Formation of narrow wires deposited by focused Au ion beam-induced chemical vapor deposition method

Ryo Okada[1], Junichi Yanagisawa[1,2,3], and Shinji Matsui[3,4]
[1]Grad. School of Eng. Science, Osaka University, Toyonaka, Osaka 560-8531, Japan
[2]CQST, Osaka University, Toyonaka, Osaka 560-8531, Japan
[3]CREST-JST, 4-1-8 Honcho, Kawaguchi, Saitama 332-0012, Japan
[4]LASTI, University of Hyogo, 3-1-2 Koto, Kamigori, Ako, Hyogo 678-1205, Japan

Using a focused Ga ion beam (GaFIB) operated at 30 keV and phenanthrene as a source gas, Kometani *et al.*[1] reported the formation of biological tools such as nano-injectors and nano-manipulators by FIB-assisted chemical vapor deposition (FIB-CVD). The deposited materials were mainly made up of diamond-like carbon (DLC), but implanted Ga was also contained around its projected range from the surface.[2] The effects of Ga on biomaterials are not known so much, but it might cause sever damage on them. Therefore, the formation of DLC without Ga should be desired. In this paper, FIB-CVD with Au ions was investigated to form Ga-free DLC materials.

15 keV Au FIB was scanned repeatedly along one line under phenanthrene gas atmosphere on a Si substrate at a fluence of 1.5×10^{16} cm^{-2}. Using three kinds of scanning condition shown in the figure caption, AuFIB irradiation time and the interval of one period of repetition was 0.3 ms and 22 ms for the sample A, 7 ms and 247 ms for the sample B, 280 ms and 7880 ms for the sample C, respectively. The AuFIB irradiated region was investigated by atomic force microscope (AFM).

Deposition of materials was surely confirmed using Au ions, and the peak height of them was 210, 90, and 60 nm for the samples A, B, and C, respectively, as shown in Fig. 1. The difference in the peak height might be because of the difference in sputtered amount of the deposited materials and/or decomposition rate of the phenanthrene molecules for each period of the repetition of the AuFIB scanning. Because the total Au fluence was the same in all samples, the content of Au might be different among them, indicating that the materials with the different physical properties can be formed using different scanning conditions of the AuFIB.

---

[1] R. Kometani, T. Morita, K. Watanabe, T. Hoshino, K. Kondo, K. Kanda, Y. Haruyama, T. Kaito, J. Fujita, M. Ishida, Y. Ochiai, S. Matsui, J. Vac. Sci. Technol. **B 22**, 257 (2003).
[2] T. Morita, R. Kometani, K. Watanabe, K. Kanda, Y. Haruyama, T. Hoshino, K. Kondo, T. Kaito, T. Ichihashi, J. Fujita, M. Ishida, Y. Ochiai, T. Tajima, S. Matsui, J. Vac. Sci. Technol. **B 22**, 2737 (2003).

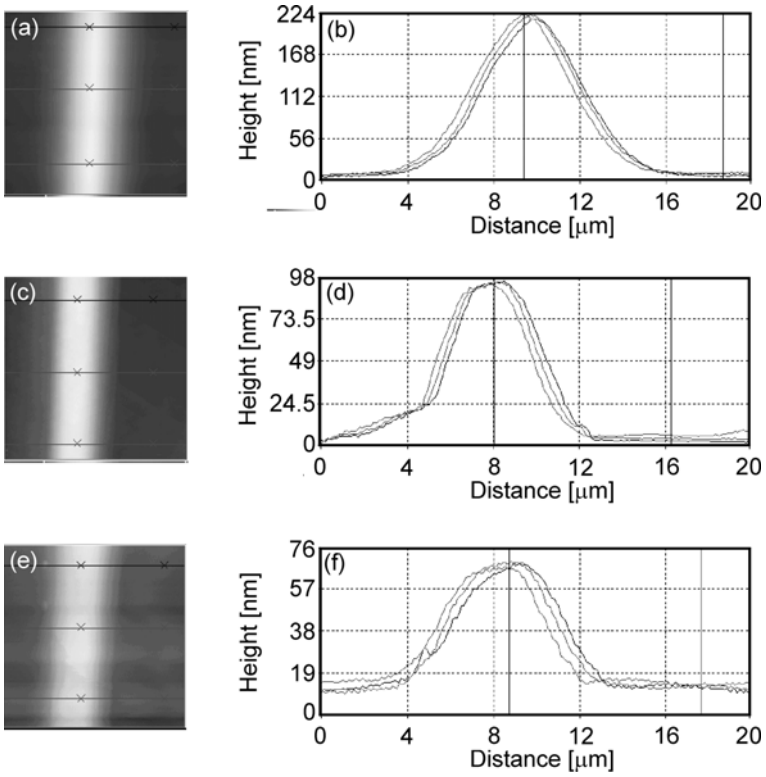

Fig. 1. Two-dimensional ((a), (c), (e)) and cross-sectional ((b), (d), (f)) images of AFM measurements for the three kind of deposited materials by the FIB-CVD method. AuFIB was scanned repeatedly along one line under phenanthrene gas atmosphere. Total fluence of the AuFIB irradiation was equal among the samples (1.5×10^{16} cm^{-2}), but the dwell time, the repeat number of the FIB scanning, and the total process time were 1 μs, 240000, 90 min. for the sample A (the result was shown in (a) and (b)), 32 μs, 7500, 30 min. for the sample B ((c) and (d)), and 1024 μs, 235, 30 min. for the sample C ((e) and (f)), respectively.