DOI: http://doi.org/10.21698/simi.2022.ab31

SCAN-RATE INFLUENCE ON SENSING PROPERTIES OF AN ETHANOL ELECTROCHEMICAL SENSOR BASED ON PANI-TIO2 NANOCOMPOSITES ACTIVATED WITH GOLD NANOPARTICLE

Alexandru Trandabat[1,2], Alexandru Arcire[1], Roxana Luisa Mandoc[3], Ramona Simionescu[2], Mona Adriana Mosneagu (Andrei)[2]

[1]S.C. Intelectro Iasi SRL, 3 Iancu Bacalu Street, 700029, ftrada@yahoo.com, Romania
[2]Gheorghe Asachi Technical University of Iasi, 67 Bld.Profesor Dimitrie Mangeron, 700050, Iași, Romania
[3]National Research And Development Institute For Cryogenic And Isotopic Technologies, Ramnicu Valcea, mandoc_lui@yahoo.com, Romania

Keywords: *ethanol sensor; gold nanoparticle activation; PANi-TiO_2 nanocomposites; scan-rate influence, screen-printed carbon electrode*

Introduction

The quality control of alcoholic beverages during the fermentation process is influenced by the measurement of ethanol level which necessitates having rigorous analytical methods for ethanol in beverages. For this purpose, an electrochemical sensor based on a screen-printed carbon electrode (SPCE) was developed modified with TiO_2/PANi nanocomposites, and activated with gold nanoparticles (AuNP). TiO_2 nanotube array is a promising functional material for applications in gas sensors and biosensors due to its flexibility in adjusting the microstructure in terms of tube length, tube diameter and chemical composition, highly uniform morphology, and large surface area with controllable pore sizes.

Materials and methods

A screen-printed carbon microelectrode (SPCE) with a hybrid configuration of carbon/ceramic nanotube/conductive polymer/metallic nanoparticle (CNF/TiO_2/PANi/AuNP) is developed on a standard 3-electrode electrochemical sensor structure width is coated by screen printing methods with a thin layer of carbon nanofiber with DRP-CNFSOL ink (Dropsens), carbon nanofibers with a diameter of 40-80 nm and a length of 0.5 - 1.5 µm with a helical structure. Initially, very thin polymer fibers were obtained from polymethyl methacrylate (PMMA) by electrospinning. The polymeric nanofibers were coated with TiO_2 ceramic oxides by sputtering, respectively magnetic spraying with a radio frequency magnetron, the polymeric core being removed by heat treatment which implicitly led to the obtaining of TiO_2 ceramic nanotubes. TiO_2 ceramic nanotubes were coated with conductive PANi polymers by drop-casting and then deposited on the SPCE. Finally, the sensor was activated with Au particles by drop-casting and evaporation.

Results and conclusions

From scanning electron microscopy (SEM) and atomic force microscopy (AFM) analysis images (Figure 1) it can be seen how the smaller gold nanoparticles attach themselves to the oxide nanotubes or probably fill in the empty spaces.

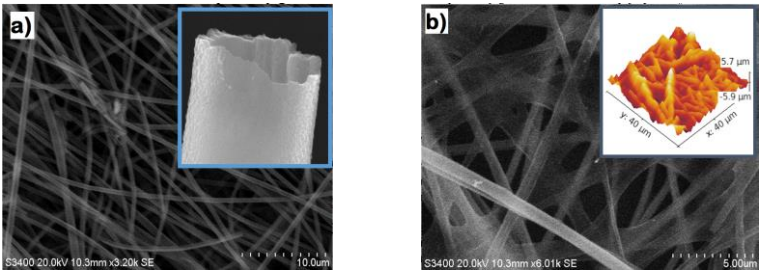

Fig. 1. SEM image TiO_2 nanotubes+PANi (inset TiO_2 nanotubes) si b) SEM image TiO_2 nanotubes+PANi+AuNPs (inset 3D AFM)

The purpose of the tests was to determine the influence of the scan rate and the potential domain on the sensitivity of the hybrid electrode to ethanol (concentrations of 9.5, 14, and 24 ppm). The measurements were made at two potential ranges: -0.1 – 1.5 V şi ± 1 V and at two scan rates of 30 mV/s and 90 mV/s, respectively. The best results to determine the concentration of ethanol were obtained at the scan rate of 30 mV/s in the potential range of -0.5 V ÷ 1.5 V (Figure 2).

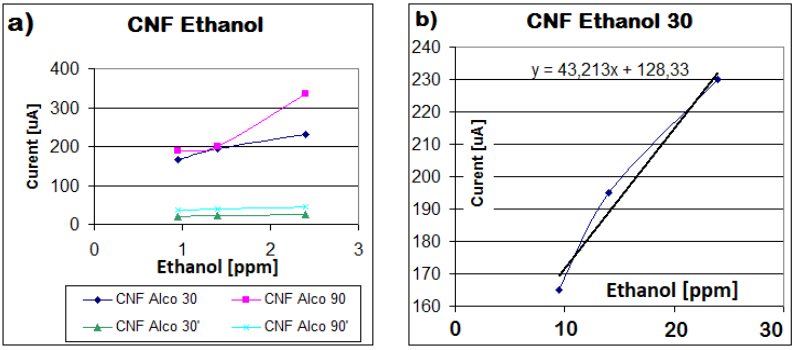

Fig. 2. a) The comparative diagram with the sensor's response to ethanol b) the diagram of the oxidation peak values at 30mV scan rate and -0.5 V ÷ 1.5 V potential domains.

Acknowledgment. The work was supported by: grant P_37_766, cod Mysmis 103847, nr. 68/08.09.2016, of the Romanian National Authority for Scientific Research and Innovation, NANO-IMUNELCHIMPLAT, Project/Competitiveness Operational Programme 2014-2020