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TOWARDS GRAPHENE BASED LABEL-FREE SENSORS FOR CARDIOVASCULAR RISK BIOMARKER DETECTION

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We report on our progress towards the development of label-free chemical vapour deposition graphene field effect transistor (GFET) immunosensors for the sensitive detection of Fibrinogen, a well-known biomarker of cardiovascular disease (CVD). GFET sensors are low cost, have fast response and are portable for point-of-care (PoC) applications and could therefore revolutionise early diagnosis of a range of diseases. Initial proof-of-concept tests using the GFETs have been conducted using human chorionic gonadotropin (hCG), a glycoprotein risk biomarker of pancreatic cancer as well as pregnancy. The GFET sensors were fabricated on Si/SiO2 substrate using photolithography with evaporated chromium and sputtered gold contacts. GFET channels were functionalised with a linker molecule to immobilise anti-hCG antibody on the surface of graphene. The binding reaction of the antibody with varying concentration levels of hCG antigen demonstrated the limit of detection of the GFET sensors to be below 1 pg/mL using four-probe electrical measurements. We also show that annealing can significantly improve the carrier transport properties of GFETs and shift the Dirac point (Fermi level) with reduced p-doping in back-gated measurements. In addition, we are also developing multiplex circuits to enable simultaneous detection of a panel of biomarkers to increase confidence in the state of the measured disease and enable prognostic monitoring. The developed GFET biosensors are generic and could find applications in a broad range of medical diagnostics in addition to cardiovascular and cancer, such as neurodegenerative (Alzheimer's and Parkinson's) and environmental monitoring.

Recent Publications

1. Haslam C et al (2018) Label-Free Sensors Based on Graphene Field-Effect Transistors for the Detection of Human Chorionic Gonadotropin Cancer Risk Biomarker. Diagnostics 8;8(1). pii: E5. doi: 10.3390/diagnostics8010005
2. Van Holten T C et al (2013) Circulating Biomarkers for Predicting Cardiovascular Disease Risk; a Systematic Review and Comprehensive Overview of Meta-Analyses. Plosone 8 (4): e62080.
3. Cole L A (2010) Biological functions of hCG and hCG-related molecules. Reproductive Biology and Endocrinology: RB&E, 2010. 8: p. 102-102.
4. Tsampala M et al (2010) Human chorionic gonadotropin: A hormone with immunological and angiogenic properties. Journal of Reproductive Immunology 85(1): p. 93-98.
5. Haslam C et al (2018) Label-Free Sensors Based on Graphene Field-Effect Transistors for the Detection of Human Chorionic Gonadotropin Cancer Risk Biomarker. Diagnostics 8;8(1). pii: E5. doi: 10.3390/diagnostics8010005.

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