Cleaning Graphene as part of wafer scale GFET fabrication

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Optimizing process integration and 2D material-based field effect transistors (GFETs) is an ongoing topic in academia and for industrial applications [1]. One issue is the presence of photoresist residue after photolithography, especially after the step of patterning the graphene [1-4]. This work shows results of residue cleaning on wafer scale (150 mm, 960 GFETs per wafer) using two different cleaning methods after graphene patterning: dry cleaning with H_2 plasma etching and with wet cleaning using reagents. The results are compared to references wafers without cleaning. Raman spectra, micrographs and transfer curves using 4 probe configurations were obtained from a total of 15 wafers. The lowest device yield of any wafer was 92%. Average graphene mobilities of 4000 cm²/V·s were obtained after cleaning, an increase of 600 cm²/V·s compared to the reference wafer (see Figure 1(a) and (b)). The relationship between the doping presented in the transfer curves (Figure 1(c)) and residues (a-C peak) presented in the Raman spectra were also analysed.

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References

[1] Lemme, M. C., Akinwande, D., Huyghebaert, C., Stampfer, C., Nature Commununications, 13, 1, (2022), 1-5.
[2] Li, B., Pan, G. Suhail, A., Islam, K., Avent, N., Davey, P., Carbon 118 (2017) 43–49.
[3] Yun, H., Lee, S., Jung, D., Lee, G., Park, J., Kwon, O.J., Lee, D.J., Park, C-Y., Applied Surface Science 463(2019), 802–808.
[4] Choi, A., Hoang, A.T, Van, T.T.N., Shong, B., Hu, L., Thai, K.Y., Ahn, J-Y., Chemical Engineering Journal 429(2022), 132504.
[5] Cheng, Z., Zhou, Q., Wang, C., Li, Q., Wang, C., Fang, Y., Nano Letters 11 (2011), 767-771.

Figures

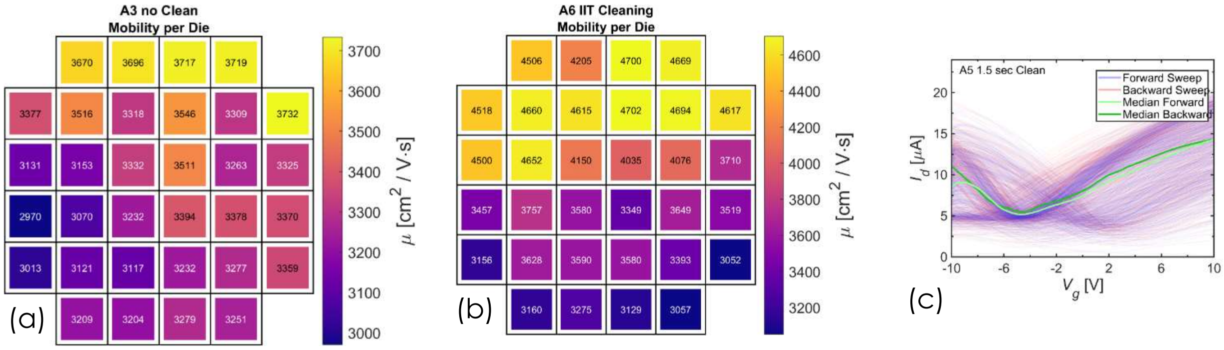

Figure 1: Wafer maps showing median of the device mobilities for each die in the wafer (each die has 30 devices). (a) reference wafer, no cleaning. 97% yield. (b) wafer processed with wet cleaning, 96% yield. (c) transfer curves from the wafer processed with dry cleaning (backward and forward sweeps are shown). The green line is the median. P and n doping are visible.