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Investigation of Localized Surface Plasmon/Grating-coupled Surface Plasmon Enhanced Photocurrent of TiO_2 Thin Film

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1. Introduction

TiO_2 is known as a famous photocatalysts. However, only solar photon in UV region can excite this photocatalyst due to its large energy band gap [1]. Thus, the improvement of the photocatalytic activities of TiO_2 in the visible region have been attached interest. In this work, we study the photocurrent properties of AuNPs-TiO_2 nanocomposites. The improvement of the photocurrent is attributed to the effect of SPR of gold nanoparticles. Furthermore, we investigate the improvement of the photocurrent of TiO_2 which is enhanced by the combination between SPR of gold nanoparticles and the grating-coupled SPR (GC-SPR) of gold grating.

2. Experimental

To fabricate the AuNPs-TiO_2 nanocomposite photocatalyst electrode on gold grating substrate, the BD-Rs were cut into small rectangles (2.5 x 4.0 cm) and immersed into conc. HNO_3 to remove a dye layer on the BD-Rs. The BD-Rs were cleaned and dried. The cleaned BD-Rs were coated with 150 nm gold film through thermal evaporation. The gold gratings were coated with the AuNPs-TiO_2 nanocomposite dispersed in 50% methanol via spin-coating method. The photocatalyst electrodes were annealed at 90 °C for 30 minutes.

3. Results

We studied the effect of GC-SPR enhanced catalytic properties of the nanocomposites by monitoring of photocurrents under white light illumination with s-polarization, whereas for non-SP excitation and p-polarization, whereas for SP excitation. Fig 1A shows the schematic diagram that indicates the electric field of GC-SPR on the surface of gold grating under p-pol illumination. Therefore, the electron-hole pairs generation of TiO_2 that exist in the vicinity of the strong electric field are promoted. Fig 1B shows the photocurrent of TiO_2/gold grating. The result shows the improvement of the photocurrent of TiO_2/gold grating with SP excitation for all incident angles. Fig1C shows the photocurrent of TiO_2/flat gold, TiO_2/gold grating, and AuNPs-TiO_2 nanocomposites/gold grating irradiated with p-polarization. The further increase of photocurrent of AuNPs-TiO_2 nanocomposites/gold grating was observed. This might be attributed to the effect of localized SPR of gold nanoparticles and GC-SPR of the gold grating.

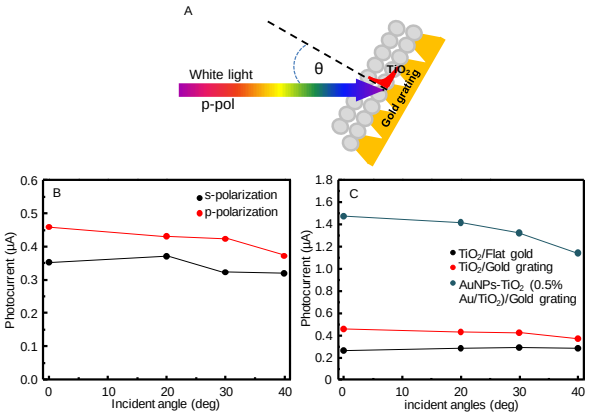

Figure1. (A) Schematic of fabricated TiO_2/gold grating. (B) The photocurrent of TiO_2/gold grating photocatalyst electrode. (C) The photocurrent of TiO_2/flat gold, TiO_2/gold grating, and AuNPs-TiO_2 nanocomposites/gold grating irradiated with p-polarization.

4. Conclusions

We have investigated the improvement of photocurrent activity of AuNPs-TiO_2 nanocomposites as compared to the original TiO_2. The photocurrent of the nanocomposites was further enhanced by surface plasmon resonance excitation from gold grating substrate. The combination between the GC-SPR of the gold grating and the LSRP of gold nanoparticles provides promising enhancement effect to increase the photocurrent.

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