

課題番号 : F-18-HK-0031

利用形態 : 共同研究

利用課題名(日本語) :

Program Title (English) : Enhanced Plasmon-induced Photocurrent Generation using a Co-catalyst

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キーワード/Keyword : 成膜・膜堆積、膜加工・エッチング、表面処理

1. 概要(Summary)

Plasmon-induced water splitting has been demonstrated on gold nanoparticles loaded semiconductor. [1] The water oxidation reaction is regarded as the bottleneck in the water splitting processes, which includes a four-electron transfer uphill reaction. To improve the water splitting reaction, we proposed to employ a co-catalyst, NiO, to accelerate the water oxidation reaction on an Au nanoparticle/TiO₂/Au-film (ATA) photoelectrode.

2. 実験(Experimental)

【利用した主な装置】

Atomic layer deposition (ALD) (Picosun SUN-R), Helicon Sputtering (ULVAC MPS-4000C1/HC1), Scanning electron microscopy (SEM) (JEOL JSM-6700FT), Pulsed laser deposition (PLD) (Pascal PAC-LMBE)

【実験方法】

The ATA photoelectrode was fabricated as follows. A 100-nm Au film was first sputtered on the surface of silica glass substrate. Titanium dioxide thin films were then deposited onto Au film using ALD. Au-NPs were fabricated on TiO₂ thin film by thermal annealing a 3-nm Au thin-film at 300°C. the co-catalyst of NiO was decorated on the surface of ATA by pulsed laser deposition. The surface morphology was observed by scanning electron microscopy.

3. 結果と考察(Results and Discussion)

The ATA structure with 0-nm Au-NPs inlaid depth was fabricated for plasmon-induced water splitting study according to the reported method. [1] Figure 1a shows absorption spectra of ATA and ATA

decorated with 1-nm NiO. A typical optical image is also shown in the inserted panel. Strong coupling between the Fabry-Pérot nanocavity mode of TiO₂ thin-film/Au-film and the localized surface plasmon resonance (LSPR) mode of Au-NPs induced a strong light absorption in the visible wavelength region. Figure 1b shows the IPCE action spectra measured in an aqueous electrolyte solution of KOH (0.1 mol/dm³). A remarkable IPCE enhancement was observed for the ATA decorated with co-catalyst of NiO.

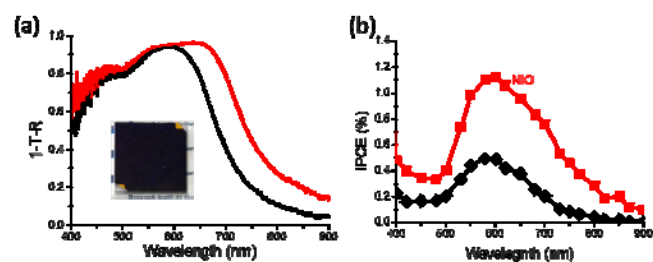


Figure 1. (a) Absorption spectra of ATA (black) and ATA decorated with co-catalysts (red). (b) IPCE action spectra of ATA (black) and ATA decorated with co-catalysts (red).

4. その他・特記事項(Others)

・参考文献

[1] X. Shi, K. Ueno, T. Oshikiri, Q. Sun, K. Sasaki, H. Misawa, *Nat. Nanotechnol.*, 13 (2018) 953-958.

・共同研究者: X. Shi, K. Hayashi, K. Ueno, T. Oshikiri, Q. Sun, and H. Misawa

5. 論文・学会発表(Publication/Presentation)

なし

6. 関連特許(Patent)

なし