

Immuno-probed graphene nanoplatelets on electrolyte-gated field-effect transistor for stable cortisol quantification in serum

Abstract

Physiological and emotional stress affects the regulation of cortisol secretion, a routine process in circadian rhythm. Regular monitoring of cortisol level as a biomarker in the blood stream becomes vital to determine cortisol-related diseases. This study reports immuno-probed graphene nanoplatelets on electrolyte-gated field-effect transistor (EGFET) biosensor for cortisol determination in human serum. Solution-processed graphene nanoplatelets were evidenced on the surface by Raman spectroscopy analysis and utilized as the transducing element on the field-effect transistor. Further, confirmed the binding events of the antibody on graphene nanoplatelets using X-Ray Photoelectron Spectroscopy and characterized the electrostatic gating effect of cortisol and intermediate functionalization on graphene nanoplatelets-EGFET. The biosensor exhibited good sensitivity of $72.30 \mu\text{A} \cdot (\text{g/mL})^{-1}$ in a linear range between 1.00 pg/mL to 10.00 ng/mL , with a limit of detection (LOD) of 0.85 pg/mL . Confirmation with binding events on the biosensor was done using the relevant molecules, progesterone, cortisone, and corticosterone, and found to be selective towards cortisol. Cortisol was also successfully detected with interference by the human serum, suggesting the capability of graphene nanoplatelets-EGFET sensor for determining cortisol in a complex matrix.

Keywords

Cortisol; Field-effect transistor; Graphene nanoplatelets; Human serum; Immunosensor