§13. Research and Development of Wall Conditioning Techniques for LHD

Toyoda, H., Sugai, H., Ito, N. (Nagoya Univ.), Sagara, A., Inoue, N., Noda, N.

So far, wall conditioning of LHD has been performed by glow discharge cleaning and titanium gettering. However, considering various limitations for conditioning in superconducting magnetic coils, it is needed to develop more powerful and convenient methods applicable to LHD. To meet with such demands, lithium conditioning has been proposed in this study. The lithium conditioning can be a powerful tool[1-5] to reduce oxygen impurity and hydrogen recycling. In this year, lithium-induced suppression of chemical sputtering of graphite is studied with plasma-wall interaction at carbon divertor plate of LHD in mind.

The experiment is performed by a small cylindrical vessel with 60 cm in length and 30 cm in diameter. Graphite sample (graphite sheet, Toyo Tanso, perma foil, PF-UHPL) with 14 cm in diameter is set into the vessel through a load-lock system. The sample holder has a heater to control the sample temperature up to 500 K. A lithium oven is set at the bottom of the vacuum vessel. By heating the oven up to 450°C, lithium layer of ~100 nm in thickness is deposited on the graphite within 10 minutes. Film deposition rate is *in-situ* monitored by a quartz oscillation deposition monitor. Just after finishing the lithium deposition, a DC glow discharge between an anode and the vessel wall (cathode) is ignited to measure chemical sputtering yield of the graphite. Typical discharge voltage and current are ~200 V and 0.3 A, respectively, at a hydrogen pressure of 20 mTorr. Ion energy bombarding the sample is estimated to be ~200 eV. Chemical sputtering yield of graphite is measured by monitoring methane partial pressure with a differentially pumped quardupole mass analyzer. To obtain absolute value of methane yield from the graphite, calibration has been performed prior to the experiment: CH_4 gas is fed into the vessel through a mass flow controller, and the QMA signal is calibrated as a function of methane flow rate. As the graphite surface is always exposed to the plasma in fusion devices, it is meaningful to investigate the difference of graphite treatment, *i.e.*, with or without plasma-exposure, on the lithium conditioning effects. So the effect of hydrogen plasma exposure before the lithium deposition is also tested in this study.

Figure 1 shows the temporal variation of methane yield from graphite samples with and without lithium deposition. In case of the graphite sample without lithium deposition (filled circles), methane yield increases immediately after turning on the hydrogen discharge and is saturated at the methane yield of ~6×10^{13} molecule/cm^2s. In case of the lithium deposited graphite, however, methane yield is very low compared with the case of pure graphite at the initial stage of the hydrogen discharge (< 5min), and is also low by factor of ~20% at t=10 min. In our previous research, it has been found that the lithium atoms deposited on the graphite can easily penetrate into the graphite bulk even at a room temperature (graphite intercalation). The reason why the methane yield is not completely suppressed even by enough amount of lithium (equivalent to 100 nm in film thickness) can be understood by the lithium-graphite intercalation.

To investigate the effect of hydrogen retention in graphite, a sample exposed to the hydrogen discharge is prepared before depositing lithium on the graphite. After the lithium deposition, the sample is again exposed to the hydrogen plasma to measure the methane yield. However, clear difference of methane yield is not observed between lithium deposited pure and hydrogen-exposed graphites.

References

1) Isozumi,T., Yoshida, S. and Sugai, H. : Kaku-Yugo Kenkyu **60**(1988)304.
2) Snipes et al. : J. Nucl. Mater. **196-198**(1992)686.
3) Sugai, H. et al. : J. Nucl. Mater. **220-222**(1995) 254.
4) Sugai, H. et al. : Vacuum **47**(1996)981.
5) Toyoda, H. et al. : J. Nucl. Mater. **241-243**(1997)1031.

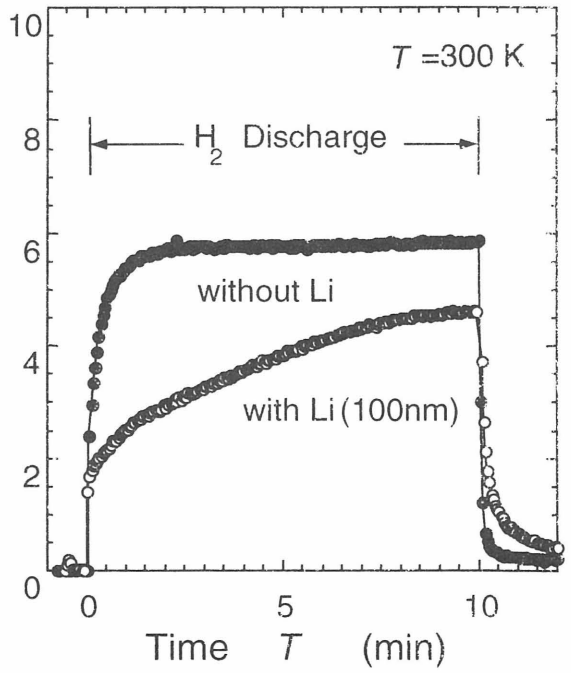

Fig. 1. Temporal variation of the methane yields from pure (filled circles) and lithium-deposited (open circles) graphites. The sample temperature is 300 K.