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Bilayer graphene device: Fabrication and characterization of the electronic transport properties

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Abstract – In this work, we present a method for fabrication of graphene bilayer devices by using laser beam lithography, where double-layer graphene were obtained by micromechanical cleavage technique of graphite that produced large graphene samples up to 30µm in size. The number of graphene layers was verified by resonant Raman spectroscopy. We have measured the magnetoresistance and Hall resistance as a function on the back-gate voltage and found initially p-type doping in graphene, but annealing inside cryostat at 127C° in He, the samples become n-type. Our measu rements show mobilities in the range of 1,000cm^2/V-s.

One of the major challenges to explore the physics of graphene is the reliable fabrication of multiterminal devices with well defined geometries. The bilayer graphene flakes were obtained micromechanical exfoliation (repeated peeling) of graphite from National Company of Graphite and transferred to Si substrate with a 300nm-thick SiO_2 layer which allowed quick recognition of the bilayer graphene sheets by contrast optical [1]. Typically, graphene bilayer films of lateral size 5-10µm are chosen for device fabrication. The AFM (Atomic Force microscopy) height profile analysis shows an apparent height of ~1.5nm (Fig1a). Unambiguous verification of the number of deposited graphene layers is performed by resonant Raman spectroscopy through G peak and 2D band features in bilayer graphene (Fig1b) [2].

After a suitable graphene sample has been selected, all the device processing, from the localization of graphene on the substrate to the fabrication of electrical contacts are performed using direct writing photolithography with a laser beam equipment (Microtech LW405). Bilayer graphene flakes can be precisely located using built-in infrared illumination, with the photoresist already on top of the substrate. No mask is needed since this is a direct writing process. We have studied various process parameters in order to optimize the contact resistance between graphene and metallic micro-electrodes.

Magnetoresistance and Hall resistance measurements as a function on the back-gate voltage show initially a shift of the Dirac peak to a value of V_g~30V, that it is attributed an unintentional p-type doping by absorbed water, however, samples annealing inside cryostat at 127Cº in He atmosphere, the Dirac peak changes to a value of V_g~-30V (Fig2a). Annealing in graphene led to n-type behavior. Quantum Hall effect plateaus in longitudinal resistance and Hall resistance are observed for magnetic fields up to 15T (Fig2b). Carrier mobilities in our bilayer devices were typically around 1,000 cm^2/V-s, which is lower than for devices made from single-layer graphene [3]. Nonetheless, graphene devices fabricated make an overview of our work in electrical transport and also of the future prospects and developments that we expect to achieve.

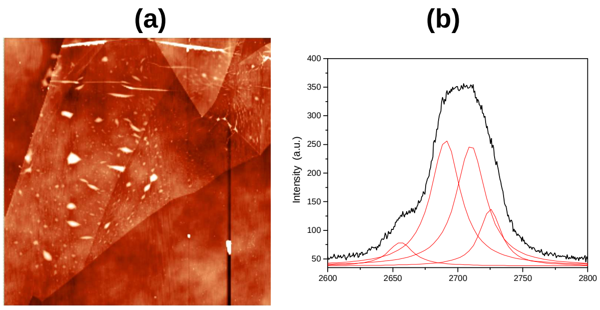

Figure 1: a) AFM image of micro-cleavved graphite. **b)** The 2D band Raman spectra at 514nm used for determining of number of layers .

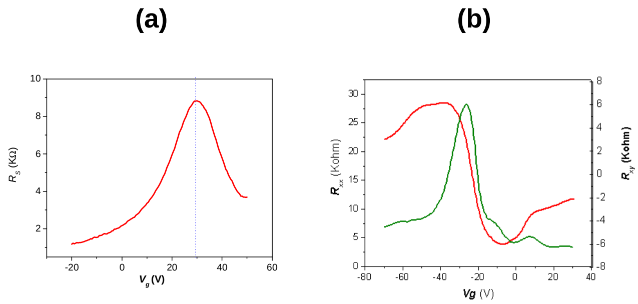

Figure 2: a) Typical dependence of the magnetoresistance on back-gate voltage. **b)** Magnetoresistance and Hall resistance at B=15T and T=7K.

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