Biochemical sensors: comparison of the performance of TiO_2, SnO_2:F and ITO used as the main sensing element

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Nanostructured oxide materials have been widely studied for use in sensors. Titanium dioxide (TiO_2) is a material with a large range of applications, such as biosensors, gas sensors and photovoltaic cells, due to its biocompatibility, photo-stability and high refractive index[1]. Other oxide materials have also been investigated. This work presents the study of several oxides thin films, such as titanium dioxide, fluorine-doped tin oxide (FTO) and indium tin oxide (ITO), used as the sensitive extended gate for a field effect transistors (EGFET), with a final purpose to construct a biosensor. The EGFET device is compose by a sensitive electrode as an extended gate that is immersed on a solution, connected on a commercial MOSFET[2]. This apparatus can be used as several different biosensors, depending on the functionalization of the oxide surface with the enzyme of interest. For instance pH and urea were studied to be detected and quantified, and comparison with the three oxide thin films was made with the intention to construct a biosensor with a high sensitivity, high selectivity and fast response. Different techniques for oxide thin films preparation were used, such as sputtering, anodic oxidation and sol-gel dip-coating. TiO_2 samples prepared by sputtering and anodic oxidation presented pH sensitivities about 34.4mV/pH and 43.6 mV/pH, respectively, as shown in figure 1, for measurements performed in buffer solutions with a pH range from 2 to 12.

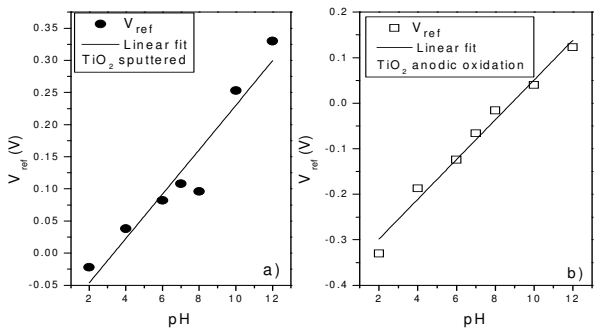

Figure 1: TiO_2 thin films sensitivities: a) sputtered and b) anodic oxidation.

UV illumination for 6 hours improved the surface properties and new sensitivities of about 47.6 mV/pH and 43.8 mV/pH respectively, were obtained and it will be discussed. ITO samples were made by sputtering and presented an original sensitivity of 53.5 mV/pH. For FTO films, two different techniques were used such as spray-pyrolysis and CVD. The sensitivities were about 37 mV/pH and 54.1 mV/pH, respectively. The comparison of the results and their discussion based on the respective preparation techniques will be presented. The functionalization of the TiO_2 films with urease and glucose oxidase enzymes will be discussed, and compared with the same functionalization of FTO and ITO films. Work supported by Capes, CNPq and FAPESP.

[1] Chettah, H., et al. *Ionics*. vol. 15, pp. 169-176 (2009).

[2] Batista, P. D. and Mulato, *M. J Mater Sci*. vol. 45, pp. 5478-5481 (2010).