Electrical characterization of suspended graphene nanoribbons fabricated by b-HF free process

JAIST, °(P)A. Banerjee, O. G. Agbonlahor, M. Muruganathan, H. Mizuta

E-mail: mano@jaist.ac.jp

Suspended structures of atomically-thin graphene nano ribbons (GNR) are promising candidates for many nanoelectromechanical applications, such as, pressure-, chemical-, biological-, mass-sensor, etc [1,2]. Unique electrical properties of graphene, such as, large transfer-conductance and ambipolar characteristics [3] make transduction of mechanical signal to electrical signal possible even in the nanoscale, where employing conventional methods (such as, capacitive sensing) become challenging [4]. Suspended graphene ribbons offer extremely high carrier mobility [5]; thereby, further assisting in the sensing process. However, electrical properties of suspended GNR are depleted by contaminants introduced during a typical multistep lithography process. These effects and effective decontamination strategies are worth studying.

We have developed a direct suspension method for making suspended GNR bypassing conventional b-HF oxide etching process, eliminating use of this toxic etchant and avoiding unwanted overhangs of metal on GNR (schematic, Fig. 1(a)). Transport-characteristic (Fig. 1(b)) and ambipolar transfer-characteristics (collected through a local bottom-gate; Fig. 1(c)) from a suspended GNR are shown below. However, resist residue on GNR is observed to significantly impede the conductance modulation by V_g and to shift the charge-neutrality point to > 60 V. We will present how current annealing, annealing in vacuum and H_2+Ar environment help restore the intrinsic electrical characteristics in suspended GNR.

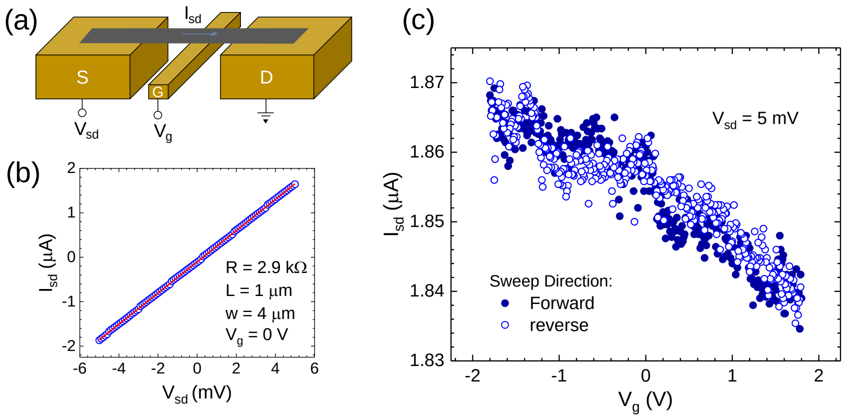

Fig. 1. (a) Schematic diagram of suspended GNR with local bottom-gate; (b) transport characteristic (at V_g = 0 V) of a suspended ribbon (length (L) = 1 μm, width (w) = 4 μm); (c) ambipolar characteristics of the ribbon.

Acknowledgement: This research is supported by TAIYO YUDEN Co. Ltd and Grant-in-Aid for Scientific Research Nos: 18K04260, 18H03861, 19H05520 from Japan Society for the Promotion of Science (JSPS). A.B. Thanks JSPS Postdoctoral Fellowship number P20060.

References: [1]Smith et al., Nano Lett. 13, 3237–3242 (2013), [2]Bunch et al., Science 315, 490-493 (2007), [3]Ha et al., ACS Appl. Mater. Interfaces 5, 16–20 (2013), [4]Xu et al., Appl. Phys. Lett. 97, 243111 (2010), [5]Bolotin et al., Solid State Commun. 146, 351-355 (2008)