Charge sensing properties of nanostructured fluorine-doped tin oxide surfaces

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Medical applications that need the use of biosensors are being widely studied. For these devices one of the main focuses resides on the influence of the structure and the surface properties of oxide thin film materials to be used as a sensitive layer of biosensors. Final fast response, high selectivity and high sensitivity are desired. Semiconductor materials with nanosized structures are good choice for electronic devices, due to properties such as charge diffusion. This work studies the properties of fluorine-doped tin oxide (FTO) surfaces, with the aim to be used as the sensitive layer of an extended gate field effect transistor (EGFET) for a future purpose to construct a pH biosensor to be use in medical applications[1]. The used buffer solutions pHs varied in a range from 2 to 12, and the experimental conditions studied were: i) varied surface areas, ii) response under controlled illumination and comparison with response in the dark; iii) varied buffer temperature; and iv) time response from sub-second to over 10 minutes. The FTO effective area was 230 mm^2 for most of the studies, except for a specific study where the FTO effective area presents a range from 42 up to 230 mm^2. For this case two variations were performed: i) the same FTO sample was used and the total immersed surface was varied. Increase in sensitivity of about 46% was observed; ii) different FTO samples with varied areas were used, and in this case an increase of about 270% was observed in sensitivity, as shown in figure 1. The change in results for varied effective areas and measurements will be discussed. The sensitivity in dark was about 37 mV/pH. For measurements under 6.7 W/m^2 UV-VIS irradiance the sensitivity decreases about 10% in comparison with results in the dark. This light effect will be discussed. Variation of the buffer solution temperature from 25ºC up to 60ºC led to a 60% increase in sensitivity. For the time response study, stabilization of the current depends of the pH value of buffer solution used regardless of pH value. Charge variation processes as a function of time, both in the dark and under UV-illumination will be discussed.

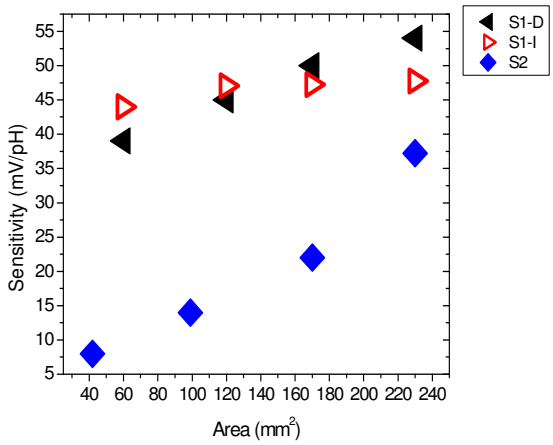

Figure 1: Sensitivities for different FTO effective areas. S1-D (S1-I) represents the same FTO sample immersed several times in a buffer solution decreasing (increasing) the area immersed and S2 is the sensitivity of different FTO samples with varied areas.

The purpose of these studies is to show how the measures process changing the final response of the sensor, and how much care must be taken when the sample will be reuse in sequential experiments. All the discussion will also take into account the miniaturized sensor to use in future in real patients. Work supported by Capes, CNPq and FAPESP.

[1] Batista, P.D., Mulato, M. *J Mater Sci*, vol. 45, pp. 5478-5481 (2010).
[2] Batista, P.D., et al, *Br J Phys*, vol. 2A, pp. 478-481 (2006).