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A study on defective graphene: correlating Raman and transport measurements, and towards strain effects

Abstract: Although previous studies had reported Raman and weak localization properties of graphene separately, very few studies examined the correlation between Raman and weak localization characterizations of graphene. Here, we report a Raman spectroscopy and low magnetic field electronic transport study of graphene devices with a controlled amount of defects introduced in graphene by exposure to electron-beam irradiation and oxygen plasma etching. The relationship between the defect correlation length, calculated from the Raman “D” peak, and the characteristic scattering lengths computed from the weak localization effects measured in magnetotransport was investigated. Furthermore, the effect on the mean free path length due to increasing amounts of irradiation incident on the graphene device was examined. The dependence of parameters on the increase of irradiation was shown to be related to the increase of disorder through the concomitant decrease in mean free path length. These findings are valuable for understanding the correlation between disorder in graphene and the phase coherence and scattering lengths of its charge carriers. In the next step we will also transfer such defective graphene on ferroelectric substrates such as PMN-PT and we will discuss the potential strain tuning effects and applications.

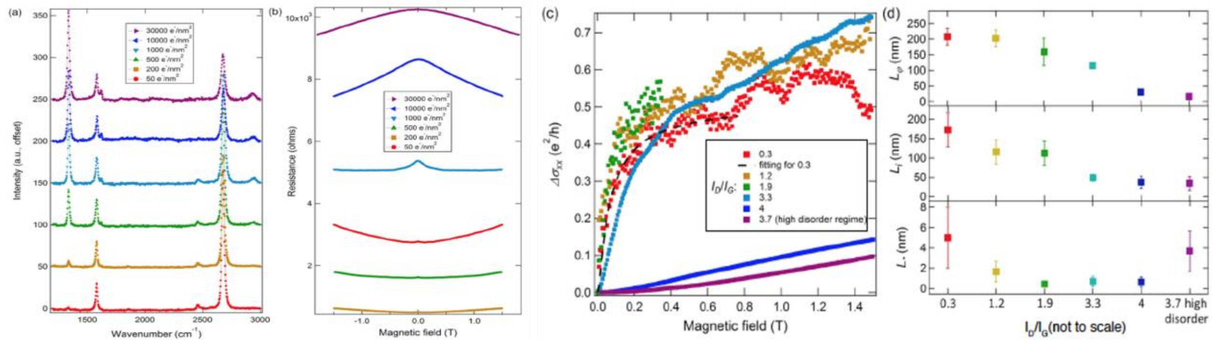

Figure 1: Disorder Induced by e-- Beam Exposure (a) Raman spectra (excitation wavelength 532 nm) of graphene for a progression of accumulated electron-beam exposures show an increase in the disorder-induced ‘D’ peak with increased radiation exposure. The spectra are offset vertically for clarity. (b) Magnetic field versus measured dependent resistance yield symmetric line shapes that notably develop a central resistance peak associated with weak localization (c) Average change in conductivity versus magnetic field for the same progression of accumulated electron-beam exposures which are denoted by their ID/IG ratio derived from part (a). (d) A comparison that shows the decrease of scattering length for low to high disorder samples as indicated by the increasing ID/IG ratio. Weak localization scattering lengths are derived from the conductivity curves in (c).