Ultraclean High-Mobility Graphene on Technologically Relevant Substrate

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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 high-mobility graphene (~ 10 000 $cm^2 V^{-1} s^{-1}$ at room temperature) to have reduce device losses and compact design. To date, these mobility values are only obtained when suspending or encapsulating graphene with other 2D materials. In this work we demonstrate a two-step cleaning approach that yields high mobilities for scalable graphene directly on the most common technologically relevant substrate: silicon dioxide on silicon (SiO_2/Si). Which is done by using acetone and remover (1,3-Dioxolane, 1-Methoxy 2-Propanol) and analyzed by atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS) and Raman spectroscopy confirming rapid elimination of the polymeric residues which remain on graphene after transfer and fabrication and adversely affects the electrical transport properties. We apply this approach on matrixes of graphene single crystals that can be used to populate 6" wafers [1]. Transport measurements demonstrate that ultra-clean single-crystal graphene consistently present mobilities up to 9000 $cm^2 V^{-1} s^{-1}$ over wafer scale without any kind of encapsulation, thus paving the way to the adoption of this material in optoelectronics and photonics [2].

References

[1] Giambra et al., *ACS Nano,* 2021, 15, 2, 3171–3187.
[2] Tyagi et al in preparation.

Figures

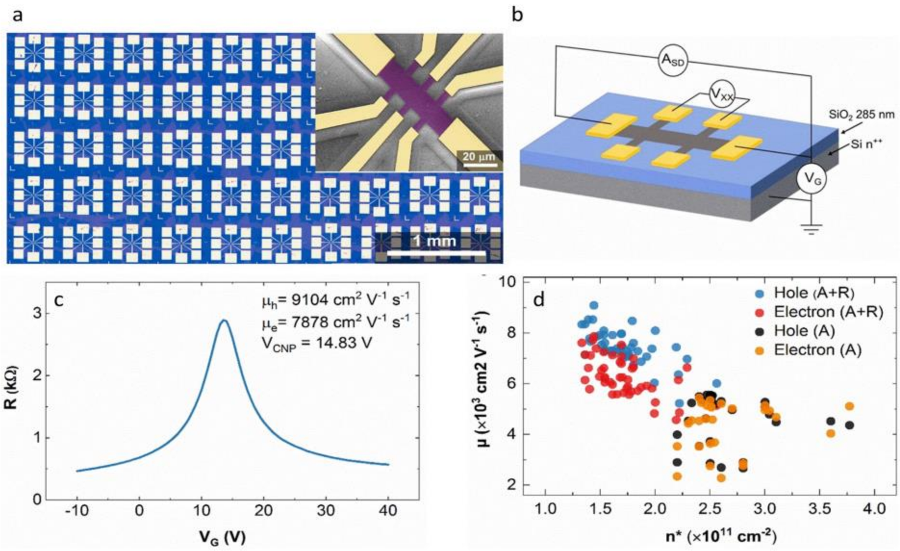

Figure 1: (a) Optical image of 50 graphene Hall bars on SiO_2/Si. Inset: false-colour SEM image of a single Hall bar. (b) Schematic diagram of the 4-terminal electrical characterization setup. c) Typical resistance curve of a graphene device. (d) Mobility statistics of graphene Hall bars prepared with conventional acetone cleaning method (black, orange) and two-step cleaning (red, blue) approach.