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EGFET nanostructured manganase oxide and carbon nanotubes as pH sensors

G. R. Silva(1)*, L. A. Montoro(3), J. M. Rosolen(2), M. Mulato(1)*

(1) DFM/FFCLRP, Universidade de São Paulo, Ribeirão Preto, São Paulo, Brasil, e-mail: glaucio_r@yahoo.com.br, mmulato@ffclrp.usp.br
(2) DQ/FFCLRP, Universidade de São Paulo, Ribeirão Preto, São Paulo, Brasil
(3) LNLS, Laboratório Nacional de Luz Sincrotron, Campinas, São Paulo, Brasil
* Autores para correspondência.

Abstract: The work portrays the study of manganese oxide and carbon nanotubes as selective membranes for H+ ions, as extended gate of a field effect transistor. These membranes were made by spray-pyrolysis. Their structural and morphological characteristics were analyzed by XRD, FTIR and SEM. It was found that the structure of MnOOH presents multiple walls nanowires and nanotubes. As pH sensors, in the EGFET configuration, sensitivities of 50.1 and 75 mV / pH for the manganese oxide and 51, 6 and 53, 1 mV / pH for carbon nanotubes were obtained using a pH range from 2 up to 12.

This work presents the results related to the study of materials such as manganese oxide and carbon nanotubes as part of the development of devices such as selective membrane to pH sensor. These membranes are used as extended gate of field-effect transistor, EGFETs, an almost similar working principle of ion sensitive field-effect transistor, ISFET.

The manganese oxide was produced by the hydrothermal method, leading to nanowires, while carbon nanotubes have been produced by the CVD method, leading to multi-walls type. The manganese oxide and carbon nanotubes were then used to deposit thin films by using the technique of spray-pyrolysis, changing the deposition temperature, concentration of solution and surface roughness of glass substrates, with the aim of studying the electrical response of the EGFET[1] as a function of the concentration of H^+ ions.

The best sensitivities for manganese oxide were 50.1 mV/pH and 75 mV/pH for the films grown on rough and flat glass substrates, respectively, with a concentration of 2g/l and substrate temperature of 80°C. On the other hand, for the thin films made with carbon nanotubes, the best sensitivities were obtained for films produced on rough substrate at 80°C and on flat substrate at 100°C. The corresponding sensitivities were 51.6 mV/pH and 53.1 mV/pH, respectively. Both thin films were produced with a concentration of 3g/l. These materials have improved sensitivities over other materials already reported used for the same purpose and the same principle of detection (EGFET). Another important fact is that other reported materials were produced by expensive and sophisticated techniques such as sputtering, which is not our case, since both were made by spray-pyrolysis.

These materials are promising and alternative candidates with potential for use as pH sensors and also as biosensors, however more studies need.

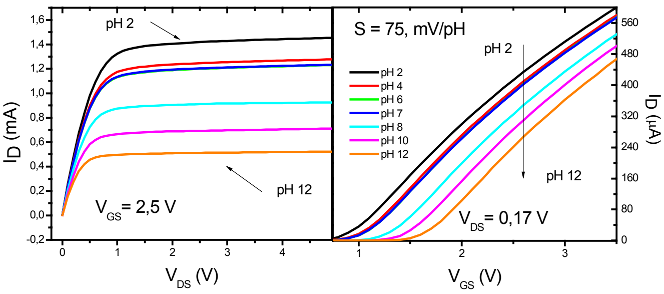

Figure 1: Manganase oxide EGFET response. Saturated regim (left) and linear regime (right). Film made at 80°C in flat substrat with a solution of 2g/l.

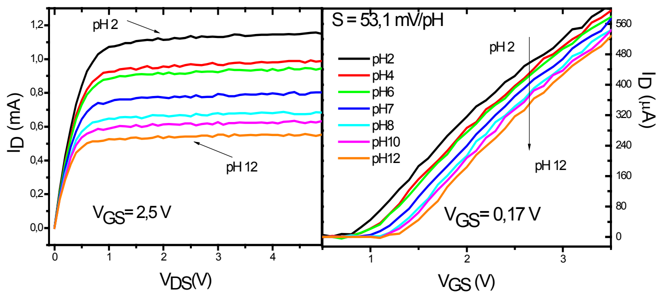

Figure 2: Carbon nanotubes response. Saturated regime (left) and linea regime (right). Film made at 100°C in flat substrate with a solution c 3g/l.

[1] Chou, Jung-Chuan, Chiang, Jung-Lung, and Wu, Chin-Lung, J. J. Appl. Phys. vol. 44, n° 7A (2005) pp. 4838-4842.