CVD graphene and graphene for sensing application

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Abstract

Owing to its novel electrical properties [1] and large surface to volume ratio, graphene is regarded as excellent candidate for ultrasensitive biological (chemical) detection and diagnosis devices. Before reaching such ambitious biological applications of graphene, its response to various electrolyte compositions, where the biomolecules site in, has to be clarified first of all. In fact, large variations in sensitivities have been reported for graphene-based ion sensors. For example, contradicted pH sensitivities ranging from a low value of 12mV/pH to a supra-Nernst value of 99mV/pH (Nernst value, 60mV/pH at room temperature), were reported in previous literature.

The present work [1] serves to resolve this discrepancy. We start with either exfoliated graphene or chemical vapor deposition (CVD) graphene [2] grown on 25 um thick copper foils. The CVD graphene allows for the transfer of high-quality graphene with lateral scale of many centimeters on arbitrary substrates. Further characterizations indicate that we achieved predominant uniform, monolayer graphene with high mobility ~3000cm^2/Vs. As shown in Fig. 1, liquid-gated graphene field-effect transistors (GFETs) with reliable performance are developed. It is revealed that ideal defect-free graphene should be inert to electrolyte composition changes in solution, whereas a defective one responses to electrolyte composition. This suggests that graphene cannot sense the chemical potential of protons or ions (the proton or KCl concentration), but rather senses the electrostatic potential of the solution [3]. This finding sheds light on the large variety of pH or ion-induced gate shifts that have been published for GFETs in the recent literature. As a next step to target graphene-based (bio-) chemical sensing platform, non-covalent functionalization of graphene has to be introduced [4].

References

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Figures
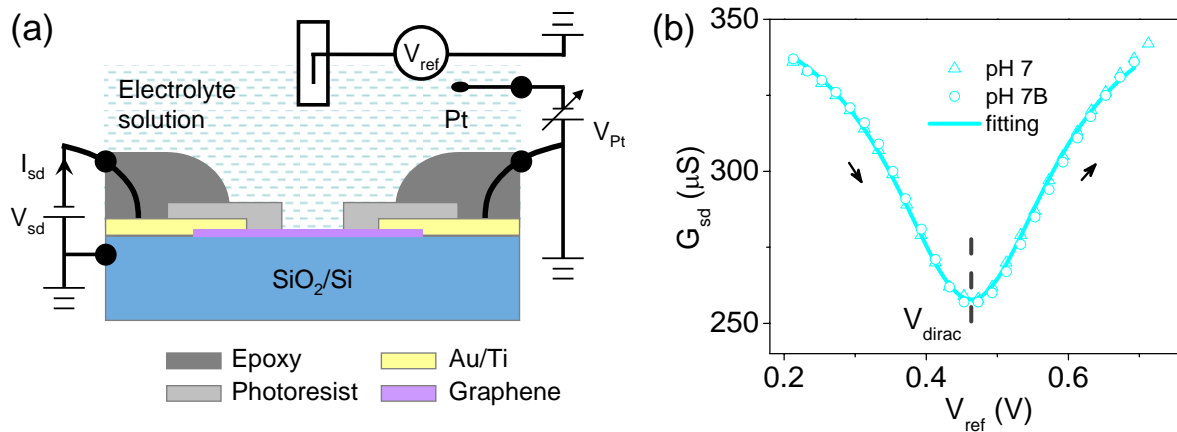
Fig. 1 (a) Schematics of the experimental setup and the electrical circuitry of the liquid-gated GFET. The gate voltage V_{Pt} was applied to the solution via a Pt wire. The electrostatic potential in solution V_{ref} was monitored by the reference calomel electrode. (b) Two data sets obtained for pH = 7 are shown to illustrate the excellent degree of reproducibility. Here a bipolar transfer curve is observed corresponding to different type of charge carriers that can continuously be tuned from holes (left) to electrons (right) with the charge-neutral point V_{CNP} at minimum G_{sd}.