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Barium titanate thin films prepared by dip-coating process

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Abstract – Thin films of pure barium titanate have been prepared by the sol-gel process from sols containing titanium alkoxides and barium acetate (molar ratio [Ba]/[Ti]=1). The films were analyzed by UV-visible spectroscopy, X-ray diffraction and atomic force microscopy (AFM). Parameters such as chemical concentration, viscosity, withdrawal speed and drying temperature influence the film thickness. This process led to the formation of homogeneous and adherent coatings with controlled thickness.

Modern electronics requires thin films with specific electrical properties. The preparation of nanostructured ferroelectric materials, such as barium titanate by dip-coating process offer convenient method of producing these kinds of films.

In this work, thin films were prepared by sol-gel method using the dip-coating process. The solution (sol) was prepared by diluting a stoichiometric amount of tetraisopropilorthotitanate in alcoholic solution, and barium acetate in aqueous solution (molar ratio [Ba]/[Ti]=1), under agitation at room temperature (25 ^{o}C). In order to avoid precipitation and keep the viscosity within the desired range for a certain time, acetylacetone and acetic acid were added to the solution. The system was left to stand for a period of time until it reached the necessary viscosity to obtain good coatings (>2 cp). The viscosity, density and pH were controlled during the deposition of the films. Pyrex substrates were dipped into the solution using different withdrawal speeds and viscosity. The samples were dried at room temperature (25 ^{o}C) for five minutes and heated between 100 and 900 ^{o}C for ten minutes. To increase the thickness of the film a multiple procedure was used, including the sintering step [1, 2]. The transmittance, refraction indices and thickness were estimated by UV-Visible spectroscopy. The crystalline barium titanate structures were confirmed by X-ray diffractometry and the average grain size and roughness by atomic force microscopy.

It was possible to produce transparent and adherent films, without cracks, deposited on Pyrex substrate with thicknesses between 30 to 500 nm. The coating surface is formed by nanocrystalline particles with average grain size between 6 and 20 nm.

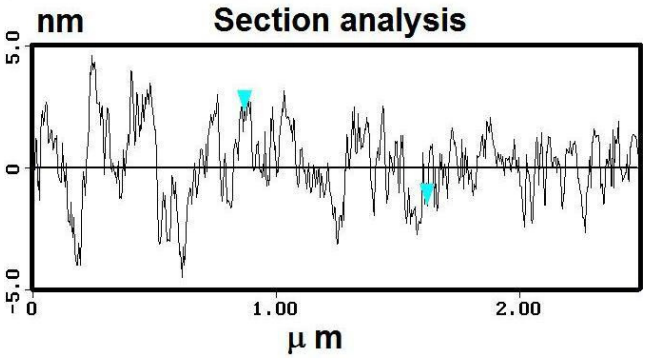

Figure 1: $BaTiO_3$ thin film section analysis – particle diameter. Thermal treatment: 750 ^{o}C

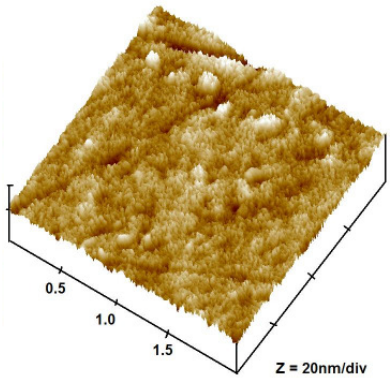

Figure 2: AFM image of $BaTiO_3$ thin film treated at 750 ^{o}C

[1] N. D. S. Mohallem, Thesis, University of São Paulo (1990).
[2] N. D. S. Mohallem, L. M. Seara, M. Novak, E. Sinnecker, Braziliam J. Phys. 36 (2006) 1078.