The Effect of Sulfurization Temperature on $CuIn(Se,S)_2$ Solar Cells Synthesized by Electrodeposition

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초 록: The properties of thin film solar cells based on electrodeposited $CuIn(Se,S)_2$ were investigated. The proposed solar cell fabrication method involves a single-step $CuInSe_2$ thin film electrodeposition followed by sulfurization in a tube furnace to form a $CuIn(Se,S)_2$ quaternary phase. A sulfurization temperature of 450–550° C significantly affected the performance of the $CuIn(Se,S)_2$ thin film solar cell in addition to its composition, grain size and bandgap. Sulfur(S) substituted for selenium(Se) at increasing rates with higher sulfurization temperature, which resulted in an increase in overall band gap of the $CuIn(Se,S)_2$ thin film. The highest conversion efficiency of 3.12% under airmass(AM) 1.5 illumination was obtained from the 500° C-sulfurized solar cell. The highest External Quantum Efficiency(EQE) was also observed at the sulfurization temperature of 500° C.

1. 서론

In most high-efficiency chalcopyrite-based solar cells, an absorber layer of the chalcopyrite is deposited by expensive vacuum-based processes, such as evaporation and sputtering.[1,2] However, these vacuum-based deposition techniques require expensive equipment and are difficult to scale up the deposition area for commercial production.[3] This results in weak competitiveness for chalcopyrite-based solar cell technology. In this study, a $CuInSe_2$ thin film absorber layer was deposited in a single-step electrodeposition. The sequential process, consisting of electrodeposition of $CuInSe_2$ followed by sulfurization, produced a quaternary phase of $CuIn(Se,S)_2$ for the absorber layer of the solar cell. The effect of the sulfurization temperature on PV performance in terms of open circuit potential (Voc), short circuit current (Isc) and fill factor (FF) was investigated. The composition of the thin film, grain size and optical band gap were also examined.

2. 본론

As the sulfurization temperature was increased from 450 to 550 ° C, the following results were observed: i) an increase in the grain size and crystallinity, ii) increased substitution of S for Se and iii) an increase in the bandgap.In this work, the highest performing $CuIn(Se,S)_2$-based solar cell was fabricated with a sulfurization temperature of 500° C.

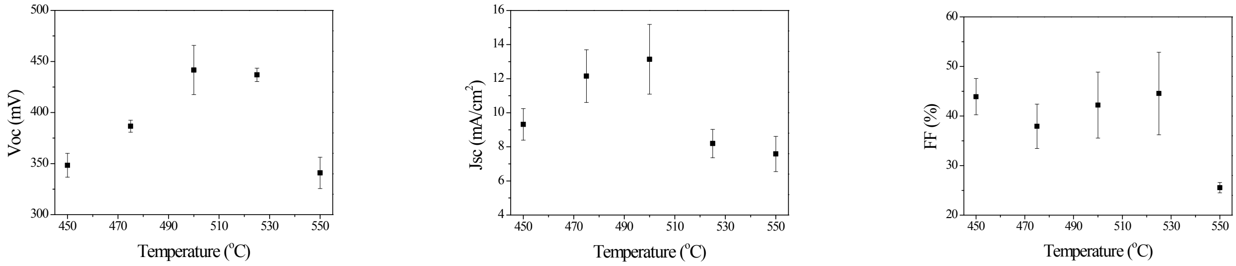

Figure. Characteristics of the solar cell with different sulfurization temperature from 450 to 500 ° C

3. 결론

This best performing $CuIn(Se,S)_2$-based solar cell had a conversion efficiency of 3.12%, a Voc of 480mV, a Jsc of 13.94mA/cm^2, and a fill factor of 46.66%. An external quantum efficiency exceeding 73 % was observed over a wide wavelength range. Although the achieved efficiency was relatively lower than those of our previous works in this research, the proposed method in this study can be an alternative for replacing vacuum-based absorber deposition to reduce the overall production cost of thin film solar cells.

참고문헌

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