## §21. Radiation Damage and Deuterium Trapping Property in F82H Ferritic/martensitic Steel

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Reduced activation ferritic/martensitic steel F82H is one of a candidate alloys for the first wall of fusion reactors as well as for the beam window of spallation target for ADS. In this study, trapping behavior of deuterium in F82H was studied following helium and/or deuterium irradiations by means of thermal desorption spectrometry (TDS) and microstructural observation by TEM.

F82H ferritic/martensitic steel used in this study was IEA-heat 4-20 prepared for Japanese fusion reactor material program. The specimens with a dimension of 6×10 mm were mechanically cut to the thickness of around 2mm. Then the surfaces of the specimens were mechanically polished up to buff polishing with 0.03μm colloidal silica for low energy ion irradiations.

Low energy helium irradiations and following deuterium irradiations were performed at Research Institute for Applied Mechanics (RIAM), Kyushu University. After the irradiations, thermal desorption of $D_2$ and He under heating with a ramping rate of 1 K/s were measured with high resolution quadruple mass spectrometer. At the same time, the samples for the microstructural study by TEM were prepared using focused ion beam system (FIB) from the same specimens.

Thermal desorption spectra of He and $D_2$ from specimens irradiated with 5 keV $He^+$ and 0.5 keV $D_2^+$ are given in fig.1 and fig.2. Microstructures observed by TEM are given in fig.3. In fig.2, the deuterium desorption spectrum from the specimen with only $D_2$+ irradiation, which is without helium irradiation, is also shown for comparison.

Helium irradiation on F82H alloys shows remarkable effect on the trapping behavior of deuterium. Normally, for the case of no helium irradiation, large desorption stage from deuterium appears between the temperatures from 350 K to 500 K. On the other hand, in the case with helium irradiation, the desorption stage around this temperature region shifts to higher temperatures for about 30 K, as shown in fig.2. In addition, the large desorption stage appears only in the low temperature region and most of the deuterium desorption ends at this temperature region, as can be seen in fig.1. According to the microstructure observation given in fig.3, large helium bubbles are densely formed near the surface of the specimens. If all implanted deuterium was trapped inside of these helium bubbles, deuterium desorption peak should appeared in the higher temperature region which corresponds to that of the helium desorption peak, which is above 1000 K where stagnant helium bubbles at lower temperature become mobile. Therefore, the result indicates that the implanted deuterium was trapped in some other weaker trapping sites, which expected to be the surrounding of helium bubbles.

These types of peak shift on hydrogen gas release behavior for high energy proton irradiated F82H alloy was also seen on the former studies on gas release measurement and microstructural investigation of STIP irradiated materials. According to these studies, the desorption stage which should be attributed to the release of hydrogen gases from helium babbles appears more clearly on the specimens irradiated to 20.3 dpa at around 400 ºC where formation of high-density small helium bubbles occurs, compared to that irradiated to the lower dose of 10 dpa at around 100 ºC where no visible helium bubble formation was observed, which consequently appears as a peak shift.

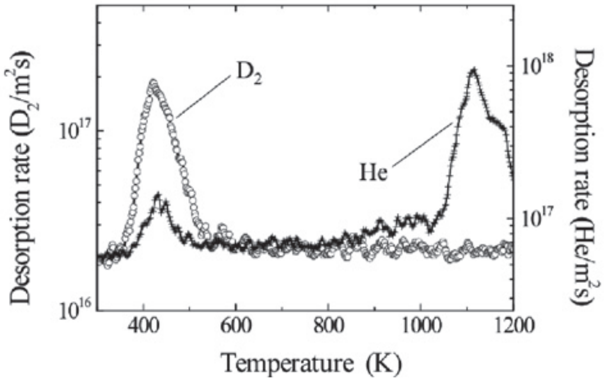


Fig. 1. Thermal desorption spectra of $D_2$ and He from $He^+$ and $D^+$ irradiated spicimen.

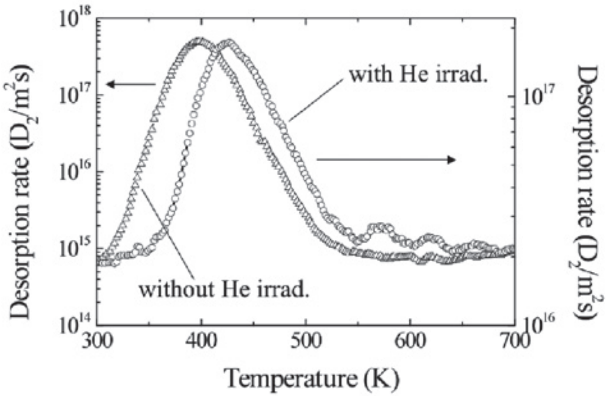


Fig. 2. Thermal desorption spectra of $D_2$ from $He^+$ and $D^+$ irradiated spicimen. The spectrum from the specimen without helium irradiation is also shown for comparison.

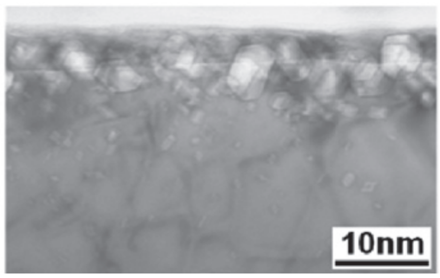


Fig. 3. The microstructures of as-received and re-tempered specimens irradiated with 5keV $He^+$ at 600 ºC.