Scanning Tunneling Spectroscopy (STS) studies of Graphene-Au interactions

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Graphene, an allotrope of carbon, has exciting potential for electronic applications. However, properties of graphene can be affected by the substrate it has been deposited on. It is crucial to understand the nanoscale electronic properties of graphene in terms of the electron density of states (LDOS) on different substrates. In case of some metallic substrates (Al, Cu, Ag, Pt and Au) the conical shape of dispersion relation is preserved [1-3]. However, presence of doping effect has been established - position of Dirac point (E_D) relative to Fermi level (E_F) is shifted. It it especially vital in case of Au, which is widely used as contacts in graphene-based devices.

We present scanning tunneling microscopy and spectroscopy (STM/STS) investigations of graphene on Au substrate [4, 5]. Mono-, bi- and tri- graphene layers (MG, BG, TG) were deposited on 8nm Au / 0.5nm / 100 nm SiO_2 / Si substrate. This setup allowed for both optical microscopy (OM) identification of graphene layers and measurements of uninterrupted electronic structure of graphene/Au system. Graphene has been identified with OM, Raman Spectroscopy (RS) with Renishaw InVia spectrometer and scanning electron microscopy (SEM) using Vega Tescan microscope. STM/STS experiments were conducted using VT-STM/AFM microscope integrated with the XPS/UPS/AES/LEED/MULTIPROBE P system (Omicron GmbH) in room temperature. Experimental results has been confronted with theoretical predictions.

STS investigations of LDOS prove that graphene on Au substrate is doped with holes. For MG Dirac point is shifted to 0.25 – 0.45 eV above Fermi level (Fig. 1b). In case of BG doping is ranging from 0.22 to 0.30 eV. For TG doping value is about 0.10 – 0.15 eV. This shows that value of doping decreases with increasing number of graphene layers. CITS maps presented on Fig. 2b show heterogeneity of LDOS between MG, BG and TG regions. In case of MG, shift of Dirac point has been compared with theoretical values obtained using local density approximation and van der Waals density functionals.

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References

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Figures

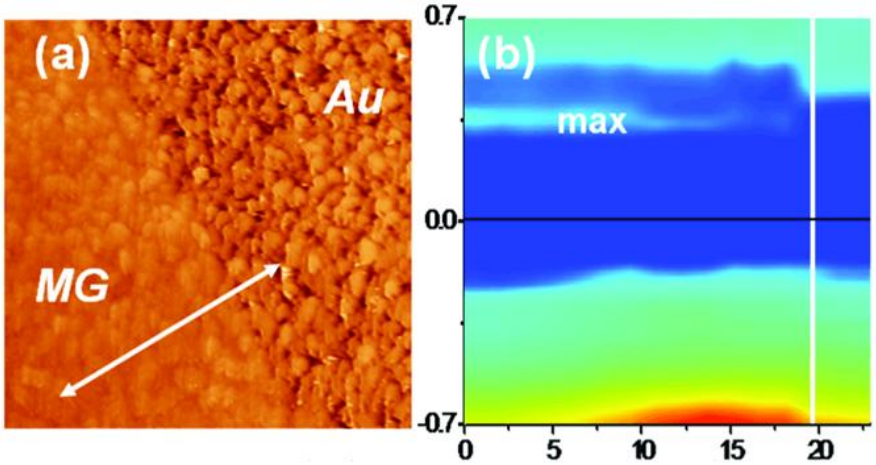

Fig. 1 a) 450 nm x 450 nm STM topography showing the details of MG and Au border line. **b)** dI/dV (E, line) map recorded on MG/Au border along the arrow in Fig. 1 a).

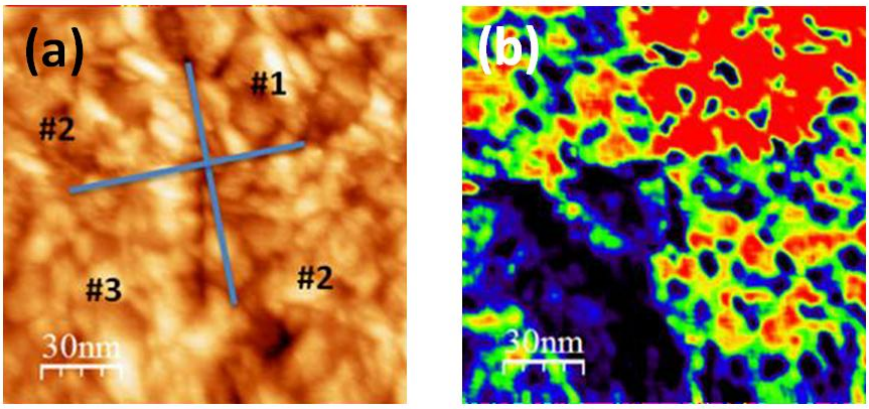

Fig. 2 a) 150 nm x 150 nm STM topography of MG/BG/TG region. Numbers denote number of graphene layers. Grey lines represent borders. **b)** dI/dV map of region presented in a) for 0.08 V