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Flexible laser-induced graphene electrodes on polyimide film: Hybrid nanoflower-modified dielectric microjunctions for non-faradaic analysis

Abstract

Laser-induced Graphene (LIG) electrodes on flexible substrates have attracted significant research interest, making them an excellent alternative to conventional fabrication of transducers on rigid planar substrates. In this study, four individual capacitor-like triangular LIG electrodes were fabricated on polyimide (PI) film with micron gap (MG) spacing of 30, 66, 125 and 180 μm, to study the relationship between gap spacing and capacitance. A novel N, N-carbonyldiimidazole-copper (CDI-Cu) hybrid nanoflower (NF) was synthesised via one-pot biomineralization and deposited at the triangular junction of acid-base treated LIG-MG for the immobilization of neutravidin. The gap spacing and structure of the LIG-MG were analysed using high-resolution microscopes, revealing a porous nanofiber-like graphene structure. X-ray Photoelectron Spectroscopy (XPS) of acid-base treated PI film proved carboxyl group formation. A decrease in capacitance was observed with an increasing gap spacing in a non-faradaic environment. The capacitance of CDI-Cu NF following neutravidin modification for 30, 66, 125 and 180 μm spacings were 1.77E-07, 1.36E-07, 4.73E-08, 4.84E-08 F, respectively, suggesting excellent biomolecular modification sensitivity of the LIG-MG with 30 μm spacing. A comparative analysis of dielectric performance for different gap-spaced devices revealed that a 30 μm spacing would be optimal for bio-capturing because of the close confinement of biomolecules for smaller gapped areas.

Keywords

Biomodification; Carbon material; Dielectrode; Hybrid nanostructure; Micro-gap spacing