The electron-phonon and the electron-electron interactions interplay in graphene and are observed in the Raman spectra around \( \sim 1600 \text{ cm}^{-1} \) (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].