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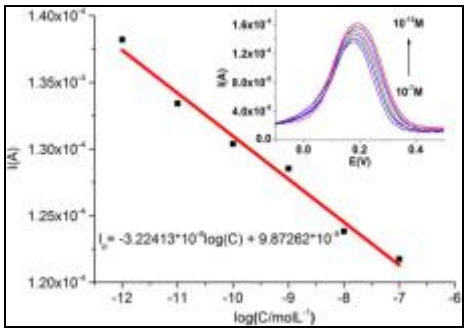
Graphene biosensors for label-free detection of DNA and protein disease biomarkers

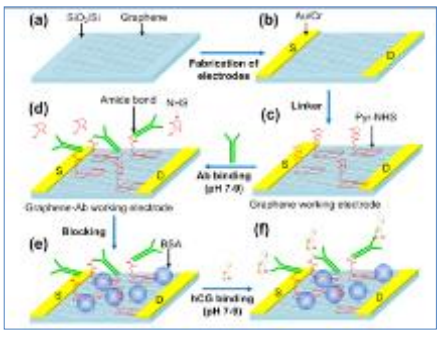
Graphene is an excellent candidate for high sensitivity biosensors for detection of disease biomarkers for clinical diagnostic applications. In this talk, I will review our work on two novel biosensors developed for detection of protein and DNA biomarkers: an ultrasensitive label-free graphene immunoFET for detection of Human Chorionic Gonadotrophin (hCG) and an rGO-graphene double layer structure for detection of human immunodeficiency virus 1 (HIV1) gene. For immunoFET, an argon etching technique and deep UV treatment was developed for patterning clean graphene channels. The rGO-graphene structure was achieved by immobilization of GO on graphene followed by electrochemical reduction by cyclic voltammetry. The immunoFET showed a unique resistance change pattern with high reproducibility and an ultralow label-free detection limit of 1pg mL^{-1} and high sensitivity of 0.30 Ω/ng/mL. The hCG concentration gradient demonstrated a broad analytical range of 0.01~15 ng mL^{-1} exhibiting a sensor potency of approximately 4.95 ng mL^{-1} which is significantly lower than the clinical limit for hCG. In case of rGO-graphene structure, 42% higher redox current was observed in compared to graphene electrode. The hybridized dsDNA demonstrated a linear range from 10^{-7} M to 10^{-12} M with a detection limit of 1.58 x 10^{-13} M.

References

[1] Bing Li *et al.*, *Biosens. Bioelectron.* 72 (2015) 313;
[2] Bing Li *et al.*, *Carbon* 118 (2017) 43e49;
[3] Kamrul Islam *et al.*, submitted to *Biosens. Bioelectron.*



(A)



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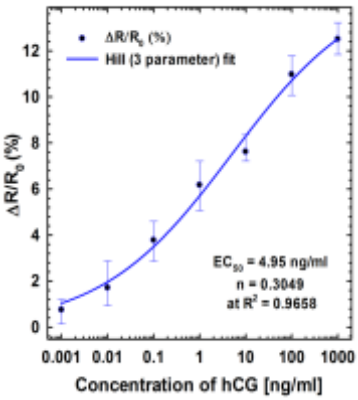

(C)

Figure 1: (A) Dependence of peak currents of DPV spectra of the rGO DNA sensor on the concentration of target cDNA; (B) Surface modification of back-gated immuno graphene field effect transistor (immunoFET); (C) Dependence of relative resistance changes of the immunoFET sensor on hCG concentration.