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炭素照射タングステン表面からの炭化水素放出におよぼす
炭素化学状態依存性

Dependence of chemical state of carbon for the hydrocarbon desorption for carbon implanted tungsten

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Tungsten(W) is one of candidates for plasma-facing materials in fusion reactors. It is thought that W will be exposed to energetic hydrogen isotopes and impurities like carbon, and not only the retention of hydrogen isotopes but also the re-emission of hydrogen isotopes as hydrocarbons will be enhanced via the sputtering processes in D-T fusion reactors operation. The understanding of the dynamics of the sputtering behavior on the W surface under hydrogen isotopes irradiation is one of key issues for the fuel cycle. Therefore, in situ measurement system for the mass balance estimation including number of dynamic sputtered particles under deuterium irradiation has been developed. In this study, hydrogen was irradiated to C^+-implanted W, WC and HOPG to elucidate the dependence of chemical stares of carbon on sputtering, which have different chemical states of carbon.

The disk type of W and tungsten carbide (WC), and plate types of Highly Oriented Pyrolytic Graphite (HOPG) were used as the samples. These samples were preheated at 1173 K for 1 hour. For the preparation C^+ implanted W, 10 keV C^+ irradiation was performed with an ion flux of 1.0×10^{17} C^+ m^{-2} s^{-1} and an ion fluence of 1.0×10^{21} C^+ m^{-2} at R.T. (C^+ imp. W). Then, 3 keV hydrogen (H_2^+) irradiation was performed for all the samples with an ion flux of 1.0×10^{18} H^+ m^{-2} s^{-1} at 673K. In-situ measurement for the sputtered particles was performed by QMS (INFICON Transpector2 H100M) equipped in the implantation chamber to understand the recycling behavior of hydrogen on the surface of tungsten during H_2^+ irradiation.

Figure summarizes the ratios of hydrocarbons by H_2^+ irradiation for various samples. CH_4 and CH_2 were the major sputtered particles for HOPG, although CH_3 and CH_2 were typical particles for WC. The saturated atomic ratios of D/C were known to be 0.4 for HOPG and 0.07 for WC, respectively. The carbon concentration on the surface of C^+ implanted W was limited to be ~30% according to XPS analysis, which would refrain the formation of C-D bond on the surface region. These facts indicate that CH_3 is the major chemical state for C^+-implanted W. It was concluded that the chemical forms of hydrocarbons sputtered were controlled by the hydrogen concentration on the sample surface, especially the amount of the C-H bonds.

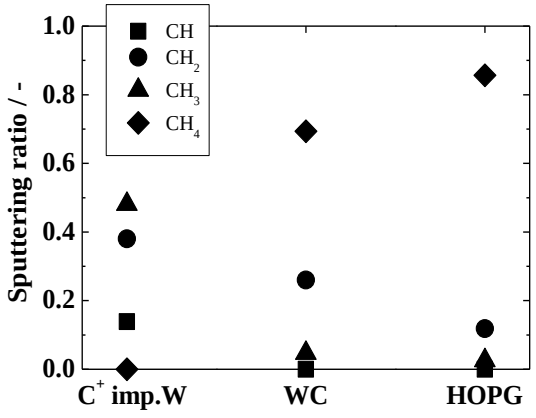

Fig. The ratios of hydrocarbons by H_2^+ irradiation for C^+ implanted W, WC and HOPG.