Suspended electrolyte-gated graphene field-effect transistors with enhanced electrical performance and reduced drift

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In this work we discuss a simple and robust fabrication process for suspended electrolyte-gated graphene field-effect transistors (EG-gFETs) [1]. Devices with dimensions up to 20 µm are successfully obtained, as seen in the SEM and Raman characterization shown in Figures 1(a) and 1(b). The suspended EG-gFETs are electrically actuated using a coplanar gold gate to obtain their transfer curves, with PB 10 mM as the electrolyte, and compared to their supported counterparts, as shown in Figure 1(c). The transfer curves of the suspended devices show improved electrical conductivity, carrier mobility, and transconductance, as a result of the reduced interactions of charge carriers with substrate defects. These devices are also remarkably resilient against successive cleaning steps and evaporation of the electrolyte media.
In addition, it was previously proposed that the transfer curve drift in EG-gFETs is primarily caused by the progressive charge trapping of carriers in the defects of the insulating silicon oxide layer beneath the graphene [2]. This work shows that, indeed, by selectively removing the oxide layer and suspending the EG-gFETs, the transfer curve drift reduces when compared with supported devices actuated under identical conditions and experimental protocols. We also fit a previously developed analytical model [3] to the drift measured experimentally and conclude that the observed drift reduction can be attributed to a reduction in substrate concentration of defects of approximately one-third of the original value.

References

[1] A. Béraud et al, Analyst, vol. 146, no. 2, pp. 403–428 (2021)
[2] Y. Illarionov et al, Nat Commun, 11, 3385 (2020)
[3] J. Mouro et al, npj 2D Materials and Applications, 9 (1), 26 (2025)

Figures

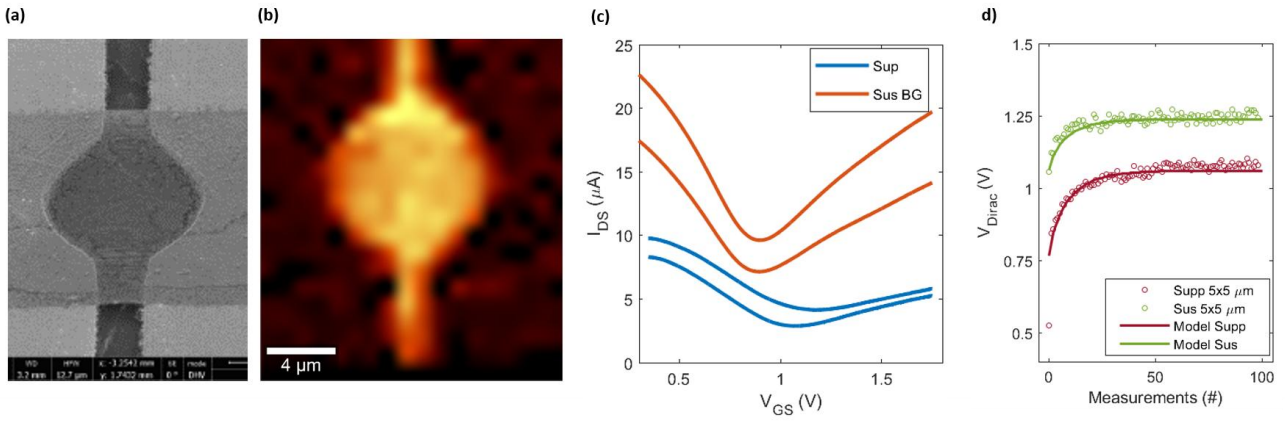

Figure 1: (a) SEM and (b) Raman characterization of a suspended EG-gFET membrane; c) Examples of transfer curves of the EG-gFETs prior (blue)) and after suspension (red); d) Experimental and modelled drift of Dirac point with consecutive acquisitions in supported (red) and suspended (green) devices.