Tunable mid-infrared plasmonics in graphene nano-hole arrays fabricated by a scalable technique

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Tunable graphene plasmonics in the mid-IR has great potential for applications in devices such as bio-sensors and photodetectors.[1] A major bottleneck in extending its use beyond academic research is the expensive and low-throughput fabrication technique used to fabricate graphene nanostructures. We present for the first time a detailed experimental study on electrostatically tunable graphene nano-hole array surfaces which can be fabricated by a scalable nanoimprint lithography (NIL).[2] We demonstrate experimentally that such nanostructured graphene surfaces behave as plasmonic crystals, supporting multi-band resonances in the range ~1300–1600 cm^{-1} (Figure 1). The plasmonic response of these nanostructures can be tuned by changing the geometrical parameters and/or applying an electrical voltage. The intensities and quality-factors of the plasmonic response from these nano-hole surfaces fabricated by electron beam lithography (EBL) and NIL are similar (Figure 2). Such large area plasmonic nanostructures are suitable for industrial applications, for example, surface-enhanced infrared absorption (SEIRA) sensing. This is because they combine easy design, extreme field confinement, and the possibility to excite multiple plasmon modes for multiband sensing, a feature not readily available in nanoribbons or other localized resonant geometries.

References

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[2] K. K. Gopalan, B. Paulillo, D. M. A. Mackenzie, D. Rodrigo, N. Bareza, P. R. Whelan, A. Shivayogimath, V. Pruneri, *Nano Lett.* **2018**, *18*, 5913.

Figures

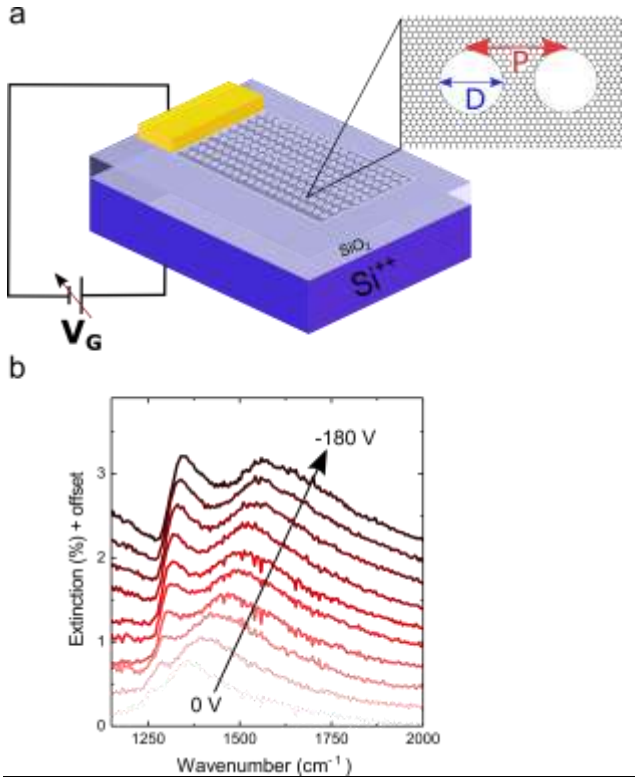

Figure 1: Electrostatic tuning of GNHAs. a) Schematic of the electrostatic tuning of GNHA. b) Experimental extinction spectra as a function of the gate voltage for nano-holes with P = 190 nm and D/P = 0.7. Curves are vertically stacked for clarity.

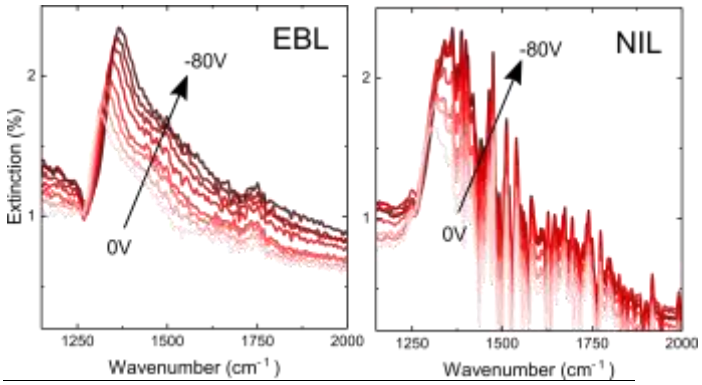

Figure 2: Comparison between the extinction spectra of EBL fabricated and NIL fabricated graphene nano-hole arrays with similar geometric parameters.