課題番号　　:F-15-HK-0046
利用形態　　:機器利用
利用課題名（日本語）　　:プラズモン水分解系の助触媒効果
Program Title(English)　　:Co-catalyst effect on plasmon-induced water splitting
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1. 概要（Summary）

We explored the performance of hydrogen (H_2) evolution using noble metals or their metal oxides as cocatalysts in the plasmon-induced water-splitting system. We eliminated the adverse effect of the Schottky barrier by obtaining ohmic contact between the semiconductor and the metal or metal oxide co-catalysts, and we used two separate reaction chambers for H_2 and O_2 evolution to avoid reverse reactions. A 2−3 nm thick rhodium layer deposited on a platinum board exhibited relatively high performance, a 3-fold increase compared with the absence of a metal or metal oxide cocatalyst thin layer.

2. 実験（Experimental）

【Main equipment】

Helicon Splitting (ULVAC, MPS-4000C1/HC1), Focused Ion Beam (Hitachi, FB-2100), X-ray Photoelectron Spectroscopy (JEOL, JPS-9200), X-ray Diffract (RIGAKU RINT-2000), Cs-corrected STEM (JEOL, JEM-ARM200F)

【Methods】

Single-crystal strontium titanate ($SrTiO_3$, 0.05 wt % niobium doped) with a (110) surface was used as a semiconductor substrate. A 3 nm thin gold film was deposited on the front side of the $SrTiO_3$ by sputtering and annealed at a temperature of 800°C for 1 h in a nitrogen atmosphere to form gold nanoparticles (Au-NPs) on the $SrTiO_3$ surface. The Ru and Rh thin films were deposited onto the Pt board by sputtering. An In−Ga alloy paste was applied to the back side of the Nb-$SrTiO_3$ substrate to form ohmic contacts. Subsequently, a Pt board with a noble metal or metal oxide thin film was adhered to the back side of the substrate. The water-splitting device contained sealed reaction cells with two solution compartments separated by the $NbSrTiO_3$ substrate.

3. 結果と考察（Results and Discussion）

Various noble metals and metal oxides were used as H_2 evolution co-catalysts for comparison, and the corresponding rates of H_2 and O_2 evolution are shown in Fig. 1. The evolution of both H_2 and O_2 linearly increased with irradiation time in all cases. The relatively higher yield of H_2 evolution obtained using Rh as a co-catalyst is likely attributable to the difference in the free energy of H_2 adsorption.

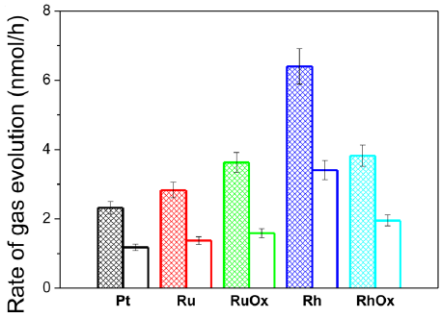

Fig. 1 Comparison of the rates of H_2 (patterned filled bars) and O_2 evolution (open bars) in the water-splitting system using a Pt board decorated with various co-catalysts.

4. その他・特記事項（Others）

・参考文献

[1] Y. Zhong et al. *Angew. Chem. Int. Ed.*, **2014**, *53*, 10350-10354.

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5. 論文・学会発表（Publication/Presentation）

論文発表

(1) Y. Zhong, Y. Mori et al. *J. Phys. Chem. C*, **2015**, *119*, 8889-8897.

6. 関連特許（Patent）

なし