

Light-induced Chemical Deposition of *p*-type Cu₂O Films from an Aqueous Solution

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INTRODUCTION

A *p*-type semiconducting cuprous oxide (Cu₂O) has attracted increasing attention as components of solar cells and photo diodes, because of the band gap energy of 2.1 eV and high absorption coefficient. Cu₂O films have been prepared by gas phase deposition techniques such as rf-magnetron sputtering, molecular beam epitaxy and laser abrasion techniques. The direct preparation of oxide films from aqueous solutions has several advantages over the gas phase deposition techniques and is an environmentally friendly process at low temperature. The electrodeposition of the Cu₂O film was developed by Switzer and co-workers and was carried out from an aqueous solution containing a lactic acid and hydrated cupric sulfate.¹ The substrates are limited for conductive substrates in the electrodeposition.

This paper demonstrates for the first time the chemical deposition of the Cu₂O layer in the presence of UV-light irradiation and reports the structural and electrical characteristics.

EXPERIMENTAL

An aqueous solution used for preparing Cu₂O films contained of 0.4 mol dm⁻³ hydrated copper sulfate and 3 mol dm⁻³ lactic acid. The solution pH was adjusted with 1 mol dm⁻³ NaOH aqueous solution. A quartz glass sheet was used as the substrate. UV-light irradiation was carried out throughout the film deposition with a cell previously reported.²

RESULTS AND DISCUSSION

Any films could not be obtained at solution pH below 6 in the presence of UV irradiation and even at pH above 6 in the absence of UV irradiation. The Cu₂O film with a cubic cuprite structure could be prepared under conditions of pH 9.5-12.5 and UV irradiation. Figure 1 shows X-ray diffraction patterns for the films prepared at pH 9.5 (a) and 12.5 (b). XRD peaks were assigned to those for Cu₂O with a cubic cuprite structure, irrespective of the solution pH, whenever electrochemically prepared Cu₂O film, the preferred orientation strongly depended on the solution pH, <100>- and <111>-orientated Cu₂O films at 9.5 and 12.5 pH value.¹

Figure 3 shows the SEM photographs for the Cu₂O

films deposited at pH 9.5 and 12.5. The electrodeposited Cu₂O films were composed of aggregates of columnar grains grown in the direction normal to the substrate surface, whenever Cu₂O films shown in Figure 2 were composed of aggregates of grains and some pores located between the Cu₂O grains. The grain size increased from 180 to 650 nm with the raise in solution pH from 9.5 to 12.5.

M. I. expresses his thanks to The Foundation for Technology Promotion of Electronic Circuit Board for their financial support.

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2. M. Izaki, *Chem. Commun.*, 476 (2002).

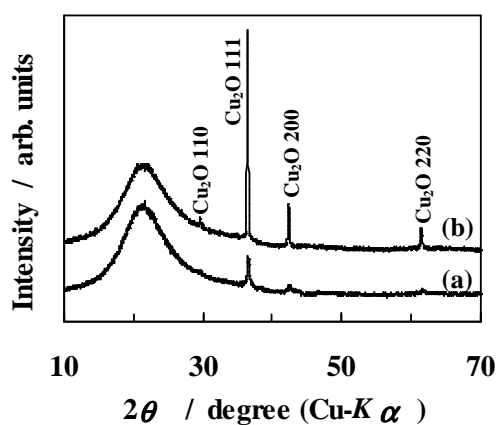


Figure 1. XRD patterns for the film light-induced deposited at (a) pH 9.5 and (b) 12.5.

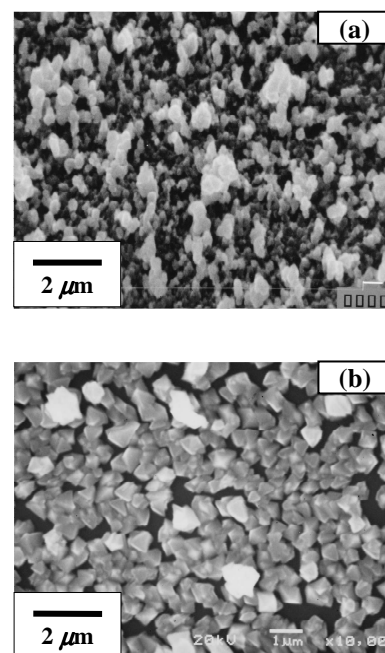


Figure 2. SEM photographs for the Cu₂O films deposited at (a) pH 9.5 and (b) 12.5.