

Electrodeposition Process of Zn-Te Compound Semiconductors

Y. Kawanaka¹, T. Ohgai^{2*}, K. Takao², M. Mizumoto², A. Kagawa²,
Y. Tanaka³ and S. Sumita³

¹Graduate School of Science & Technology, ²Department of Materials Science and Engineering,

^{1,2}Nagasaki University, 1-14 Bunkyo-machi, Nagasaki 852-8521, JAPAN

³TDK Corporation, 2-15-7 Higashi-Ohwada, Ichikawa-shi, Chiba, 272-8558, JAPAN

*Tel/Fax: +81-95-819-2638, E-mail: ohgai@nagasaki-u.ac.jp

Abstract

Zn-Te compound semiconductors were synthesized in aqueous solution using electrodeposition technique. During the co-deposition of Zn and Te, under potential deposition (UPD) of Zn was observed. By rising the solution temperature up to 353 K, UPD of Zn was promoted by formation of Zn(OH)₂. Band gap energy of Zn-Te films annealed at 573 K was close to 2.26 eV.

Keywords: Zn, Te, semiconductor, UPD, electrodeposition

Introduction

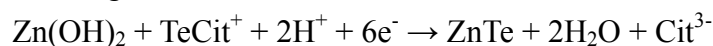
II-VI compound semiconductors (ZnO, ZnS, ZnSe, ZnTe, etc.) with wide band gap energy can be applied to the opto-electronic devices such as light emission devices and photovoltaic solar cells. Among of the II-VI compound semiconductors, ZnTe can be applied to green light emission devices (ca. 550 nm) and photovoltaic solar cells because the band gap energy of ZnTe is 2.26 eV. Te can be electrodeposited from acidic aqueous solution [1] and is not harmful elements such as As, Cd, Pb and Se. In this paper, electrodeposition process of Zn-Te compound semiconductors from acidic aqueous solution was studied.

Experimental

Aqueous electrolytic solutions were synthesized from zinc sulfate, tellurium oxide and citrate acid (or malic acid). The solution pH was adjusted to 5.0 by adding sulfuric acid and sodium hydroxide and the solution temperature was kept to 353K. A glass sheet coated with ITO, a gold wire and Ag/AgCl electrode were used as a cathode, an anode and a reference electrode. Optimum condition for Zn-Te deposition was determined by the cathodic polarization curves measured at a wide potential range. Phase, structure and chemical composition of electrodeposited Zn-Te was investigated by using XRD and EDX. Band gap energy of Zn-Te electrodeposited on ITO was estimated by using UV spectrophotometer.

Results and Discussions

Figure 1 shows cathodic polarization curves for Zn-Te electrodeposition. The polarization curves obtained from the solution containing H_3BO_3 (No.2) and the solution bubbled by blowing N_2 gas (No.3) are also shown in the figure. H_3BO_3 in the solution acts as pH buffer substance and N_2 gas in the solution prevents TeCit^+ ions from oxidation. At the potential of ca. -0.2 V, H^+ ions began to be reduced. With increasing the current up to 10^{-6} A, the potential polarized to around -0.5 V and Te began to deposit. With increase in the current over 10^{-5} A, the potential polarized from -0.5 V to -1.0 V. In the potential range, pH in the vicinity of cathode can increase up to around 6 due to the diffusion limit of H^+ ions and TeCit^+ ions, then $\text{Zn}(\text{OH})_2$ forms in the vicinity of cathode [2]. Electrodeposition of ZnTe will proceed by Zn UPD due to the formation of $\text{Zn}(\text{OH})_2$ as the following reaction.



Zn-Te films deposited in the potential range from -0.8 V to -0.9 V mainly contained ZnTe phase with stoichiometric composition. Furthermore, with increase in the current more than 10^{-4} A, the potential polarized to less-noble than -1.0 V. In the potential range, massive metallic Zn began to deposit from Zn^{2+} ions.

Band gap energy of as-deposited Zn-Te films was less than 1.5 eV. On the other hand, the band gap energy of Zn-Te films annealed at 573 K was close to 2.26 eV, which is ideal value of ZnTe.

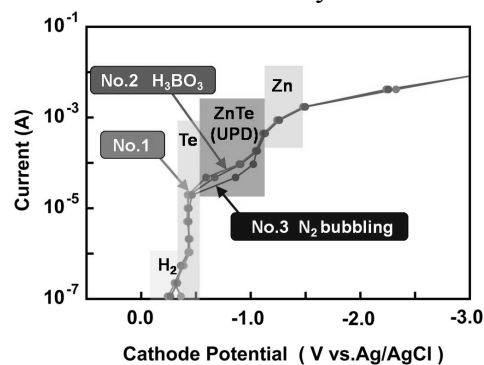


Fig.1. Cathodic polarization curves for Zn-Te electrodeposition. (No.1: standard solution, No.2: solution containing H_3BO_3 , No.3: solution bubbled by blowing N_2 gas.)

Conclusions

Optimum deposition potential to obtain ZnTe single phase was determined to the range from -0.8 V to -0.9 V. Zn UPD due to the formation of $\text{Zn}(\text{OH})_2$ promoted the electrodeposition of ZnTe with stoichiometric composition. By annealing the electrodeposited Zn-Te films, the band gap energy increased up to around 2.26 eV.

Acknowledgements: This work was supported in part by Japan Society for the Promotion of Science (Grant-in-aid for Scientific Research C : No.19560734), The President's Discretionary Fund of Nagasaki University, Yazaki Memorial Foundation for Science & Technology and TDK Corporation.

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 and R. Kammel, *METALL*, **55**, 676 (2001)