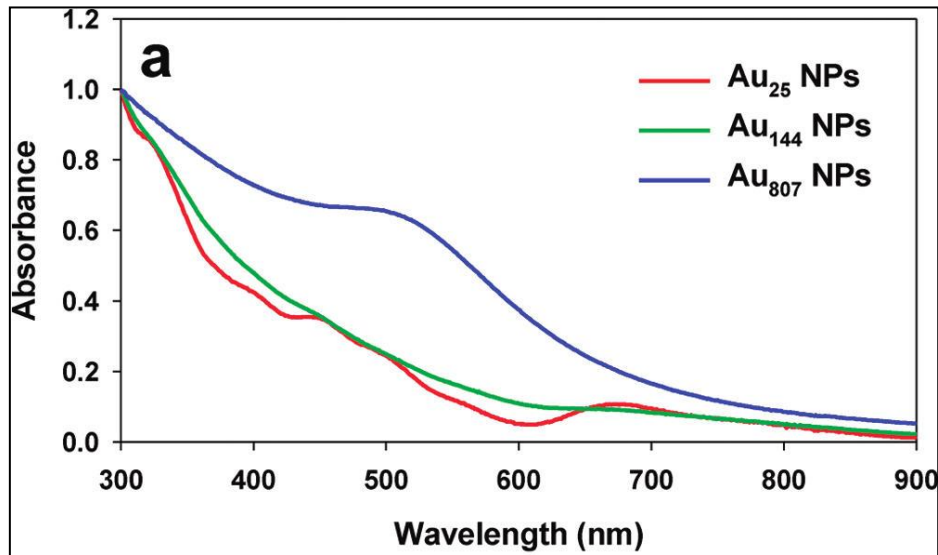
J. Am. Chem. Soc. **2007**, *129*, 7706–7707

In this paper...

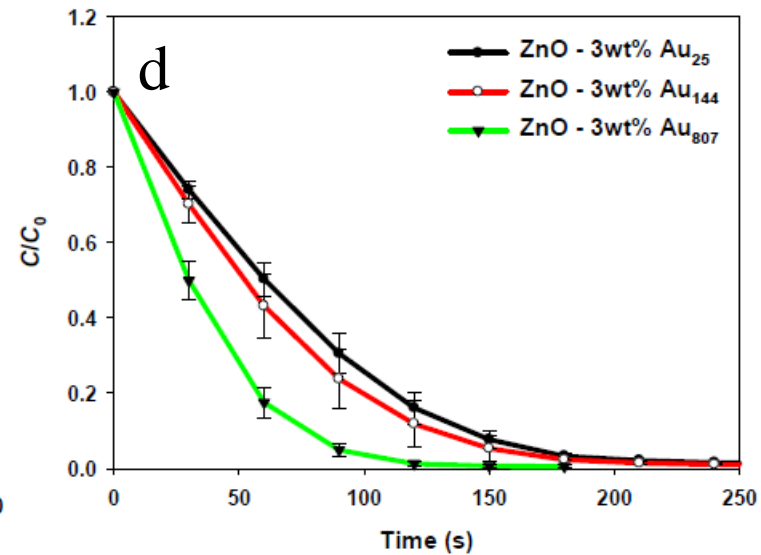
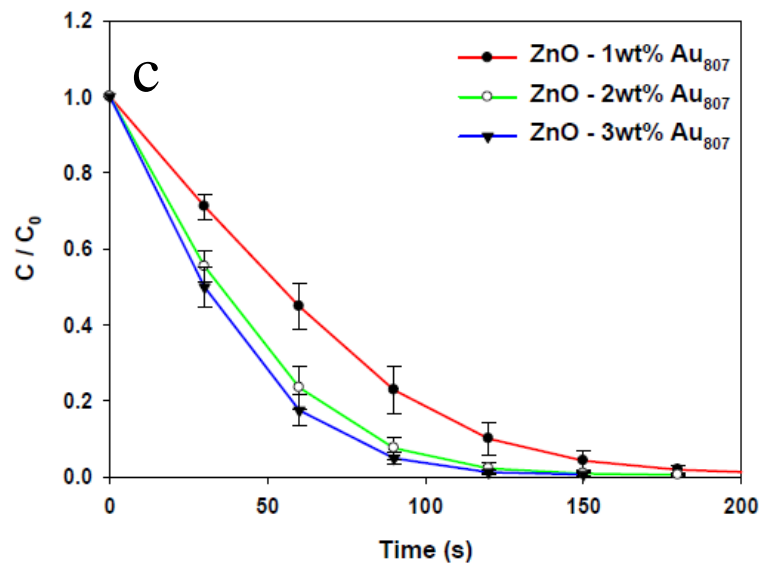
