

課題番号 : F-17-HK-0088  
 利用形態 : 機器利用  
 利用課題名(日本語) :  
 Program Title (English) : Plasmon-induced photocurrent generation for exploring the near-field  
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 キーワード/Keyword : Plasmon, Strong coupling, Near-field spectroscopy, Internal quantum efficiency, Lithography

## 1. 概要(Summary)

To construct efficient light harvesting optical antennae, an optimization of structural design is one of the most important research topics in plasmon-induced light energy conversions. Coupled plasmonic systems such as nanogap heptamer, dolmen, metal-insulator-metal nanostructures, and so on is promising as a photoelectrode design because of their strong near-field enhancement and wide wavelength responsibility. In this study, a coupled plasmonic system based on a waveguide-LSPR coupling system is employed to investigate whether the photocurrent response extends over a wide wavelength range and is promoted by near-field enhancement in the plasmon-induced photocurrent generation using gold nanostructured titanium dioxide (TiO<sub>2</sub>) photoelectrodes. Near-field spectrum and photocurrent action spectrum are compared to elucidate the effect of near-field enhancement on the photocurrent generation.

## 2. 実験(Experimental)

### 【利用した主な装置】

Ultra-high precision electron-beam lithography system, ELS-F125 (Elionix), Atomic layer deposition system, SUNALE-R (Picosun), Helicon sputtering system, MPS-4000C1/HC1 (Ulvac)

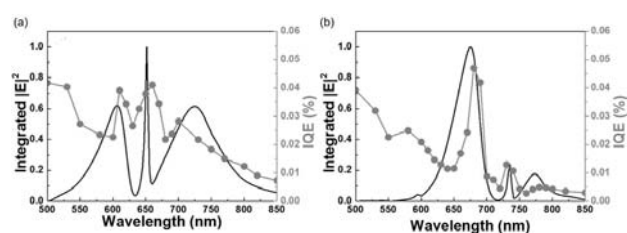
### 【実験方法】

TiO<sub>2</sub> photoelectrodes supporting periodic gold nanogratings (AuNGs) with different pitch sizes were fabricated by a deposition of TiO<sub>2</sub> on a glass substrate with a thickness of 250 nm using an atomic layer deposition (ALD) reactor, and subsequent electron beam lithography and lift-off

processes. A conventional photoelectrochemical measurement was performed.

## 3. 結果と考察(Results and Discussion)

Internal quantum efficiency (IQE) spectra of the photocurrent generation and simulated near-field spectra of the AuNGs/TiO<sub>2</sub> photoelectrodes with 300 nm and 350 nm pitch sizes by FDTD are shown in Figure. 1. It was clearly elucidated that IQE spectrum has successfully reproduced the near-field spectrum under the coupling conditions. This indicates that the photocurrent response extended over a wide wavelength range utilizing the coupled plasmonic systems and near-field enhancement effects promoted the plasmon-induced water oxidation because IQE values increased responding to the near-field spectra<sup>1</sup>.



**Figure 1.** IQE spectra (plot & line) and simulated near-field spectra (solid line) of the Au-NGs/TiO<sub>2</sub> photoelectrodes with 300 nm (a) and 350 nm (b) pitch sizes, respectively.

## 4. その他・特記事項(Others)

### 参考文献

1. Y. Nishijima et al. *JPC-L*, **2010**, *1*, 2031.  
 共同研究者: X. Shi, J. Li, Q. Sun, T. Oshikiri

### 5. 論文・学会発表(Publication/Presentation)

1. J. Guo et al. *J. Phys. Chem. C* **2017**, *121*, 21627.

### 6. 関連特許(Patent) なし