§24. Deuterium Retention Properties of SiC/SiC Composites as Plasma Facing Materials for Fusion Reactors after Deuterium Irradiation at Elevated Temperatures

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In this study, deuterium retention properties of SiC/SiC composites irradiated by deuterium ions at different temperatures in the range from 293 K to 923 K were investigated with thermal desorption spectroscopy, and the relationship between deuterium retention and the change of atomic composition was also examined. The sample used in this study was SiC/SiC composites produced by the nano-powder infiltration and transient eutectoid (NITE) process. Deuterium ion irradiation was performed with an ECR ion irradiation apparatus. In the deuterium irradiation experiments, a D_3^+ ion with energy of 5 keV (1.7 keV for sole D particle) was implanted into the SiC/SiC composites. The flux of ion was in the order of 10^{13} $cm^{-2}s^{-1}$, which was estimated from the sample current, and the ion fluence constant at $5x10^{18}$ cm^{-2}. The sample temperature during ion irradiation was varied from room temperature to 923 K. After deuterium irradiation, the sample was extracted from the ECR apparatus and mounted in a TDS apparatus. In TDS analysis, the sample was heated from room temperature to 1273 K with a ramp rate of 0.5 K/s. The change of atomic composition after irradiation was examined with Auger electron spectrometry.

Figure 1 shows the depth profiles of atomic composition before deuterium irradiation (Fig.1 (a)) and after deuterium ion irradiation at 673 K (Fig.1 (b)). It is considered that the enhancement of carbon erosion by chemical sputtering in the SiC matrix, SiC fiber and PyC regions is a possible reason for the reduction of carbon after deuterium irradiation.

Thermal desorption spectra of D_2 in SiC/SiC composites after deuterium ion irradiation is shown in figure 2. Thermal desorption spectra of D_2 showed two major peaks which was regarded as deuterium released from its Si-D and C-D bonds, respectively. Figure 3 shows the total amount of desorbed deuterium and the ratio of the amounts of desorbed D_2 at the lower and the higher temperature peaks, which were estimated from a peak separation. At the irradiation temperature of 673 K, the ratio of the amounts of desorbed D_2 at lower desorption peak (Si-D bond) increased compared to the room temperature case, owing to the decrease in carbon composition at the surface, as seen in Fig.1. On the other hand, at the irradiation temperatures at 823 and 923 K, the ratio of the amounts of desorbed D_2 at higher desorption peak (C-D bond) increased due to thermal release of D once trapped by Si-D bond during irradiation.

The present data suggests that the fuel hydrogen retention properties of SiC/SiC composites are significantly affected by the surface temperature.

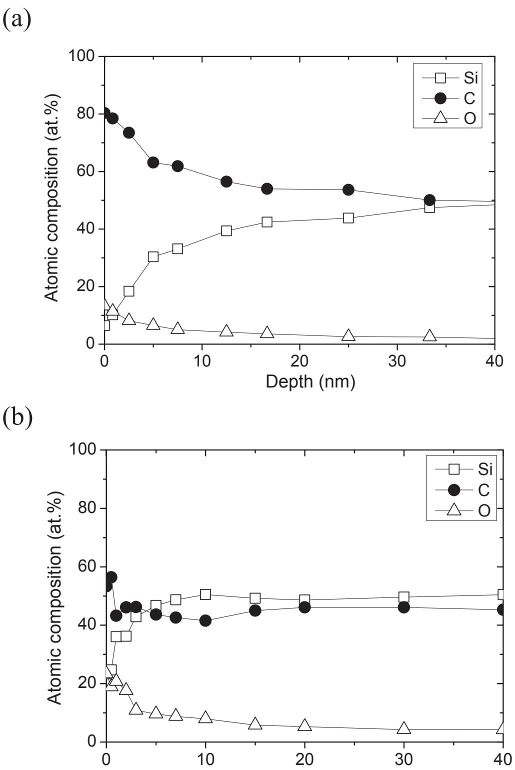

Figure 1 Depth profiles of the atomic composition of SiC/SiC composites before deuterium irradiation (a) and after deuterium irradiation at 673 K (b).

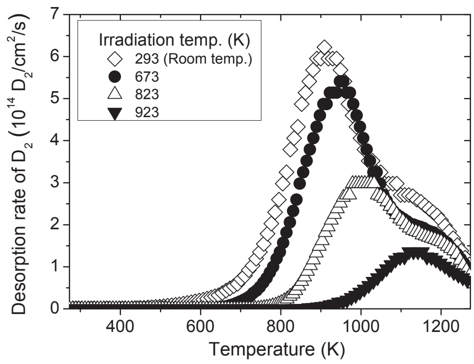

Figure 2 Thermal desorption spectra of D_2 after deuterium ion irradiation at various irradiation temperatures.

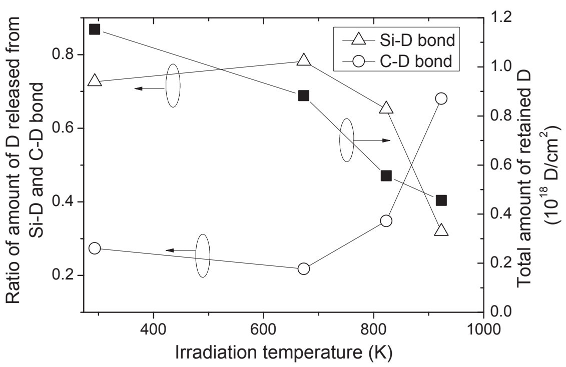

Figure 3 Total amount of desorbed deuterium, and the ratio of the amounts of desorbed D_2 at the lower (Si-D bond) and the higher (C-D bond) temperature peaks.