

Supplementary Material

Deep-Ultraviolet (DUV)-Induced Doping in Single Channel Graphene for Pn-Junction

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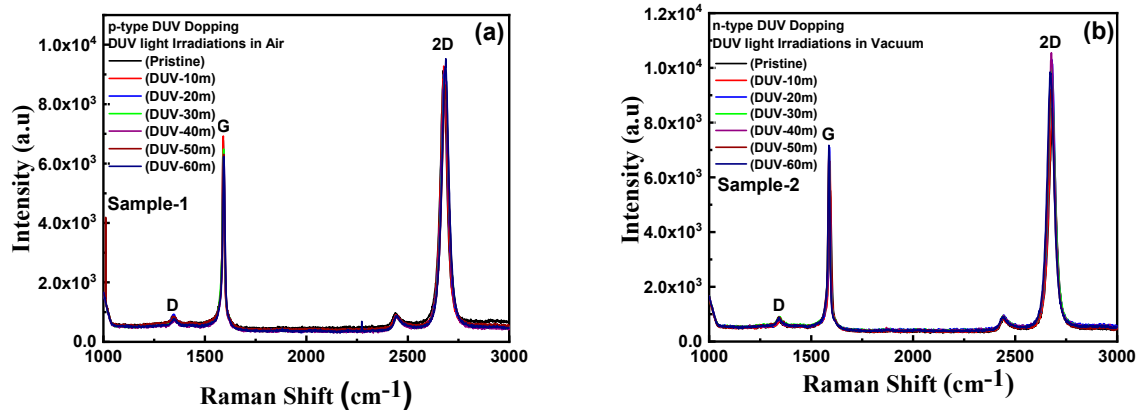


Figure S1: Raman spectroscopy; (a) The Raman spectroscopy analysis for sample-1 with different exposure time to induce p-type doping in graphene by DUV irradiations in air, with different exposure times. (b) The Raman spectroscopy analysis for sample-2 with different exposure time to induce p-type doping in graphene by DUV irradiations in vacuum, with different exposure times.

