Septicemia detection using graphene transistors integrated in a microfluidic platform

Proposers

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Introduction

Septic shock - one of the most deadly diseases nowadays - is a medical emergency caused by a severe blood infection. The key to improve survival rate is to detect and control the source of infection at an early stage. Clinical symptoms, such as fever, arterial hypotension and thrombocytopenia, are variable and unspecific. Consequently, the need for finding specific septicemia blood biomarkers is increased, and the idea of making a diagnostic and prognostic tool (e.g. point-of-care) based on that information has gained interest. C-reactive protein (CRP), procalcitonin (ProCT), various cytokines, and cell surface markers are examples of biomarkers studied to detect early stages of sepsis. However, the difficulty remains in the inexistence of assays with sensitivity and specificity for those biomarkers, and in the need to detect a panel of biomarkers to identify septicemia. Multiplex assays are thus required to determine personalized treatment and decrease the mortality.

Graphene low-dimensionality, high carrier mobility and chemical stability, allow for the design of extremely sensitive biosensors. Target specificity is achieved by immobilization of biomarker specific probes on the graphene surface. Transducing is provided by the change of resistance of a graphene channel defined between two metal contacts, capacitively coupled to the liquid electrolyte that floods the channel. Changes in the dielectric environment of the graphene will produce, through the mechanism of local gating, modifications in the conductivity of the channel. These will appear as changes in voltage or current in an external circuit built around the graphene transistor. Integration of these sensors in a multiplexed microfluidic platform, will allow to signal a panel of biomarkers in human blood for septicemia diagnosis.

Partner 1

The INL team has expertise in fabrication of micro/nanoelectronic devices based on 2D materials and in their use for biosensing applications.

Partner 2

The Thin-Film MEMS and BioMEMS group at INESC MN has extensive experience developing and characterizing thin-film silicon MEMS resonators as well as PDMS-based microfluidics.

Project outline/goal

1) Fabrication and functionalization of the graphene biosensor
2) Test of the graphene immuno-sensor in the microfluidic system in model systems using spiked samples
3) Benchmarking the graphene immuno-sensor against technologies based on optical detection
4) Test of the graphene immuno-sensor in the microfluidic system using clinical samples

Student profile

Profile sought: preference, but not limited, to students with a background in Engineering Physics, Biomedical Engineering or Biological Engineering with an interest in exploring complex advanced microsystems for practical applications. Experience in Micro and Nanofabrication would be helpful.