Intrinsic and extrinsic temperature dependences of Raman spectra of graphene 

DANER ABDULA, TANER OZEL, KWANGU KANG, DAVID G. CAHILL, MOONSUB SHIM, University of Illinois Urbana-Champaign — Implementation of single-layer graphene (SLG) into next-generation electronics is of high interest due to unprecedented transport capabilities. Therefore, the importance of SLG doping and vibrational band structure is pronounced, both of which can be characterized with Raman spectroscopy. This work offers insights on the temperature dependent behavior of energy and linewidth of $E_{2G}$ G-band and $A_1'$ 2D-band Raman spectral features of intrinsic and air-exposed SLG. Mechanically exfoliated graphene in air exhibits a G-band linewidth that increases with temperature between 298K and 573K but shows an opposite trend after annealing under Ar. The opposing temperature dependences are considered within the context of Kohn anomaly induced phonon softening and broadening. The primary cause of the changes in $E_{2G}$ phonon energy and the electron-phonon coupling is attributed to ambient O$_2$ shifting the Fermi level away from the Dirac point. Our results emphasize the need to consider sample environment when investigating electronic and vibrational properties of graphene as well as when they are utilized, for example, in devices where SLG would undergo lithographic processing or even be operated in contact with various materials that may compromise its supposed high performance.

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