## Fabrication and electrical characterization of a graphene - to - graphene crossbar device. JAIST<sup>1</sup>, Univ. of Southampton<sup>2</sup>, °K. Jothi Ramalingam<sup>1</sup>, M. Manoharan<sup>1</sup>, Marek E. Schmidt, Hiroshi Mizuta<sup>1,2</sup> E meile iatbi@iait as in

E-mail: jothi@jaist.ac.jp

Bilayer graphene, a two parallel layers of carbon atoms, each arranged with a honeycomb arrangement as in monolayer and its properties are highly depending on how each layer is stacked on another layer. Bilayer graphene in Bernal stacking has massive charge carriers with zero band gap, twisted bilayer graphene with a random orientation of the layers has a massless electronic dispersion similar to that of monolayer graphene [1]. To study interlayer properties of the graphene, cross junction graphene devices are essential [2]. In the present work, we fabricate the graphene to graphene crossbar device by electron beam lithography process and study its electrical characterization.

Figure. 1 (a) shows a schematic diagram of graphene cross bar device. The bottom graphene ribbon is patterned by high resolution negative resist hydrogen silsesquioxane (HSQ), dimension of the bottom ribbon is 1  $\mu$ m × 3  $\mu$ m (width × length). The graphene cross junction device is fabricated by transferring Chemical Vapor Deposition grown graphene on to the bottom ribbon covered with SiO<sub>2</sub>, and then the top graphene ribbon is also patterned by negative resist HSQ. Dimensions of the top graphene ribbon are 1  $\mu$ m × 3  $\mu$ m (width × length).By removing the SiO<sub>2</sub> between the top graphene and bottom graphene using buffered hydrofluoric acid (BHF), the graphene cross junction is realized. Graphene to graphene overlapping area is 1  $\mu$ m × 1  $\mu$ m. Fig.1 (b) shows the SEM image of the fabricated graphene cross bar device. Voltage – current characteristics of graphene cross bar device, the conduction through the intra layer (top ribbon) as well as the conduction between the interlayer (bottom to top ribbon) at various temperatures from 5 K to 300 K is shown in Fig.1 (d) - (e).Temperature dependence of intra and inter layer is shown in Fig.1 (f).Detailed discussion on inter layer resistivity of graphene to graphene crossbar device along with its fabrication by lithography process will be presented.



**Fig. 1** (a) Schematic of graphene to graphene crossbar device. (b) SEM image of graphene cross bar device. (c) Electrical equivalent circuit of graphene crossbar device. Voltage – current characteristics of the device: (d) Intra layer (top ribbon). (e) Inter layer (bottom to top ribbon). (f) Temperature dependence of intra and inter layer resistance.

## Acknowledgements

This research was supported by Grant-in-Aid for Scientific Research (S) No. 25220904 from Japan Society for the Promotion of Science.

## Reference

[1]. C. Park, B.G. Sumpter, G. Kim, and M. Yoon, Phys. Rev. Lett. 115, 015502 (2015).
[2]. Y. Kim, H. Yun, S.G. Nam, M. Son, D.S. Lee, D.C. Kim, J.S. Kim, Phys. Rev. Lett. 110, 1 (2013).