11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

Stability study of conducting polymers as gas sensors

J. P. H. Lima [(1)*], and A. M. de Andrade[(1, 2)]

(1) EPUSP-PSI, USP, Av. Prof. Luciano Gualberto, trav. 3 n. 158, 05508-900, Sao Paulo, Brazil
(2) IEE, USP, Av. Prof. Luciano Gualberto, n.1289, 05508-900, Sao Paulo, Brazil.
* Corresponding author.

Abstract – Conducting polymer gas sensors were characterized to learn about its long term stability. This work shows the sensitivity loss of the sensors and addresses the main issues related to the degradation due to undoping processes and permanent adsorption of analytes.

Long-time instability and irreversibility are the main drawbacks of conducting polymer as gas sensors[1]. A sensor can present a high sensitivity in its first post-produced day but it can also exhibit important signal response reduction on the next few days. Despite these undesirable characteristics, electronic noses (E-nose) made with those materials are been studied to detect aromas and odors in different areas as food, cosmetics and pathogenic diseases. Their main known advantages are operation at room temperature, high sensitivity and easy processing [1]. Chemiresistors are sensors that use the electrical characteristics (resistance and capacitance) of specific materials to detect and quantify different analytes.

In order to measure the electrical characteristics of these films, glass slides covered with 32 pairs of ITO interdigitated electrodes were used. The sensors were produced by spin coating and layer-by-layer techniques using different conducting polymers, as described elsewhere [2, 3, 4].

All sensors were submitted to different analytes during five consecutive days. Table 1 show the normalized sensitivity loss of each sensor for different analytes. P3HT showed the lowest variation while POMA/Ni-phtalocyanine exhibited a very high sensitivity loss for only one of the analytes. The sensitivity loss is different for each sensor and for each analyte, which can be due to the permanent adsorption of analytes in different concentrations. Another important factor that contributes to the sensitivity loss is the polymer undoping effect.

POMA thin films were deposited, annealed at 60ºC for 30 min and immersed in a HCl solution (pH 0.8) for 60 seconds. After drying with nitrogen, the sensors were kept in vials. The electrical resistance was measured daily using a Keithley Sourcemeter 2120C. It can be seen an important decrease in the electrical resistance values in the first five days followed by a discrete increase afterwards (Fig 1). This phenomenon can be related with the water content in the films in such a way that, in a first moment it contributes to an increase in the protonation process concurring with a chlorine loss that reduces the film doping level.

As a general conclusion it is shown that polymer gas sensors are susceptible to instability due to film undoping and analyte permanent adsorption phenomena. Continued studies are under way to enlighten the reasons for the changes in the polymer behaviour.

Table 1: Normalized per day sensitivity loss (%/day).

Sensor#		Ethanol	Fragrances		
			1	2	3
1	P3HT 1000 rpm_1	6	3	8	11
2	PEDOT 1000 rpm_3	20	20	16	17
3	PEDOT 3000 rpm_2	19	20	20	19
4	POMA 3000 rpm_2	20	17	12	15
5	POMA 1000 rpm_2	19	17	14	15
6	POMA/PPY 20B_3	18	13	10	15
7	POMA/FTNi 20B_3	11	55	14	3
8	PEDOT 2000 rpm_1	19	17	5	14
9	PANI/PEDOT 10B_2	7	14	8	16

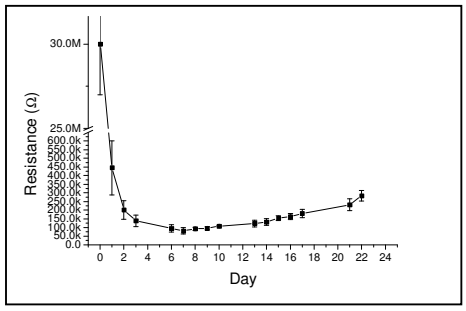

Figure 1: Electrical resistance of POMA (3000 rpm) in function of days after the chemical

References

[1] Bai, H and Shi, G, "Gas Sensors Based on Conducting Polymers", Sensors, Vol. 7, (2007), pp. 267-307.
[2] Braga, G. S. et al, "Study on the Stability of Self-Assembled Films Used as Chemical Sensors in an Electronic Tongue System", Proc 6th Brazilian MRS Meet, Natal, Brazil, Oct. 2007, F528.
[3] Lima, J. P. H. and Andrade, A. M., "PEDOT:PSS Thin Films as Gas Sensors", Proc 7th Brazilian MRS Meet, Guarujá, Brazil, Oct. 2008, H550.
[4] Lima, J. P. H. et al, "Simulation and Analysis of Conductive Polymers Characteristics Obtained by Spin Coating Technique Using Artificial Neural Networks", Proc 12th BWSP, S Jose dos Campos, Brazil, Apr. 2005, th117.