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Graphene biochip for multiplex biomarker detection

Graphene is a 2D material with unique electrical and mechanical properties. Graphene devices and sensors promise to be a disruptive technology in next generation electronics and sensors - due to graphene's exceptional electronic properties and aptitude for chemical modification. Novel graphene sensor technology used to develop sensors, based on chemically functionalized graphene microchannels and their application in lab-on-chip POC (Point-of-Care) diagnostics will be presented. Several different chemical functionalization methods for graphene have been evaluated and used in sensing applications of graphene, electrochemical and CHEMFET sensors. Direct and indirect (using a modification of an adsorbed layer or polymer film on top of the graphene) functionalization techniques including diazotisation, aminosilane chemistry and non-covalent functionalization methods will be reviewed. Surface amine chemistry has been used to modify graphene in order to attach "bioreceptor" molecules, capable of specific and selective detection of target biomarkers. The technology is now being applied to detect biomarkers related to cardiac disease and Alzeimers Disease. Changes in the current-voltage characteristics of the graphene sensors are used to detect proteins. There are several advantages of graphene sensors over alternative sensor platforms such as carbon nanotubes (CNTs) or silicon nanowires (SiNWs), including easier processing and greater sensitivity. The main benefits of graphene for sensing applications will be highlighted in a comparison with other materials. Finally, the integration of graphene sensors into packaging and microfluidics will be presented. Important considerations for processing of samples using microfluidics/lab-on-chip technology and the challenges in developing multiplex sensors will be presented.

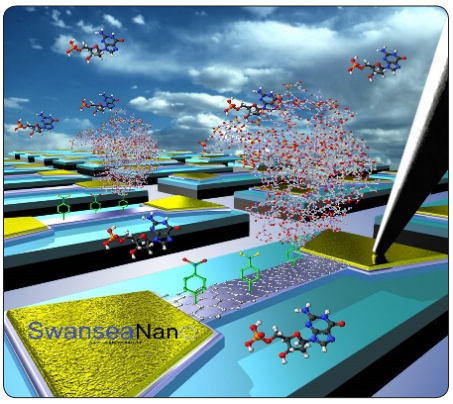

Figure 1: Illustration of a graphene immuno biosensor, consisting of a functionalized graphene channel between metal electrodes

Recent Publications

1. Forsyth R, Devadoss A and Guy O J (2017) Graphene Field effect transistors for biomedical applications: current status and future prospects. Diagnostics 7(3):45-63.
2. Tehrani Z et al. (2014) Generic epitaxial graphene biosensors for ultrasensitive detection of cancer risk biomarker. 2D Materials. 1(2):025004.

3. Webb M J et al. (2014) Effects of a modular two-step ozone-water and annealing process on silicon carbide graphene. Applied Physics Letters. 105:081602.
4. Teixeira S (2014) Epitaxial graphene immunosensor for human chorionic gonadotropin. Sensors and Actuators B: Chemical. 190:723-729.
5. Gualeni B et al. (2018) Minimally-invasive and targeted therapeutic cell delivery to the skin using microneedle devices. British Journal of Dermatology. 178(3):731-739. Doi:10.1111/bjd.15923 .

Biography

Owen J Guy is the Head of Chemisty, Director of the Centre for Nanohealth in the College of Engineering at Swansea University, UK- a unique facility applying device fabrication & cleanroom semiconductor processing to healthcare problems in collaboration with industry. He is also Head of the Systems Process & Engineering Centre (SPEC) one of 3 research centres within engineering. His group has 14 years' experience in clean room device fabrication (silicon, graphene & MEMS technology). He has developed graphene and microfluidics technology through EPSRC and innovate UK projects. He currently leads EPSRC and Marie Curie sensor projects at Swansea – in collaboration with Plymouth University – and a Newton fund project developing sensors for hepatitis. He has PI grant income of more than £4 million. He has published 60 papers and holds 2 granted patents (WO2011004136 and P100072GB).

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