

課題番号 : F-16-HK-0063
利用形態 : 共同研究
利用課題名(日本語) :
Program Title (English) : Plasmonic photoelectric conversion using gold nanoparticles loaded TiO₂ photoelectrode with 3D photonic lattices
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1. 概要(Summary)

In the present study, we propose a plasmon-induced photocurrent generation system using a photoelectrode composed of gold nanoparticles (AuNPs) loaded TiO₂ inverse opal (TIO) photonic crystals. The AuNPs loaded TIO photonic crystal photoelectrode was fabricated by using an atomic layer deposition (ALD) method and electrochemical deposition techniques of gold nanoparticles with HAuCl₄ aqueous solution inside the photonic crystal. We explored the photoelectric conversion property of the fabricated photoelectrode.

2. 実験(Experimental)

【利用した主な装置】

原子層堆積装置,ヘリコンスパッタリング装置,高分解能電界放射型走査型電子顕微鏡 SEM, ICP 高密度プラズマエッチング装置

【実験方法】

TiO₂ with thickness of 50 nm was deposited on FTO by ALD. The opal structure was prepared by a self-assembled method using polystyrene beads (PS). Then, TiO₂ was deposited by ALD and annealed at 500°C to remove the PS to form the TIO. AuNPs were dispersed on the inverse TIO electrode by an electrochemical reduction using a HAuCl₄ aqueous solution. Photoelectrochemical measurement was performed by a three-electrode system, using Pt wire and Ag/AgCl as counter and reference electrode, respectively.

3. 結果と考察(Results and Discussion)

From reflection and transmission spectra, the photonic stop band was confirmed at around the wavelength of 600 nm which closely overlap the plasmon resonance spectrum of AuNPs when

polystyrene beads with a diameter of 300 nm were used for the opal template. The I-T-R spectra with and without AuNPs, which is closely corresponding to the absorption, were compared, and the difference spectrum (Δ I-T-R) is calculated to be absorption of AuNPs. Figure 1 shows the IPCE action spectra. We found that the photocurrent enhancement was observed in visible wavelength range from 400 nm to 700 nm especially the enhancement was larger in the shorter wavelength region of Δ I-T-R spectrum. We discussed about the light harvesting property by photonic crystals in the plasmon-induced photocurrent generation.

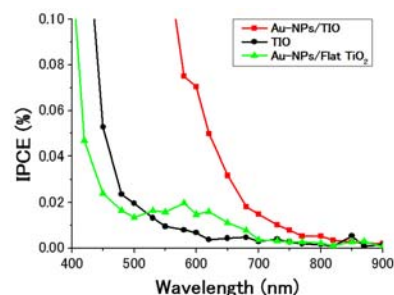


Fig. 1 IPCE action spectra measured using Au-NPs loaded flat TiO₂ and TIO photoelectrodes (green and red plots). IPCE action spectrum measured using TIO photoelectrode without Au-NPs which is displayed as a reference (black plot).

4. その他・特記事項(Others)

共同研究者: Xiaolong Yang, Xu Shi, Tomoya Oshikiri, Kosei Ueno, Hiroaki Misawa

5. 論文・学会発表(Publication/Presentation)

- (1) Xiaolong Yang, Xu Shi, Tomoya Oshikiri, Kosei Ueno, Shuyan Gao, Hiroaki Misawa, The 97th CSJ Annual Meeting, Keio Univ., Yokohama, March (2017).

6. 関連特許(Patent)

なし