Fluctuation analysis of polymer-coated Ag nanowire network

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Neuromorphic circuits composed of electronic devices are required to realize brain-like information processing such as learning and recognition which are observed in a biological system. Atomic switches [1,2] have attracted attention as the materials for mimicking the functions of synapses. The electrical conductivity of atomic switch changes depending on the history of applied voltage, which characteristic is useful for providing synaptic plasticity to the circuits. Recently atomic switch networks have been studied for generating the neuromorphic structure and function by interconnecting numerous atomic switches each other.[3] However the phenomena occurring in the network have yet to be revealed. In this study, we analyze the fluctuation observed in the polymer-coated Ag nanowire (pc-AgNW) network, one of the atomic switch networks, for understanding the network dynamics.

As for experiments, AgNWs were synthesized by polyol process. Briefly, $AgNO_3$ was chemically reduced in the polymer solution. The AgNW network was prepared by drop-casting on a SiO_2 substrate. The electrical measurement was carried out by using a home-built multiple-probe scanning probe microscope with tungsten probes (inset of Fig. 1a).

Scanning electron microscopy (SEM) revealed that average of the diameter and length of synthesized pc-AgNWs was 150 – 400 nm and 15 μm, respectively, and AgNWs formed a random network structure on the substrate (Fig. 1a). The spontaneous fluctuation in output current was observed when the constant voltage was applied to pc-AgNW network. Figure 1b shows a typical power spectral density (PSD) of current signal obtained by fast Fourier transform. The PSD followed the inverse of frequency. This behavior is well-known as 1/f noise. It was found that the exponent of 1/f (slope of PSD) changes with the conductance of network, and expected that this behavior should correlate to the network dynamics.

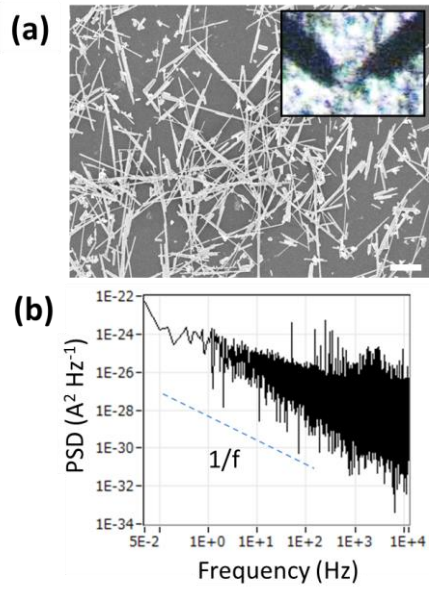

Fig. 1 (a) SEM image of AgNW network. The inset shows optical micrograph of double probes and sample. Scale bar = 10 μm. (b) PSD of measured current.

References: [1] K. Terabe *et al.*, Nature 2005, 433, 47; [2] T. Ohno *et al.*, Nat. Mater. 2011, 10, 591; [3] A. V. Avizienis *et al.*, PLoS One 2012, 7, e42772.