Graphene chemiresistors for gas sensing

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Graphene has demonstrated great promise for technological use, yet control over material growth and understanding of how material imperfections affect the performance of devices are challenges that hamper the development of applications.[1,2] In this work we reveal new insight into the connections between the performance of the graphene devices as environmental sensors and the microscopic details of the interactions at the sensing surface. Specifically, we monitor changes in the resistance of the chemical vapor deposition grown graphene devices as exposed to trace concentrations of ethanol. We perform thermal surface treatments after the devices are fabricated, use scanning probe microscopy to visualize their effects on the graphene sensing surface down to the nanometer scale and correlate them with the measured performance of the device as an ethanol sensor. Our observations are supported by theoretical calculations of charge transfers between molecules and the graphene surface. We find that, although often overlooked, the surface cleanliness after device fabrication is strongly correlated with the device performance and reliability. Moreover, we present a compact solution for field testing of our devices. These results further our understanding of the mechanisms of sensing in graphene-based environmental sensors and pave the way to optimizing such devices, especially for their miniaturization, since decreasing the size of the active zone will inevitably lead to an increased interference from surface contaminants.

REFERENCES

[1] Akinwande, D., Petrone, N., Hone J., Nat Commun, 5 (2014) 5678
[2] Yang S., Jiang C., Wei S., Appl. Phys. Rev. 4 (2017) 021304

FIGURES

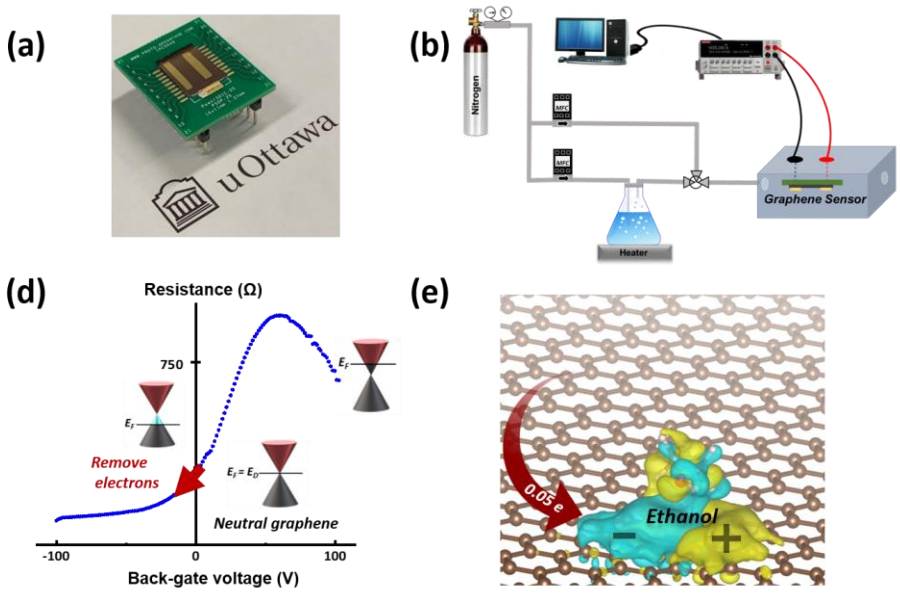

Figure 1: (a) Picture of the sensor geometry (b) Schematic of experimental setup for sensor testing (c) Working principle of graphene as a chemiresistor (d) Schematic of adsorbed ethanol molecule and the charge density distribution.