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Talk Invited Invited Talk

Probing the optical phonons of graphene by mechanical loading

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Central to most applications involving monolayer graphenes is its mechanical response under various stress states. To date most of the work reported is of theoretical nature and refers to tension and compression loading of model graphenes. In this work, graphene flakes are subjected to uniaxial tension and compression using the polymer cantilever beam technique [1],[2]. The mechanical response is monitored by simultaneous Raman measurements through the shift of either the G or 2D phonons of graphene using different excitation wavelengths. The G mode at around 1580 cm^{-1} corresponds to the doubly degenerate E_{2g} phonon at the Brillouin-zone center. The 2D peak at about 2680 cm^{-1} (λ=514.5 nm) is the second order of the D peak which originates from the breathing modes of sp^2 rings and requires a defect for its activation. In tension, the embedded flake seems to sustain strains up to 1.3% in a reversible manner,whereas in compression there is an indication of flake buckling over 0.6% strain. The experimental findings are compared and discussed with changes of the electronic and vibrational properties of graphene under strain, using first principles calculations [3].

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[1] G. Tsoukleri, J. Parthenios, K. Papagelis, et al., *Small* **21**, 2397 (2009).

[2] O. Frank G. Tsoukleri, J. Parthenios, K. Papagelis, et al., *ACS-Nano*, in print (2010).

[3] M. Mohr, K. Papagelis, J. Maultzsch and C. Thomsen, *Phys. Rev. B* **80**, 205410 (2009).