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Deuterium retention and desorption of SS316L under Ar gas puffing

Arガスパフ下におけるSS316Lの重水素保持脱離挙動

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In order to evaluate the deuterium retention/desorption properties under argon gas puffing SS316L sample was exposed to deuterium ions with introducing argon gas in the vicinity of the sample. For this purpose, a new sample holder was installed in an ECR plasma device. The Langmuir probe measurement showed the decrease in electron temperature and the increase of electron density in the case with the argon gas puffing. Thermal desorption measurements showed the amount of desorbed deuterium rapidly increased when an argon mixture ratio was 0.03.

1. Introduction

The heat load on the divertor plate in fusion devices would increase with the plasma stored energy, which would lead to the enhancement of the divertor erosion as well as the decrease in the lifetime of the divertor plates to solve this problem, attempts such as noble gas injections into the divertor plasma and the baffle-structured closed divertor has been carried out in fusion devices such as the Large Helical Device [1]. However, the plasma-wall interactions such as fuel particle recycling during these conditions have not been clarified yet. The objective of the present study is the evaluations of deuterium desorption/retention properties under the inert gas puffing. For this purpose, SS316L sample was exposed to deuterium ions with Deuterium discharge is per formed while introducing argon gas in the vicinity of the sample. The effects of the Ar gas puffing on the desorption/retention behaviors were discussed.

2. Experiment

SS316L sample with a size of 10mm × 10mm × 0.5mm was mechanically polished using Al_2O_3 powders, cleaned in ethanol and degassed in a vacuum at 1273 K for 60 min. The degassed samples were exposed to the plasmas in an ECR plasma apparatus shown in Fig.1. In order to introduce argon gas in the vicinity of the sample, new sample holder was installed in the apparatus. Fig.2 shows the photograph of this sample holder. The sample holder has tiny holes near the sample position through which Ar gas was introduced. The deuterium pressure was 8Pa with D_2 flow rate of 10sccm. The flow rate of the Ar gas was varied between 0 ~ 0.3sccm. The input power was 200W. The biased voltage of the sample was 250V. Discharge duration was 60 min. Total ion fluence during exposure was estimated to be order of $10^{17}cm^{-2}$. The electron density and the electron temperature of the vicinity of the sample were measured using a Langmuir probe. Optical emission spectrum near the sample was also measured. The deuterium desorption/retention properties of the irradiated samples were evaluated by thermal desorption spectroscopy, TDS. After the irradiation, the sample was transferred to a TDS apparatus with air-venting, and then linearly heated from RT to 1273K with a heating rate of 0.5 K/s. During the heating, the amount of desorbed deuterium from sample was quantitatively measured by a quadruple mass spectrometer. In addition, the surface morphology of the samples and atomic composition were observed using a scanning electron microscope, SEM and an auger electron spectroscopy, AES, respectively.

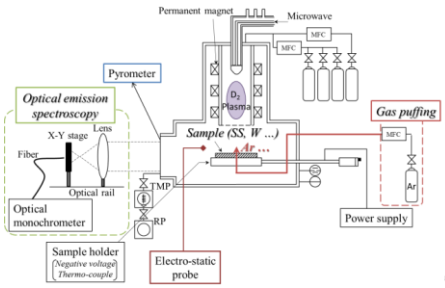

Fig.1. Schematic of ECR plasma apparatus.

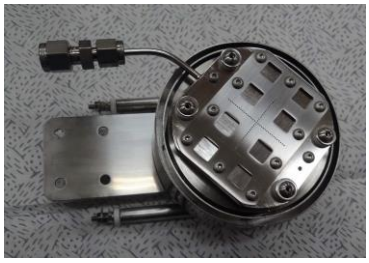

Fig.2. Photograph of new sample holder.

3. Results

Fig.3 shows Ar flow rate dependence of the electron temperature and the electron density near the sample. As Ar gas flow rate increased, the electron temperature decreased and the electron density increased. In particular, they drastically changed when the Ar flow rate was 0.3sccm.

