Scanning tunneling potentiometry on FIB-deposited PtC pattern by using multi-probe STM

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Beam-assisted deposition is a fabrication technique that uses a focused electron or ion beam scanning over a sample surface in variety of organic metal gases, to induce selective deposition of metals along the path that is scanned by the beam. This technique makes it possible to fabricate complex nanostructures in combination with scanning electron microscopy (SEM) or focused ion beam (FIB) technique. It has been widely used in fabrication of prototypical nanodevises or restoration of minute circuits. However, the electrode which is made by this technique often suffers from the high resistivity compared to the pure metal electrodes. Particularly, the high resistance becomes a serious problem when small and fast circuit is demanded. Although it is said that the high resistivity originates from the impurities such as the organic molecules mixed into the deposits, relations between physical structure and the local electric conductance is not yet clear. In this study, we investegated correlation of the structure and the voltage drop in a FIB-deposited PtC pattern on mica by mapping local electric potential of the sample with applying a bias current to a sample using multi-probe STM, simultaneously with acquiring conventional STM topography in the same region Since the potential measurement was done by a STM prove via a finite tunnel gap, i.e. without contacting sample, the measurement was done completely in a nondestructive way.

Figure 1 shows an SEM image of the PtC pattern with dimension of 140 μm × 5μm × 500 nm (W ×D ×H), which was deposited by FIB-SEM on mica substrate bridging the two predeposited gold electrodes. We used Ga^+ beam and $C_5H_5Pt(CH_3)_3$ gas for deposition. In the zoomed image (Fig.1 inset), regular grooves are found on the top surface of the pattern, suggesting the pattern consists of PtC wires ~200 nm in diameter as a result of the beam scan in parallel direction.

A contour plot of the measured potential is superposed upon a STM topographic image in Fig. 2. We can confirm potential gradient from left to right, in parallel to the bias current. The equipotential lines are crowded at the regions pointed by purple arrows. These regions corresponds to the local region with high resistance and we found the dent structures on the nano-wires there. The detail of the measurement setup and interpretation of the result will be discussed at the presentation.

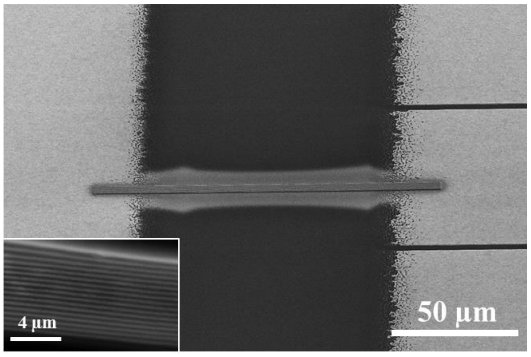

Fig.1 SEM image of PtC pattern. (Inset: zoomed image.)

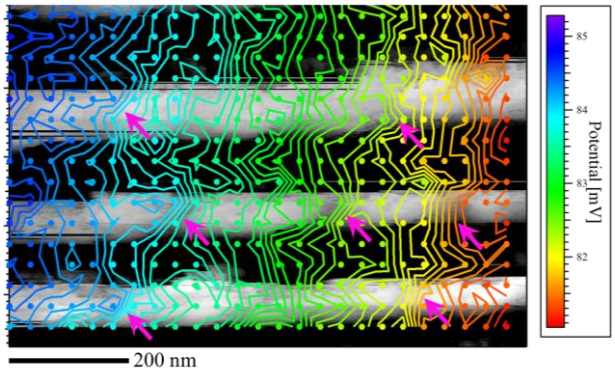

Fig.2 Potentials mapping superimposed to a STM topographic image.