ICAM 2009

11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

Current tunneling properties of anodized alumina barriers

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Abstract – In this work, it was investigated the electrical transport properties of alumina barriers at the bottom of alumina pores filled with electrodeposited Co. In other words, the tunneling transport was investigated between the Co nanowires and the Al film that was let from the anodization process. The results shown non uniformity of barrier thickness and allow to estimate its average thickness by fitting the current voltage dependence using Simmons model.

The electrical properties of nanostructures are of great interest for the electronic industry. The direct electrodeposition in nonoporous alumina templates is an alternative route to fabricate nanostructures without use of expensive lithographic processes [1]. Aluminum 120nm thick films were prepared by e-beam evaporation on previously deposited 5nm tick Ta layers on glass substrates. Anodization was performed using 0.3M of acid oxalic under an applied potential of 40V at 20°C. Each sample was submitted to chemical etching using 0.2M of phosphoric acid, for different times, in order to enlarge the pore size and reduce the barrier width, prior the electrodeposition of Co. Current versus voltage curves (i vs v) were performed for several Co nanowires connected at the same time and for different position on the surface of the filled alumina membrane on top of the Al film. This procedures allowed to obtain representative results for the electrical properties and uniformity of the alumina barriers. A PtIr wire with a 2mm diameter was used as a tip for the electrical contact with the nanowires, giving an estimate of about 500 nanowires contacted at each measurement. From i vs v measurements (Figure 1), performed at same sample, were observed different conduction properties such as Ohmic, tunneling and insolating (for low voltage range used). When the i vs v curves presented an exponential dependence with voltage, indicating tunneling mechanism, they were fitted using Simmons theory [2]. From the fitting of several measurements were obtained the barrier potential height and width distributions (Figure 2). The highest probability to found tunneling currents was detected for sample etched during 20min. Larger etching times resulted in predominantly ohmic contacts with low average resistance. From the barrier height and width distributions it was inferred average values of 0.5eV and 2.7nm, respectively.

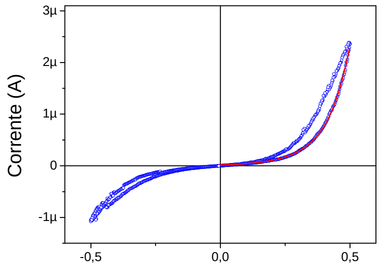

Figure 1: Tipical i vs v tunneling dependence. Red line fit result from Simmons model.

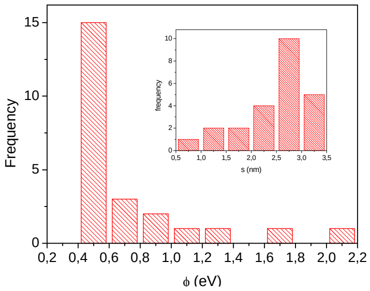

Figure 2: Distibution of tunnel barrier thick and height obtained from Simmons model fit.

References

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[2] J.G. Simmons, J. of Appl. Phys. , 34, (1963), page. 1793-1803.