Fabrication of Photocatalytic Solar Cell using Manganese Oxide Solid Electrolyte.

○Reiki Kaneki, Kouiti Iwawaki, Seichi Rengakuji
*Yuuko Nakamura
Department of System Engineering of Materials and Life Science, Faculty of Engineering, Toyama Univ.,*Center for Institute Analysis, Toyama Univ.
3190, Gofuku, Toyama city, Toyama, 930-8555, Japan

INTRODUCTION: Metal oxide precursor solution has been made by advanced sol-gel method, in which hydrophilic and hydrophobic mixed solvents were used for hydrolysis and polymerization of alkoxide. Photocatalytic activity of TiO_2 thin film prepared by this method is greater than that of conventional sol-gel method. More efficient photocatalytic activity would be expected for TiO_2-SnO_2 thin film. In this work, we fabricated a photocatalytic solar cell, a kind of capacitor, using manganese oxide solid electrolyte and high photocatalytic TiO_2-SnO_2 thin film. Manganese oxide electrolyte was prepared by advanced sol-gel method. The cell voltage generated by irradiation of black light was measured.

EXPERIMENTAL: SnO_2 precursor solution was prepared as described below. By refluxing tin chloride anhydrate in butanol and toluene solvent, tin alkoxide solution was formed and then concentrated. Toluene and butanol containing distilled water was added in condensed solution to produce tin oxide precursor solution. Manganese oxide solution was prepared by the same preparation process of SnO_2 precursor solution except that the starting material was manganese chloride tetrahydrate and the hydrophilic solvent was ethanol. To prepare the TiO_2-SnO_2 precursor solution, SnO_2 precursor solution was added to TiO_2 precursor solution. TiO_2 precursor solution was made by our method.

TiO_2-SnO_2 thin film was made by spincoating on FTO substrate and heat-treatment at 500 ^oC. Manganese oxide precursor solution was spincoated on FTO substrate, and heat-treated at various temperatures. Schematic view of photocatalytic solar cell is shown in Fig.1. The TiO_2-SnO_2 thin film was suited to the manganese oxide film. The cell voltage was measured under the UV-light irradiation of wavelength 352 nm. The crystal structure of these oxides was measured by XRD. The surface morphologies of these were observed by FE-SEM and AFM.

RESULTS AND CONCLUSIONS: Fig.2 shows XRD patterns of manganese oxide after heat-treatment at 200~500^oC. At 350^oC the Mn_3O_4 phase appeared. At 500^oC the peaks showed the two phases of Mn_3O_4 and Mn_2O_3 structure. Fig.3 shows the cell voltage under UV irradiation when manganese oxide was used as solid electrolyte, heat-treated at 200~500^oC. After irradiation of UV-light for about 20 second, a steady state was obtained. The cell voltage using solid electrolyte heat-treated at 350^oC was about 0.75 V. This voltage is considered relatively high for a cell made under another condition. When solid electrolyte was heat-treated at a lower or higher temperature than 350^oC, cell voltages did not exceed about 0.7 V. The highest voltage is obtained at Mn_3O_4 phase. It is considered that the manganese electrolyte takes part in oxidation-reduction reaction with hole and electron, these species produced by photocatalytic excitation on TiO_2-SnO_2 film. These mechanisms occurred at the interface between manganese oxide and TiO_2-SnO_2, as shown in Fig.1.

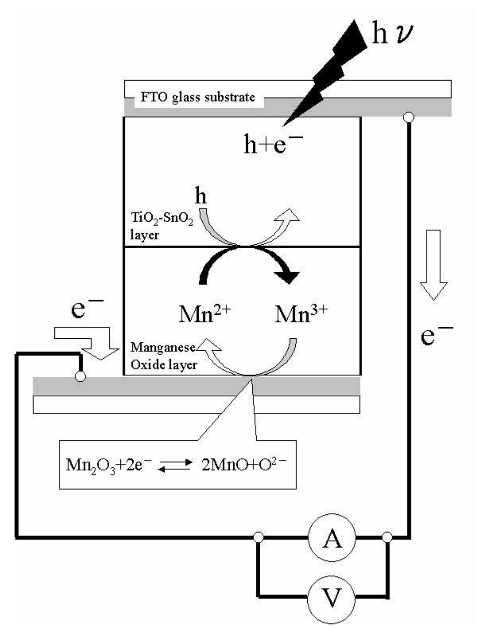

Fig.1. The schematic view of photocatalytic solar cell.

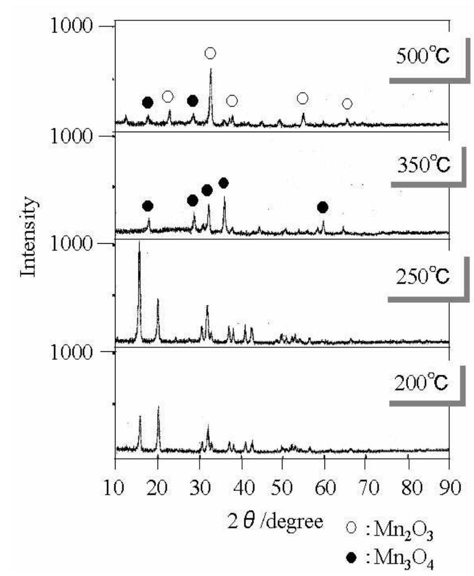

Fig.2. X-ray diffraction patterns of manganese oxide at various temperatures: 200, 250, 350 and 500^oC.

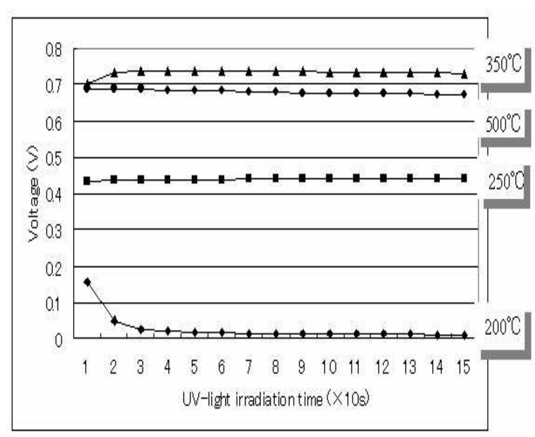

Fig.3. Measurement of voltage under the UV-light.