

課題番号 : F-19-HK-0022  
 利用形態 : 共同研究  
 利用課題名(日本語) :  
 Program Title (English) : Hot Charge Carrier Dynamics on plasmonic WO<sub>3</sub>/AuNP photoanodes.  
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 キーワード/Keyword : WO<sub>3</sub> Sputter Deposition, Colloid Lithography, Transient Absorption, Plasmon, Hot charge carrier dynamics, 成膜・膜堆積

## 1. 概要(Summary)

Aiming to understand the dynamics of plasmon-induced hot charge carriers at the interface of AuNPs and WO<sub>3</sub> n-type semiconductor. Herein, we apply electrochemical and transient absorption measurements to monitor plasmon induced electron injection into WO<sub>3</sub> conduction band.

## 2. 実験(Experimental)

### 【利用した主な装置】

ヘリコンスパッタリング装置 (ULVAC MPS-4000C1/HC1), 高分解能電界放射型走査型電子顕微鏡 (JEOL JSM-6700FT).

### 【実験方法】

A 1.2- $\mu\text{m}$  WO<sub>3</sub> film was sputtered on the surface of FTO glass and annealed in air at 600°C for 30 min. A periodic array of Au-NPs was fabricated on the WO<sub>3</sub> thin film by colloid lithography. The surface morphology and element distribution were observed by SEM and EDX mapping. The photoelectrochemical response was investigated and compared to bare WO<sub>3</sub>. Transient absorption was used to observe electrons injection into the conduction band of WO<sub>3</sub>.

## 3. 結果と考察(Results and Discussion)

Figure 1 shows the SEM and EDX mapping results for W and Au of the WO<sub>3</sub>/AuNP plasmonic photoanode. Below the optical transmission spectra of bare WO<sub>3</sub> (black) and WO<sub>3</sub>/AuNP (orange) with distinct plasmonic absorption region.

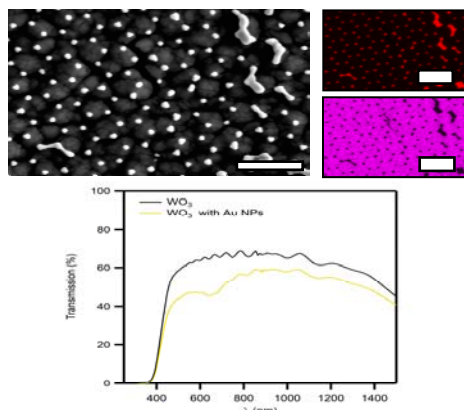


Figure 1. WO<sub>3</sub>/AuNP photoanode structure and optical properties.

Figure 2 (top) shows the photoelectrochemical activity of WO<sub>3</sub> (black) and WO<sub>3</sub>/AuNP (orange) versus wavelength. The plasmonic AuNP clearly extend the activity further into the red spectral range. Transient absorption measurements are shown below. We probe at 3500 nm and pump at 550 nm, 650 nm and 750 nm. In the first case both photoanodes show the same electron dynamics in the conduction band because of direct excitation of bulk WO<sub>3</sub> electrons. At 650 nm and 750 nm the plasmonic photoanode shows dramatically shorter lifetimes of electrons injected into the WO<sub>3</sub> conduction band. Interestingly there exist long living electrons in WO<sub>3</sub> photoanodes at these wavelengths, which is currently still under investigation.

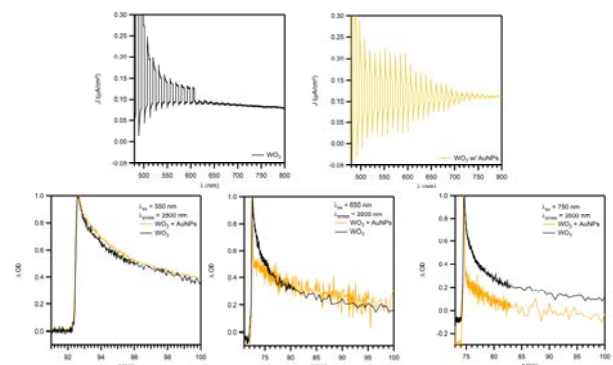


Figure 2. PEC response vs. wavelength of WO<sub>3</sub> and WO<sub>3</sub>/AuNP photoanodes (top) and their transient absorption probed at 3500 nm and pumped at 550 nm, 650 nm and 750 nm respectively.

## 4. その他・特記事項(Others)

Main collaborators: Xu Shi, Hiroaki Misawa (RIES-Hokkaido University)

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

なし

## 6. 関連特許(Patent) なし