19B/2002P019

Soft X-ray emission study of nano-structured carbon

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Introduction

Nano-structured carbon has recently been of great interest from the viewpoint of, e.g., hydrogen storage. Glass-like structure of nano-structured carbon with hydrogen was investigated by neutron diffraction and Raman scattering studies [1]. It was observed that the structure of the nano-structured carbon is highly deviated from that of graphite crystal. An sp^3 local structure would be expected in addition to the sp^2 configuration of the original material. It is, however, not yet well understood why it shows such significant potentials by only making it fine particles.

Soft x-ray emission and absorption spectroscopy (SXES and XAS) are useful techniques to investigate electronic structures with focusing a special character of angular momentum, and good tools to explore electronic (and spatial) structures of a specified element. Especially, they can discriminate an sp^3 electronic structure in carbon materials from sp^2 one, for which scattering techniques for studying the atomic structure can hardly be accessible.

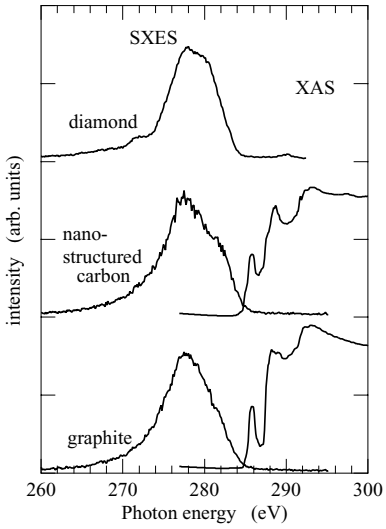
In this paper, we report results of SXES and XAS spectra for nano-structured carbon, and discuss it by comparing to those of diamond and graphite.

Experimental procedure

SXES and XAS spectra of nano-structured carbon (Nisshinbo, Type ACC-440), polycrystal graphite, and diamond were measured at the beamline BL-19B of PF/KEK near the C 1s core absorption energy for investigating the 2p partial density of states in the valence and conduction bands. The measurements were carried out under ultra-high vacuum of less than 3×10^{-9} Torr. The C 1s SXES spectra were recorded using a 1200 l/mm bent grating having a 7 m radius with an 100 μ-input-slit. The resolving power ($E/\Delta E$) of the SXES was about 350. Total-electron-yield XAS spectra were measured by monitoring the sample current. Its $E/\Delta E$ was about 2500.

Results and discussion

Figure shows SXES spectra obtained using an incident photon energy of 301.8 eV and XAS spectra of diamond, nano-structured carbon, and graphite (from top to bottom) as a function of photon energy. Significant differences of the spectra are observed among them, especially at the shoulder around 282 eV in the valence-band. The magnitude of the shoulder with respect to the main peak at 278 eV of nano-structured carbon lies between those of diamond (sp^3) and graphite (sp^2). The spectrum of nano-structured carbon is very similar to those of amorphous carbon [2], where the sp^2- and sp^3-configured carbon atoms are believed to coexist. Clear differences between the nano-structured carbon and graphite are also seen in the structure of the antibonding states, 286-290 eV. Detailed spectral analysis is now in progress.



References

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