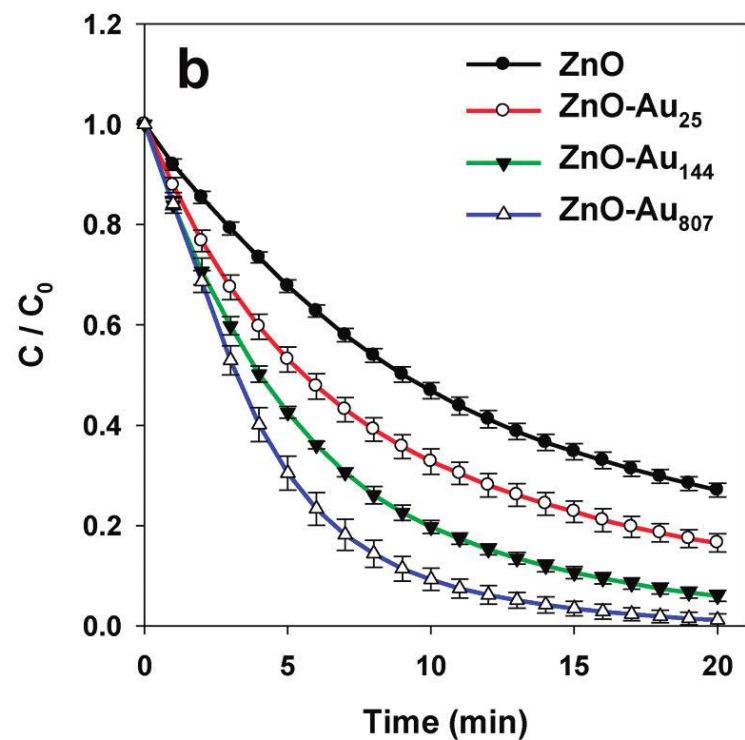
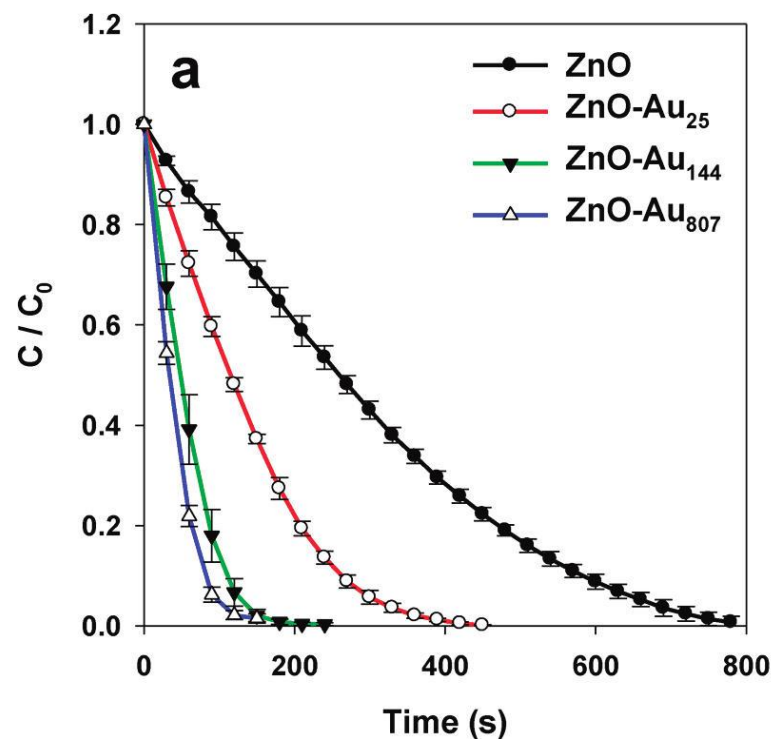


Experimental Section

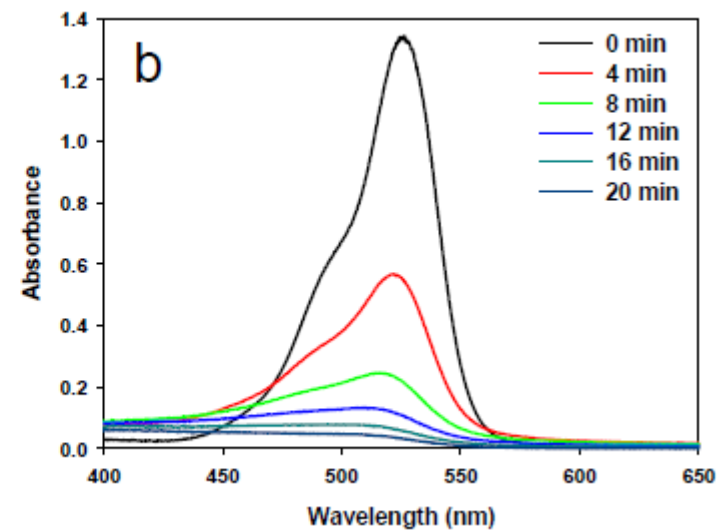
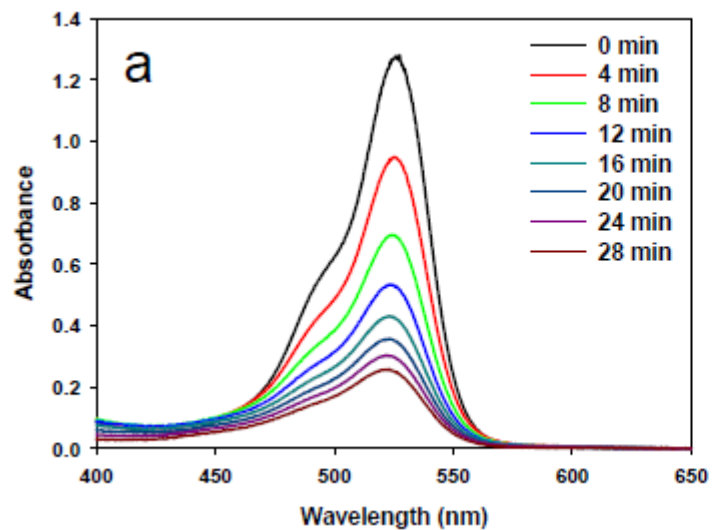
