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Abstract

3D printed sensors based on modified-polylactic acid for electrochemical sensing †

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Abstract: A wide variety of materials have historically been considered when developing electrochemical sensors. Initial studies relied on mercury electrodes, which were soon replaced by different inert metals (mainly Au and Pt) and carbon-based materials (e.g., glassy carbon electrodes). However, the performance of such bare electrodes is usually limited, lacking the sensitivity and/or selectivity required for the analysis of complex real samples. In this direction, modification of electrode surfaces with different electrocatalysts was explored as a solution given their more efficient electron exchange and/or faster reaction rate. This lead to the popularization of chemically modified electrodes (CMEs), with carbon paste electrodes first, and screen printed electrodes later, as the most common choices.

Nowadays, 3D-printing is emerging as an alternative approach for the fabrication of customized electrochemical sensors, owing to their many unique advantages such as its low-cost (both of the material and equipment), tunability and easy prototyping. Concretely, electrodes are fabricated by fused deposition modelling from thermoplastics such as polylactic acid (PLA) or acrylonitrile-butadiene-styrene (ABS), commonly doped with different carbon-based materials to overcome the insulating nature of PLA and ABS. In this regard, herein we explore the preparation of bulk-modified conductive filaments through the incorporation of redox mediators/electrocatalysts for the manufacturing of 3D-printed voltammetric sensors. Developed electrodes were characterized electrochemically by cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS), and morphologically by scanning electron microscopy-energy dispersive X-ray spectroscopy (SEM-EDX). Finally, their performance was benchmarked against commercial electrodes and applied for the voltammetric detection of drugs.

Keywords: 3D printing; additive manufacturing; modified electrode; voltammetric sensors; conductive filaments; melatonin; hydrogen peroxide; Prussian blue

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