ELECTROCHEMICAL DETECTION OF REDUCED GRAPHENE OXIDE IN WATER

Najib Ben Messaoud[1], Rui S. Ribeiro[2], Laura Rodriguez-Lorenzo[1],Marília Barreiros dos Santos[1], Begoña Espiña[1], Raquel Queirós[1]

[1]International Iberian Nanotechnology Laboratory, Avenida Mestre José Veiga, Braga, 4715-330, Portugal
[2] Associate Laboratory LSRE-LCM, Department of Chemical Engineering, Faculty of Engineering, University of Porto, 4200-465 Porto - Portugal
Najib.messaoud@inl.int

Abstract

Many products used in everyday life are made with the assistance of nanotechnologies. Industry, agriculture, medicine and electronics are only a few examples of fields that extensively used nano-sized particles (NPs), generally added to improve product quality [1]. Of these, carbon-based nanoparticles (CNPs) represent one of the most promising products in the field of nanotechnology. For example, graphene oxide (GO) and its derivatives have attracted much attention in industrial applications due to its fascinating properties such as high dispersion in aqueous media, hydrophilicity, surface functionalization ability and high biocompatibility [2]. Because of the wide spectrum of usage of these materials, toxicity to the environment and living organisms has been reported, raising concerns about their utilization [3]. For these critical reasons, the development of analytical methods for the detection of CNPs at trace concentrations has become a very important subject of research. Until now, only a few studies were reported on the detection of CNPs. Almost all of them used nano-impact electrochemistry method [4–6]. This method can provide information about size distribution, mass-transfer, and concentration of single NPs. But the selectivity toward the NPs and the effects of environmental interferences are not understood yet. Voltammetry methods can be a good answer for selectively detecting and quantifying of CNPs in water samples. Voltammetric detection is performed by measuring the generated redox current of the targeted NPs related to the particles concentration. This strategy has been recently used for the detection of silver nanoparticles [7] and carbon nanotube [8].

In this work, carbon screen printed electrodes were employed for the investigation of electrochemical response of reduced GO (rGO) through differential pulse voltammetry (DPV) method. First, rGO was characterized by temperature-programmed desorption method, scanning electron microscope (SEM), dynamic light scattering, and Raman spectroscopy. The influence of rGO dispersing solution concentration on the sensor response was also tested. Next, DPV, electrochemical impedance and SEM characterization of the sensor before and after detection were carried out. Under the best experimental conditions, the sensor exhibited good performance in terms of linear range (from 1 to 50 μg/mL) and detection limit of 2.5 μg/mL. Finally, the reproducibility, selectivity and practical application in water samples were examined.

References

[1] P.C. Ray, H. Yu, P.P. Fu, Journal of Environmental Science and Health Part C. 27 (2009) 1–35.
[2] A.T. Smith, A.M. LaChance, S. Zeng, B. Liu, L. Sun, Nano Materials Science. 1 (2019) 31–47.
[3] A.N. Ghulam, O.A. Dos Santos, L. Hazeem, B. Pizzorno Backx, M. Bououdina, S. Bellucci, Journal of Functional Biomaterials. 13 (2022) 77.
[4] C. Renault, S.G. Lemay, ChemElectroChem. 7 (2020) 69–73.
[5] X. Shen, D. Wang, Electrochemical Science Advances. 2 (2022) e2100069.
[6] H. Kwon, J.-H. Jeong, B.-K. Kim, J.H. Park, Research on Chemical Intermediates. 44 (2018) 3753–3760.
[7] S. Duan, R. Yue, Y. Huang, Talanta. 160 (2016) 607–613.
[8] A. Kaliyaraj Selva Kumar, R.G. Compton, The Journal of Physical Chemistry Letters. 13 (2022) 5557–5562.