High Yield and Scalable Fabrication of Nano/Bio Hybrid Graphene Field Effect Transistors for Cancer Biomarker Detection

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Graphene field effect transistors (GFETs) hold tremendous promise for use as biosensor transduction elements due to graphene's high mobility, low noise and all-surface structure with every atom exposed to the environment [1]. We developed a GFET array fabrication based on two approaches, pre-patterned transfer and post-transfer photolithography [1-2]. Both approaches are scalable, high yield, and electrically stable. Functional groups for protein immobilization were added to the GFET using various bi-functional pyrene-based linkers. One approach immobilized an azide engineered protein through a “Staudinger Reaction” chemistry with NHS-phosphine reacting with a 1-aminopyrene linker. Another approach bound an engineered antibody via 1-pyrene butanoic acid succinimidyl ester, where an amine group of the antibody reacts to the succinimide of the linker. GFETs were studied by Raman spectroscopy, AFM and current-gate voltage (I-Vg) characterization at several steps of the fabrication process. A sensing response was obtained for a breast cancer biomarker (HER2) as a function of target concentration (Figure 1). We have started to design multiplexed sensor arrays by adding several functional groups to GFETs on a single chip. Simultaneous detection with these devices will be discussed.

[1] M. B. Lerner, *et.al.* Nano Letter, **14** (2014) 2709.

[2] N. J. Kybert, *et. al.* Nano Research, **7** (2014), 95.

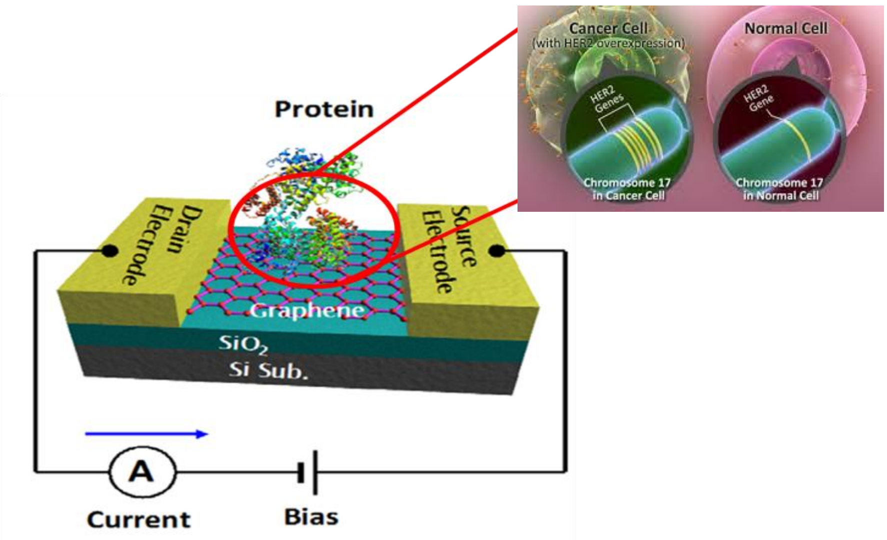

Figure 1. Illustration of anti-HER2 single chain variable fragments bounds to the graphene FET.