SIMULATION AND PLASMA OPTICAL EMISSION ANALYSIS OF THE GROWTH OF COBALT OXIDE FILMS BY REACTIVE SPUTTERING

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1. Introduction

The magnetron sputtering technique is versatile, however the physical principles that involves the reactive sputtering are complex and not linear. Some models have been developed in order study the reactive processes, for example the models of Berg [1] and Depla et. al. [2], that consider the proportions of the reactive species in the target and substrate and the implantation of the reactive gas on the target during process the sputtering. The results obtained by these models can help in setting deposition parameters. The cobalt oxide has demonstrated interesting applications in photocatalysis, sensor gas for detect carbon monoxide and supercapacitors. The phase stable cobalt oxide are cubic spinel Co_3O_4 and cubic CoO. In this study film cobalt oxide were deposited by DC magnetron sputtering in different conditions the depositions with objective analyze the deposition regime and the influence in stoichiometry and structure of the samples.

2. Experimental

The films were deposited by DC Magnetron Reactive Sputtering using metallic cobalt target 99.95 %. The samples were deposited on silica substrate, using different power depositions and oxygen flow. The simulation for calculation of the kinetic energy that particles arrive substrate, were performed using software TRIM [3] and the deposition regime was simulated using software RSD2013 based in the Berg´s and Depla´s models [1-2]. The optical emission lines from the plasma was acquired by Avantes Fiber Optic Spectrometer System in the 260-1010 nm wavelength range. The structural analysis of the films were performed in a Rigaku Ultima 2000^+ X-ray diffractometer, using grazing incidence and CuKα radiation.

3. Results and Discussions

TRIM simulations indicated that the calculated kinetic energy of particles (Ar^+, Co and O^+) that arrive to the substrate after crossing the plasma, display a decrease due to gas phase collisions. Besides, the losses of the oxygen ions are smaller, so these ions arrive to substrate with more energy that Ar^+ and Co.

The results of the simulation based in the Berg´s and Depla's model indicated that in lower power (80 W) the deposition regime occurs in the poisoned target regime. On the other hand, in depositions at higher powers (240 W), the metal target regime is favored. Moreover, it was observed that the increase of the oxygen flow rate can also favor the poisoned target regime. The X-ray diffraction results indicated that depositions in low power favor the cubic spinel Co_3O_4 phase, while higher powers favor the cubic CoO phase. In conclusion, results indicate that the phase and structure changes observed in the films, as a function of the deposition conditions, are mainly related to the reactive oxygen availability in the substrate during the growth of the films.

4. References

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Acknowledgments

LNNano and LNLS (Proposal ID:20160103)

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