Spatial modulation of graphene's chemical potential

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Controlling graphene's chemical potential is significant for photonic and plasmonic applications since this provides a way to modulate its optical properties at the core of tunable/reconfigurable devices [1]. In addition, chemical potential spatial control would allow us to engineer doping profile areas in graphene thus enabling the development of novel components without patterning the graphene sheet nor implementing complex matrices of electrodes [2, 3].
We here propose and characterize a structure to achieve spatial modulation of graphene's chemical potential by using charge transfer between graphene and transition metal oxide [4, 5]. Graphene is transferred onto a structure, which consists of a patterned 10nm-thick layer of tungsten oxide (WO_3) deposited onto 90nm-thick silica layer on a silicon substrate. Depending on the supporting material, namely silica or tungsten oxide, graphene is expected to have a different chemical potential. Nano-XPS scans indeed suggest a chemical potential shift of 0.1eV between graphene areas in contact with either silica or tungsten oxide, which is further confirmed by Raman spectroscopy cartography.
This approach paves the way towards an easy implementation of spatial doping modulation in graphene without patterning or chemical modification of graphene.

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References

[1] Q. Bao and K. P. Loh, ACS Nano, 6 (2012) 3677-3694
[2] R. El-Ganainy *et al.*, Nature Physics, 14 (2018) 11-19
[3] P. A. Huidobro *et al.*, ACS Nano, 10 (2016) 5499-5506
[4] J. Meyer *et al.*, Scientific Reports, 4 (2014) 1-7
[5] M. T. Greiner *et al.*, Nature Materials, 11 (2012) 76-81
[6] J. E. Lee *et al.*, Nature Communications, 3 (2012), 1024

Figures

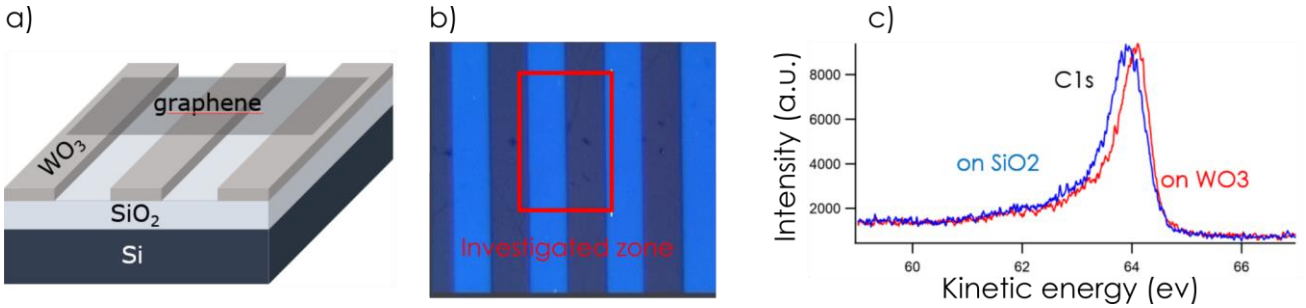

Figure 1: a) Schematic of the structure, b) optical micrograph of the sample's surface with the investigated area indicated by the red contour and c) Nano-XPS carbon C1s core-level spectra of graphene in contact with SiO2 (blue) or WO3 (red).