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Flow and temperature effect on thin films of yttria-stabilized zirconia by sputtering.

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The oxides ZrO_2-Y_2O_3 and ZrO_2 films have been applied in science and technology of thermal barrier coatings, electrodes in smart windows, oxygen-permeable electrolytes for gas sensors and fuel cells[1-2], however; nowadays there is more interest because their high mechanical properties and high-energy band gap changes on submicron scales.

The propose of the present study was to carry out more detailed investigation of effect of flow and temperature of ZrO_2-Y_2O_3 thin films on morphology and optical properties for possible used of the thin films as counter electrode in smart windows[3]. ZrO_2-Y_2O_3 thin films were deposited by using a rf magnetron sputtering V3 system Intercovamex, the target used was a disk of ZrO_2-Y_2O_3 25.4mm. Power of rf magnetron sputtering was increased from 80 to 130 W at different temperatures. A set of ZrO_2-Y_2O_3 thin films have been prepared in-situ at 25, 300, 400 and 500°C, and deposited on glass and silicon (100) substrates of 200 mm2 attached to a substrate holder with rotation velocity at 0.5 rpm. Thin films deposited onto glass were characterized by using a UV-Vis spectrometer Perkin Elmer Lambda2 in wavelength range from 300 to 1100 nm in order to study of the optical absorption spectra and calculate the energy-gap.

The influence of temperature on the phase of YSZ thin films on substrates of glass is shown in the figure 1 shown that when the temperature increases, the intensity of the reflexion 111 of the cubic phase increase too. The films deposited on glass are transparent and have very good adhesion. When the power increases, decrease the %T because the thickness of the film rise. If the temperature increases the material absorbs in the region between 400 to 600nm. The values of gap calculated are 4.05 to 4.15eV, when the power changes and 3.94 to 4.04 ev for change of temperatures. According of literature an increase of the room-temperature band gap from 4.23 to 4.96 eV is observed in crystals of the superionic material yttria-stabilized cubic zirconia (YSZ).[4]

The figure 2 revealed the morphology on glass, in the case of silicon the roughness increases with the power, in the glass the formation of agglomerates to major power, due to a greater interaction between atom and atom that with the substrate. The films are more homogeneous and thinner in silicon than glass. In the figure 3 is observed the morphology on glass with the variation of temperature in the glass the formation of thin film is more homogeneous and the thickness is greater that silicon the roughness increases with the temperature. It was found that the films deposited on silicon and glass would develop a highly cubic phase with preferential orientation (111) using different powers and substrate temperatures. For optical properties as increments the power, decrease the value for band gap. From optical transmission data, an energy gap between 4.05 to 4.15 eV was calculated. For 500 C band gap energy increases to 4.04 eV.

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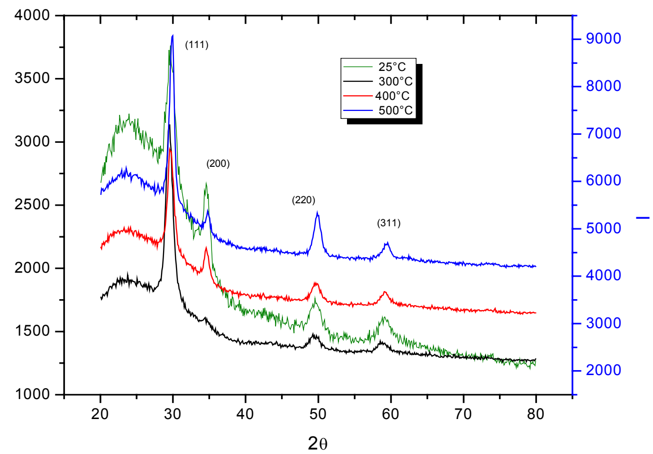

Fig. 1 XRD patterns of the 8 YSZ films prepared by sputtering onto glass at different temperatures.

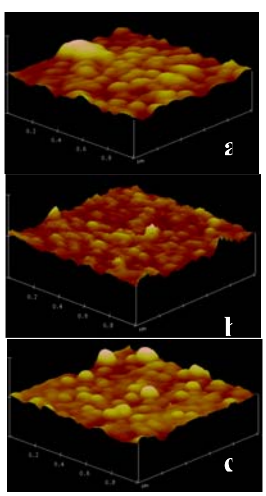

Fig. 2 AFM images that show the influence of the power in the roughness and morphology in the thin films on glass.
a) 80, b) 100 and c) 120 Watts.

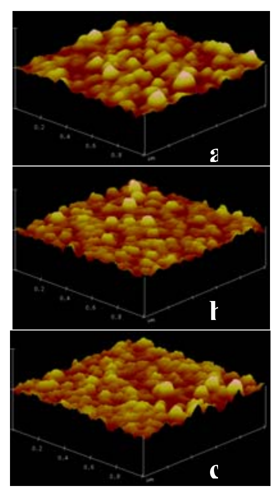

Fig. 3. AFM images that show the influence of the temperature in the roughness and morphology in the thin films on glass a) 25, b) 300 and c) 400 deg C.