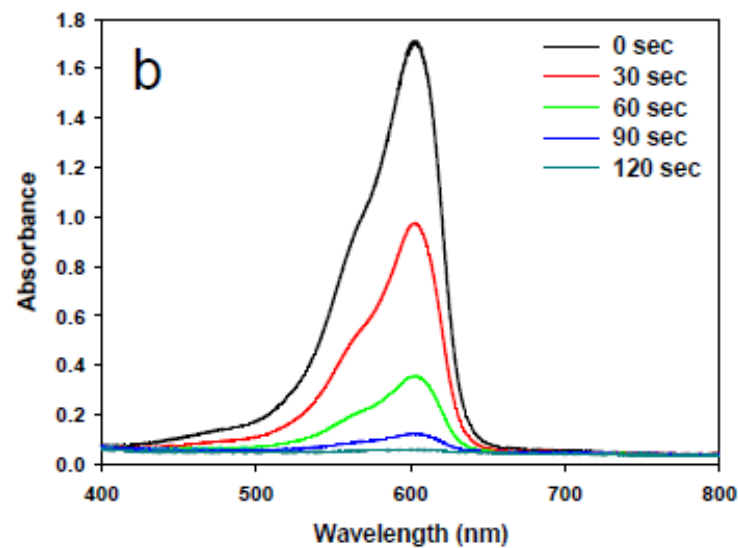
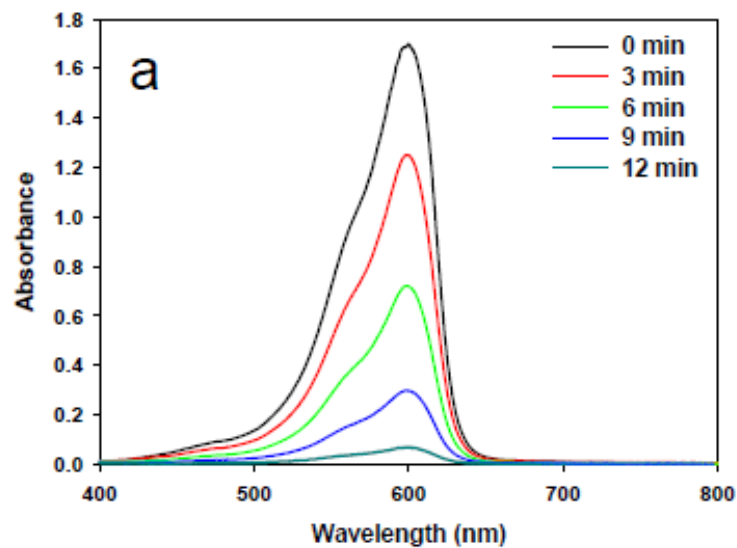
- Glutathione (GS)-protected AuNPs were synthesized using a modified Brust synthesis.
