Interplay of electron-phonon and electron-electron interactions in gate modulated Raman spectroscopy of graphene

Eddwi Hesky Hasdeo, Ahmad Ridwan Tresna Nugraha, Riichiro Saito

Tohoku University

Contact e-mail: *hasdeo@flex.phys.tohoku.ac.jp*

The electron-phonon and the electron-electron interactions interplay in graphene and are observed in the Raman spectra around ~1600 cm $^{-1}$ (G band). The existence of the gapless linear energy bands (Dirac cones) in graphene modifies phonon energy, spectral broadening, and spectral lineshape of the Raman spectra. One of the well-known phenomena is the Kohn anomaly effect, in which the phonon energy (lifetime) becomes lower (shorter) due to the interaction between a phonon and an electron-hole pair in the linear energy band. The other phenomenon is the asymmetric spectral shape of phonon spectra, also known as the Breit-Wigner-Fano (BWF) lineshape, which long been observed in metallic nanotubes and recently observed in graphene as a function of Fermi energy. The origin of the BWF lineshape in graphene is due to the quantum interference effect of phonon spectra with the electronic Raman spectra (ERS) [1]. Taking both phenomena into account, we successfully reproduce the Fermi energy dependence of frequency shift, spectral linewidth, and spectral asymmetry of the G band Raman spectra [2].

[1] E. H. Hasdeo et al., PRB 88, 115107, (2013)

[2] E. H. Hasdeo et al., PRB 90, 245140, (2014)