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Mn_3O_4 Tetrahedral with Carbonyldiimidazole Nanoflower Deposition on Laser-Scribed Graphene for Selective Bio-Capture

Abstract

Dengue fever, a mosquito-borne viral infection, poses a significant global health challenge, particularly in tropical and subtropical regions. The absence of non-effective vaccines and specific treatments underscores the need for advanced diagnostic tools for early detection and management. This study presents a novel biosensor for detecting dengue virus type 4 (DENV-4) by combining carbonyldiimidazole nanoflower (CDI-NF) with Mn_3O_4 on laser-scribed graphene (LSG). Material characterization techniques, including Raman spectroscopy, TEM, XRD, XPS, and FTIR, were employed to confirm the successful integration of Mn_3O_4 and CDI-NF, resulting in a unique 3D flower-like structure. In order to verify the sensing efficiency, a selective DNA sample captured on LSG/Mn_3O_4-CDI-NF was investigated for specifc binding with Aedes aegypti target DNA through selective hybridization and mismatch analysis. Electrochemical impedance studies further confirmed sensitive detection of up to 1 fM, where the sensitivity was confirmed by large transfer resistance (R_{ct}) before and after hybridization with a regression coefficient 0.97373. EIS results demonstrated successful surface modifications and the biosensor's specificity in distinguishing between complementary, mismatched, and non-complementary target sequences. The biosensor's ability to differentiate between these sequences highlights its potential for accurate and targeted DENV-4 detection, offering a promising avenue for advancing dengue diagnostics.

Keywords

dengue virus; electrochemical biosensor; laser-scribed graphene; surface functionalization