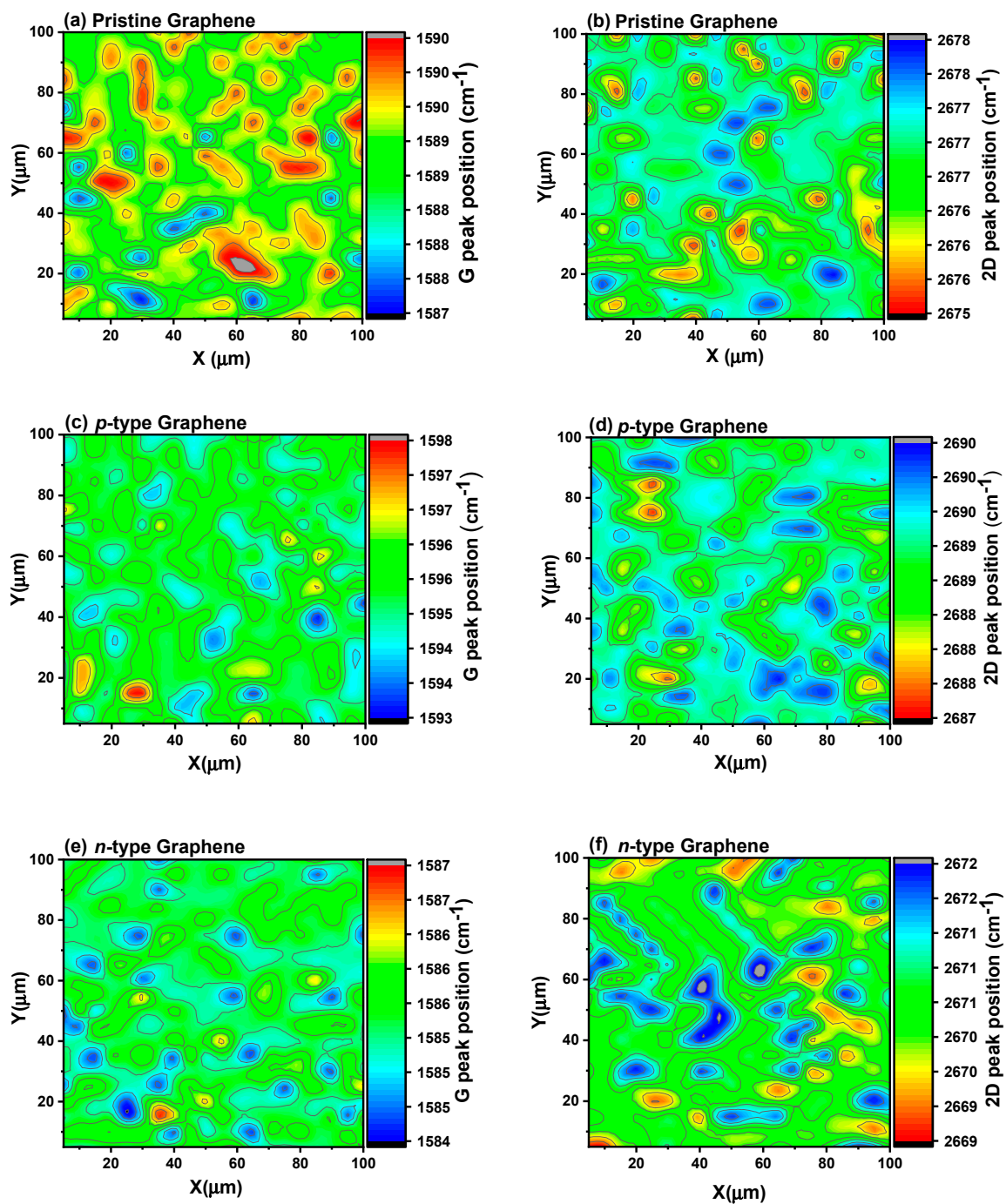


Figure S2 Raman Mapping: (a, b) The Raman mapping for G and 2D peak positions for well-defined area of pristine graphene. (c, d) The Raman mapping for G and 2D peak positions for well-defined area of p-type doped graphene under DUV irradiations in air for 60mins. (e, f) The Raman mapping for G and 2D peak positions for well-defined area of n-type doped graphene under DUV irradiations in vacuum for 60mins.

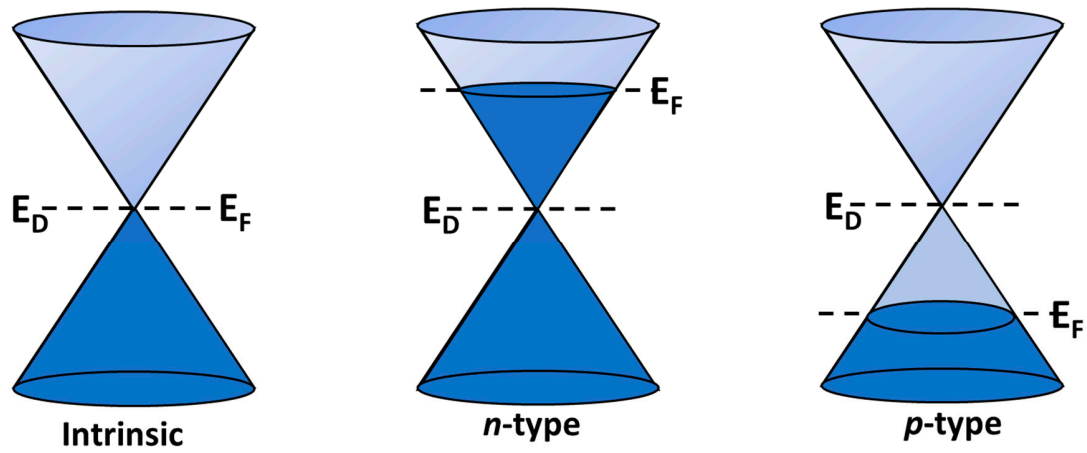


Figure S3 Energy Band Diagram: Energy band diagram for pristine, n-type and p-type doped graphene. Depending on the majority charge carrier concentration the E_F is increased or decreased above or below E_D for n and p type doped samples, respectively.

Table-S1: Hall measurement characteristics

Characteristics	<i>p</i> -type Graphene	<i>n</i> -type Graphene
Bulk Carrier Concentration	$4.77 \times 10^{19} \text{ [}/\text{cm}^3\text{]}$	$-3.426 \times 10^{15} \text{ [}/\text{cm}^3\text{]}$
Sheet Carrier Concentration	$4.808 \times 10^{12} \text{ [}/\text{cm}^2\text{]}$	$-3.413 \times 10^8 \text{ [}/\text{cm}^2\text{]}$
Mobility	$10.198 \times 10^3 \text{ [cm}^2\text{/Vs]}$	$7.006 \times 10^3 \text{ [cm}^2\text{/Vs]}$
Sheet Resistance	$1.084 \times 10^3 \text{ [}\Omega\text{/square]}$	$2.601 \times 10^3 \text{ [}\Omega\text{/square]}$
Average Hall Coefficient	$1.298 \times 10^{-1} \text{ [cm}^3\text{/C]}$	$1.822 \times 10^{-3} \text{ [cm}^3\text{/C]}$