- AuNPs bearing carboxylic acid groups and ZnO nanoparticles were stirred together for 12 h to produce Zn-Au composites.



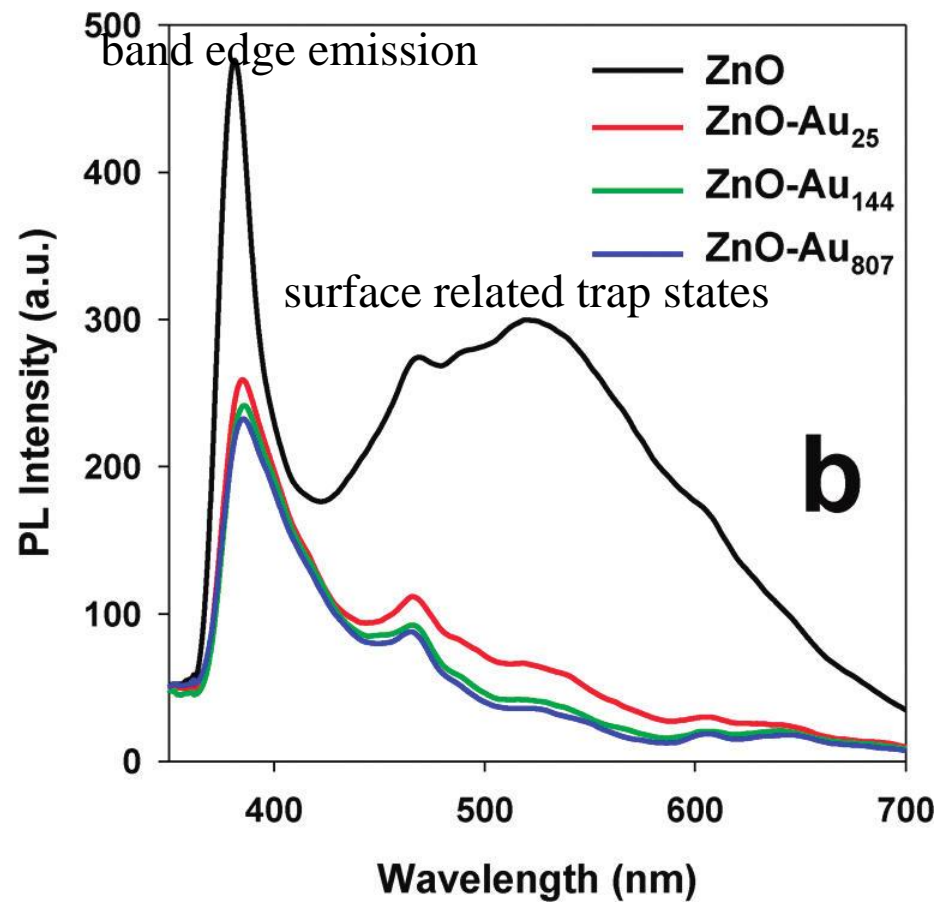
