§2. Retention and Desorption of Deuterium in Model Alloys of Ferritic Steel

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Retention and desorption of injected deuterium into model alloys of ferritic steel were investigated by using TDS, XPS, and TEM complementary. Three model alloys (Fe-9Cr) and Pure-Fe were prepared as test materials. After rolled to 0.2 mm thickness, some of them were annealed at 1023 K for 2 hours to reduce dislocations. As-rolled and annealed specimens were irradiated at room t emperature with 8keV-deuterium ions up to the fluence of 6×10^{21} D^+/m^2, and successively thermal desorption of D_2 and HD under the constant heating rate (1K/s) was measured using quadruple mass spectroscopy.

In general, retention of deuterium in the rolled Fe-Cr alloys was quite low and most of them desorbed up to 700 K. Remarkable desorption was observed even at room temperature, which indicates the existence of rather weak traps.

Figure 1 shows thermal desorption spectra of D released from As-rolled and annealed Fe-9Cr specimens irradiated with 8 keV-D_2^+ ions to $2 \times 10^{21}D/m^2$ at room temperature respectively. The retention decreased drastically in the annealed specimens. This fact indicates that the dense dislocations formed by cold work provide good trapping sites for deuterium diffusing deeply into the specimen.

Figure 2 shows thermal desorption spectra of D from annealed Fe-9Cr irradiated with 8 keV-D_2^+ ions up to 6×10^{21} D^+/m^2 at room temperature. A special feature of the Fe-Cr alloys was the remarkable decrease of the retention above the fluence of $3 \times 10^{21}D_2^+/m^2$.

The composing elements and their chemical states at the surface were examined by means of XPS technique. Figure 3 Shows Depth profile of Atomic concentration. It was found that the surface of the alloys was covered with oxide layer of about 7 nm thickness, which is just the thickness of sputtering erosion by the irradiation of 8 keV-D_2^+ for 6×10^{21} D_2^+/m^2. Taking into account that 8 keV-D_2^+ is injected in the much deeper region (projected range is about 30 nm), it is likely that the surface oxide layer acts as desorption barrier and once the layer is removed by the sputtering desorption during and after irradiation occurs actively. As a result, retention of deuterium decreases above 3×10^{21} D_2^+/m^2 as observed. Interstitial type dislocation loops are formed in the narrow subsurface region. But their density and size are too low to explain the retention of the deuterium, namely, these defects don't work as main deuterium trapping site.

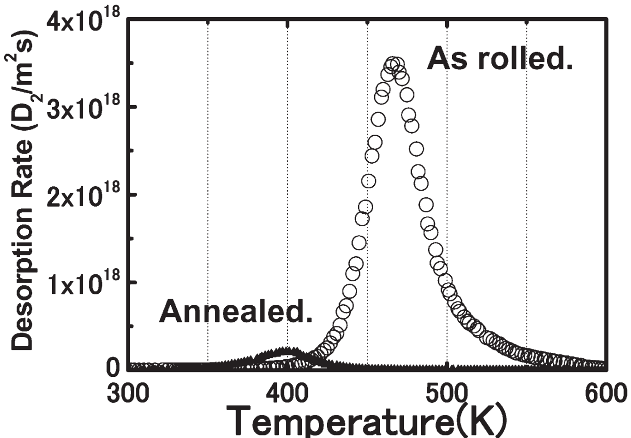

Figure 1 Thermal desorption spectra of D released from As-rolled and annealed Fe-9Cr specimens irradiated with 8 keV-D_2^+ ions to $2 \times 10^{21}D/m^2$ at room temperature.

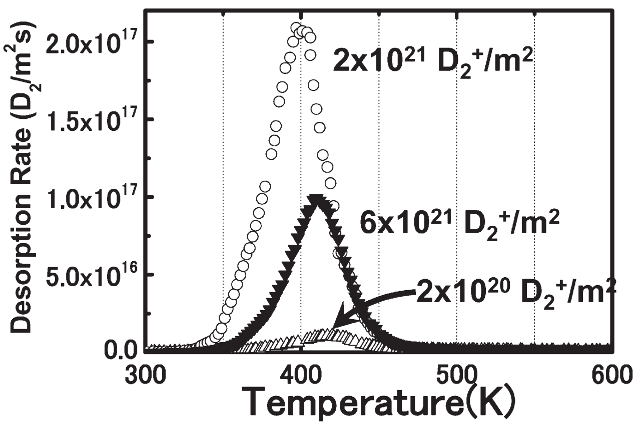

Figure 2 Thermal desorption spectra of D from annealed Fe-9Cr irradiated with 8 keV-D_2^+ ions up to 6×10^{21} D^+/m^2 at room temperature.

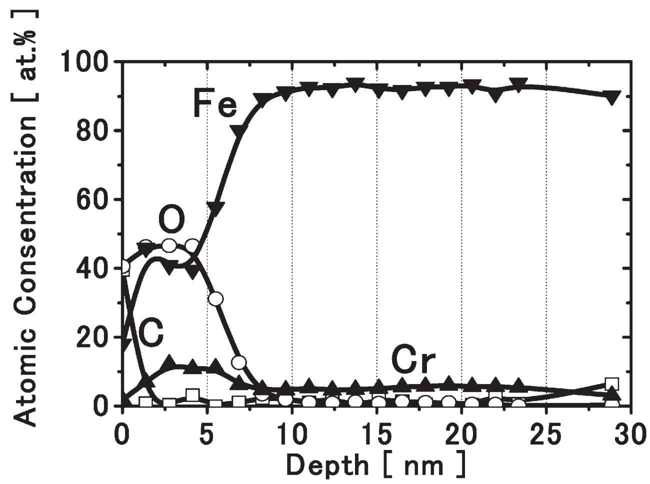

Figure 3 Depth profile of Atomic concentration in annealed Fe-9Cr.