Self-Terminated Ultra-Fine H-ELGP Pt-based Nanogap Electrodes

[O]Yoon Young Choi, Ain Kwon, Yutaka Majima

Laboratory for Materials and Structures, Tokyo Institute of Technology, Japan

E-mail: choi.y.ae@m.titech.ac.jp

Nanogap electrodes are one of the platforms of sub-10nm scale electronic devices such as single-electron transistors and molecular devices. We have been developed a simple and high yield method for fabricating multiple nanogap electrodes simultaneously by combining an electron-beam lithography (EBL) and an electroless gold plating (ELGP) technique [1, 2]. Moreover, we have demonstrated logic operations of SETs by using the ELGP Au-based nanogap electrodes with ~3nm of gap separation and ~60nm of linewidth [3].

Nevertheless, for the more stable operation of sub-10nm scale devices, it is strongly demanded to reduce not only nanogap separation with the smaller top radius of nanogap ends, but also the linewidth of source-drain electrodes toward sub-20nm scale for obtaining the larger gate capacitance. However, our ELGP Au-based nanogap electrodes have limitation in fabrication of these finer nanogap electrodes with sub-3nm nanogap separation and sub-20nm linewidth due to Rayleigh instability. Therefore, we introduced Pt metal for robust and finer initial nanogap electrodes against Rayleigh instability and also hemispheric-ELGP (H-ELGP) process for the sub-3nm scale nanogap separation with the very small top radius of nanogap ends.

Here we demonstrate self-terminated fabrication processes of H-ELGP Pt-based nanogap electrodes. The hemispheric nanogap ends are controlled by self-termination mechanism with sub-3nm nanogap separation and a few nm top radius as shown in Fig. 1(b). Furthermore, these self-terminated ultra-fine H-ELGP Pt-based nanogap electrodes show the strong durability in thermal stress.

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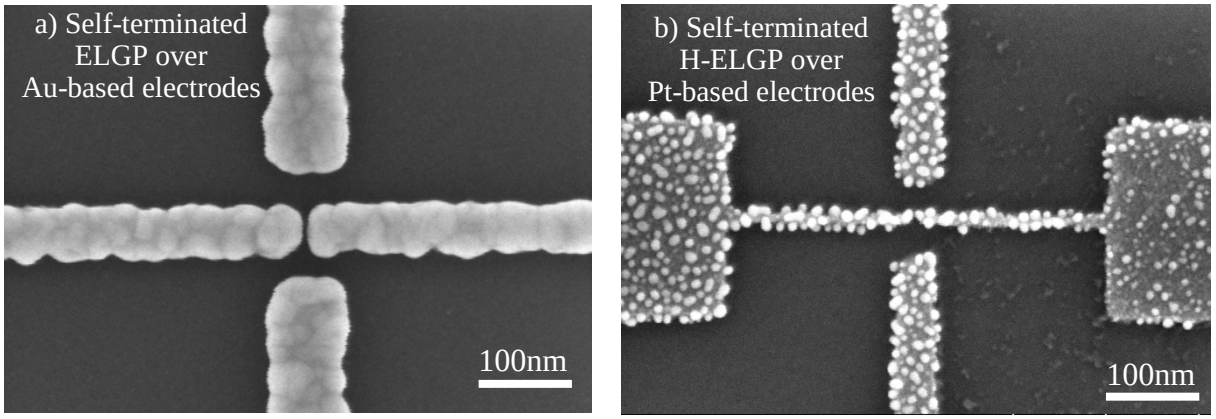

Fig.1. Comparison of SEM images of a) the self-terminated ELGP Au-based nanogap electrodes and b) the self-terminated ultra-fine H-ELGP Pt-based nanogap electrodes