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Synthesis and the development of graphene-layered substrates for flexible wearable biosensors

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Extended Abstract

Due to its unique 2D structure, graphene has been reported to have a high charge carrier mobility [1] and high surface energy [2]. As a result, it is an excellent substrate for the immobilization of biomolecules which helps in the long-term stability of biosensors [3]. Additionally, the improved immobilization of biomolecules would enhance the sensitivity of biosensors due to an increased number of sensing sites available [4]. Therefore, graphene is an attractive material for the research and development of electrochemical-based biosensors for healthcare and biomedical applications [5].

In order to demonstrate its potential, we synthesized high quality, horizontal graphene using an in-house developed chemical vapor deposition system [6], [7] which was employed in a glucose biosensor. In addition, we also investigated the potential of developing flexible wearable biosensors by transferring the synthesized graphene on to a highly flexible polyethylene terephthalate (PET) substrate.

Raman spectroscopy was used to characterize the quality of the synthesized graphene and the characteristic "2D" peak which correspond to the single-layered structure of the graphene [8] is clearly observed. Furthermore, the intensity ratio between the "2D" peak to the "G" peak is greater than 2 which suggests the formation of monolayer graphene [9]. A value lower than 2 would indicate few-layer graphene or multilayer graphene. After the graphene is transferred on to the PET substrate, a pair of electrodes is fabricated over the substrate and a polydimethylsiloxane (PDMS) microfluidic channel chip is then placed over the substrate to form the flexible biosensor.

In order to use it for glucose sensing, glucose oxidase (GOx) is first immobilized on the graphene by leaving it overnight[10]. Next, the resistance across the two electrodes is then measured while the sample fluid, containing different concentrations of glucose, is pumped across the graphene surface. A clear drop in the measured resistance is observed with increasing glucose concentration which suggests that interaction between the GOx and glucose can be monitored using graphene. This demonstrates the potential of using the synthesized graphene as a biosensor for glucose sensing applications. It is envisioned that the present research will have a direct impact on the development of graphene-enhanced heterointerfaces for the development of wearable electronics or biosensors with improved performance.

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