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Electrodeposition of Cu_2O semiconducting oxide for spintronic applications

V. Stenger[(1)], I. S. Brandt[(1)], V. C. Zoldan[(1)], D. L. da Silva[(1)], Alexandre D. C. Viegas[(1)], Wagner Figueiredo[(1)], and A. A. Pasa[(1)*]

(1) Departamento de Física, UFSC, Florianópolis, Brazil, e-mail: pasa@fisica.ufsc.br
* Corresponding author.

Abstract – In this work, we have studied the electrodeposition of Cu_2O thin films on different substrates from electrolytes containing lactic acid and copper sulfate. The substrates used were n-Si (100), highly doped p-Si (111) and Ni/n-Si (100), and the deposits were characterized by atomic force microscopy (AFM), X-ray diffraction (XRD), Raman spectroscopy, and transmission electron microscopy (TEM). The results strongly support a columnar growth mechanism for the formation of the layers. Preliminary experiments with Co doping also confirms a ferromagnetic transition above room temperature.

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Copper oxide Cu_2O is a semiconducting oxide with potential application as emitter in spin transistors [1], and as a diluted magnetic semiconductor (DMS) [2] for injection of spin polarized currents.

In this work, we have studied the electrodeposition of Cu_2O on different substrates from electrolytes containing lactic acid and copper sulfate. The substrates used were n-Si (100), highly doped p-Si (111) and Ni/n-Si (100). The deposits were characterized by atomic force microscopy (AFM), X-ray diffraction (XRD), Raman spectroscopy, and transmission electron microscopy (TEM).

The AFM morphology of the Cu_2O electrodeposited layers was typical of granular films with defined texture, which was dependent on orientation of the substrate as confirmed by X-ray diffraction. The surface roughness and the grain size of the Cu_2O layers as a function of the thickness, obtained from AFM images, were consistent with columnar growth with columns that have the same height as the thickness of the deposits, as observed by TEM. Figure 1 shows the increase of the correlation length L_c, directly related to the grain size [3], as a function of the deposition time, and Figure 2 displays the columnar structure of the electrodeposited Cu_2O films that is in agreement with the AFM and XRD measurements.

Preliminary results obtained from samples doped with Co during the electrodeposition synthesis conformed a ferromagnetic transition above room temperature.

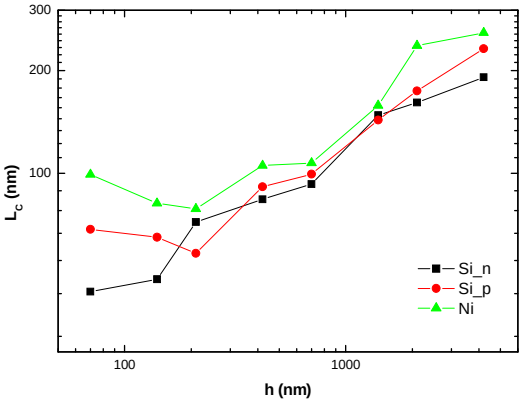

Figure 1: Dependence of the correlation length obtained from AFM images and related the grain size, as a function of the thickness of the Cu_2O layers.

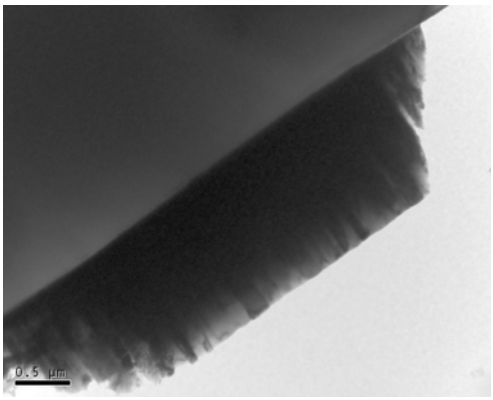

Figure 2: TEM image of the Cu_2O deposits with the expected columnar growth mode.

References

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