Effect of interface states on the electronic properties of Graphene on SiO_2 substrate

Anil Kumar Singh
Anjan Kumar Gupta

Indian Institute of Technology Kanpur, Kanpur-208016, India

skanil@iitk.ac.in

The role of electronic states at graphene-SiO_2 interface leading to electronic inhomogeneities in graphene is investigated using scanning tunneling microscopy and spectroscopy. Local tunnel conductance spectra show two minima, which evolve along the bias-voltage axis with the back gate voltage. This evolution is modeled using the effect of tip-gating and interface states. We found a broad energy dependent interface states' density, D_{it} (E) leading to an effect similar to a reduction in the Fermi velocity while a narrow D_{it} (E) leads to the pinning of the Fermi energy close to the Dirac point. The spatial evolution of electronic inhomogeneity with back-gate voltage shows a systematic reversal of contrast in some places in the STS maps and sharp changes in cross-correlations between topographic and conductance maps, as the Fermi level approaches the Dirac point. These are attributed to the change in charge-state of interface defects. The spatial correlations in the conductance maps are described by two different length scales whose growth during approach to Dirac point shows a qualitative agreement with the linear screening theory of graphene within random phase approximation.

Further, these interface states are utilized for reversibly controling the doping in graphene by manipulating charge state of the interface defects. With careful interface preparation we have been able to make devices with negligible hysteresis at room temperature and by exploiting hysteresis at high temperatures, due to interface states, we get a wide, but reversible, tunability of interface charge density and graphene doping, by cooling to room temperature under gate-voltage.

References

[1] A. K. Singh and A. K. Gupta, J. Phys. Condens. Matter, 29 (2017) 385302.
[2] A. K. Singh and A. K. Gupta, arxiv, 1706.08703 (2017).
[3] A. K. Singh and A. K. Gupta, J. Appl. Phys., 122 (2017) 195305.