

OR0708

In situ spectrophotometry and X-ray diffraction investigations during the oxidation of copper oxide thin films

Jean-Francois Pierson¹, Guangjia Liu¹, Pascal Boulet¹, Sylvie Migot¹

¹Institut Jean Lamour / Dpt CP2S, Nancy, France

jean-francois.pierson@ijl.nancy-universite.fr

The binary copper-oxygen contains two stable phases: cuprite (Cu_2O) and tenorite (CuO) and a metastable phase: paramelaconite (Cu_4O_3). Reactive magnetron sputtering is the unique method to synthesize the metastable copper oxide phase. When submitted to vacuum or air annealing, paramelaconite decomposes into Cu_2O or oxidizes into CuO , respectively. CuO being the stable phase at high temperature, cuprite films also oxidize into CuO during air annealing. Since these three oxides exhibit different optical transmittance [1], the spectrophotometry may be used to characterize the structure of copper oxide films. Thanks to the smart Linkam® heating cell, this study emphasizes the potentialities of in-situ spectrophotometry combined with X-ray diffraction for the characterization of the structural evolution during air annealing of copper oxide films. 200-nm thick copper oxide films were deposited on glass substrates by pulsed-DC magnetron sputtering of a copper target in reactive Ar-O_2 mixtures. The composition of as-deposited films (Cu_2O , Cu_4O_3 and CuO) was controlled by the oxygen flow rate introduced in the deposition chamber. The tetragonal paramelaconite films exhibited a strong preferred orientation in the [101] direction as confirmed by pole figure. In situ XRD analyses showed that the oxidation into tenorite occurred at temperature higher than 300 °C. Pole figure on oxidised film also showed a preferential orientation resulting from a crystallographic relationship between the paramelaconite and the tenorite structures. Furthermore, a growth of the oxide grain after the annealing treatment was observed by TEM analyses. Finally, the oxidation of cuprite and paramelaconite thin films was monitored by spectrophotometry. For both oxides, a decrease of the film transmittance was observed as a function of the annealing temperature or the treatment duration, and the oxidation of cuprite/paramelaconite into tenorite was confirmed by the changes of spectra at temperature higher than 300 °C. The experimental results were fitted using the Avrami model.

[1] J.F. Pierson et al., Appl. Surf. Sci. 253 (2007) 7522

Keywords

Structure

in situ XRD

In situ spectrophotometry