3D-Printed Electrochemical Sensor Composed of Graphite, PLA, and Castor Oil for Sensitive Dopamine Detection

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Recent research on 3D-printed electrochemical sensors has shown great analytical potential[1]. In particular, the development of conductive filaments for 3D printing electrodes has gained attention, offering greater control regarding materials and their proportions. Considering this, the present study aimed to develop conductive filaments composed of graphite (GR), castor oil (CO), and PLA for 3D-printed devices targeting dopamine (DA) detection, which is an important biomarker for neurodegenerative diseases[1,2]. The composites were prepared by dispersing GR powder (45% w/w) through a chemical route, along with CO (15% w/w) and PLA, under controlled stirring and temperature conditions, followed by extrusion into filaments[3,4]. Electrodes were then 3D-printed and subjected to physicochemical and electrochemical characterizations. DA was detected using cyclic voltammetry (CV) and differential pulse voltammetry (DPV) in 0.1 M PBS, pH 7, showing linear responses in the ranges of 7.5–88 μM and 0.9–88 μM, respectively. The LOD and LOQ were 1.49 μM and 4.96 μM for CV, and 1.85 μM and 6.18 μM for DPV, which are suitable for detecting DA in human urine (0.1–4.7 μM)[5]. Sensitivities were 0.293 and 0.348 μA μM^{-1} cm^{-2}, respectively. The sensor exhibited good regeneration performance, with I_{pa} decreasing by 5±0.5% (CV) and 19±0.3% (DPV) after 22 mM NaOH for 30 minutes. These findings highlight the potential of this 3D-printed, non-enzymatic electrochemical sensor as a fast and reliable platform for DA detection.

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