24P093-P

Structural analysis of carbon co-deposited layer in LHD

LHD における炭素再堆積層の構造に関する詳細解析

Naoko Ashikawa[1)], Kensuke Fukayama[2)], Yukinori Hamaji[3)], Yuji Yamauchi[4)], Yuji Nobuta[5)], Kazunori Koga[4)], Masaharu Shiratani[4)], Yoshio Ueda[3)], Tomoaki Hino[2)], Takeo Muroga[1)] and the LHD experimental group[1)]

芦川直子[1)]，深山健介[2)]，浜地志憲[3)]，山内祐二[2)]，信太祐二[2)]，古閑一憲[4)]，白谷正治[4)]，上田良夫[3)]，日野友明[2)]，室賀健夫[1)]，LHD 実験グループ[1)]

[1)]National Institute for Fusion Science, 322-6, Oroshi-cho, Toki, Gifu 509-5292,Japan
核融合科学研究所　〒509-5292　岐阜県土岐市下石町 322-6
[2)]Hokkaido University, Kita-13, Nishi-8, Kita-ku, Sapporo, Hokkaido 060-8628, Japan
北海道大学大学院工学研究院，〒060-8628　北海道札幌市北区北 13 条西 8 丁目
[3)]Osaka University, Yamadaoka, Suita, Osaka 565-0871, Japan
大阪大学工学研究科，〒565-0871　大阪府吹田市山田丘 2-1
[4)]Kyushu University, 744, Moto-oka, Nishi-ku, Fukuoka, Fukuoka, 819-0395, Japan
九州大学大学院システム情報科学府　〒819-0395 福岡県福岡市西区元岡 744

Graphitic structures of deposition layer on target samples have been applied Raman spectroscopy and X-ray photoelectron spectroscopy (XPS) in LHD. Those deposition layers show characterization of amorphous carbon by Raman spectroscopy. The low amount of sp3 bonds are observed by XPS and the ratio of sp2 to sp3 by Raman is larger than that by XPS due to the difference of depth resolution.

1. Introduction

An estimation of retained hydrogen isotopes in plasma facing material is important issues in ITER and Demo reactors. Carbon-based materials are still one of the candidate and favorable for fusion applications because of a low atomic number, good thermo-mechanical properties, low coefficient of thermal expansion and the absence of melting. But high T retention in Carbon-based materials are serious problem due to safety maintenance after vacuum vent, interaction between leaked water and carbon dust in high vacuum level in vessel and domestic regulation retained in vessel tritium in ITER. In particular, carbon is known to take different structures, such as graphite, amorphous, diamond, with different characterizations. On the other hand, the diamond like carbon (DLC) in industrial investigations has been studied and a lot of groups are shown DLC characterization of carbon structure and hydrogen concentration using different analytical methods. If characterizations of co-depositied carbon can be shown correctly, a range of hydrogen isotopic retention will be estimated by reference data in industrial investigation.

In this study, using different type of carbon deposition layer were made in LHD, there structural analysis were investigated using Raman spectroscopy and X-ray photoelectron spectroscopy (XPS).

2. Experiment

Target samples made by SUS316 and Si were installed the section 6.5 at inner poloidal cross-section in LHD. These samples were set in the different facing holder and mainly two kinds of group can be separated facing samples, namely S1 and S2 and not facing samples, namely S3 and S4, to graphite divertor targets. A different point of S1 and S2 is the viewing angles from samples to divertor target.

Raman spectroscopy is sensitive to the graphitic structures (phonon distribution) and has been applied in order to study the structural changes of CBMs. Various CBMs, e.g. fine grain graphite, pyrolytic graphite, diamond, CFC, glassy carbon, were characterized.

XPS shows chemical bindings with depth profile using Ar ion etching. Carbon 1s intensitiy can be separated by fitting analysis and main carbon peak was calibrated by experimental results using Highly Oriented Pyrolytic Graphite (HOPG). The top surface of HOPG was peeled off to reduce surface contaminations and lower surface layer was

used the calibration analysis.

