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The electronic structure of graphene induced by substrate interaction

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Monolayer graphene (MG) is a new two-dimensional allotrope of carbon, which possesses unique electronic properties due to massless Dirac fermion character of charge carriers, which derives from the conical dispersion relation close to the Dirac point. It has been shown that this type of dispersion relation leads to the occurrence of quantum Hall effect, ballistic transport of electrons, electronic spin transport, micron scale coherence length and Klein tunneling and scattering.

However, it has been demonstrated that the presence of different adsorbates and substituting atoms leads to the significant modification of the electronic properties of this material. In particular, graphene conical dispersion relation can be also modified by the charge carrier transfer from the substrate, which is exhibited by shift of Fermi level relative to the Dirac point [1].

We present studies of graphene deposited on different substrates using Scanning tunneling microscopy/spectroscopy (STM/STS), atomic force microscopy (AFM), low energy electron diffraction (LEED), Angle Resolved X-ray Photoelectron Spectroscopy (ARXPS) and Angle Resolved Photoelectron Spectroscopy (ARPES). Samples were prepared by both CVD growth, where propane gas was used as a carbon precursor [2], and mechanical exfoliation. Our results recorded on the mono- and bilayer of graphene deposited SiO_2, SiC, TiO_2, and metallic substrates like Cu(111) and Cu foils clearly show that substrate significantly modifies graphene electronic structure and changes its corrugation. Depending on substrate, the Fermi level shift downwards or upwards relative to the Dirac point, which means that either holes or electrons are donated to the graphene. It is worth pointing out that these changes are also visible for non-conducting or semi-conducting substrates and can be changed locally in nanoscale. Our findings were confirmed by Density Functional Theory (DFT) calculations.

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