Fig.4 shows the desorption spectra of D_2 of the samples with changing the Ar flow rate of the vicinity of the sample. Desorption peaks were observed at around 500K and 1000K. The high temperature peak seemed to be desorption from carbon deposition layer, which was originated from the graphite separator in the apparatus. The carbon deposition might be slightly enhanced with small Ar gas puffing. On the other hand, it was presumed that the 500K peak were desorption of deuterium implanted in the SS316L. The peak temperature was similar to that for deuterium implanted in SS316L, which was reported in [2].

Fig.5 shows the amounts of desorbed deuterium in the low temperature peak. The deuterium amounts drastically increased when the Ar flow rate was 0.3sccm, while there was no remarkable change up to 0.20sccm. The increase of desorbed amount might result from the enhancement of inward deuterium diffusion.

Discussion on the deuterium retention/desorption properties based on optical emission, SEM and AES measurements will be also presented.

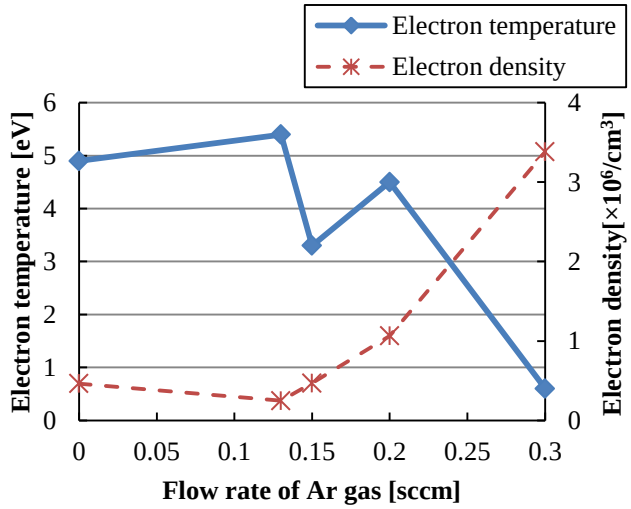

Fig.3. Ar Flow rate dependence of electron temperature and electron density.

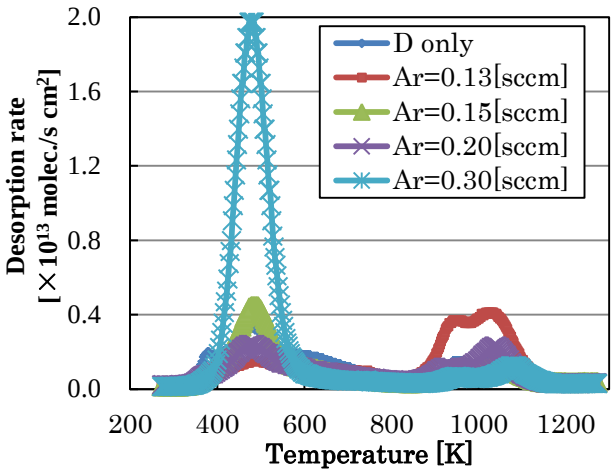

Fig.4. Thermal desorption spectra of D_2 for the samples with and without argon gas puffing.

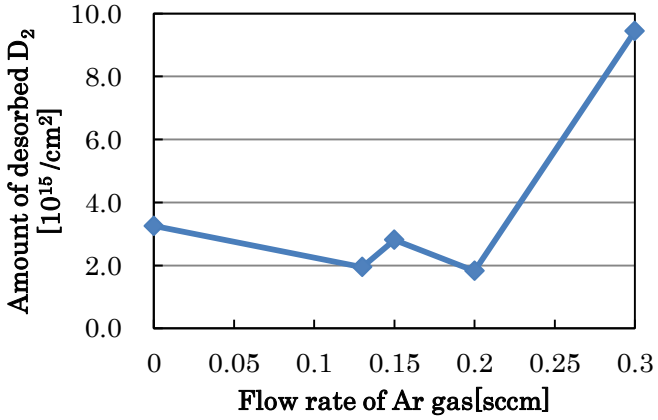

Fig.5. Amounts of desorbed deuterium of desorbed low temperature.

4. Reference

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