Área: ELE

Uric acid quantification with pencil-drawn graphite electrodes modified with niobium oxide and electrochemically reduced graphene oxide

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Highlights

Low-cost sensors were produced with a pencil-drawn technique. Niobium oxide and reduced graphene oxide were used as modifiers. The sensors were explored for uric acid quantification.

Abstract

Uric acid is the primary product of purine metabolism, being generated by enzymatic reaction with xanthine oxidase. Abnormal uric acid concentrations in humans are indicators of chronic renal, cardiovascular, hyperuricemia, gout, Lesch-Nyhan syndrome, and so forth. Uric acid is usually found in blood serum in concentrations ranging from 240 to 520 μmol L^{-1}, and in urine, from 1.44 to 4.43 mmol L^{-1}.[i] Pencil-drawn graphite electrodes are valuable tools for routine analysis as disposable devices. Although first described in 1960, only recently have they been used in various applications. Some studies, however, have reported that they provide poor analytical performance for some species, which can be overcome by electrode surface modification. Although largely studied, a few works have used niobium oxide for uric acid detection. Graphene oxide has been extensively used to detect uric acid, but the modification of pencil-drawn electrodes with both oxides has never been reported. In this work, a pencil-drawn electrode modified with niobium oxide and electrochemically reduced graphene oxide was evaluated to determine uric acid. The results showed a synergistic effect of both materials, with the pencil-drawn modified electrode leading to a peak potential shift of ~400 mV compared to the non-modified one. In addition, the peak current significantly enhanced (118%) after modification with both oxides. A good correlation between signal and concentration was found between 50 to 1000 μmol L^{-1}, with a limit of detection (LOD) of 29 μmol L^{-1}. Considering the LOD values, the sensors might be used for uric acid determination in urine and blood serum samples. Additionally, the reproducibility was good, with an RSD of 4.6%. The device cost was estimated, and the value is ~1 dollar cent per unit. This is considerably low, making the proposed sensors attractive analytical platforms for various applications.

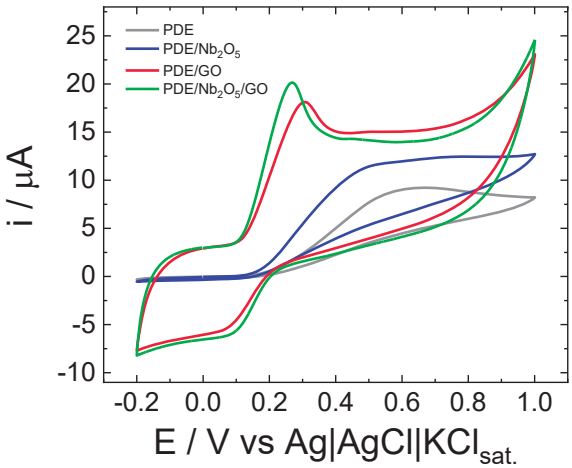

Figure 1 – Cyclic voltammograms recorded in PBS with pencil-drawn electrodes (PDE) at 0.1 V s^{-1} in a 2.0 mmol L^{-1} uric acid solution.

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[i] Shang, K.; Wang, S.; Chen, S.; Wang, X. Biosensors 2022, 12, 588. https:// doi.org/10.3390/bios12080588