Área: ELE

Cost-effective 3D-printed electrode for nitrite electrochemical sensing

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Highlights

Developing affordable electrodes using a 3D printing pen. Evaluating the alkaline electrochemical treatment on the analytical signal. Exploring the electrode potentiality for nitrite quantification.

Resumo/Abstract

Fused Deposition Modeling (FDM), a three-dimensional (3D) printing technique, enables the rapid fabrication of electrochemical sensors. The printing process involves using a heated nozzle to extrude a molten thermoplastic composite. The 3D structure is generated right after filament deposition. This project aims to produce electrodes using a 3D printing pen, an acrylic mold, and a commercial conductive filament, which is composed of polylactic acid (PLA) and carbon black (CB). The resulting sensors were initially tested with $[Ru(NH_3)_6]^{3+}$, providing well-defined and consistent voltammetric profiles for this redox probe (Figure 2). Subsequently, the sensors were subjected to an alkaline electrochemical treatment, evaluating their electrochemical signal for nitrite oxidation (Figure 2). For the treatment, ten cyclic voltammograms were recorded over +1 to -1 V in 0.5 mol L^{-1} NaOH. Figure B shows that the treatment enhanced the analytical signal (1.5-fold) for nitrite oxidation and the electrode's ability to resist the fouling effect. The signal enhancement is related to partially removing the PLA from the electrode surface, exposing the electroactive carbon sites. Additionally, the stability enhancement is probably due to the changes in the electrode surface hydrophobicity, minimizing the deactivation process. Once characterized, the nitrite oxidation was evaluated at different pH (from 2 to 8), selecting pH 4 as an optimum condition. Next, a calibration curve was constructed for nitrite (Figure C), generating a linear range from 10 to 200 µmol L^{-1}. These results bring encouraging findings for nitrite quantification. Therefore, the next step will involve analyzing water, soil, and sausage samples.

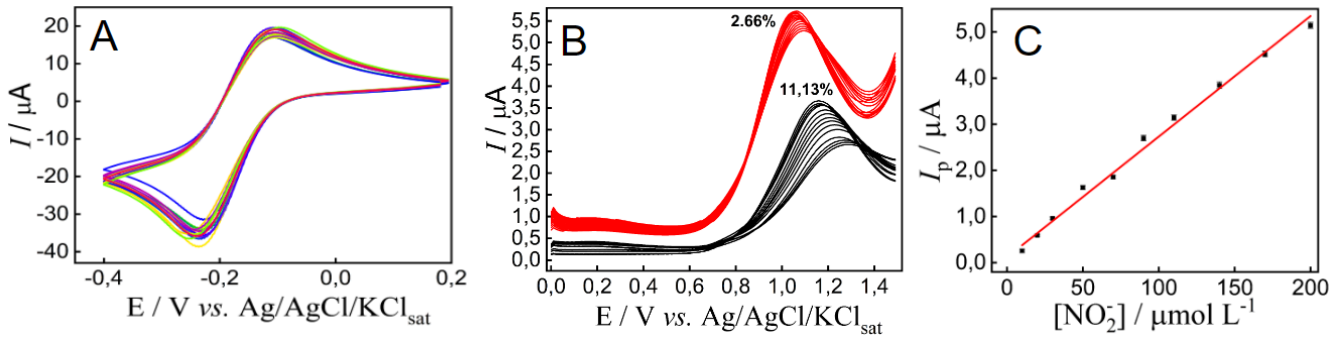

Figure 1 – A) Cyclic voltammograms for twenty different non-treated electrodes recorded in 5 mmol L^{-1} $[Ru(NH_3)_6]^{3+}$ and 0.1 mol L^{-1} KCl at 100 mV s^{-1}; B) Square wave voltammograms recorded with electrodes before (black) and after (red) performing electrochemical treatment. The measurements were recorded in 100 µmol L^{-1} nitrite and 0.1 mol L^{-1} Britton-Robinson buffer pH 4. C) Calibration curve for nitrite determination using the treated electrodes.

1.PRADELA-FILHO et al. Patterning (Electro)chemical Treatment-Free Electrodes with a 3D Printing Pen. Analytical Chemistry, 22 June 2023.

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