Fabraction and efficiency for n-CdS/p-CGS hetrojunction solar cell

Sangyoul Lee, Kwangjoon Hong

[a]Department of Physics, Chosun University, Gwangju 501-759, South Korea

Abstract : $CuGaSe_2$ (CGS) layers were grown by the hot wall epitaxy method. The optimum temperatures of the substrate and source for growth turned out to be 450 and 610 °C, respectively. Based on the absorption measurement, the band-gap variation of CGS was well interpreted by the Varshni's equation. By analyzing these emissions, a band diagram of the observed optical transitions was obtained. From the solar cell measurement, an 11.17 % efficiency on the n-CdS/p-CGS junction was achieved.

Key Words : $CuGaSe_2$ (CGS) layers, Characterization; Hot wall epitaxy; n-CdS/p-CGS junction , Solar cells

1. Introduction

The I-III-VI_2 compounds have been known to be ternary analogues of the II-VI compounds. Currently, solar cells based on CGS have achieved efficiencies of 9.5% and 9.7%, as absorbers of thin film and single crystal shapes, respectively [1,2].

In this paper, the CGS layers, which could be used for absorbance in solar cells, were grown on a GaAs substrate by the HWE method. From these results, we discuss the structural and optical properties of the CGS layers. Furthermore, CGS-based solar cells were investigated.

2. Results and discussion

2.1. Solar Cells

CGS-based solar cells were investigated. Fig. 1 shows the dark and illuminated current density-voltage (J-V) characteristics of solar cells. Also, the sub figure in Fig.1 shows a diagram of the n-CdS/p-CGS junction. As shown in the subfigure, it is fabricated to a p-n-junction type between the p-CGS layer as the absorber material and the n-CdS layer [3]. The solar-cell parameters obtained from the J-V characteristic are given in Table 4. From these results, the open-circuit voltage (V_{oc}) and short-circuit current-density (J_{sc}) were observed to be 0.51 V and 22.9 mA/cm^2, respectively. As Table 4 shows, this means that the achievement of 11.17 % efficiency is an improvement in comparison to the previous devices [4,5]. Also, it is superior to the best single crystal CGS device to date (9.7 % active area efficiency) [6].

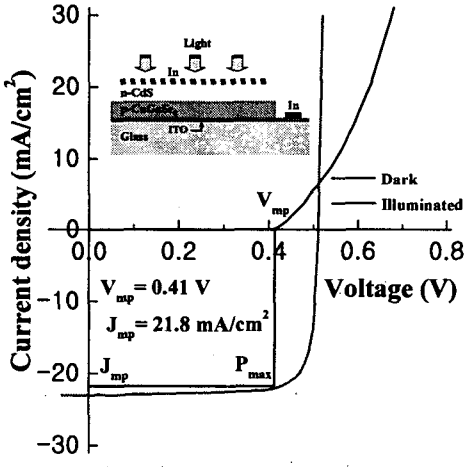

Fig. 1. Dark and illuminated current density-voltage characteristics of solar cells. (Here, the subfigure shows a diagram of the n-CdS/p-CGS junction. Also, J_{mp} and V_{mp} are the current density and Voltage values at the maximum power point P_{max}, respectively.).

3. Conclusions

The CGS layers, which are now charming as solar-cell materials, were grown by the HWE method. From the results of the PL and XRD measurements, the optimum growth temperatures of the substrate and the source turned out to be 450 and 610 °C, respectively. Also, the CGS layers were confirmed to be the epitaxially grown layer along the <110> direction onto the GaAs (100) substrate.

From the solar cell measurement, an 11.17 % efficiency on the n-CdS/p-CGS junction was achieved.

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