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Stokes and anti-Stokes Raman scattering in mono- and bilayer graphene

Abstract
Stokes and anti-Stokes Raman spectroscopy associated with the intervalley double resonance process in carbon materials is a unique technique to reveal the relationship between their characteristic electronic band structures and phonon dispersion. In graphene, the dominant resonant behavior for its 2D mode is an intervalley triple resonance Raman process. Here, we report the Stokes and anti-Stokes Raman scattering of the 2D mode in pristine graphene. The excitation energy (E_{ex})-dependent frequency discrepancy between anti-Stokes and Stokes components of the 2D mode ($\Delta\omega(2D)$) is observed, which is in good agreement with the theoretical results. E_{ex}-dependent $\Delta\omega(2D)$ is attributed to the nonlinear dispersion of the in-plane transverse optical (iTO) phonon branch near the K point, confirmed by the nonlinear E_{ex}-dependent frequency of the 2D mode ($\omega(2D)$) in the range of 1.58–3.81 eV. The wavevector-dependent phonon group velocity of the iTO phonon branch is directly derived from $\Delta\omega(2D)$. We also report Stokes and anti-Stokes Raman scattering of the D mode in defected graphene and the 2D mode in bilayer graphene associated with intervalley double resonance Raman processes.

References

[1] Xin Cong et. al, Nanoscale, 34 (2018) 16138

Figures

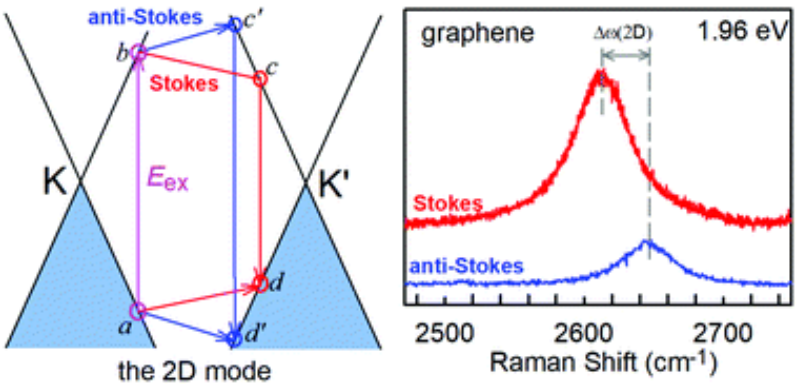

Figure 1: Left panel, Stokes and anti-Stokes Raman scattering of 2D mode. Right panel, Stokes and anti-Stokes Raman spectra of 2D mode with E_{ex}=1.96 eV.