Tunnel barriers and single electron transistors in suspended multi-wall carbon nanotubes fabricated by Ga focused ion beam irradiation

N. M. Ghazali[1,2], N. Hagiwara[1,3], K. Suzuki[1], H. Tomizawa[1,], A. M. Hashim[2], T. Yamaguchi[1], S. Akita[4], and K. Ishibashi[1,2,3,5]

(1.RIKEN, 2.MJIIT,UTM, 3.Chiba Univ., 4.Osaka Pref. Univ.,5.RIKEN CEMS)

E-mail: norizzawati.ghazali@riken.jp

This study investigates a reliable technique to fabricate tunnel barriers in the suspended multi-wall carbon nanotubes (MWCNT) by the mechanical transfer technique and Ga focused ion beam (FIB) irradiation. This process also may be useful for the fabrication of mechanical vibration devices. Samples were fabricated with different ion dose and the effect of the resistance change after irradiation is investigated. The resistance before irradiation is ranging from 10kΩ to 20kΩ for all samples. It is found that the resistance of MWCNT increases with the increase of Ga ion dose as shown in Fig. 1 [1]. Data is shown for samples fabricated on the substrate as well as suspended samples. Resistance change is found to be dependent not only on the dose but also on the diameter. The data was further analyzed by cooling down the sample in a liquid helium refrigerator from a room temperature to the lowest temperature of 1.5 K. The barrier height estimated from the Arrhenius plot in suspended MWCNTs shows similar tendency with the nanotubes on substrate (Fig.2). Coulomb diamond and coulomb oscillation in a single electron transistor fabricated by two tunnel barriers were successfully realized with the present technique.

[1] H. Tomizawa, K. Suzuki, T. Yamaguchi, S. Akita, K. Ishibashi, Nanotech. **28**, 1 (2017).

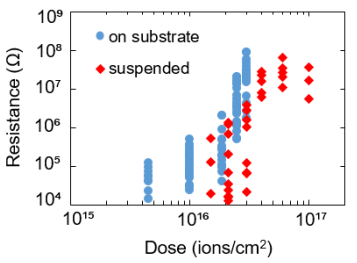

Fig. 1 Dose dependence of resistance at RT

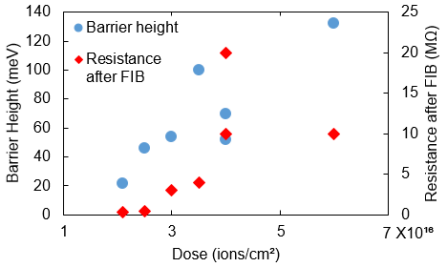

Fig. 2 Barrier height and resistance after FIB as a functions of ion dose