Engineering of graphene nanoribbon surface for low concentration ethanol gas sensing

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Ethanol is a renewable resource, which is used in the food, paints, biomedical, beverage industries, and biochemistry. However, the inhaling of ethanol gas molecules leads to addictive disorders in human beings [1-2]. Graphene is one of the promising 2D materials in the field of gas sensing due to its high surface area, low electrical noice, large conductivity, and sensitivity. However, the main drawback of gas sensors based on graphene and graphene oxide devices is good sensitivity only at high concentrations (> 100 ppm) [3].

Surface functionalization of graphene surface is one of the promising approaches to achieve enhanced sensing property even at low concentration and temperature. Herein, we report a novel activated carbon functionalized graphene nanoribbon for effective ethanol gas sensing at low concentrations. Functionalized activated carbon on the surface of graphene nanoribbon didn't modify the work function and we also observed the ambipolar behavior with slight p-doping as shown in the results.

Fig.1a shows the schematic illustration of the graphene nanoribbon FET sensor, which was exposed to ethanol gas during the measurements. Fig.1b shows the SEM image of the fabricated device with 200 nm × 200 nm CVD monolayer graphene nanoribbon on SiO_2/Si substrate. Fig. 1 c displays the I_d vs V_g measurement of GNR sensor under vacuum and 13.4 ppm concentration of ethanol at 150 °C. These results revealed that the physically adsorbed ethanol molecules act as donors and results in to shift in the charge neutrality point towards the negative gate voltage. The ethanol molecules are adsorbed on the surface of graphene via its oxygen lone pair of electrons, which also donate the electrons to the graphene. Also, ethanol molecules with lower electron affinity lead to electron donors and transfer its electron to graphene. Details of the different ethanol concentrations results will be discussed in the presentation.

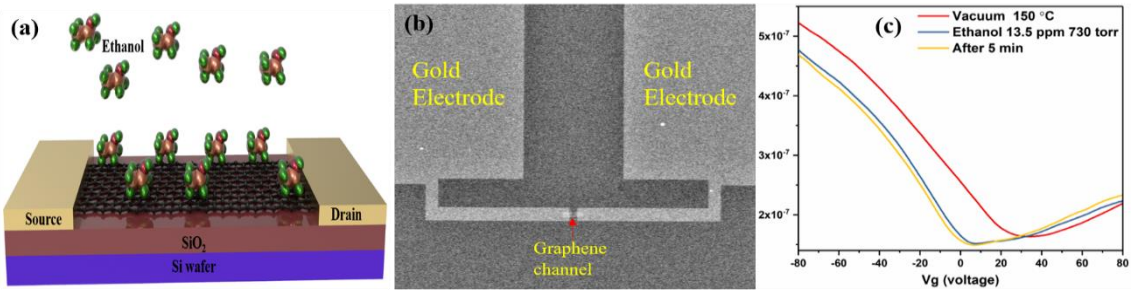

Fig. 1 Schematic illustration of GNR sensor, (b) SEM image of GNR device (c) I_d-V_g characteristics under Ethanol gas

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Reference [1] **V**.Tomer, ACS Omega., 2,7, 2017, 3658-3668. [2] A. Umar et al., Chem. Phys. *Lett.* 2021, 763, 138204. [3]. Y. Liu et al., Transducers, 961-964, 2015. 18th Iinternational conference on solid state sensor. Actuators and microsystems (TRANSDUCERS).