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Grazing Incidence X-ray Diffraction (GIXD) method to analyze the effect of thermal annealing on copper foil

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1. Background and research purpose

Copper in the form of foil is widely being used as a substrate in chemical vapor deposition techniques to grow carbon-based materials i.e. graphene, carbon nanotubes, carbon nanowalls [1]. In the growth process, parameters such as nucleation rate, morphology, growth rate, and crystal quality of carbon structure are closely related to the surface properties of the Cu foil [2]. In the deposition process, Cu foil undergoes a thermal and chemical treatment, which can alter the microstructure and surface quality, resulting in adverse or desirable electronic properties [3]. Therefore, it is important to investigate the effect of thermal treatment on the crystal structure and morphology of the copper foil, which was being used to grow carbon nanowalls using Radial Injection Plasma Enhanced Chemical Vapour Deposition (RI-PECVD) in CH_4/H_2 plasma. In this study, high-intensity synchrotron radiation with high-resolution X-ray diffraction (XRD) was implemented to analyze the evolution of crystal structure.

2. Experiment content

The copper foil with a thickness of 40 μm was annealed at 700 ℃ for 5 mins under H_2 atmosphere. Synchrotron X-ray diffraction measurements were carried out on the beamline BL8S1 at the Aichi synchrotron radiation center, Japan. The wavelength of the X-ray was λ = 0.863 Å corresponding to 14.3 KeV. At this beamline, out of plane θ-2θ, XRD measurements were performed on as-received Cu foil and annealed Cu foil. The grazing incidence diffraction (GID) measurements were performed to analyze the anisotropic distribution of crystalline orientation at the surface of Cu foil.

3. Results and Discussion

The θ-2θ and GID 1° diffraction patterns for pre and post-annealed Cu foil are plotted in Figure 1(a) and 1(b), respectively. All the diffraction peaks corresponding to the Cu crystal structure appeared in as-received Cu foil and also GID 1° showed similar peaks, indicating homogeneous polycrystalline nature. However, post-annealing H_2 the prominent peak for Cu (220) reduced to a negligible intensity.The I_{200}/I_{220} and I_{200}/I_{311} ratios also indicated preferential orientation in Cu (200) and Cu (400) direction. Such high preferential orientation was also confirmed in GID1° measurement, at the surface the Cu (200) was absent while others Cu(111), Cu(220), and Cu(311) appeared with some lattice distortion.

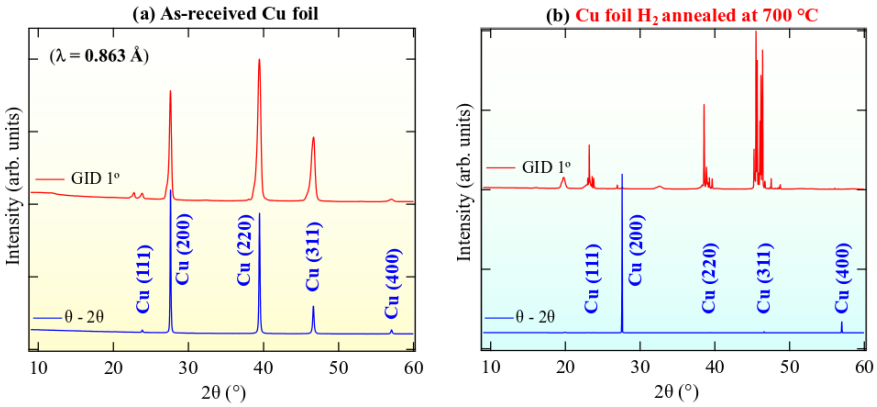

Figure 1 X-ray diffraction patterns of (a) as-received and (b) H_2 annealed Cu foil

References

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