Suspended graphene under moderate intrinsic strain

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Abstract

Graphene is a perfect 2D covalent crystal, which forms the basis of all graphitic structures[1]. It can be stacked into three-dimensional graphite, rolled into one-dimensional nanotubes, or wrapped into zero-dimensional fullerenes. Due to its inherent properties and the great variety of possible applications graphene has stimulated a lot of theoretical and experimental research over the last decade. The mechanical properties of graphene make it an ideal candidate for micro and nano-mechanical applications. Graphene has intrinsic tensile strength higher than any other known material and tensile stiffness similar to values measured for graphite[2]. Furthermore, mechanical deformation (strain) can be used to tailor its electronic properties[3] allowing the fabrication of all-graphene circuits. In addition, certain strain configurations are equivalent to high pseudo-magnetic fields[4]. Therefore, the understanding of graphene properties under strain is of great importance.

In this work, a graphene flake was sandwiched between two PMMA layers and was suspended in air by removing a section of the polymer with e-beam lithography. This procedure resulted in the imposition of true uniaxial tension to graphene of up to 0.8% strain (fig.1), as confirmed by laser Raman mapping at steps as small as 100 nm along and across the flake. Splitting of the Raman G line as well as of the 2D line was observed. The strain estimated directly from the well-known peak shifts of the Raman G^- sub-peaks. The dependence of Raman shift of G^-, G^+, $2D^1$, $2D^2$ and 2D' modes on strain are presented. Our results are in excellent agreement with the previously reported results for supported graphene and the theoretical predictions for graphene in air.

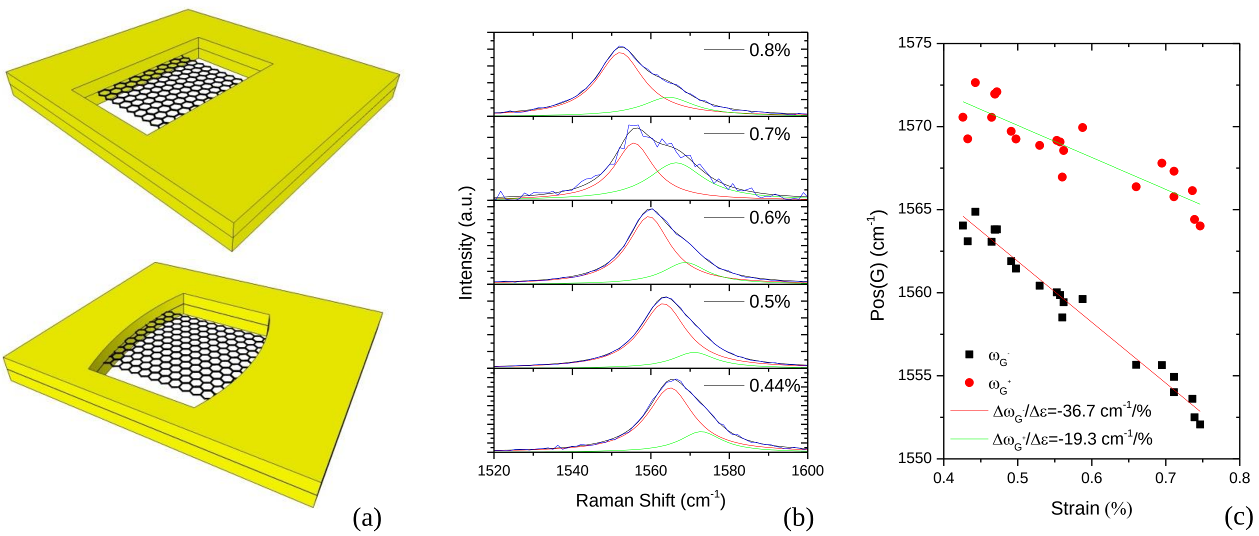

Figure 1 (a) Initial (zero strain) and final (with strain distribution) window (b) Representative Raman spectra of the G-peak at various strain levels (c) G sub-peaks position as a function of strain for suspended SLG

References

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