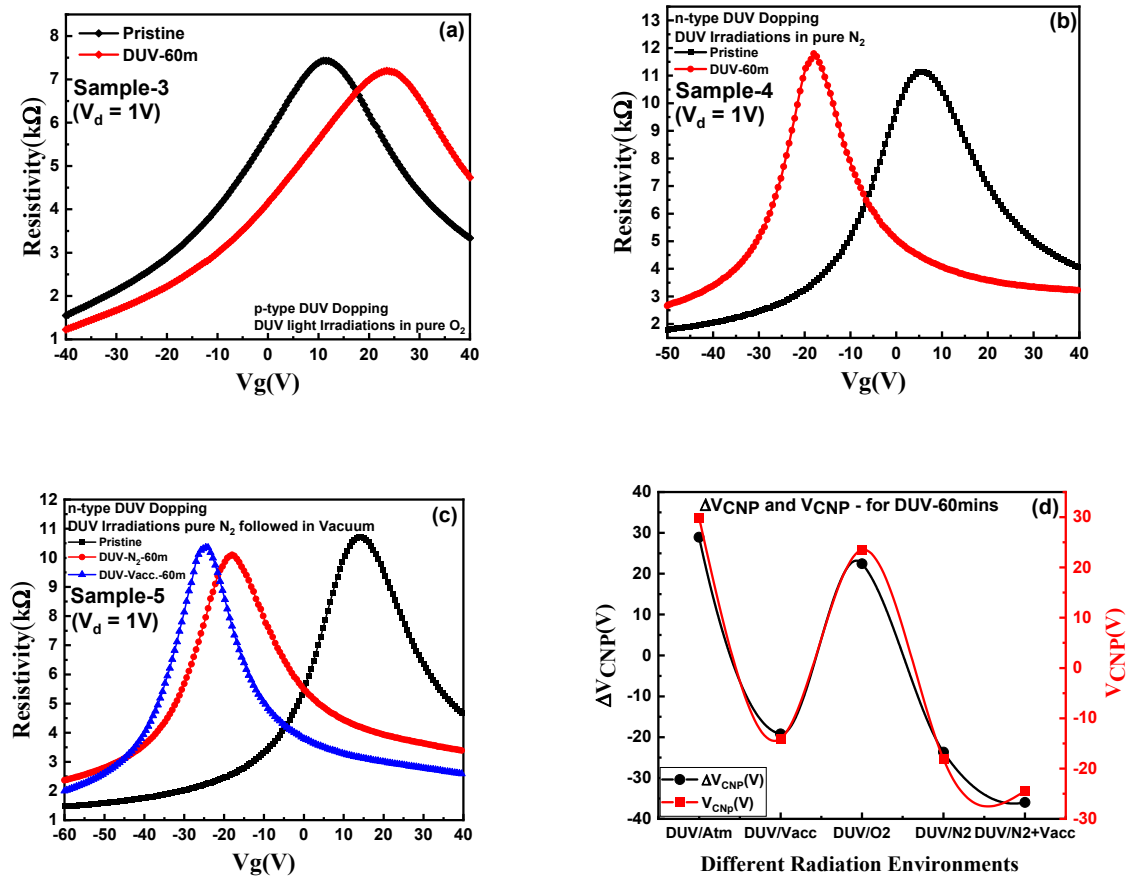


Figure S4 Transfer characteristics and a shift in charge neutrality points (CNP): (a) Transfer characteristic with resistivity as a function of V_g for sample-3 (DUV irradiation in pure O_2) illustrating the p-type doping in graphene, for 60 mins of exposure time. (b) Transfer characteristics of sample-4 (DUV irradiations in pure N_2), exhibiting n-type doping behavior when exposed to DUV irradiations in pure N_2 environment for 60mins. (c) Transfer characteristics for sample-5 (60 min DUV in pure N_2 followed by 60 mins irradiations in vacuum), exhibiting a high n-type doping effect. (d) ΔV_{CNP} (CNP after DUV Doping – CNP Before DUV Doping) and V_{CNP} for DUV doping under different irradiation environments, showing a higher shift in the CNP position under air conditions in p-type doping and pure N_2 followed by vacuum condition in n-type doping, for 60 mins of DUV exposure time.

