



Enhanced Electrocatalytic Detection of Doxorubicin via Gold Nanoparticle/Reduced Graphene Oxide Modified Screen-Printed Electrodes

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Abstract: Enhancing the clinical sensitivity of screen-printed carbon electrodes (SPCEs) is vital for transitioning electrochemical devices into reliable point-of-care diagnostics. In this study, we engineered high-performance sensors by modifying SPCE surfaces with reduced graphene oxide (rGO) decorated with varying loads of gold nanoparticles (0.5, 2, and 4 wt% AuNPs). Successful nanohybrid assembly was verified via XRPD, FTIR, Raman, SEM/EDS, and TGA. Raman analysis specifically identified n-type doping via a G-band redshift, confirming intense electronic coupling within the composite. The 2 wt% AuNP/rGO formulation displayed the best graphitic alignment and thermal resilience and was subsequently applied to detect the anticancer therapeutic doxorubicin (DOX). When evaluated voltammetrically, the modified architecture promoted a highly favorable quasi-reversible redox pathway, achieving an anodic peak current density of 18.912 $\mu\text{A cm}^{-2}$ (a 3.3-fold rise compared to bare electrodes). Electrokinetic studies confirmed swift electron transport kinetics, supported by a diminished Tafel slope (140 mV dec⁻¹) and an elevated rate constant ($k_0 = 2.57 \times 10^{-5} \text{ cm s}^{-1}$). Consequently, the platform offered a 1.45-fold increase in sensitivity (0.221 $\mu\text{A} / \mu\text{mol L}^{-1}$) and lowered the limit of detection by 20.9% (13.193 $\mu\text{mol L}^{-1}$) in a 0.5 to 10.5 $\mu\text{mol L}^{-1}$ concentration range. These outcomes demonstrate the strong promise of AuNP/rGO frameworks for next-generation, high-sensitivity medical sensors.

Keywords: screen-printed electrodes, electrochemical sensor, doxorubicin, reduced graphene oxide, gold nanoparticles.