Multi-nanostructured auto-regenerative sensor for H_2O_2 quantification with enhanced sensitivity at zero potential

R.M. Trujillo[1Ψ]*, M.L. Zamora*[1Ψ]*, F. Ashur*[1]*, C. Dore*[2]*, C.J. Felice*[1]*, A. Cattani-Scholz*[2]*, R.E. Madrid*[*1]

[1]*Laboratorio de Medios e Interfases (LAMEIN), DBI, FACET, Universidad Nacional de Tucumán and INSIBIO, CONICET, Av. Independencia 1800, 4000 Tucumán, Argentina.*
[2] *Walter Schottky Institut and Physics Department, Technische Universität München, Am Coulombwall 4, 85748 Garching, Germany*
*Corresponding author: *rmadrid@herrera.unt.edu.ar*
[Ψ] *These authors contributed equally*

Hydrogen peroxide (H_2O_2) is a common analyte in sensors area, and of great importance for modern medicine, environmental control, and several branches of industry. Although various techniques have been found to detect H_2O_2, electrochemical techniques are the preferred methods due to their particular features such as high sensitivity, selectivity, and simplicity. Prussian blue (PB) ($Fe_4^{III}[Fe^{II}(CN)_6]_3$) has the peculiar characteristics of its great electrocatalytic activity and selectivity towards the reduction of (H_2O_2) at low potentials.
In this work we present two nanostructured systems. The first one is a gold disc with drop casted PB nanoparticles (Au + PBNPs), and the second one, a double nanostructured system consisting of a gold disc with electrodeposited nanostructured Iridium Oxide and drop casted PBNPs (Au + EIROF + PBNPs). Both systems are capable to detect very low concentrations of H_2O_2. All measurements were carried on in a tripolar cell. Amperometric measurements were made at 0V DC, by successive addition of low concentrations of H_2O_2. The Au+PBNPs system responds to concentrations as low as 1 µM, while the Au+EIROF+PBNPs systems responds with concentrations as low as 0.1 µM, one order below. The system measures at 0V polarization. This feature makes this system almost free of interference and electrochemical degradation. The combination of these two nanostructures (EIROF and PBNPs) improves the sensitivity of the system. On the other hand, it is well known that oxygen can lower the system sensitivity to H_2O_2 (1). This system can respond even in aerobic solutions, so, it can be applied for the evaluation of H_2O_2 in culture systems without the need to degas with N_2.
The method employed to synthetize the PBNPs was used for applications in magnetic resonance imaging (MRI) (2), but not used in the development of sensor systems. This procedure allows to obtain NPs, which are very stable and attach strongly to the surfaces by drop casting method, avoiding electrodeposition or other chemical agents such as Nafion® or cross-linking agents to prevent desorption. Another advantage is that both systems have the capacity to regenerate themselves in air, since oxygen re-converts them to its electro-active form.
This results show a promising multi-nanostructured matrix for the development of H_2O_2 sensors. Compared to previously reported H_2O_2 sensor systems, the Au+EIROF+PBNPs one presented here, is an interesting proposal due to its great sensitivity at null polarization and its auto-regenerative capacity.

References

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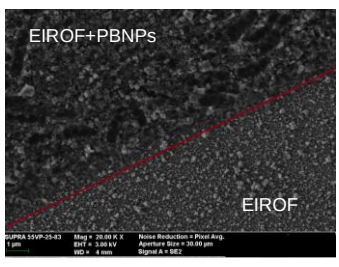
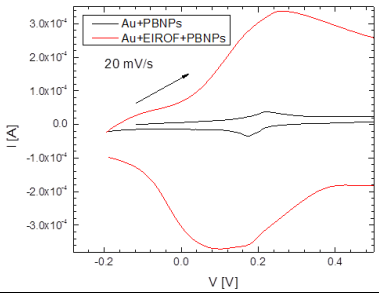
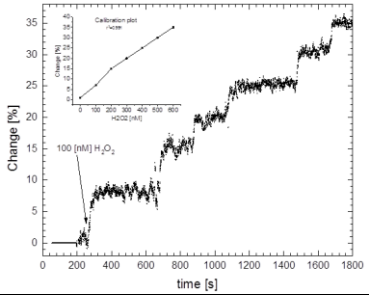
2. Shokouhimehr M, Soehnlen ES, Hao J, Griswold M, Flask C, Fan X, et al. J Mater Chem. **20(25)** (2010) 5251.



SEM picture of Au+EIROF+PBNPs



CVs of drop casted PBNPs



% of Change of Au+EIROF+PBNPs