Devices

Univ. of Pennsylvania: Vapor sensors based on graphene combined with single stranded DNA

H.L. Gomes

DNA & MISFET marriage for a "noselike" vapor sensing system

This paper published by the **University of Pennsylvania** demonstrates that graphene can be combined with single stranded DNA (ssDNA) to create a chemically diverse family of vapor sensors that is promising for use in a "noselike" vapor sensing system. In this sensor, the DNA is not used for its biological functionality but instead provides sequence-dependent chemical recognition capability. The role of the ssDNA is to concentrate water and analyte molecules near the otherwise chemically inert and hydrophobic conduction channel and in this way greatly increase the current response compared to that of bare graphene. The sensor structure is a metal insulator field effect transistor (MISFETs) fabricated in thermally oxidized silicon substrates. Figure 1 depicts an artistic view of a graphene MISFET channel coated with ssDNA strands. Two types of single stranded DNA were used and the device response was tested for several analytes, such as dimethylmethylphosphonate (DMMP) and propionic acid.

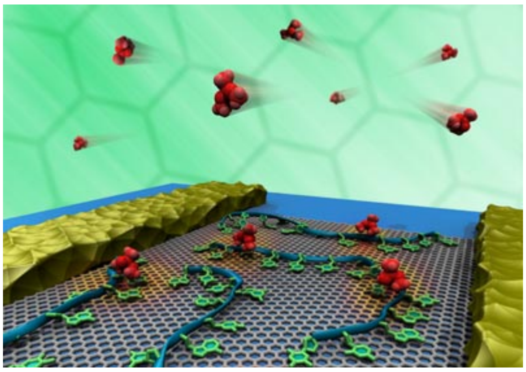

Figure 1 : Artistic view of a MISFET devices where the active channel is graphene combined with single stranded DNA are electrically sensitive to changes induced by vapors.
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After coating with ssDNA, enhanced responses on the scale of 5%–50% were observed (Figure 2). The responses to analytes were reproducible, with nearly perfect recovery to baseline upon purging.

It is claimed that it should be possible to fabricate devices with different chemical sensing responses. Each ssDNA sequence behaves a little differently on the surface of graphene because it has a different shape, pH and hydrophilic properties. This means that every sequence interacts differently with different volatile organic chemicals. In comparison with previous works, this technology offers easy and cheap way to produce hundreds of different sensors needed for "electronic nose" systems.

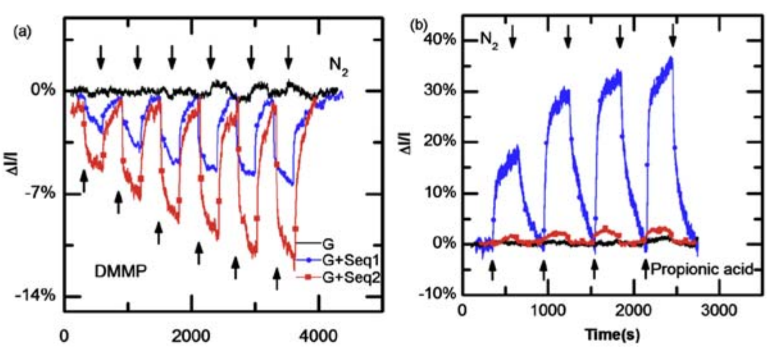

Figure 2 : Normalized changes in current vs time for ssDNA-graphene vapor responses. Lower arrows indicate introduction of analyte at progressively larger concentrations, while upper arrows indicate flushing with pure carrier gas. Clean graphene devices (black data).
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However, it is not clear if the changes in the device current are caused by intrinsic changes in the carrier transport (mobility, carrier density) or by changes in the threshold voltage (extrinsic). The authors do not explore the full potential of the MISFET device as a multi-parameter sensor.

"DNA-decorated graphene chemical sensors" ; Y. Lu, B.R. Goldsmith, N.J. Kybert, A.T.C. Johnson : ***Applied Physics Letters*** **97**, 083107 (2010).