DEUTERIUM RETENTION AND DEPTH PROFILE IN NEAR SURFACE OF TIC AND C IRRADIATED WITH DISSOCIATED DEUTERIUM ATOMS IN AN ECR PLASMA

K. Yano, Y. Ishibe, H. Oyama, Y. Sakamoto, M. Yanokura, I. Kohno
The Institute of Physical and Chemical Research, Wako, Saitama, 351-01, Japan

1. INTRODUCTION

Titanium carbide and graphite are promising materials for vacuum wall surfaces in contact with plasmas because of their heat-resisting property and relatively lower atomic number materials. They are candidates for limiters and first walls of thermonuclear fusion devices for the reason that they are low atomic materials in particular. In our previous studies [1], we have successfully carried out wall conditioning using an ECR(Electron Cyclotron Resonance)hydrogen plasma on the basis of the chemical sputtering. In this case, neutral hydrogen atoms play an important role because of their chemical activity. The purpose of this study is to investigate the plasma surface interaction between the surfaces of TIC and C, and deuterium atoms produced in the ECR deuterium plasma in order to clarify the behavior of deuterium atoms in near surface taking part in the chemical sputtering.

2. EXPERIMENTAL SET-UP

Figure 1 shows a schematic drawing of the ECR deuterium plasma irradiation apparatus. The electron density and electron temperature were 9.6 x 10^7 cm^-3 and 4.7 eV for the gas pressure of 2 x 10^-2 Pa, respectively. Samples were set 200 mm apart from the center of the plasma column in parallel with the resonance magnetic field so that they can be irradiated with only neutral atom fluxes which are estimated to be about 10^16 atoms cm^-2 s^-1. TIC samples were made by means of CVD(Chemical Vapor Deposition) coating with the film thickness of 20 μm on poco graphites, which were also used as graphite samples. These samples contain inevitably much of hydrogen atoms because of being made by CVD method as shown in Fig.3.

The ERD(Elastic Recoil Detection) by using Ar^+ beam was employed in measuring the near surface concentration of deuterium atoms[2]. The arrangement is shown in Fig.2. An aluminum foil of 20 μm in thickness was inserted just before the detector(SSD 1) in order to eliminate the components like Ar, Ti and C from a recoiled beam.

3. RESULTS AND DISCUSSION

Figure 3 shows the depth profiles of H and D in the near surfaces of TIC and C after 1 hour irradiation with dissociated deuterium atoms during rise in the sample temperature. In this case, the deuterium atom fluence is estimated to be about 2 x 10^19 atoms cm^-2. Incident deuterium atoms with the energy of about 5 eV are mainly produced by the dissociative
excitation process[3]. As seen in Fig.3, deuterium atoms diffuse from the surface to inside, ranging over several hundred nm in the TiC, as the sample temperature is increased. Deuterium atoms in the graphites are localized at the near surface. Figure 4 shows the depth profiles of H and D in the near surface of TiC for as received, 5 hours and 20 hours irradiation with plasma(D^+,D^0). The hydrogen concentration decreases with the irradiation time and this is because of desorption and/or replacement of hydrogen with deuterium due to the sample temperature rise during the plasma irradiation(130°C). Deuterium atoms distribute up to several hundred nm from the surface, but concentration saturates near the surface after 5 hours irradiation.

ACKNOWLEDGMENT

Drs. M. Aratani and T. Nozaki of RIKEN are acknowledged for continuing guidance and encouragement, and Dr. S. Sukenobu of Toshiba corp. for giving the samples and information concerning these samples.

REFERENCES

Fig. 1. Schematic arrangement of ECR plasma irradiation apparatus.

Fig. 2. Diagram of experimental apparatus for profiling H and D.
Fig. 3. Depth profiles of H and D in the near surface of TiC and C irradiated with deuterium atoms during rise in the sample temperature.

Fig. 4. Depth profiles of H and D in the near surface of TiC irradiated simultaneously with deuterium atoms and ions.