Electronic and morphological properties of the graphene/Ge(110) interface as a function of temperature

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Investigating the interfacial properties between graphene and traditional semiconductors is crucial to develop novel electronics. In this context, graphene/Ge(110) heterostructure has recently received a great deal of attention [1,2]. However, no insights into the electronic and morphological properties of this system are today available. Here, we investigate the evolution of the system's interface properties upon vacuum annealing performed at different temperatures [3,4]. We use low-temperature scanning tunneling microscopy (STM) to probe the surface structure with atomic precision at each stage. When growing graphene by chemical vapour deposition, hydrogen that is used during growth passivates the Ge surface sites thus stabilizing the unreconstructed surface. Annealing the sample at 350°C leads to the desorption of hydrogen from Ge surface and both STM and low energy electron diffraction (LEED) reveal that the surface of Ge(110) reconstructs into a (6x2) phase, never observed for bare Ge. Upon a further annealing above 700°C, STM shows that the Ge surface modifies forming a different surface reconstruction with a symmetry close to the bulk truncated surface. To gain insights into the electronic properties, we perform angle-resolved photoemission spectroscopy (ARPES) for each of the observed phases. The ARPES data (Fig. 1), show how graphene's doping changes at each phase. Data obtained by ARPES are correlated to Raman spectroscopy, X-Ray Photoelectron Spectroscopy, and Near Edge X-ray Absorption Fine Structure Spectroscopy.

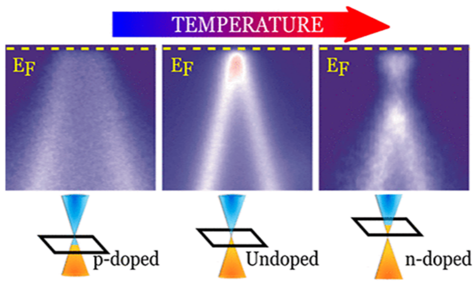

Fig. 1. ARPES data and graphene Dirac cones as a function of temperature. Fermi points are reported as "E_F".

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