Probing quantum interference effects in epitaxial graphene by STM and magnetotransport studies

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A comprehensive understanding of the relationship between growth conditions and the resulting atomic and electronic structure is expected by characterizing the morphology of grown graphene layers which also allows comparing the mechanisms of electron diffusion in graphene and hence controlling the charge transport through it. The graphitization can be achieved under ultra-high vacuum (UHV) conditions or in controlled atmosphere, starting from either the 6H-SiC(0001) (Si face) or 6H-SiC(000-1) (C face) surfaces. The resulting graphene layers have different disorder and morphologies depending on the growth conditions.

We present the scanning probe characterization of a gently graphitized 6*H*–SiC (0001) [1] surface prepared under ultra-high vacuum conditions and compare it with low temperature magneto-transport studies. The general surface morphology and atomically resolved Local Density of States (LDOS) is mapped by Scanning Tunneling Microscopy (STM). The differentiation between mono- and bi-layer graphene, presence of defects and interlayer coupling is determined by STM. LDOS mapping demonstrates the observation of quantum interference effects when quasiparticles are scattered off graphene edges, where the later represents line defects. The quantum transport properties are quite sensitive to the nature of disorder in graphene, due mainly to the presence of two additional symmetries: the symmetry between A and B sites in the unit cell (isospin) and the symmetry between the different valleys K-K' (pseudospin). The nature of disorder (local defects or folds in graphene sheets for example), is responsible for locally breaking either of these symmetries, opening intra- and intervalley scattering processes [2].

Depending on the intrinsic disorder observed in the sample's morphology and on its mobility, the magneto-resistance shows either the conventional weak localization when intervalley scattering is strong or the weak anti localization (WAL), in agreement with the recent WAL theory for graphene [3]. Typically, the feature at small values of magnetic field, show a negative magneto resistance characteristic of weak localization, whereas at larger field a positive magneto resistance typical of anti-localization is observed. The weak localization at small fields depends only upon the phase coherence time, whereas the high field behaviour is dominated by a combination of the intervalley and intravalley scattering time. Each of these scattering times can be extracted from the magneto resistance curves and correlated to the surface morphologies. The consistency of this analysis has been checked using a "universal" scaling for the magneto-transport which will be presented [4].

References

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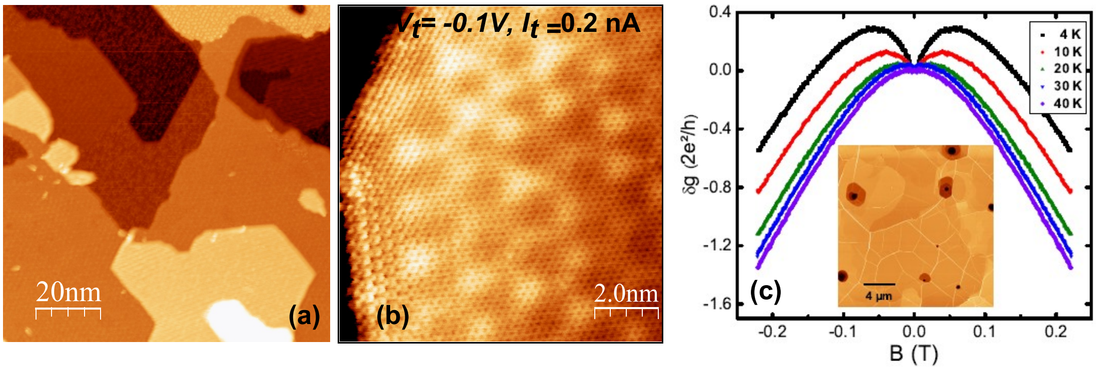

Figure 1: (a) STM topographic image of graphene on Si face SiC showing terraces of buffer zone, monolayer and bilayer graphene. (b) Low bias STM image of zig-zag and armchair edges present on a monolayer graphene on SiC. (c) Magnetoresistance curves for mulitlayered graphene samples grown under Ar atmosphere (shown in inset).