

## Electrodeposition of Zinc-Telluride Compound Semiconductors

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### Abstract

Zinc-telluride compound semiconductors were electrodeposited from acidic aqueous solution. Under potential deposition (UPD) of zinc was observed during the co-deposition of zinc and tellurium. UPD of zinc was promoted by rising the solution temperature up to 353K. Band gap energy of annealed zinc-telluride films with almost ideal stoichiometric composition (Zn:Te=1:1) were close to 2.26 eV.

**Keywords:** *zinc, telluride, compound semiconductor, under potential deposition*

### Introduction

Zinc based compound semiconductors such as zinc oxide, zinc sulfide, zinc selenide and zinc telluride are applied to high energy conversion opto-electronic materials due to their wide band gap energy. Among of them, zinc telluride (ZnTe) based diode is applicable to the green light emission device and photovoltaic solar cell because the band gap energy of ZnTe is 2.26 eV. Zinc and tellurium can be electrodeposited from aqueous solution [1] and they are not environmental pollutants such as Hg, Cd, Tl, Pb, As and Se. In this study, optimum conditions for electrodeposition of ZnTe compound semiconductor film obtained from aqueous solution were investigated.

### Experimental

Electrolytic solution was synthesized from ZnSO<sub>4</sub> and TeO<sub>2</sub>. The solution pH was adjusted by adding H<sub>2</sub>SO<sub>4</sub> and NaOH. The solution temperature was maintained to 353K during the electrodeposition. Indium tin oxide (ITO) glass and gold wire were used as a cathode and an anode, while the Ag/AgCl electrode immersed in saturated KCl solution was used as the reference electrode. ZnTe film was potentiostatically electrodeposited on the ITO glass. Crystal structure of the deposited films was analyzed by using X-ray diffraction (XRD). The chemical composition was determined by means of energy dispersive X-ray spectrometer (EDX). Band gap energy of the deposited films was estimated by using ultraviolet and visible spectrophotometer (UV).

## Results and Discussion

XRD patterns of electrodeposited films are shown in Fig.1. These XRD patterns correspond to (111) reflection planes of zincblende type ZnTe. During the electrodeposition of ZnTe, hydrogen ions are also reduced and pH in the vicinity of cathode increases up to around 6. At the pH, Zn(OH)<sub>2</sub> forms in the vicinity of cathode [2]. UPD of zinc during ZnTe electrodeposition is caused by the formation of Zn(OH)<sub>2</sub>. H<sub>3</sub>BO<sub>4</sub> in the solution acts as pH buffer substance and prevent Zn(OH)<sub>2</sub> from forming in the vicinity of cathode. Therefore, the sample obtained from the solution containing H<sub>3</sub>BO<sub>4</sub>, consists of ZnTe and Te phase as shown in Fig.1-(b). ZnTe films with almost stoichiometric composition (Zn:Te=1:1) were obtained at under potential range more noble than -1.0 V vs. Ag/AgCl. Band gap energy of as-deposited ZnTe films was less than 1.5 eV, which is smaller than the ideal band gap 2.26 eV of ZnTe. On the other hand, the band gap energy of ZnTe films annealed at 573 K was close to 2.26eV. This is resulting from disappearing crystal defects and recrystallizing electrodeposited ZnTe fine crystals.

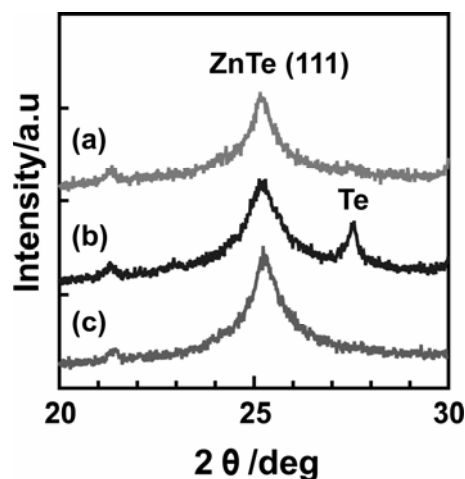


Fig.1 X-ray diffraction profiles of electrodeposited films obtained from three different conditions. Standard condition (a), solution containing H<sub>3</sub>BO<sub>4</sub> (b) and bubbling with N<sub>2</sub> gas (c).

## Conclusion

Cubic zincblende type ZnTe compound semiconductor was potentiostatically electrodeposited on ITO glass from aqueous solution. Co-deposition of zinc and tellurium proceeded at potential region more noble than the equilibrium potential of zinc. By rising the solution temperature up to 353K, the formation of Zn(OH)<sub>2</sub> and the electrodeposition of ZnTe were promoted. Band gap energy of ZnTe films with annealed at 573 K was close to the ideal value of 2.26 eV.

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## References

- 1: T. Ohgai, L. Gravier, X. Hoffer and J.-Ph. Ansermet, *J. Appl. Electrochem.*, **35**, 479 (2005)
- 2: H. Nakano, T. Ohgai, H. Fukushima, T. Akiyama, R. Kammel, *METALL*, **55**, 676 (2001)