Visible-frequency graphene plasmons

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Abstract

The nanoscale confinement of its charge carriers is an effective approach for engineering the properties of graphene[1,2]. We demonstrate that amplifying the random nanoscale corrugation of graphene, create an edge-free lateral confinement in ultra-small (sub-5nm) areas[3]. This soft confinement allows the low-loss lateral ultra-confinement of graphene plasmons, scaling up their resonance frequency from the native terahertz to the commercially relevant visible range[4]. Visible frequency graphene plasmons enable at least three orders of magnitude stronger Raman enhancements than previously achieved with graphene, allowing the detection of molecules from femtomolar solutions or ambient air with high selectivity. SERS substrates based on nanocorrugated graphene offer a series of practical advantages over conventional nanoparticle films[5], such as much simpler and cheaper fabrication, better reproducibility and highly improved environmental stability of up to several months. Moreover, nanocorrugated graphene sheets also support propagating visible plasmon modes, as revealed by scanning near-field optical microscopy observation of their interference patterns[6,7,8] (Fig.1).

References

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Figures

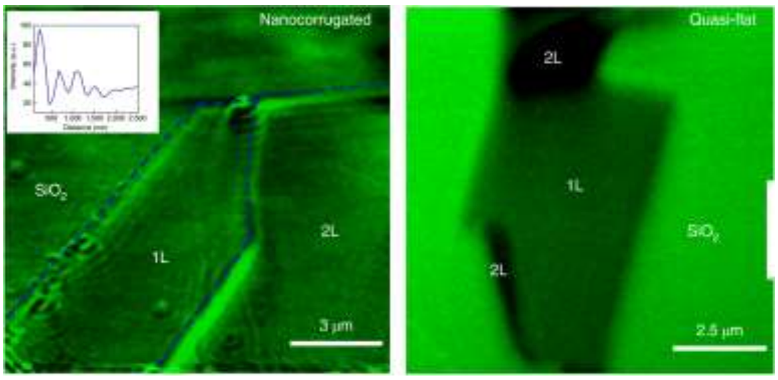

Figure 1: [Left], SNOM image (wavelength λ = 488 nm) of nanocorrugated graphene revealing clear interference maxima and oscillations in the proximity of edges (marked by dashed lines) and defects. The inset shows a line cut perpendicular to the graphene edge. 1L represents the single layer and 2L the bilayer graphene areas on the SNOM images. [Right], SNOM image of quasi-flat graphene recorded under the same conditions, showing no interference patterns