※課題番号　：F-12-HK-0015

※支援課題名（日本語）　：原子層堆積装置を用いた金ナノ構造／酸化チタン電極の作製と光電変換特性

※Program　Title（in English）　：Fabrication of gold nanostructured titanium dioxide photoelectrodes using atomic layer deposition and its photocurrent generation properties

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※概要（Summary）：

We are studying to develop a plasmonic solar cell and an artificial photosynthesis system using gold nanostructured oxide semiconductor such as titanium dioxide (TiO_2), strontium titanate and so forth. In this study, gold nanostructured TiO_2 photoelectrode was fabricated by sputtering of gold thin film on a TiO_2 substrate, that were prepared by a deposition of TiO_2 using atomic layer deposition on a glass substrate, and a subsequent annealing of the substrate. Photocurrent was clearly observed with an irradiation of visible light and the IPCE (Incident Photon to Current Conversion Efficiency) action spectrum was good agreement with the plasmon resonance spectrum.

※実験（Experimental）：

TiO_2 (anatase) was deposited on a glass substrate with a thickness of 300 nm by ALD and the substrate was used as a photoelectrode of the plasmon-enhanced photocurrent generation system. In the ALD process, $TiCl_4$ and H_2O were used as precursors. Gold nanostructures were fabricated on the TiO_2 photoelectrode by sputtering of gold thin film with a thickness of 3 nm and subsequent annealing of the substrate at 250°C under ambient atmosphere conditions. For the measurement of I-V curve and IPCE action spectrum, a three-electrode type of the conventional photoelectrochemical measurement system was employed.

※結果と考察（Results and Discussion）：

The crystal structure of TiO_2 film deposited on a glass substrate by ALD was determined as anatase by XRD measurement. From a scanning electron microscope (SEM) image of the gold nanostructured TiO_2 surface, gold nanoparticles with a diameter of ~10 nm were successfully fabricated on the TiO_2 substrate (data were not shown here). Extinction spectrum of the gold nanostructured TiO2 photoelectrode was shown in Fig. 1(b). A plasmon resonance band peaking at 585 nm wavelength was clearly observed. I-V curves measured with and without irradiation of light were shown in Fig. 1(a). In this experiment, Xe lamp spectrally filtered to the wavelength from 440 nm using a long pass filter was irradiated. As most important points, anodic photocurrent was clearly observed even with an irradiation of visible light. IPCE action spectrum is shown in Fig. 1(b). IPCE value as high as more than 0.4% was obtained at the plasmon resonance wavelength. It is emphasizing, furthermore, that the IPCE action spectrum is almost accordance with plasmon resonance spectrum. This means that plasmon-enhanced photocurrent generation was clearly obtained. Therefore, we concluded that TiO_2 film deposited on a glass substrate by ALD can be also used as a photoelectrode for a plasmon-enhanced photocurrent generation.

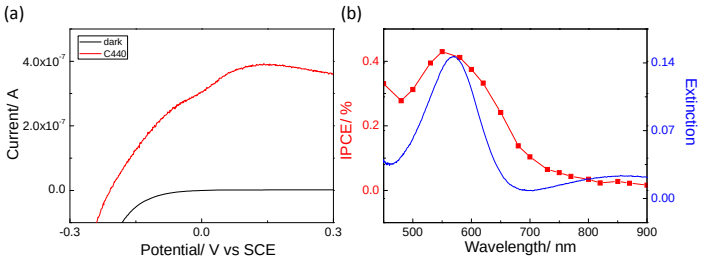

Fig. 1 (a) I-V curves measured with and without irradiation of light. Xe lamp spectrally filtered to the wavelength from 440 nm using a long pass filter was employed. (b) Extinction spectrum of the gold nanostructured TiO_2 photoelectrode and IPCE action spectrum.

※その他・特記事項（Others）：

According to deposit NiO on the photoelectrode as a hole transport material, we will construct transparent solid-state plasmon solar cell.

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論文・学会発表（Publication/Presentation）：なし

関連特許（Patent）：なし