Effect of film corrugation on the optical phonon lifetime in graphene

PETER EKLUND, Department of Physics, Department of Material Science and Engineering, Pennsylvania State University, University Park, PA 16802, AWNISH GUPTA, Department of Physics, Pennsylvania State University, University Park, PA 16802 — We present results of a microRaman study of n-layer graphene films supported on ~atomically flat mica, Si/SiO$_2$ (or varying roughness) and suspended above a trench. Using the Raman G-band line width $\Gamma_G$, we find that the optical phonon lifetime $\tau \sim 1/\Gamma$ decreases linearly with increasing rms substrate roughness $\delta$, and independent of the chemical composition of the substrate. In agreement with this general observation, we find that $\Gamma_G$ for unsupported graphene is significantly higher (i.e., the $q=0$ optical phonon lifetime is significantly lower) than observed when the film is supported on mica. Correlating $\Gamma_G$ with values obtained from supported films, we infer an inherent rms roughness $\delta \sim 2$ nm for unsupported graphene, in reasonable agreement with recent STM reports that first suggested that graphene might prefer to spontaneously convert to a corrugated system. Our observations may then relate to the effect of the local bending of the sp$^2$ sheet on the electron-phonon interaction.

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