実験番号：202002029（6 シフト）

BL8S1

Crystal structure analysis of nano graphene with XRD

Swapnil Ghodke[1]，Dennis Christy[1], Shih-Nan Hsiao[1], Ngo Van Nong[1], Osamu Oda[1], Masaru Hori[1]

[1]Center for Low temperature plasma sciences (cLPS), Nagoya University

Keyword：Carbon nanowalls，chemical vapour deposition，crystal structure，grazing angle insident diffraction

1. Background and research purpose

Recently, two-dimentinal graphene sheets which are self-organized graphite nano-structures have attracted great interest in the next-generation electrocnic devices [1-2]. Canbon nanowallls (CNW) is a unique structure in which stacking of few graphene sheets with high preferential orientation stands verlically on the substrate. These sheets forms a self-supported network with wall thickness ranging from few nanometeres to few tens of nanometers. Its high aspect ratio, large surface area and large current carrying capability makes it promisining carbon material for energy storage, catalyst support material, and various device appilcations. Therefore, it is important to investigate the crystal structure of CNWs, but it is difficult to evalute such highly orientend and highly porous structure by conventional or laboratory equipments. Therefore, a high-intensity synchrotron radiation with high-resolution X-ray diffration is required to mearure and analyze CNW crystal structure.

2. Experiment content

The CNWs were grown on copper coated silicon substrate using Radial Injection Plasma Enhanced Chemical Vapour Deposition (RI-PECVD) in CH_4/H_2 plasma. The substrate temperature was 700 °C and the gas flow rates for H_2 and CH_4 were 50 and 100 sccm, respectively.

Synchrotron x-ray diffraction measurements were carried out on the beamline BL8S1 of the Aichi synchrotron radiation center, Japan.The wavelength of the x-ray was λ = 1.355 A ° corrosponding to 9.15 KeV. At this beamline coaxial (θ-2θ and grazing incidence angle (GID)) and non-coaxial (inplane 2θχ/φ) XRD measurements were performed for CNWs grown on Cu/Si subtrate and Cu foil. The GID and inplane measurement were performed to ananlyse the crystal structure of the thin layer (1μm) of CNW, which possesses high preferential orientation in the vertical direction.

3. Results and Discussion

The diffraction patterns for in-plane measurements with glancing angle ω (0.05°, 0.1°,0.3°, and 0.5°) are plotted in Figure 1(a), where a diffraction peak corresponding to the (002) diffraction plane of graphite was observed at 22.9°. The prominent peak was observed at a glancing angle 0.1°. The diffraction from C (002) plane was not observed with the grazing incidence angle of 1° (Fig. 1(b)). This condition may be very close to out-of- plane measurement condition so that only diffraction peaks related to copper could be observed. In the inset (Fig. 1(b)), two slightly broadened peaks related with C (004) and an overlap of Cu (111) and C (101)/(100) was confirmed. From these experimental results, we got clear insight of CNW crystal structure which has strong preferential orientation.

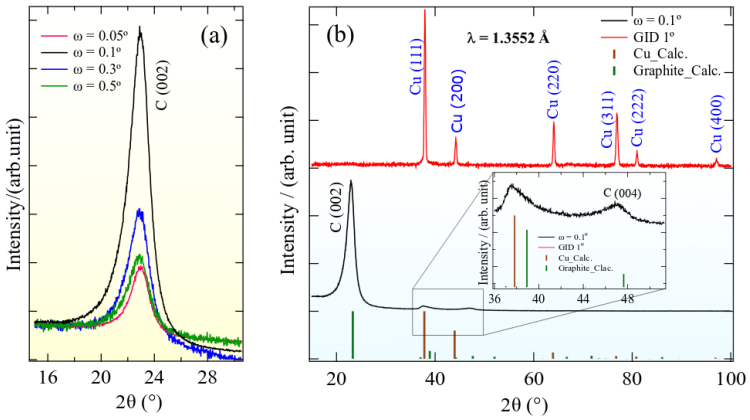

Figure 1 X-ray diffraction patterns of (a) in-plane measurements with glancing angle ω (0.05°, 0.1°,0.3°, and 0.5°) and (b) in-plane measurement (ω = 0.1°), grazing incidence measurement (1°), and along with the calculated plots of copper and graphite.

References

1. M. Hiramatsu, K. Shiji, H. Amano, and M. Hori, Appl. Phys. Lett. 84, 4708 (2004).
2. J. J. Wang, M. Y. Zhu, R. A. Outlaw, X. Zhao, D. M. Manos, B. C. Holloway, and V. P. Mammana, Appl. Phys. Lett. 85, 1265 (2004).