Influence of Hydroxylamine concentration on Structural and Electrical Properties of Titanium Oxide Films

H. Ishizaki
Tokyo University of Science Suwa
Chino 391-0292, Japan

S. Ito
Kinki University,
4-1, Kowakae 3-chome, Higashiosaka,
Osaka 577-8502, Japan

Introduction

Recently, titanium oxide is paid much attention for many applications such as photocatalysis, chemical sensor, ferroelectrical devices, opto-electric devices and solar cells, because of its ferroelectrical, photocatalytic and optical properties. In particular, for photocatalysis, sensor and opto-electric devices, the photocatalytic property and crystallinity of titanium oxide film need be improved in order to develop the titanium oxide devices with high-performance. The electrochemical technique with low growth temperature presents several advantages than the dry process such as the sputtering method and metal organic chemical vapor deposition etc.

In this paper, we reported on the influence of hydroxylamine concentration on the structural and electrical properties of titanium oxide films electrochemically grown on conductive substrate (NESA glass) from the titanium ion aqueous solution containing a complex agent and a hydroxylamine kept at 333K and pH9.

Experimental

The titanium oxide film is grown by cathodic potential ranging of -1.3V referred to Ag/AgCl electrode. The electrolyte consisted from 0.05 mol/L titanium potassium oxalate dehydrate and hydroxylamine ranging of 0.01mol/L to 1mol/L. The conductive substrate (NESA glass) is used as the cathode. The Pt/Ti sheet (99.99%purity) is used as active anode. The Ag/AgCl electrode in saturated KCl aqueous solution is used as the reference electrode. And the thickness of TiO_2 film was controlled by the electric charge. The preparation of TiO_2 film with the thickness of 50um is carried out potentiostatically using a potentiostat without stirring until the electric charge of 10 coulomb cm^{-2}.

The structural property of titanium oxide films were measured by X-ray photoelectron. The surface morphology of titanium oxide film was observed by using a scanning electron microscopy. The photocatalytic activities of the samples were examined by CH_3CHO dissolution rate under visible-light illumination.

Results and Discussion

Figure 2 shows the surface morphology of titanium oxide films. Titanium oxide films were composed of aggregates of tetragonal grains, regardless of hydroxylamine concentration. The grain size of titanium oxide films increase with a decrease in the hydroxylamine concentration.

For the Ti2p XPS spectra of titanium oxide films obtained on NESA glass. The peaks observed at about 465eV for Ti 2p1/2 and about 459eV for Ti2p3/2, regardless of theNH_2OH concentration. These binding energies are much closed to the values of the Ti^{4+} valence states of TiO_2.

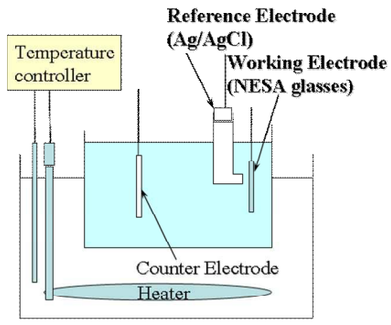

Figure 1 the schematic view of electrochemical deposition techniques system.

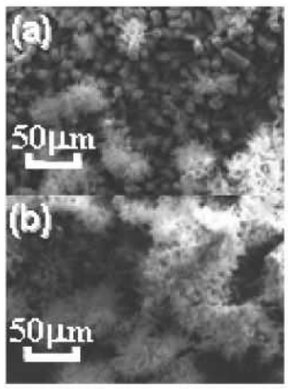

Figure 2 The surface morphology of titanium oxide electrochemically grown on NESA glasses
a) NH_2OH concentration of 0.5mol/L and
b) 1.0mol/L

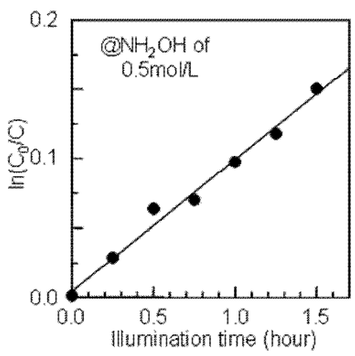

Figure 3 the photocatalytic property of titanium oxide film electrochemically grown on NESA

Figure 3 shows the photocatalytic property of titanium oxide film. The CH_3CHO dissolution rate constants were calculated from the slopes of the straight lines in the plots of $\ln(C_0/C)$ vs the illumination time. C_0 and C denote the concentrations of CH_3CHO at t=0 and t=t, respectively.$\ln(C_0/C)$ increased with an increase the illumination time, regardless of cathodic potential. The rate constants of CH_3CHO dissolution reaction increased with a decrease in the cathodic potential.

Conclusion

The pours and the polycrystalline TiO_2 films are prepared on the conductive glasses (NESA glass,) from a 0.05mol/L titanium potassium oxalate dehydrate aqueous solution containing hydroxylamine kept at 333K by electrochemical deposition without the heat treatment.