# INFLUENCE OF ELECTROLYTE COMPOSITION ON PHYSICAL PROPERTIES OF COPPER (I) OXIDE THIN FILMS

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At the present time, the problem of making cheap and affordable alternative energy sources is more urgent than ever. Copper (I) oxide is characterized by band gap energy appropriate for solar energy conversion with theoretical limit of photocurrent density of 14.7 mA/cm$^2$ under AM1.5 illumination [1]. Also $Cu_2O$ is available, low toxic, and can be prepared with simple methods [2]. This material can be used for hydrogen production, as a photocatalyst for waste water treatment and in photovoltaics devices [3, 4].

One of the most convenient and available method for synthesis of $Cu_2O$ thin films is the electrochemical deposition from solution containing copper complexes (lactate, citrate, etc.) [5]. The lactate based solutions are not convenient for the electrodeposition of $Cu_2O$ films due to difficulties in purification of lactic acid [6]. On the other hand, the citrate solutions have strong tendency to hydrolysis and thus are also uncomfortable in use [7].

We suggest a simple method for electrochemical deposition of $Cu_2O$ thin films using aqueous copper tartrate solution. As a copper source, we used the different copper salts with $SO_4^{2-}$, $Cl^-$, $NO_3^-$. The goal of our work was to investigate the influence of these anions on the morphology, structural and optical properties of the $Cu_2O$ thin films electrodeposited using the method developed by us.

X-ray diffraction demonstrated that all electrodeposited films do not contain any phases except $Cu_2O$. Single phase composition of the films is in agreement with their Raman spectra, which contain only peaks inherent to $Cu_2O$. The films deposited from sulfate and nitrate solutions display the similar X-ray diffraction patterns with pronounced (111) texture, whereas the films prepared from $Cl^-$ containing solutions are not textured.

The scanning electron microscopy revealed the cubic shape of the crystals in the case of $SO_4^{2-}$ and $NO_3^-$. The films have a thickness about 1 μm and do not contain any visible defects. For the $Cu_2O$ thin films electrodeposited from chloride-containing solution, the primary shape of crystals is octahedral, and the substrate is not covered completely by the $Cu_2O$.

Photoluminescence spectra of all electrodeposited $Cu_2O$ films demonstrate week band at ≈0.63 μm related to phonon-assisted exciton radiative recombination, as well as pronounced band at longer wavelength, which corresponds to oxygen vacancy. While intensity of this band is comparable for all samples, there is its remarkable red shift (from 0.77 to 0.82 μm) in the case of $Cl^-$ anions.

Based on the obtained data, one can conclude strong influence of anions, especially $Cl^-$, on the formation of copper oxide (I) thin films. Thus, the copper tartrate complexes solution with different anions ($SO_4^{2-}$, $Cl^-$, $NO_3^-$) could be used for electrodeposition of $Cu_2O$ thin films with desired texture, surface morphology and photoluminescence properties.

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