



506/E1

### Growth of $(\text{Cu}_2\text{O})_{1-x}(\text{CuO})_x$ thin films for PV applications

K D R N Kalubowila, R P Wijesundera\* and W Siripala  
*Department of Physics, University of Kelaniya, Kelaniya*

Copper oxide is a semiconducting material for PV application because of its band gap variation from 2 eV to 1.2 eV.  $(\text{Cu}_2\text{O})_{1-x}(\text{CuO})_x$  composite thin films can be grown by annealing the  $\text{Cu}_2\text{O}$  thin films in air. By controlling the annealing conditions, the value of  $x$  can be manipulated and hence  $\text{Cu}_2\text{O}$  material can be changed to the  $\text{CuO}$  material.

Potentiostatic electrodeposition of  $\text{Cu}_2\text{O}$  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  $(\text{Cu}_2\text{O})_{1-x}(\text{CuO})_x$  thin films were prepared by annealing the Ti/ $\text{Cu}_2\text{O}$  thin films at different temperatures of 100 to  $600^\circ\text{C}$  for the period of 15 to 30 min in air. Spectral responses of the  $(\text{Cu}_2\text{O})_{1-x}(\text{CuO})_x$  thin films were measured in a three electrode PEC cell containing a 0.1 M sodium acetate solution using a phase sensitive detection method.

$\text{Cu}_2\text{O}$  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  $200^\circ\text{C}$  for 15 min. However, it is noted that n-type material changed into p-type during the annealing at  $200^\circ\text{C}$  for 30 min and at  $300^\circ\text{C}$  for 15 min. Also, enhanced long wavelength response is observed compared to the as grown  $\text{Cu}_2\text{O}$ , when the films are annealed at  $300^\circ\text{C}$  for 30 min. All the  $(\text{Cu}_2\text{O})_{1-x}(\text{CuO})_x$  thin films, annealed at higher temperatures than  $300^\circ\text{C}$ , exhibit a p-type photocurrent and the band edge shifts towards 800 nm (1.5 eV). Although formation of  $\text{TiO}_2$  thin film cannot be ruled out at high temperature, even high resolution XRD did not indicate any evidence of  $\text{TiO}_2$  formation. The best photoactivity can be obtained for the  $(\text{Cu}_2\text{O})_{1-x}(\text{CuO})_x$  samples grown by annealing at  $500^\circ\text{C}$  for 15 min. The value of  $x$  is 1 for the samples annealed at  $500^\circ\text{C}$  for 30 min and above.

Acknowledgements: Financial assistance by National Research Council (NRC 11-13)