

Copper oxide thin films with high transparency and p-type conductivity

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Abstract

Cu₂O and CuO are p-type semiconductors attracting renewed interest in multiple applications: catalysis, batteries, solar cells, etc. [1-3], because of their inexpensive and non-toxic composition, together with their adjustable gap energy (in the 1.4-2.6 eV range) and hole density controlled by copper vacancies [4]. The optical and electrical characteristics of copper oxide thin films are greatly dependent on the preparation procedure, which determines the crystallite size and the native defects.

In the present work, Cu₂O and CuO thin films have been obtained by heating evaporated copper in air at a suitable temperature. Cubic Cu₂O with mean crystallite size ~14 nm is obtained at 250 °C (figure 1), below the temperature expected from the equilibrium diagram [5]. The increment of the heating temperature up to 350 °C produces transition to CuO with monoclinic symmetry and ~16 nm crystallite size.

Both Cu₂O and CuO thin films show transparency above 85 % in the near infrared region (figure 2). In the visible range, the optical absorption is higher for CuO (with E_g= 1.4 eV) than for Cu₂O (E_g= 2.6 eV). The p-type conductivity is above 10⁻² S/cm for Cu₂O and below 10⁻³ S/cm for the CuO.

References

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Figures

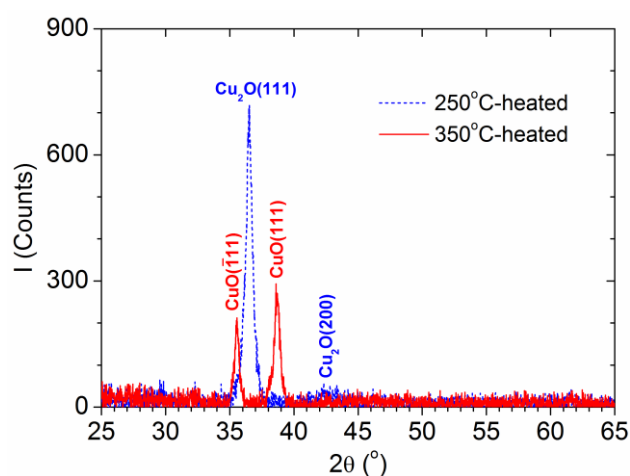


Figure 1: X-ray diffraction patterns obtained for the evaporated Cu thin films after heating in air at different temperatures.

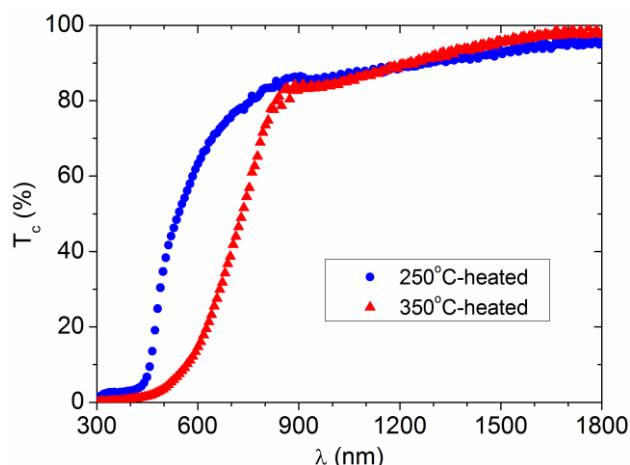


Figure 2: Optical transmittance spectra (corrected by the reflectance losses) that have been obtained for the evaporated Cu films after heating in air at different temperatures.