Fabrication of Transparent Conducting ZnO Films for Dye-Sensitized Solar Cells

Y. Nakamura, T. Aoki, T. Matsushita and A. Suzuki

Department of Electronics, Information and Communication Engineering, College of Engineering, Osaka Sangyo University, 3-1-1 Nakagaito, Daito, Osaka 574-8530, Japan

1. Introduction

Presently, for dye-sensitized solar cells, transparent conducting FTO (fluorine-doped tin oxide) films, in which titanic oxides are sintered at 500℃, are widely used. Consequently, the preparation process gave rise to FTO films with high resistivities. In order to reduce the resistivity of FTO films, laminated-layered FTO/ITO (indium-doped tin oxide) structures with anti-heat properties were employed as transparent conducting films for solar cells. But, there still remain some problems with high cost and uncertain supply accompanied by scarcity of metal indium element.

We have studied AZO (aluminum-doped zinc oxide) and GZO (gallium-doped zinc oxide) films substituted for ITO films as transparent conducting electrodes for solar cells and have reported some points with anti-heat properties.

In order to improve the anti-heat properties of zinc oxide films, transparent conducting TZO (Ti_2O_3-doped zinc oxide) films were prepared and a test of anti-heat properties was performed at 500℃ . In this report, favorable experimental results are described.

2. Experimental

The TZO films (～800 nm) have been deposited on glass substrates by irradiating the pulsed laser beam of an ArF laser (λ = 193 nm) on the split target composed of ZnO and Ti_2O_3 (99.999 % purity), with a moved distance of ZnO : Ti_2O_3 = 88 : 12. After the fabrication process, a test of anti-heat properties was carried out at 500℃ for 3 hours. Electrical and Optical properties were compared before or after the test of anti-heat properties.

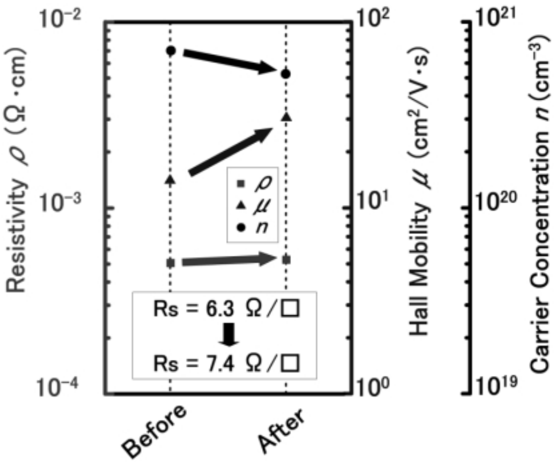

Fig. 1. Electrical properties.

3. Results

Electrical properties of TZO films before or after the test of anti-heat properties are shown in Fig.1. Before the test, sheet resistance of 6.3 Ω/□, resistivity of 5.05 $\times10^{-4}$ Ω・cm, Hall mobility of 16.7 cm^2/V・s , carrier density of 7.38$\times10^{20}$ cm^{-3}.were obtained. After the test, the test, sheet resistance of 7.4 Ω/□, resistivity of 5.88 $\times10^{-4}$ Ω・cm, Hall mobility of 20.6 cm^2/V・s , carrier density of 5.14$\times10^{20}$ cm^{-3} were obtained. From these results, it was confirmed that an obvious change in the value of sheet resistance was not caused.

In Fig.2, the optical transmittance spectra before or after the test are shown. From these results, it was recognized that an average optical transmittance in the visible range of the spectrum (wavelength range of 400～700 nm) was improved from 71.7 % before the test to 75.1 % after the test.

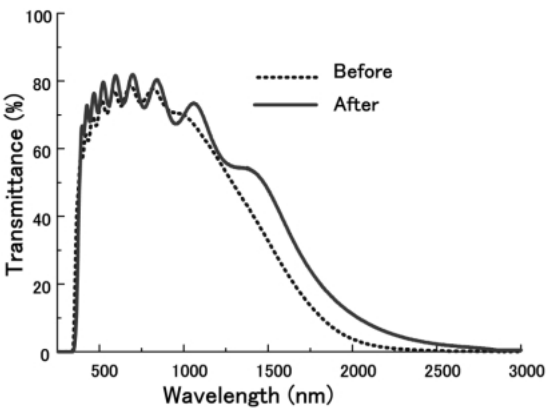

Fig. 2. Optical transmittance spectra.

4. Summary

In order to improve the defect to the anti-heat properties contained in AZO or GZO films, transparent conducting TZO films have been deposited by the pulsed laser deposition (PLD) method using ArF excimer laser (λ =193 nm) and the test of anti-heat properties was performed at 500℃ for 3 hours. As a result, it was confirmed that there was not an obvious change in the electrical properties of the TZO films after the test of anti-heat properties and therefore, there was a favorable anti-heat property for the TZO films.

References

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