Bottom-gate graphene field-effect transistors with enhanced reliability based on passivation layer

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Abstract

The reliability of graphene field-effect transistors (GFETs) is one of important issues for practical applications and has been widely reported[1]-[2]. We measured and analyzed negative bias-stress-induced instability of GFETs to investigate the reliability of GFETs. Several factors influence the reliability of GFETs including defects and residues. We investigated the effect of passivation layer to bias stress effect of GFETs by analyzing time-dependent Dirac voltage shift of transfer curves under the gate bias stress. We used H_2O-based ALD-grown aluminum oxide (Al_2O_3) for passivation layer. Passivation layer has a significant effect to GFETs according to previous report which described mobility enhancement and the suppression of p-type doping from ambient air[3]. On the other hand, we investigated the effect of passivation layer to negative bias-stress-induced instability. The instability result revealed that GFET without passivation layer showed larger Dirac voltage shift than GFET with Al_2O_3 passivation layer under the equal stress level. The origin of the difference is considered as the dynamic process of adsorption–desorption characteristic at the graphene surface without passivation. Adsorbed molecules can act as charged trapping sites which induce large Dirac voltage shift. Furthermore, fitting parameters including characteristic equilibrium time constant (τ) and stretched-exponential exponent (β) from stretched-exponential model showed the clear tendency as trap density decreased using passivation layer.

References

[1] Lee, Jung-Kyu, et al. *Applied Physics Letters* 98.19 (2011): 193504.
[2] Liu, Zihong, et al. *Nano letters* 11.2 (2010): 523-528.
[3] Zheng, Li, et al. *Applied Physics Letters* 104.2 (2014): 023112.

Figures

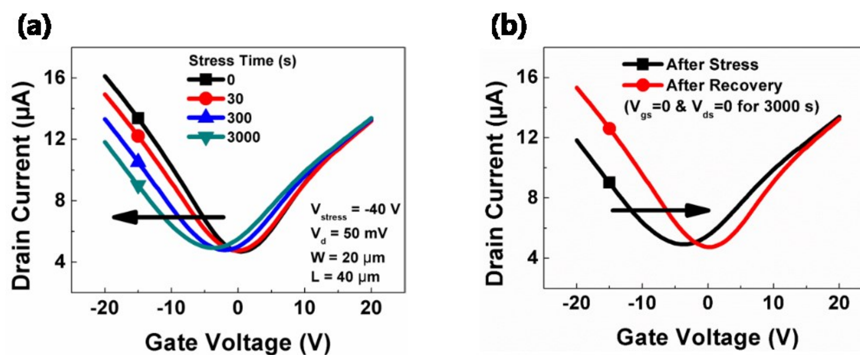

Figure 1 – Transfer curves in (a) stress phase and (b) recovery phase of graphene field-effect transistor with Al_2O_3 passivation layer.