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TiO_2 coatings obtained by Cathodic Arc Deposition on silicon substrates

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Abstract – TiO_2 thin films have been prepared by cathodic arc deposition (CAD) on silicon substrates at different temperatures and bias voltages. The coatings obtained at 400 ºC grew mainly in anatase phase with small quantities of rutile while those synthesized at room temperature resulted amorphous and were crystallized in post-annealing. The structure of the samples was characterized by XRD and the morphology was studied by AFM.

Titanium dioxide has been widely investigated in the last years due to its outstanding physical and chemical properties that turned it into an interesting material for several technological applications such as oxidant gas sensors. In fact, many techniques have been employed for the production of this material.

In this work TiO_2 thin films prepared by cathodic arc deposition (CAD) on silicon wafers are characterized toward its implementation in gas sensors. CAD devices consist in a high current arc running between a metallic (Ti) cathode and a grounded vacuum chamber serving as anode. Metallic ions are ejected from the cathode surface and deposited on a substrate. A reactive gas (O_2) can be injected into the chamber promoting a chemical combination of both species. The coatings were grown in an oxygen environment (~2 Pa) employing a 100 A continuous arc. They were synthesized at 400 ºC and at room temperature using different bias voltages between 0 (grounded) and -50 V during deposition process. The crystalline structure of the films was studied by x-ray diffraction (XRD) in the glancing angle geometry and the morphology was observed by atomic force microscopy (AFM).

The coatings obtained on grounded substrates at 400 ºC grew mainly in anatase phase with the presence of small quantities of rutile phase, while films synthesized at room temperature resulted amorphous and were crystallized in post-annealing at 400 ºC. The XRD spectra corresponding to both cases are presented in Figure 1. In Figure 2 AFM images of the same samples are shown. From the analysis of those images was obtained that films grown at 400 ºC have an average grain size (40-60 nm) smaller than that observed for post-annealed coatings (60-100 nm). The surface roughnesses were 4 and 20 nm respectively.

As the gas sensing is a surface process, a high surface to volume ratio of the grains improves the efficiency of the film. Thus, films grown crystalline should have a better performance for gas sensor applications

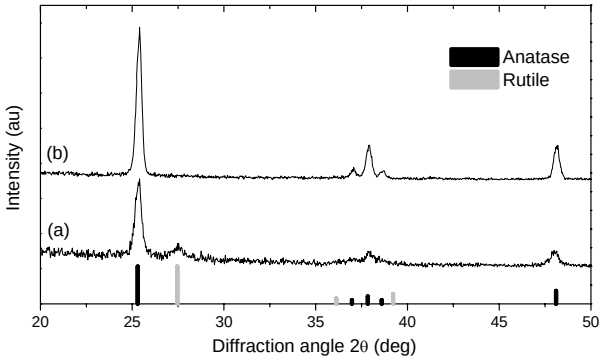

Figure 1: XRD spectra, **a)** as-deposited TiO_2 sample obtained at 400 ºC and **b)** post-annealed film grown at room temperature.

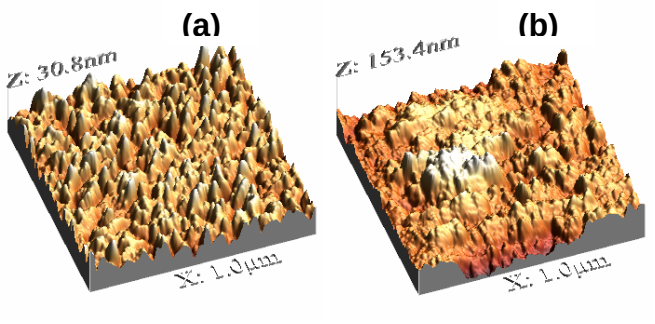

Figure 2: AFM images, **a)** as-deposited TiO_2 sample obtained at 400 ºC and **b)** post-annealed film grown at room temperature.