§5. Plasma Surface Interactions in Lithium Coating on Graphite Materials

Toyoda, H., Sugai, H., Kato, S.(Nagoya Univ.)
Sagara, A., Tuzuki, K., Inoue, N., Noda, N.

Recently, in-situ coating of thin lithium layers with a vacuum evaporation method has been performed in a small laboratory device to demonstrate a new possibility for wall conditioning.[1] Subsequently, wall conditioning with lithium pellet injection was developed in TFTR.[2] This technique led to a reduction of carbon impurities and 15-20 % improvements in supershot plasma performance. However, the underlying mechanisms for the effects of lithium-based conditioning have not been fully understood. In order to evaluate the effect of lithium evaporation onto first walls, we performed laboratory experiments.[3-5]

Experiments are performed in SUT device in NIFS. A stainless steel oven (~2cm^3) is placed on the bottom of the vessel. Solid lithium is put in the oven, which can be heated to 450 °C. A deposition monitor enables us to measure the deposition rate of lithium without opening the vessel. A graphite sample (HOPG or isotropic graphite) is placed at a position of the vessel wall by a sample holder. After lithium deposition, the graphite sample is transferred to the surface analysis chamber and depth profile of atomic composition is measured by in-situ Auger electron spectroscopy. Samples can be heated up to 250 °C, to investigate the annealing effect on the lithium depth profile.

Figure 1 shows depth profile of lithium composition in case of lithium deposited HOPG sample with and without annealing of the sample at 250 °C for 20 minutes. Estimated lithium film thickness is 250 nm. It is notable that, even in the case of as-deposited sample (closed circles), top surface of the sample is not completely covered with the lithium. This result implies that deposited lithium atoms can easily penetrate into the bulk of the graphite. After annealing the sample (open circles), penetration of lithium atoms into the bulk seems to be enhanced because the lithium depth profile become flatter and the lithium atomic composition on the sample surface become lower. It is presumably due to the enhancement of the lithium atom diffusion into the graphite by the heating of the substrate.

It is well known that the Auger spectrum of carbon is different depending on its chemical bonding state, i.e., carbide or graphite. Auger spectrum of the lithium-deposited sample is examined and it is found that carbon spectrum has drastic difference between lithium-penetrated layer and pure bulk graphite. Auger spectrum obtained at bulk graphite is not different from conventional graphite peaks. In case of lithium penetrated layer, however, carbon spectrum has sharp side peaks, which seems to be carbide peaks. These results suggest that lithium penetrated into the graphite is chamically bound to the carbon atoms in the graphite.

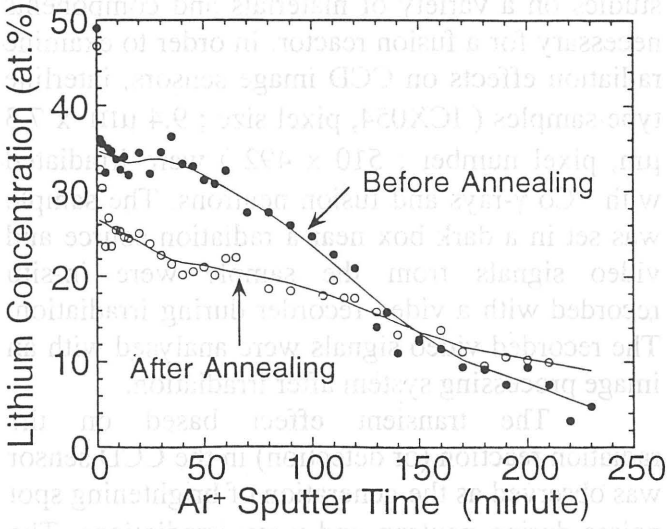

Fig. 1. Auger depth profile of lithium atom concentration of samples with and without annealing at 250°C, 20 minutes.

References

1) Isozumi,T., Yoshida, S., 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) H. Sugai et al. : Vacuum 47(1996)981.
5) H. Toyoda et al. : J. Nucl. Mater. 241-243(1997)1031.