Gas sensing application of photoelectrochemically Tailored Nano Porous Structure Titanium Dioxide

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1. Introduction

Titanium dioxide is very attractive useful material for photocatalyst activity, dye sensitized solar cell, optical device and gas sensor, etc.. Photoelectrochemical etching is a unique processing technique for tailoring a surface microstructure of various semiconductors. We have reported that the photoelectrochemical etching of titanium dioxide in sulfuric acid solution of sintered pellet titanium oxide leads to a unique nano-porous structure on the single crystal or the sintered pellet electrode surfaces depend on etching conditions. One of interesting features in thus obtained surface morphology lies in a selective evolution of the specific crystallographic surface exposed, i.e., (100) surface of rutile, by the photoetching under certain conditions. Such a surface processing of TiO_2 might be technologically applicable to some devices but no report has been found in this respect, although the microstructure of the above surface tailored TiO_2 has been analyzed in detail. This report describes an effect of the photoelectrochemical etching on gas sensing properties of TiO_2.

2. Experemental

Highly pure rutile type TiO_2 powder was press molded in vacuum at 40g/cm2 for 15min to make a pellet. The pellet was fired in at various temperature (1000°C~1300°C) for 6hrs and slightly reduced in at 1000°C for 1hr in a stream of 10% H_2/N_2 gas stream to obtain n type semiconductivity. Photoetching treatment of the electrode surface was carried out in a 1 M sulfuric acid solution under potentiostatic condition (1.0 V /vs. SCE). The electrode was illuminated using a 500W high pressure Hg arc lamp with about 365nm.

In order to make sensor devices, two strips of conductive silver paste, separated by approximately 4mm were painted on the sensor sample surface in order to provide the electrical contact and it was placed on an alumina substrate. The electric resistance of the sensor was calculated from a dc current measured using a DC current voltage source monitor under a constant voltage (0.5 V). Most of the gas sensor measurements were carried out at 400°C, 2.5% H_2/Air in a constant flow rate of air for 400 ml/min.

3. Results and Discussions

Table 1 Sensitivity and recovery time changes of TiO_2 sensor with the photoetching quantity.

	0 C/cm^2	40 C/cm^2	100 C/cm^2	250 C/cm^2	1000 C/cm^2
Sensitivity (R_a/R_g)	50	85	140	200	300

Table. 1 summarizes the sensitivity changes of TiO_2 gas sensor with the photoetching quantity change. The increased specific surface area leads to an increase of the electric resistance in the air, but does not affect the resistance in the H_2 atmosphere so much. As the consequence, the higher the sensitivity towards H_2 detection has been improved by photoetching.

4. Conclusion

The sensitivity and response time are improved by the enlargements of the specific surface area mainly consist of (100) crystal face. This is think about the increase surface active sites for oxygen adsorption and surface reaction of the semiconductor oxide sensors.

References

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