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The effect of hot-rolling conditions on deuterium retention in tungsten

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Introduction

Hot-rolling fabrication conditions for ITER W effect hydrogen trapping dynamics were studied.

Materials and methods

ITER W and various modified ITER W, provided by A.L.M.T. Corp., were used for this study – shown in table 1. Samples were exposed to D plasma with a fluence of 4×10^{24} D m^{-2} at 473 K and 573 K.

Name	Specification
WR	ITER W irradiated on the **Roller** direction (RD) surface - same as ITER outer divertor
WN	ITER W, but irradiated on the **Normal** direction surface
WT	ITER W, but irradiated on the **Transverse** direction side
WRS	Modified ITER W (RD surface) – Smaller grains
WRC	Modified ITER W (RD surface) – Cross-rolled
WRCS	Modified ITER W (RD surface) – Cross-rolled – Smaller grains

Table 1. Types of samples used in this study

Results and discussion

Total retention is shown in Fig. 1. D retention in WR (ITER W) is the same at 473 K and 573 K. WT and WN have more retention than WR at 573 K, but WN has less retention at 473 K. Total retention in samples with smaller grain sizes, WRS and WCRS, is decreased compared to their counterparts, WR and WCR (except for WRS at 473 K). Similarly, total retention in cross-rolled samples, WCR and WCRS, is decreased compared to their counterparts, WR and WRS. WRCS combines cross-rolling and smaller grain sizes and achieves the least retention at both 473 K and 573 K.

Fig. 2 shows the normalized TDS spectra. At 473 K, the left peak is largest for the cross-rolled samples, WRC and WRCS. At 473 K, the right peak is shifted to higher temperatures for the smaller grain samples, WRS and WRCS.

At 573 K, crossed-rolled samples have narrower peaks. Grain boundaries have a much broader energy distribution than other traps [1]. Therefore, a decrease in the grain boundary density, from

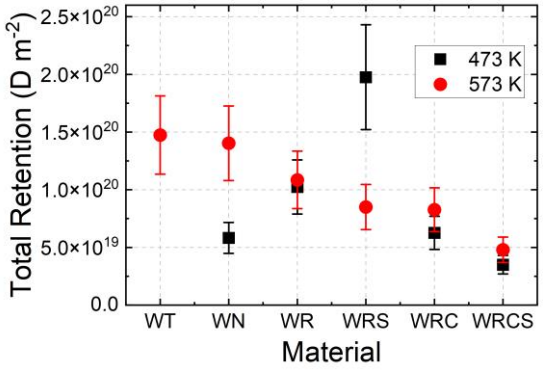

Fig. 1. Total retention from ITER W (WR) and various modified ITER W.

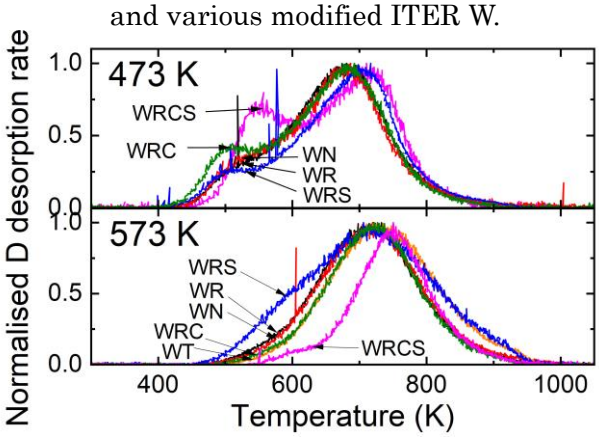

Fig. 2. Normalized desorption spectra from ITER W (WR) and various modified ITER W.

cross-rolling, could explain the narrower peaks observed. Grain boundaries could also act as fast transport channels [1]. Therefore, a decrease in grain boundaries in cross-rolled samples could decrease the effective diffusion rate, which would explain the decrease in total retention observed.

An additional shoulder appears at the trailing edge for WT and WRS at 573 K. FE-SEM images show that WT and WRS have the least blisters.

Conclusion

By changing the manufacturing process for ITER W, hydrogen retention can be decreased by more than 50%, together with blister suppression. Trapping and de-trapping dynamics could be altered for these samples.

References:

1) U von Toussaint *et al* 2011 *Phys. Scr.* **2011** 014036