§7. Surface Analysis of Carbon Materials Exposed to Fast Neutrals Generated in the GAMMA10 Tandem Mirror

Nakashima, Y., Ishimoto, Y., Kobayashi, S., Ishinuki, E., Yoshikawa, M., Yatsu, K. (Plasma Research Center, Univ. of Tsukuba),
Morita, K., Yuhara, J. (Department of Crystalline Materials Science, School of Engineering, Nagoya University),
Sagara, A., Shoji, M., Suzuki, H.

It is necessary to control hydrogen recycling for improvement of energy confinement. The first wall of plasma device is exposed to charge exchange fast neutral emitted form hot-ion plasma, and desorbed hydrogen from the wall induces hydrogen recycling. The aim of this research is control of hydrogen recycling by using carbon sheet pump (CSP) [1, 2]in actual devices. The pumping effect of CSP has already been confirmed with GAMMA10 hot-ion plasmas [3 ~5].

The purpose of surface analysis of carbon materials is to improve performance of CSP and to examine application to actual devices from a microscopic point of view. As shown in fig. 1, we installed additionally the surface station which has sample holder to the CSP test module. Exposure conditions can be arbitrary set because samples can be replaced without opening the GAMMA10 vacuum chamber to air. Moreover, not only CSP but also other candidates for plasma facing material can be exposed to actual plasma by the use of the surface station. Used samples (C/C, isotropic graphite and stainless steel) were annealed at a steady temperature of 800 °C for 10 minutes before exposure. These samples were exposed to fast neutrals from hot-ion plasma in GAMMA 10. The samples were analyzed by the use of several MeV He ion generated in Van de Graaff accelerator in Nagoya University.

The depth profile of hydrogen atom in the exposed C/C sample obtained by elastic recoil detection (ERD) is shown in fig. 2. The scattering data are probably caused by surface roughness of the sample and low fluence of fast neutrals. The counts in the case of the C/C sample exposed to fast neutrals is larger than that in the case of annealed one. This difference is considered to be caused by trapped fast neutrals. So far the pumping effect of CSP has been estimated by pressure difference between using CSP and without it during plasma discharges. From this measurement, we confirmed for the first time that fast neutrals emitted from GAMMA10 plasmas are trapped by the C/C material. The depth corresponding to the peak is about 20 nm. It is nearly equal to the projected range of hydrogen ions at an energy of 1 keV. This energy roughly agrees with the typical average ion temperature (few keV) of the GAMMA10 plasma.

The result of Rutherford backscattering spectroscopy (RBS) which can be used to analysis of impurities in near-surface region is shown in fig. 3. Only a minute amount of Oxygen was detected in the case of the exposed sample, which means that the contamination of the CSP surface in GAMMA 10 is not a serious problem.

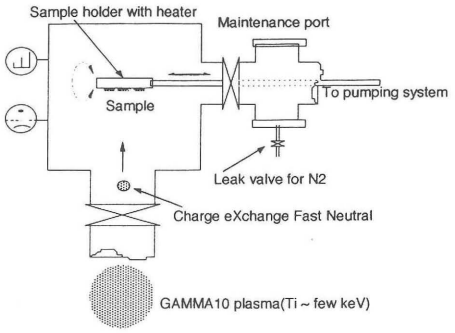

Fig. 1. Schematic illustration of the surface station.

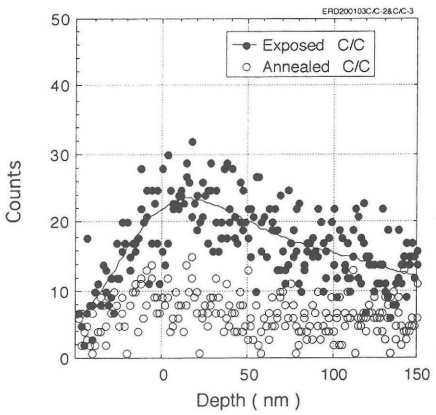

Fig. 2. Hydrogen depth profiles of samples measured by ERD.

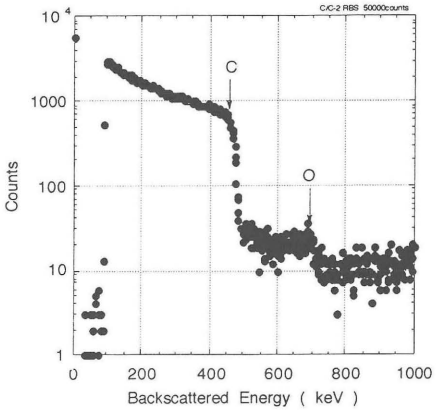

Fig. 3. Energy spectrum of He ion backscattered by exposed samples.

References

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