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Growth of $(Cu_2O)_{1-x}(CuO)_x$ thin films for PV applications

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Copper oxide is a semiconducting material for PV application because of its band gap variation from 2 eV to 1.2 eV. $(Cu_2O)_{1-x}(CuO)_x$ composite thin films can be grown by annealing the Cu_2O thin films in air. By controlling the annealing conditions, the value of x can be manipulated and hence Cu_2O material can be changed to the CuO material.

Potentiostatic electrodeposition of Cu_2O thin films on Ti substrates were carried out in the three electrode electrochemical cell containing 0.1 M sodium acetate and 0.01 M cupric acetate aqueous solution at –200 mV with respect to a Ag/AgCl reference electrode for 60 min. The set of $(Cu_2O)_{1-x}(CuO)_x$ thin films were prepared by annealing the Ti/Cu_2O thin films at different temperatures of 100 to 600^o C for the period of 15 to 30 min in air. Spectral responses of the $(Cu_2O)_{1-x}(CuO)_x$ thin films were measured in a three electrode PEC cell containing a 0.1 M sodium acetate solution using a phase sensitive detection method.

Cu_2O thin film produces an n-type photocurrent in the PEC which rapidly reduces with higher wavelengths and tailed towards 620 nm indicating a band gap energy of 2 eV. Enhancement of the long wavelength response can be noted when films are annealed at 200 ^{o}C for 15 min. However, it is noted that n-type material changed into p-type during the annealing at 200 ^{o}C for 30 min and at 300 ^{o}C for 15 min. Also, enhanced long wavelength response is observed compared to the as grown Cu_2O, when the films are annealed at 300 ^{o}C for 30 min. All the $(Cu_2O)_{1-x}(CuO)_x$ thin films, annealed at higher temperatures than 300 ^{o}C, exhibit a p-type photocurrent and the band edge shifts towards 800 nm (1.5 eV). Although formation of TiO_2 thin film cannot be ruled out at high temperature, even high resolution XRD did not indicate any evidence of TiO_2 formation. The best photoactivity can be obtained for the $(Cu_2O)_{1-x}(CuO)_x$ samples grown by annealing at 500 ^{o}C for 15 min. The value of x is 1 for the samples annealed at 500 ^{o}C for 30 min and above.

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