

Formation of Zn Film Using Electrochemical Plating

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Zinc oxide (ZnO) has been used as a catalyst of dehydrogenation reaction for unsaturated alcohol molecules. Recently, demands of ZnO films in the electronic field such as piezoelectric, transparent conductive, opt-electronic, and gas sensing materials have been increasing. We have been investigating the preparation of ZnO films by oxidation of metallic Zn films. In this study, we formed Zn films which are pre-oxidized materials using both electro-plating and electroless-plating, and it is clarified that properties of deposited Zn films are strongly affected by the plating conditions.

The compositions of plating solutions of electro- and electroless-platings are listed in Table 1. Thickness of electro-plating Zn films as a function of plating time is shown in Fig. 1. Linear relationship is observed except in the region of higher current density and longer plating time. In this region, Zn atoms precipitate at the edge of the cathode so that thickness uniformity and surface smoothness become worse. This is because the current concentration to the edge of the cathode in electro-plating process. Figure 2 shows that thickness of electroless-plating Zn films as a function of plating temperature. Film thicknesses are very thin and no temperature dependence is observed in the range between 5 and 25 C. Above 25 C, film thickness increases with increasing temperature, passes the maximum, and decreases. In the temperature range over 36 C, peel of the film is observed. So, plating time dependence of thickness is investigated in the range from 26 to 32 C, and the results are shown in Fig. 3. In all temperature, thicknesses have peak against the plating time, and the peak shifts toward shorter plating time with increase of temperature. In electroless-plating process, Zn ions substitute Al atoms because of ionization tendency difference. When the Zn film coats over Al surface, the substitutional reaction suspends and continuously dissolution reaction of Zn film into the solution proceeds. As a result, the plating time dependence of thickness shows the peak point when the solution temperature is kept constant. Moreover, in order to these substitutional and dissolution reactions enhance as solution temperature increase, the peak point shifts toward shorter plating time. The composition and structure of Zn films prepared by electro-plating and electroless-plating were analyzed using X-ray photoelectron spectroscopy (XPS) and X-ray diffraction (XRD). Asymmetric shape spectra were observed around 990 eV for both electro-plating and electroless-plating Zn films in XPS analysis. These spectra were deconvoluted two peaks; 989 eV for Zn and 986 eV for ZnO, respectively. Comparing the peak intensity of Zn and ZnO, it is found that electro-plating Zn film incorporates more amounts of oxygen atoms than electroless-plating one. From the results of XRD analysis, crystalline structure formation of Zn with small amount of ZnO was observed during electroless-plating.

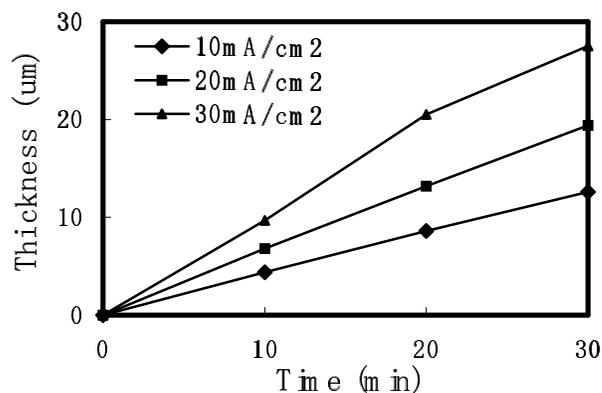


Fig. 1 Electro-plating Zn film thickness as a function of plating time

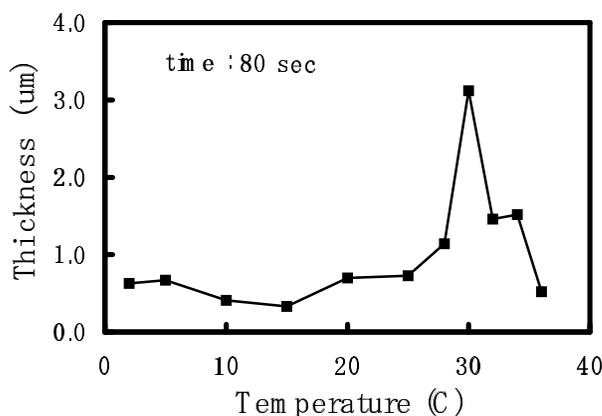


Fig. 2 Electroless-plating Zn film thickness as a function of plating temperature

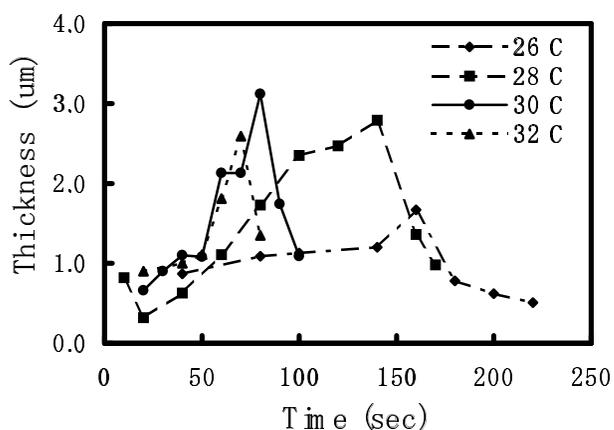


Fig. 3 Electroless-plating Zn film thickness as a function of plating time

Table 1 Composition of plating solution

Reagent	electro-plating (g/l)	electroless-plating (g/l)
ZnSO ₄	410	—
Na ₂ SO ₄	75	—
AlCl ₃	30	—
ZnO	—	5
NaOH	—	50
KNaC ₄ H ₄ O ₆	—	2
FeCl ₃	—	2
NaNO ₃	—	1
Temperature	RT	RT