Ultra-Clean High-Mobility Graphene on Technologically Relevant Substrates

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Graphene grown via chemical vapor deposition (CVD) on copper foil is nowadays recognized as a high-quality, scalable material, that can be easily integrated on technologically relevant platforms to develop a number of promising applications in the fields of optoelectronics and photonics. Most of these applications require ultra-low contaminated high-mobility graphene (*i.e.*, approaching 10 000 cm^2 V^{-1} s^{-1} at room temperature) to reduce device losses and implement compact device design. The low contamination is a requirement of foundries in which CVD graphene is included in integration process flows. The contaminant threshold for backend of line in a CMOS fab is 10^{12} at/cm^2 whereas in the frontend of line the threshold is two orders of magnitude more stringent [1]. In this work we demonstrate a rapid, facile, and scalable cleaning process, that yields high-mobility graphene directly on the most common technologically relevant substrate: silicon dioxide on silicon (SiO_2/Si). Atomic force microscopy (AFM) and spatially-resolved X-ray photoemission spectroscopy (XPS) demonstrate that the presented approach is instrumental to rapidly eliminate most of the polymeric residues which remain on graphene after transfer and fabrication. Raman measurements show a significant reduction of graphene doping and strain. Transport measurements of 50 Hall bars (HBs) present hole mobility μ_h up to ~9000 cm^2 V^{-1} s^{-1} and electron mobility μ_e up to ~8000 cm^2 V^{-1} s^{-1} which is nearly double of that measured in graphene HBs processed with conventional acetone cleaning [2]. Notably, these mobility values are obtained over large-scale before encapsulation, thus paving the way to the adoption of graphene in optoelectronics and photonics [3].

References

[1] G. Lupina et al, ACS Nano 2015, 4776–4785.
[2] A. Tyagi et al in preparation.
[3] M. A. Giambra et al, ACS Nano 2021 15 (2), 3171-3187.

Figures

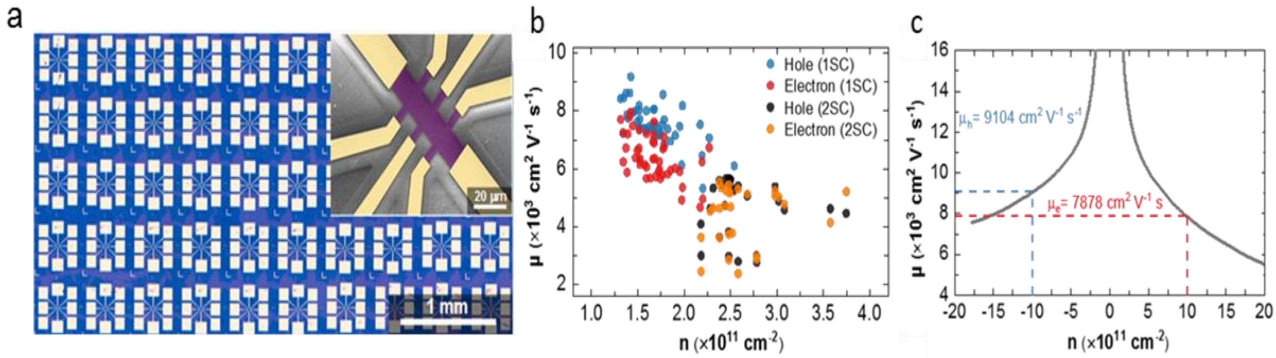

Figure 1, (a) Optical image of 50 graphene Hall bars on SiO_2/Si. Inset: false-colour SEM image of a single Hall bar. (b) Carrier mobility as a function of carrier density calculated from the measurement. (c) Mobility statistics of graphene Hall bars prepared with 1SC (black, orange) and 2SC (red, blue) as a function of n*.