2013 中技社科技研究獎學金
CTCI Science and Technology Research Scholarship

3D表面電漿共振子奈米複合材料的光電化學應用
3D Plasmonic Photocatalysts for Efficient Conversion of Solar to Chemical energy

國立清華大學 材料科學工程學系 博士班三年級 楊東翰
指導教授: 吳振名 教授

研究重點

Photocatalysts capable of promoting photocatalytic and photoelectrochemical reactions for conversion of solar to chemical energy are often composed of plasmonic noble-metal nanoparticles (Pt, Ag, or Au) deposited on a wide-bandgap oxide semiconductor (TiO_2 or ZnO). In this study, we present a precisely controlled synthesis of highly remarkable 3D photocatalysts composed of high density unaggregated plasmonic Au nanoparticles (AuNPs) chemically bound to vertically aligned ZnO nanorod arrays (ZNA) through bifunctional molecular linkers. The size and loading of AuNPs on ZNA, which are key factors for improving the photocatalytic activities, can be easily controlled simultaneously in large scale by this synthesis methodology. Experimental probes and electromagnetic simulations of electron transfer and localized plasmonic coupling processes are exploited to gain insight into the underlying light irradiation induced interactions in the 3D ZNA-AuNPs photocatalysts. Surprisingly, in comparison with the bare ZNA, the 10 nm sized AuNPs decorated ZNA exhibits 10.6-fold enhanced photoreaction rate in the entire UV-visible region. We envisage that our approach will be very useful for creating high efficiency 3D plasmonic photocatalysts in various photocatalytic areas, particularly renewable energies, environmental remediation, or chemical synthesis purposes applications.

研究成果

1. *Small.* 9, 3169 (2013). 2. *Journal of Materials Chemistry.* 22, 17071 (2012). 3. *Acta Materialia.* 60, 3310 (2012).

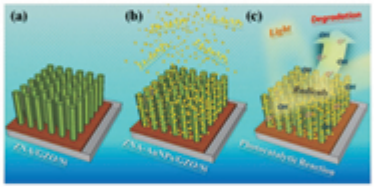

Figure 1. Schematic representation of the new platform insight into photocatalytic nanosystems.

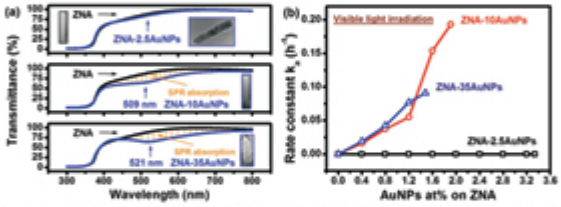

Figure 3. Optical spectra and photocatalytic evolution of the ZNA and ZNA-AuNPs photocatalysts.

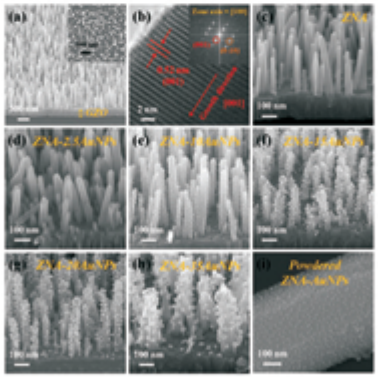

Figure 2. FESEM and HRTEM images of the ZNA and ZNA-AuNPs photocatalysts.

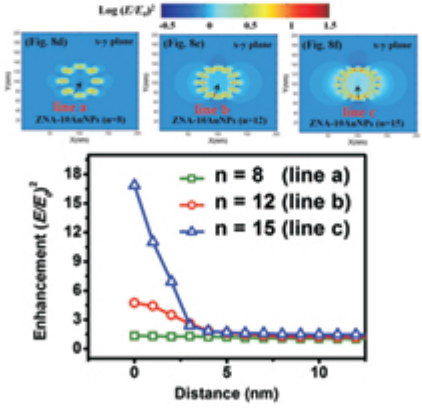

Figure 4. The electromagnetic field enhancement as a function of distance from the local hot spots under 510 nm monochromatic light illuminations.

研究生活及心得

學生現為清大材料系博士班三年級，自從進入吳振名老師實驗室以來，在吳老師的指導下，研究領域為開發一維奈米複合材料，將其特性應用至環境保護與光電元件領域。非常感謝中技社科技獎學金評審委員的肯定，讓我能夠獲得這份巨大的殊榮。非常感謝家人的支持與指導教授吳振名博士的栽培與教導，讓我充滿熱情與動力向前邁進。未來我將更專注於學術研究，使研究工作的成果對材料科學有更實際的幫助，替台灣發展永續能源與環境領域盡一份心力。

財團法人 中技社 CTCI FOUNDATION