3. Results

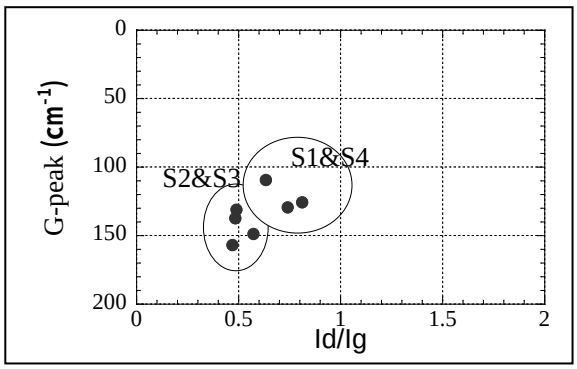

Fig.1. Variation of Raman intensity ratios (ID/IG) of target samples vs. shifted G peak position of graphite by Raman spectroscopy.

The Raman spectra from the target samples exhibit two clear peaks, which correspond to the graphite peak (G peak) around 1580 cm^{-1} and the disordered peak (D-peak) around 1355 cm^{-1}. Figure 1 shows the shifted G-peak position vs Raman intensity ratios (ID/IG). All data shows the amorphous like structure. Plotting data can be separated two groups, one is the S2 & S3, and the other is the S1 & S4. The situations of samples exposed to diverter plasma and targets are separated S1 & S2 and S3 & S4, but the result in Fig.1 shows different characterization.

Figure.2 shows the atomic concentration of deposition layer on target S2. Main composition is carbon of 80% and a few amounts of O, Fe, B are observed. As the sample data of carve fitting analysis, chemical binding energy of carbon 1s is shown in Fig.3. Mainly three kinds of peaks, sp2, sp3 and CO of C1s were considered fitting analysis and the sp2 satellite peak was negligible. From a comparison of Raman spectrum and XPS, the ratio of sp2 to sp3 is different. Because, the depth resolution of XPS is sensitive as shown in Fig.2, but Raman data shows integrated intensities in deposition layer of a few 100nm.

Quality of fitting analysis for C1s binding energies is different on S1 and S2. Data on S2 at different depth positions by XPS could be done using the same fitting parameters, but S1 could not be done. The reasons are considered different compositions and hydrogen concentrations [1] and then carbon structure is also different. More details will discuss in this poster.

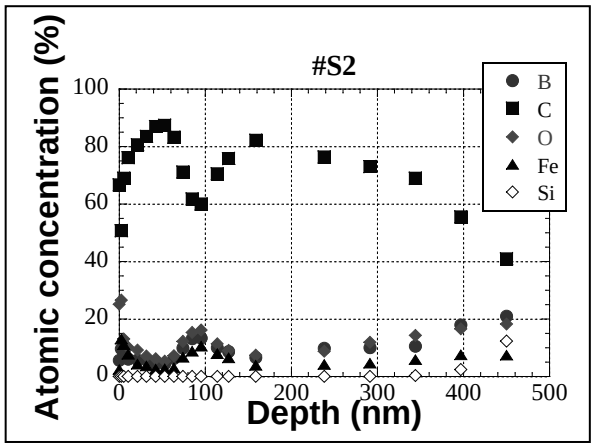

Fig.2. Atomic concentration of deposition layer on sample S2

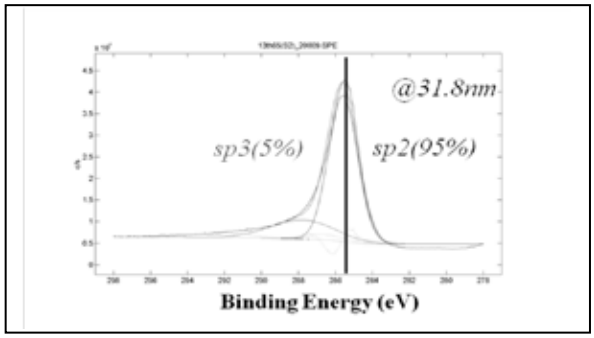

Fig.3. Fitting analysis of carbon 1s at the depth of 31.8nm on sample S2.

Acknowledgments

This work was supported by the NIFS budget UFFF028. The authors would like to thank Mr. Nomura for support of Raman analysis.

References

[1] K. Fukayama et al., this conference.