NANO-FABRICATION AND IN-SITU FARADAIC CURRENT DETECTION USING CARBON NANOTUBE PROBES

Hiromi Kuramochi[1,2], Takashi Tokizaki[1] and Hiroshi Yokoyama[1]
[1]Research Consortium for Synthetic Nano-Function Materials Project (SYNAF),
Nanotechnology Research Institute (NRI),
National Institute of Advanced Industrial Science and Technology (AIST),
1-1-1 Umezono, Tsukuba, Ibaraki 305-8568, Japan
[2]SII NanoTechnology, 36-1 Takenoshita, Oyama-cho, Sunto-gun, Shizuoka 410-1393, Japan
E-mail: hiromi.kuramochi@aist.go.jp

Scanning probe microscope (SPM) nano-oxidation is a well-established technique to fabricate nanostructures. The proper control of the oxidation reaction, improvement of reproducibility and raising the precision are the meaningful destinations for further evolution of this technique, in concurrence with understanding the nano-oxidation mechanism.

The environmental control [1] and high accuracy of positioning [2] have yielded profitable results on achieving ultimate precision and high reproducibility in nano-fabrication. As a practical urge, down-sizing of intricacy products is nessessary to develope prototype devices for nano-electronics, nano-optics and nano-mechanics, such as increasing the density of recording dots in the high-density data storage field. It is expected that improvement of the probe will open up great possibilities for miniaturization, because the size of fabricated oxide is predominantly determined by the probe apex. An effective way to decrease the probe apex is using a carbon nanotube (CNT) as a nanoprobe.

In-situ faradaic current detection is a suitable method to follow and monitor the local oxidation reaction [3-5]. The detected faradaic current has been shown to faithfully reflect the degree of probe-oxidation with a clear dependence on the variation of voltage and the tip speed. The faradaic current can serve as a sensitive monitor of the nano-oxidation reaction for implementing precise closed-loop control of the oxide-growth.

CNT-attached atomic force microscope (AFM) probes were successfully used to make simultaneous precision nano-oxidation in the dynamic mode. The probe oxidation on H-passivated Si(001) surfaces were conducted by two methods of vector-scan and raster-scan with much higher precision and resolution compared to the nanofabrication by standard cantilevers. Combining CNT probes with environmental control and high-linearity horizontal movement achieves the high precision nano-oxidation; A lattice of 15 nm wide lines with a spacing of 35 nm was fabricated without appreciable distortions by vector-scan method (Fig. 1) and a concentric circle of 25 nm wide lines with a spacing of 25 nm was successfully created by raster-scan method (Fig. 2).

Monitoring the precise nano-oxidation process through faradaic current detection is also demonstrated using the CNT probe [6]. The evaluated dimensions of the meniscus during nano-oxidation from in-situ faradaic current detection and edge broadening are agreed well with the size of product oxides.

References:

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Figures:

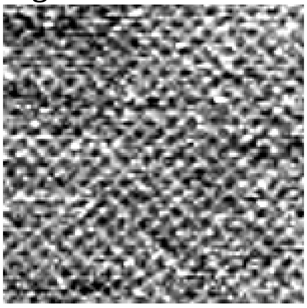

Figure 1 An AFM image (1x1 μm) of of an oxide lattice fabricated using a CNT probe by vector-scan method (30 % RH).

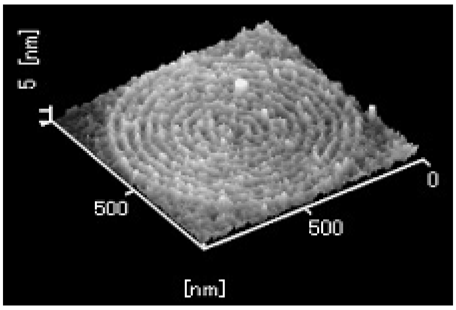

Figure 2 An AFM image (1x1 μm) an oxide concentric circle fabricated by raster-scan method (30 % RH).