Preparation of the high quality CdTe films on p-Si (111) substrate by pulsed light assisted electrodeposition

Makoto Takahashi, Yoshifumi Sano, Naoyuki Ohnishi, Akira Nishiwaki*, Koichi Wakita* and Makoto Watanabe

Department of Applied Chemistry, Chubu University

*Department of Electronic Engineering, Chubu University

Matsumoto-cho 1200, Kasugai, Aichi 487-8501, Japan

Introduction

Cadmium telluride (CdTe) is one of the most important semiconductors and its thin film has been used for solar cells, near-infrared optical devices, and so on.

The heteroepitaxial growth of CdTe thin films on the single crystal substrate is very important both technologically and scien-tifically and has a wide range of applications. In the early 1990s, Stickney and his col-leagues reported that CdTe thin films of high crystallinity could be deposited on a gold single crystal using electrochemical atomic layer epitaxy (ECALE) [1]. Since their paper was published, many researchers have applied this method for the heteroepitaxial growth of semiconductors on the single crystal substrates. We demonstrate and report that highly oriented CdTe (111) films of high- cry- stalline quality can be grown on p-Si (111) substrates by pulsed-light-assisted electrodeposition.

Experimental

CdTe films were electrodeposited from alkaline solutions containing various concentrations of Cd^{2+}-EDTA complex and TeO_2, on p-Si (111) substrate. The usual three-electrode cell with an optical window was used and the electrode potential was controlled using a potentiostat. A 300 W Xe lamp with an IR absorbing filter was used as the light source and the pulsed- illumination was provided by an optical shutter. Photoluminescence (PL) spectra were measured under the excitation of He-Cd laser at the temperature range between 18K and 300K. Atomic force microscopy (AFM), X-ray photoelectron and spectroscopy (XPS) were carried out for the characterization of films.

The concept of film growth

The present pulsed-light-assisted electro-deposition method consists of the alternate depositions of two elements to form a com-pound semiconductor, one by electro-deposition ($TeO_3^{2-} + 4e^- + 6H^+ \rightarrow Te + 3H_2O$) (in the dark) and the other by photoelectro-chemicaldeposition (Cd2+-EDTA + 2e- → Cd + EDTA) (under illumination).

Results and Discussion

Figure 1 shows the photoluminescence spectra of CdTe films, (a) 100 monolayers thick CdTe film, (b) 450 monolayers thick CdTe, measured at 18K. In these PL spectra, six peaks were observed at near 775, 796, 802, 880, and 890 nm. PL peaks were smaller and broader at higher temperatures, and intensities of these peaks increased with increasing of film thickness. These results imply that these PL peaks are due to radiative recombination within the CdTe films and that the high quality CdTe films are prepared by our method.

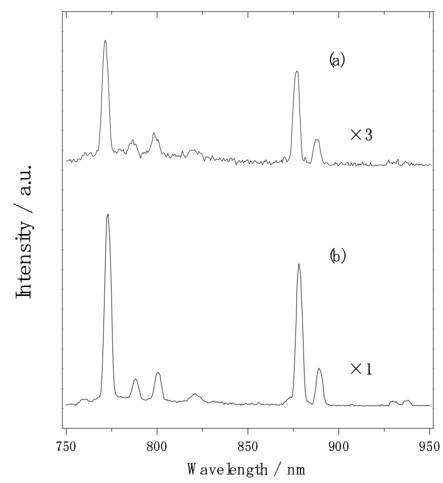

Fig 1 spectra of CdTe films at 18K
(a)100monolayers (b)450monolayers
Deposition condition:0.10M Cd-EDTA;0.1mM TeO_2,
at pH=12,E_{dep}=-1.10V vs. Ag/AgCl

Acknowledgment

This work was supported by grants from the High-Tech Research Center Establishment Project of Ministry of Education, Science, Sport and Culture.

References

[1] D.W.Suggs at.al.,J.Electrochem Soc.,138, 1279('91)