Characteristic of AZO/SiCO Film by X-Ray Diffraction Pattern and X-Ray Photoelectron Spectroscopy

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Abstract. Effect of polarity in SiCO film as gate insulator for AZO-TFT was researched. The aluminum doped ziinc oxide films were deposited on SiOC/p-Si wafer by a RF magnetron sputtering system. Polarity in SiCO film with increasing the oxygen gas flow rates changed, and SiCO film lowering polarity was observed the chemical shift in the binding energy such as Si 2p and C 1s, because of lowering the polarity due to chemical reactions between CH group and OH group as the opposite polar sites by high plasma energy. Oxidation of Si atoms will lead to a chemical shift to move higher binding energy in O 1s spectra, due to the additional potential modulation with the Si nanocrystallites by a long range Coulombic interaction of oxygen ions. The chemical shift after AZO deposition on SiCO film made was attributed to defects owing to the Vo and Zni and the valence band in AZO at interfaces between AZO and SiCO films. AZO grown on SiCO film including polar sites showed high on current in transfer characteristic of TFT because of increase of the trap charge owing to the defects.

Keywords: AZO, XRD pattern, O 1s, C 1s, Zn 2p, sputter, polarity.

1 Introduction

Transparent semiconducting ZnO with a wide and direct bandgap of about 3.4eV has found many applications in different field such as transparent conductive contacts, thin film gas sensors, varistors, solar cells, luminescent materials or displays. To realize high performance ZnO-based devices, it is essential not only the formation of high quality metal electrodes but also substrate materials for ZnO. In view of ohmic contacts to n-ZnO, it is difficult to make Schottky contacts to n-ZnO, because of a high donor concentration at the surface region of n-ZnO involving native defects such as oxygen vacancies and zinc interstitials. For Schottky, several noble metal schemes such as Au, Ag, Pd and Al have been investigated. Or to obtain effective Schottky contacts on n-ZnO, surface treatments using the solutions of HCl, HNO_3 and by the oxygen-based plasmas of O_2, and N2O have been performed. Kim et al, researched the electrical behavior of the Pt contacts to n-ZnO (000-1) surface, and suggested the electric characteristic of ZnO depending on the surface treatment conditions. In comparison with undoped ZnO, Al-doped ZnO films have lower resistivity and better stability [11-16]. Al doped ZnO (AZO) films have attractive much attention because

T.-h. Kim et al. (Eds.): SIP/WSE/ICHCI 2012, CCIS 342, pp. 85–89, 2012.

of their comparative high optical transmittance and low electrical resistivity with respect to other TCOs widely used such as Tin-doped Indium Oxide (ITO) films []. In this works to realize low temperature process, AZO was prepared on SiOC/p-Si by RF magnetron sputter. SiOC film, which can be replaced with SiO_2 film as a gate-insulator, was also by RF magnetron sputter. From the results of XPS and XRD, it was observed the influence of properties of SiOC film to achieve high mobility performance of AZO.

2 Experimental Method

The SiOC film was prepared by RF magnetron sputtering with a 2 in. diameter ceramic target (SiO:C, 97%:3% wt.) targets supplied by LTS Research Laboratories, Inc., U.S.A. The flow rate of the oxygen (99.9999%) was controlled by mass flow controller (MFC) from 5~30 sccm for 20 min, and the sputtering RF power was 250W. The substrate temperature was kept constant at room temperature. AZO film on SiOC/Si was prepared at room temperature. The AZO targets (99.99% purity) were supplied by LTS Research Laboratories, Inc., U.S.A. AZO thin film was deposited on p-type Si wafers by RF magnetron sputter at a pressure of 0.01 Torr in argon atmosphere. The target to substrate distance was kept at 100 mm and the base pressure was 4.5×10^{-5} Pa and the working pressure of the chamber with argon gas was $1.2\sim1.4 \times 10^{-3}$ Torr. The flow rate of the argon (99.9999%) was controlled by mass flow controller (MFC) with 30 sccm for 5 min, and the sputtering RF power was 300W. To investigate the chemical and the structural properties of the AZO film on SiOC film, the chemical analyses were performed using X-ray photoelectron spectroscopy (ESCALAB 210) and X-ray diffraction pattern (XDS 2000), which was at Center for research facilities, Chungbuk University, Cheongju, South Korea.

3 Results and Discussions

In order to evaluate the effect of chemical properties of the substrate on the AZO electrical properties, SiOC films were prepared with various O_2 gas flow rates of 10 sccm to 30 sccm by using RF sputtering at the room temperature, and AZO film was deposited on SiOC substrate by using RF sputtering. Figure 1 is the X-ray photoelectron spectra of AZO/SiCO film with O_2 gas flow rate of 10 sccm to 30 sccm. Concerning the possible influence of SiCO film with polarity to the characteristic of substrate for the growth of AZO film, SiCO film of amorphous structure due to the low polarity would lead to an increase of the crystallinity of AZO film that would affect the electrical properties of the film.

There were much difference in O 1s spectra between AZO/SiCO film and SiCO film, but no change in C 1s spectra between them. The chemical shift of O 1s spectra originated from the existence of trap charges and interface traps due to the oxygen vacancy in AZO film, therefore the intensity of O 1s spectra in AZO on SiCO film