Dynamics and Electron-Phonon Coupling in Graphene Heterostructures from Helium Atom Scattering

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In Helium atom scattering (HAS) spectroscopy of conducting surfaces, the exchange of energy and momentum with surface and subsurface phonons occurs via the electron-phonon coupling (EPC). Thus, as shown by Sklyadneva *et al.* [1], inelastic HAS amplitudes from surface vibrational modes are proportional to the mode-selected EPC, while the temperature-dependent HAS Debye-Waller (DW) exponent was shown to bear information on the total EPC (mass-enhancement factor λ_{HAS}) [2]. In this talk, after a brief illustration of HAS spectroscopy and the main theoretical concepts, the application to graphene monolayers on different metal substrates is discussed. It is shown that the EPC, as derived experimentally from the DW exponent temperature dependence, increases by decreasing the graphene-substrate coupling force constant [3].

Further recent studies on more complex graphene heterostructures, like a bilayer graphene (BLG) on a 6H-SiC(0001) substrate, which is made quasi-freestanding via a carbon buffer layer, or an intercalated atomic hydrogen passivation, or a 2D polar gallium bilayer [4], provide evidence of an enhanced EPC in BLG systems (λ_{HAS} in the range 0.27−0.33), as compared to the above studies on single layer graphene samples on metal substrates.

A thorough study on the structure, phonon dynamics and EPC in 1ML-$NbSe_2$/BLG/SiC(0001) [5] demonstrates the power of high-resolution HAS spectroscopy, by revealing the 9x9 supercell of the $NbSe_2$ monolayer on BLG and the important role of moiré phonons. The specific effects of moiré phonons and of the BLG interfacing on the EPC and the superconductivity T_c of the $NbSe_2$ monolayer is finally discussed in some detail.

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