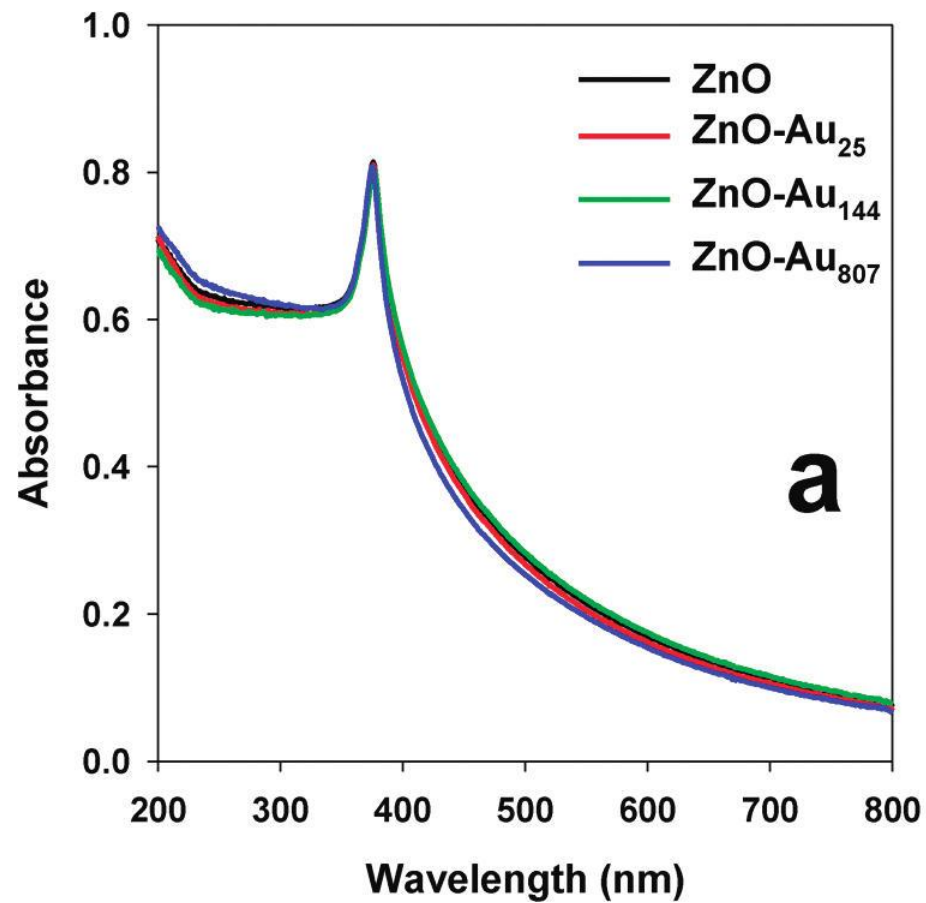
Result and discussion



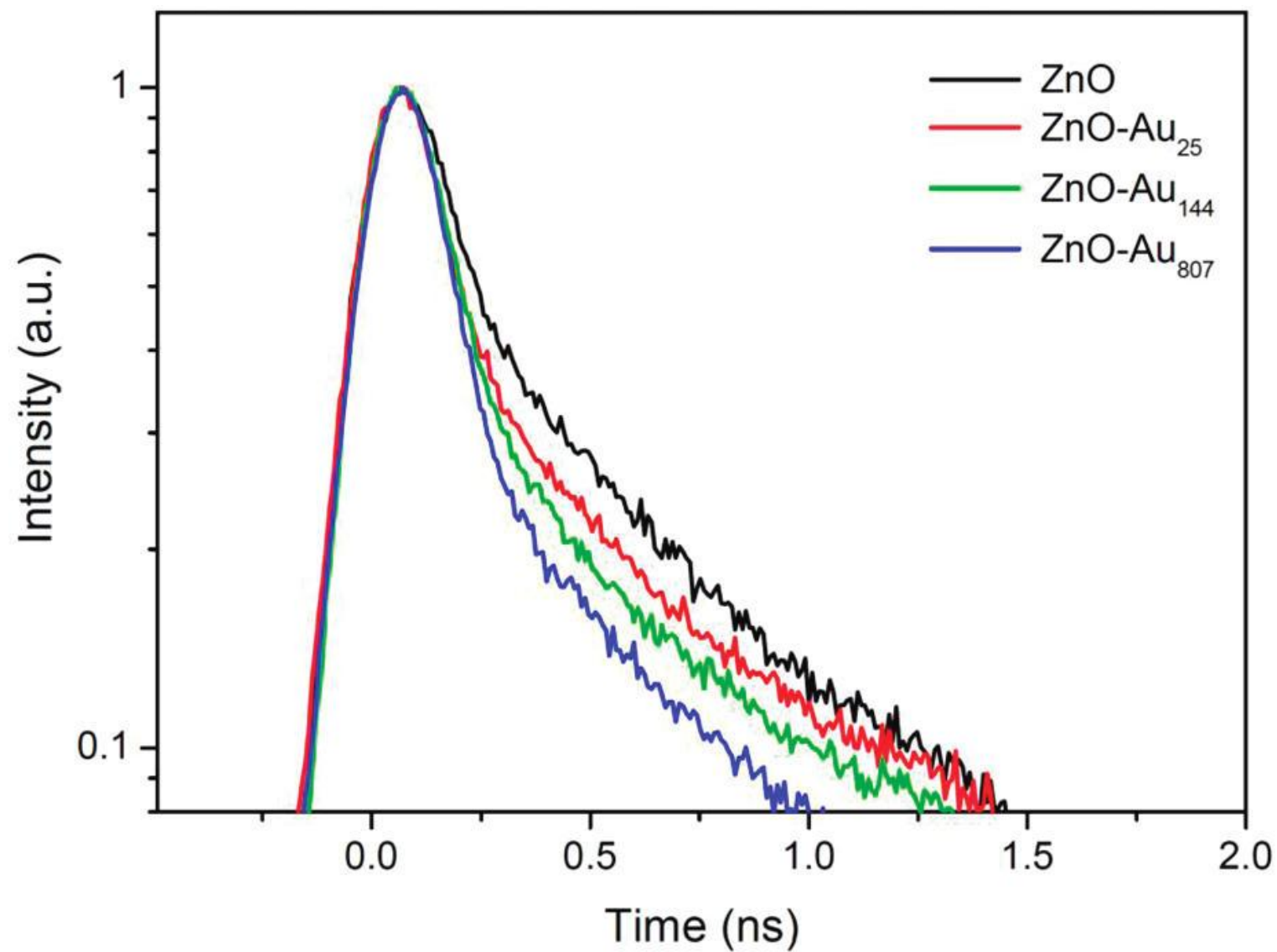
Result and discussion



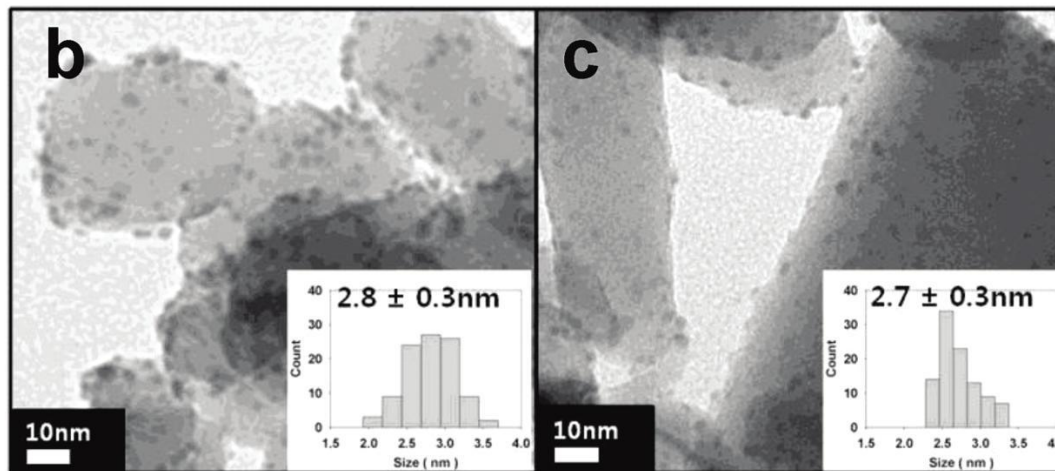
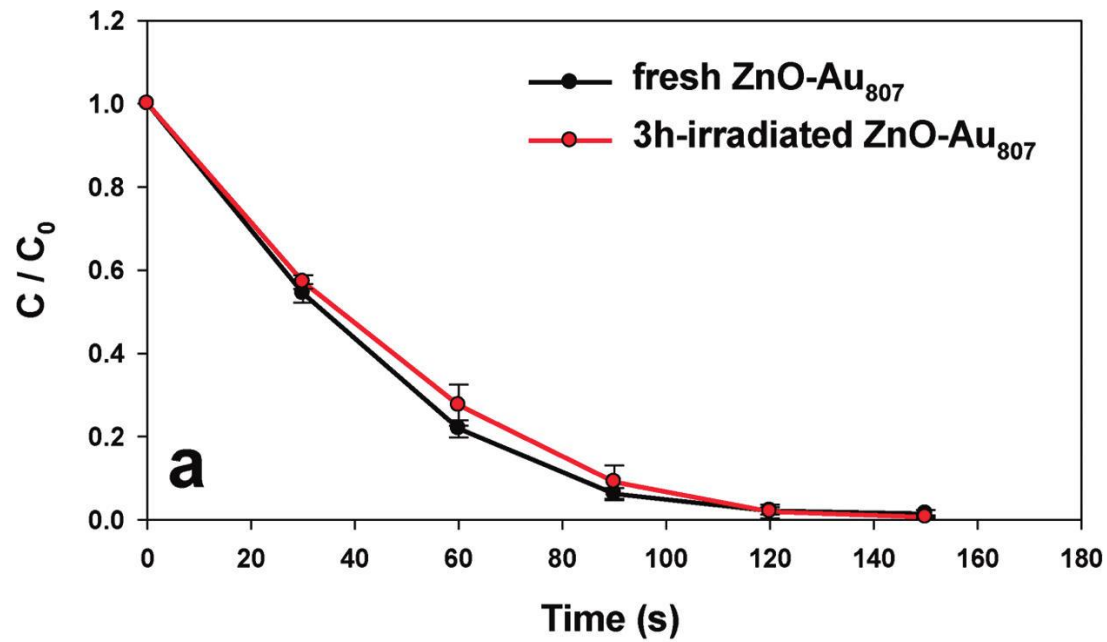
Result and discussion



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Result and discussion



Summery

- 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 QCs will further enhance the charge separation.
- Semiconductor-QC composites can act as a bifunctional sensor, it can sense both toxic metal ion and organic pollutants.

Thank You