Atmosphere-Specific Response in Graphene Field-Effect Transistors

Osazuwa Gabriel Agbonlahor[1], Manoharan Muruganathan[1], Hiroshi Mizuta[1,2]
[1]JAIST, [2]Hitachi Cambridge Lab.,
Email: agbonlahor@jaist.ac.jp

Lab-on-a-chip devices with the capability for simultaneous gas detection and ambience characterization are highly sought after as next-generation gas sensors. However, the robust spectroscopic or chromatographic set-ups utilized in contemporary ambience characterization systems are unsuitable for Lab-on-a-chip devices. In this regard, graphene's facile measurement set-up, huge carrier mobility, compatibility with CMOS technology and extreme sensitivity makes it ideal for this application. Therefore, in continuation of our previous simulation results, in which various gas environments were distinguished via their tuning voltage (TV) induced charge transfer characteristics (Figure 1a),[1] we now demonstrate this concept experimentally.

The experimental schematic involved iterative determinations of the difference in the charge neutrality point (CNP) of graphene in a particular gas environment at two constant TV's applied separately to the gate (See Figure 1c). This CNP difference (CNP disparity) was observed in various environments: dry air, 100 % N_2 and 100 % O_2, Ammonia/N_2, and (84 ppm, 5ppb, 2ppb, 1ppb) Ammonia/Real Air (the latter is shown in Figure 1d), and shown to be characteristic of each environment. Additionally, a 'quasi-equilibrium distribution' of adsorbed gases on graphene as a function of ambient temperature and pressure was also observed.

In conclusion, we demonstrate a proof-of-concept of the CNP disparity method as a facile technique for simultaneous gas detection and ambience characterization with ppb level sensitivity.

Acknowledgments: This research is supported by TAIYO YUDEN Co. Ltd and Grant-in-Aid for Scientific Research No 18k04260 from Japan Society for the Promotion of Science (JSPS).

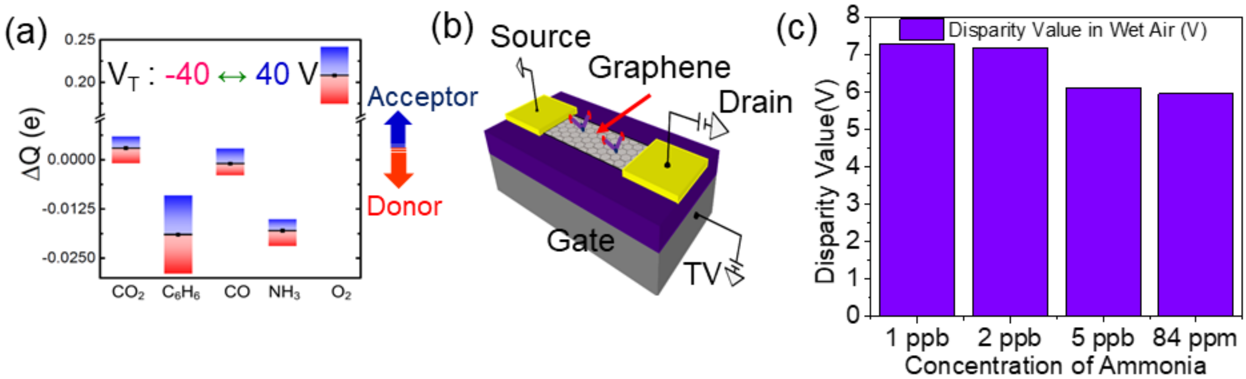

Fig.1 (a) Tunable charge transfer characteristics of some selected gases (b) Device schematic (c) CNP disparity for NH_3 in real air.

Reference:

[1] M. Muruganathan, J. Sun, T. Imamura, H. Mizuta, *Nano Lett.* **2015**, *15*, 8176.