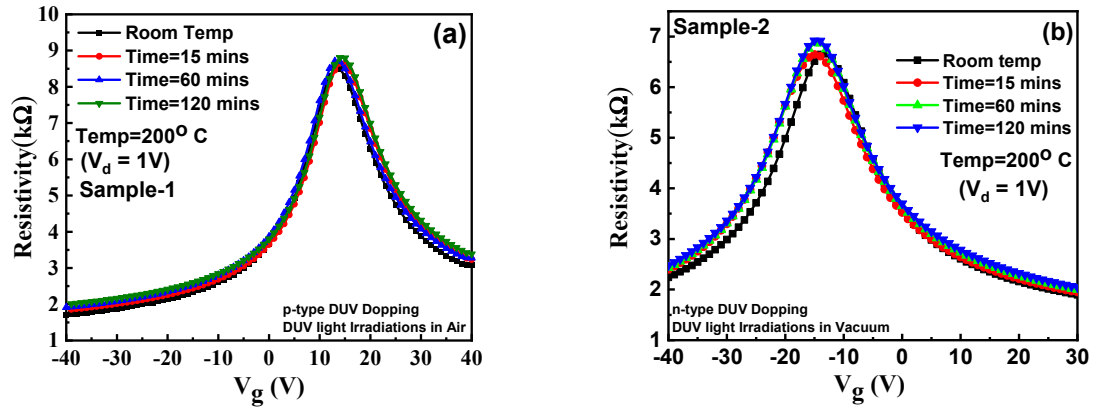


Figure S5 Stability with heating time: (a) DUV irradiations in air induced doping state of the device (sample-1) with different heating times, from 15 mins to 120 mins, at a temperature of a 200°C. (b) DUV irradiations in vacuum induced doping state of the device (sample-2) with different heating times, from 15 mins to 120 mins, at a temperature of a 200°C. Both devices exhibit a stable doping state over the different heating times.

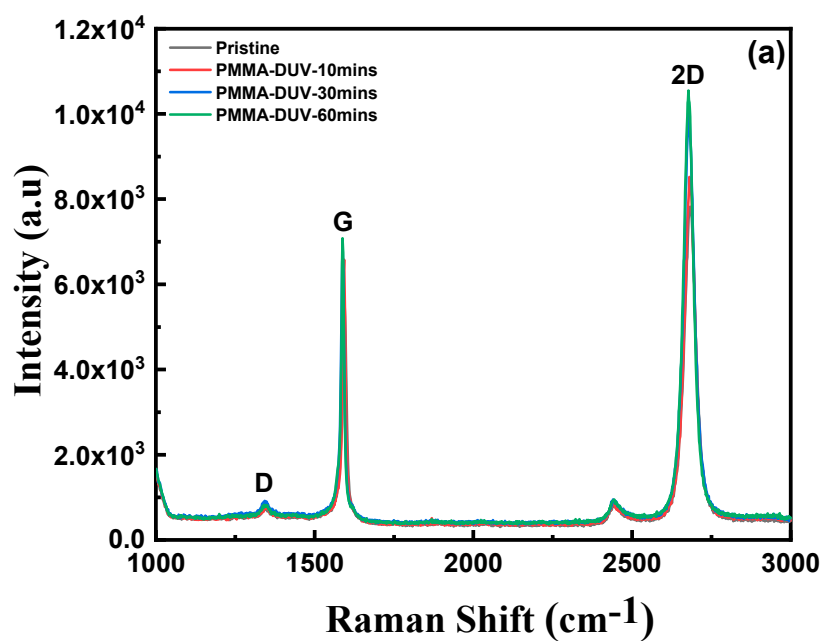


Figure S6 Raman for PMMA coated graphene: (a) Raman spectrum of graphene-coated 2548nm thick PMMA and exposed to DUV for different intervals of time, up to 60 mins. No shift in the 2D and G peaks of graphene was observed, as compared to pristine graphene for different exposure times.

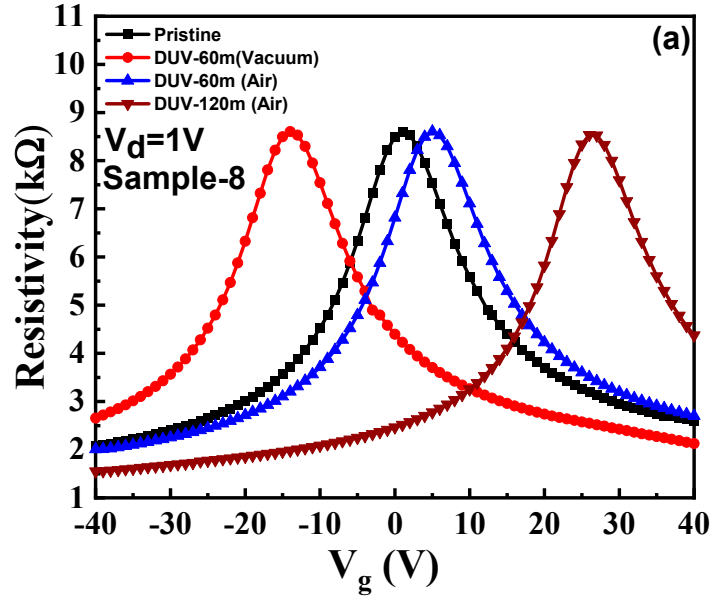


Figure S7 Transfer characteristics for reversible DUV-Doping: (a) Transfer characteristics of sample-8 to investigate the reversible nature of DUV induced doping. The device was initially n-type doped, by 60 mins of DUV irradiations in vacuum. Further, the device was exposed to DUV irradiation in air, which exhibits counter doping and high p-type doping was induced, after 120 mins exposure.