Graphene-coated Metasurface as a 'Visible' Tunable SERS Platform

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Artificially engineered ultra-thin planar optical components, referred to as metasurfaces, can effectively mould the spatial distribution of amplitude and phase of an incident light wave at a sub-wavelength scale. We demonstrate a graphene-coated, metallic metasurface as a robust, uniform and tunable Surface Enhanced Raman Scattering (SERS) substrate and exploit the two-dimensional nature of graphene to probe the enhanced surface electric fields. By patterning sub-wavelength groove arrays of different sizes in the metal, we can enhance the electromagnetic fields and hence the Raman signal at precisely targeted wavelengths of light. We quantitatively establish a link between the absorption in these arrays and the Raman signal enhancement by correlating reflection spectra with the corresponding Raman measurements as a function of the array dimensions. We conclude that the array dimensions required for maximum Raman enhancement lie between the dimensions causing maximum absorption at the excitation and emission wavelengths. Building a SERS platform whose effectivity can be visually inferred using absorption measurements will aid in fast and straightforward prediction of the achievable Raman enhancements. This work opens doors towards generation of what we refer to as 'visual' SERS substrates that no longer rely on the more complex Raman measurements for detecting their potency.

Figures

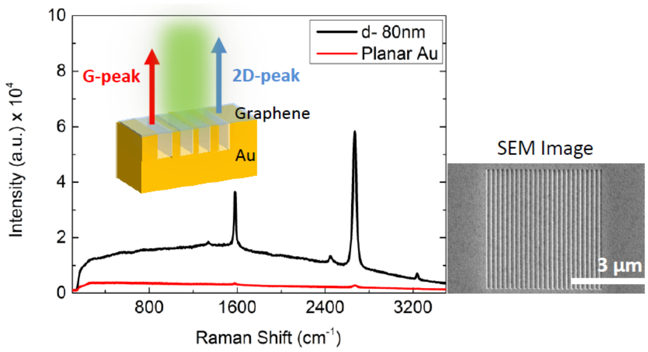

Figure 1: Raman spectrum of graphene on planar Au (red curve), graphene on groove-arrays with a width of 75nm and depth of 80nm (black curve). SEM image of the fabricated gratings. Inset: SERS platform schematic

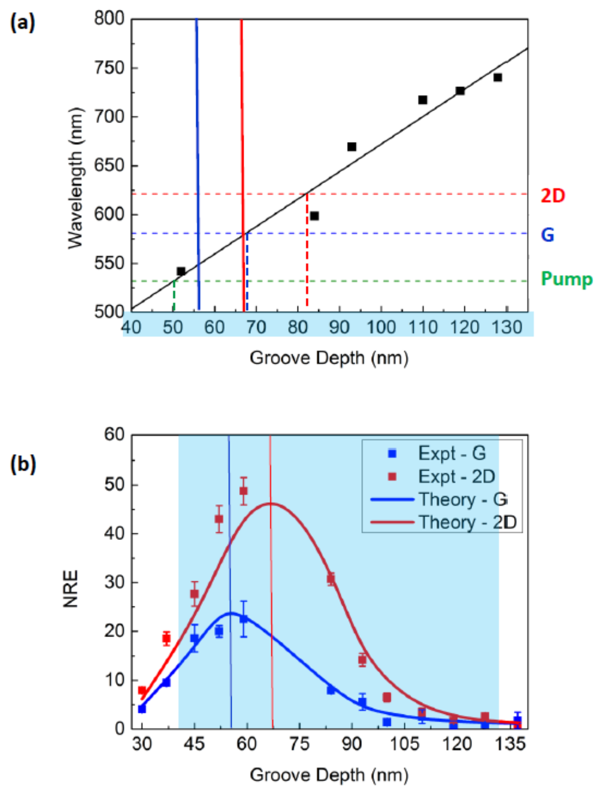

Figure 2: (a) Maximized total absorption wavelength variation with groove depth. (b) Normalized Raman enhancement variation with groove depth for G- and 2D-peaks. Dots represent experimental data points and solid curves are theoretical fits (EM simulations).