Pulse electrochemical deposition and photo-electrochemical characterization of CuInSe2 thin films.

Abstract

Direct band gap and high absorption coefficient of copper indium diselenide (CIS) make it as one of the most studied ternary chalcogenides for energy conversion. Low cost methods, such as electrochemical deposition are very beneficial because of large scale production possibility, minimum waste of components and no requirement of pure starting materials. The pulse electrodeposition allows independent variation of duty cycle. In this study pulse electrodeposition of polycrystalline thin film of CuInSe2 (CIS) onto ITO glass substrates from aqueous solution containing CuSO4, In2(SO4)3 and SeO2 was carried out. The probable potential for deposition was determined as -0.9 V from cyclic voltammogram. The deposited film was annealed at 400°C under nitrogen gas flow to provide neutral atmosphere to improve the crystalline quality and remove excess selenium. The film was analyzed using X-ray diffraction which confirmed that CIS deposit has tetragonal structure. The chalcopyrite formation and consistency in terms of stoichiometry in the deposit were proved. The optical property of the thin film was determined base on the measurement by using UV-Vis spectrophotometer. The direct band gap for the thin film is around 1.21 eV. As a result, the deposited CIS thin film is a potential candidate to be used in solar cell devices as an energy convertor. Atomic force microscope was employed to monitor the effect of duty cycles on the morphology of the thin film. It is revealed that with increasing duty cycle the surface morphology shift from smooth to dendrite structure. Photo-electrochemical characterization was performed under chopped white light in acidic redox media. It was showed that CIS film is a photosensitive material and stands as p and n-p type semiconductors by adjusting different duty cycles. The photoactivity of the films was highly affected by their surface morphology.

Keyword: CuInse2; Material for energy conversion; Photoactivity; Pulse electrodeposition; Thin film semiconductor.