PÔSTER - RESUMO - SENSORES E BIOSSENSORES

LASER-INDUCED GRAPHENE PAPER-BASED ELECTRODES FOR ELECTROCHEMICAL DETECTION OF THE PANCREATIC CANCER BIOMARKER CA19-9 IN URINE SAMPLES

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Pancreatic cancer has one of the highest mortality rates, and its early detection remains a challenge, significantly limiting therapeutic strategies. This research reports the optimization, structural characterization, and biosensing performance of laser-induced graphene (LIG) electrodes fabricated on paper substrates for CA19-9 detection. The formation of interdigitated electrodes (IDEs) was optimized by systematically varying laser power (3–8% of 22 W) and scanning speed (300–800 mm/min). To assess the trade-off between graphene formation and substrate degradation, heatmaps were generated. Based on this, the best condition was achieved at 7% power and 300 mm/min for digit formation, while for the terminals and contacts, the optimized parameters were 6% power and 500 mm/min. Morphological evaluation via scanning electron microscopy (SEM) revealed well-defined porous graphene structures. Energy-dispersive spectroscopy (EDS) confirmed the presence of carbon, oxygen, and calcium, principally. Raman spectroscopy further validated the synthesis of

multilayer porous graphene, evidenced by the characteristic D, G, and 2D bands. Spatial Raman analysis of the digits revealed structural heterogeneity, where the central irradiation zone promotes higher ablation compared to the border. Electrochemical impedance spectroscopy (EIS) demonstrated that electrodes (terminal and contacts) produced at 6% power and 500 mm/min exhibited the lowest resistivity values when compared to other conditions. Furthermore, a post-synthesis mechanical pressing step was found to significantly reduce real impedance by increasing the packing density of the graphene sheets. The optimized platform was applied as a capacitive biosensor for the CA19-9 biomarker. The sensing data followed a Langmuir–Freundlich model (R^2=0.99), yielding a limit of detection (LOD) of 2.38 U/mL and a limit of quantification (LOQ) of 7.86 U/mL. Preliminary analyses of urine samples suggest that the paper electrodes show promising results for point-of-care applications, particularly for screening above and below the clinical threshold of 37 U/mL. Enhancements in the measurement protocol are needed to develop a calibration curve that can more accurately quantify the biomarker, aligning more closely with the results obtained from the ELISA technique.

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Palavras-chave: laser-induced graphene (lig); pancreatic cancer; ca19-9; paper-based electrodes.