§33. In Situ Measurement of Surface Modification of Plasma-facing Material during the Long Duration Discharge

Sakamoto, M., Tokunaga, K. (RIAM, Kyushu Univ.),
Shoji, T. (School of Eng., Nagoya Univ.),
Ohya, K. (Fac. of Eng., The Univ. of Tokushima),
Ashikawa, N., Masuzaki, T., Sagara, A.

Understanding of phenomena of plasma-wall interaction (PWI) is one of the most critical issues from the viewpoints of the steady state operation of fusion plasma. Properties of a surface of plasma-facing material (PFM) continue to change during a long duration discharge due to PWI such as heat load, particle road, radiation damage, erosion and re-deposition. It is necessary to estimate the surface modification in real time for better understanding of PWI. The characteristic time of the surface modification of PFM is so long that it is difficult to estimate the modification in a short duration discharge. It is also difficult to understand a relation between the surface modification and the plasma condition only by a post-mortem analysis, since the plasma condition is changed according to the experimental purpose in an actual plasma operation. In this study, we develop in situ and real time measurement system of the surface modification of PMF using spectroscopic ellipsometry in a new PWI simulator.

In this year, we have constructed the PWI simulator and succeeded in the plasma production as shown in Fig.1. The plasma is produced by helicon wave of which frequency is 13.56 MHz and RF power is up to 5 kW. A pair of magnetic field coils can generate 0.05T at the plasma center. The feed gas was helium. In the next step, hydrogen plasma is produced and the plasma parameters are measured by a Langmuir probe.

As a preliminary estimation, a specimen which had been exposed to a long duration discharge in TRIAM-1M was measured by using a spectroscopic ellipsometory. Figure 2 (a) shows the image of the surface of the specimen. The bottom side of the specimen in Fig.2 (a) was near the plasma. Its color is brownish-red and the opposite side is metallic-colored. Figure 2 (b) shows the relative phase Δ of p and s polarization and Fig 2 (c) shows relative amplitude Ψ of p and s polarization. Each data of Fig.2 (b) and (c) corresponds to the position indicated in Fig.2 (a). There exists a clear difference of the spectra between the brownish-red area and metallic-colored area. The specimen was also measured by using Rutherford backscattering spectrometry (RBS). From analysis of RBS, it is found that oxygen exists in the co-deposits of which color is brownish-red in Fig.2 (a). A previous experiment revealed that oxygen affects the formation of the microstructure of the co-deposits[1]. It suggests that the difference of the spectra between the brownish-red area and metallic-colored area may be attributed to the microstructure of the co-deposits.

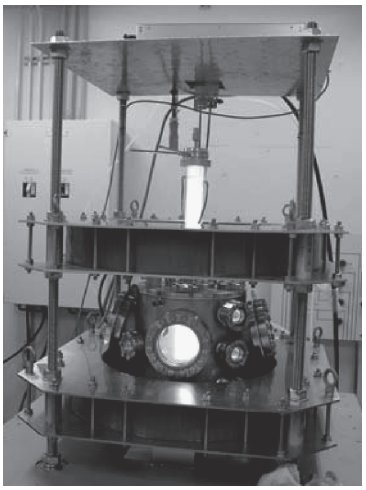

Fig.1 PWI simulator for measurement of surface modification of PFM.

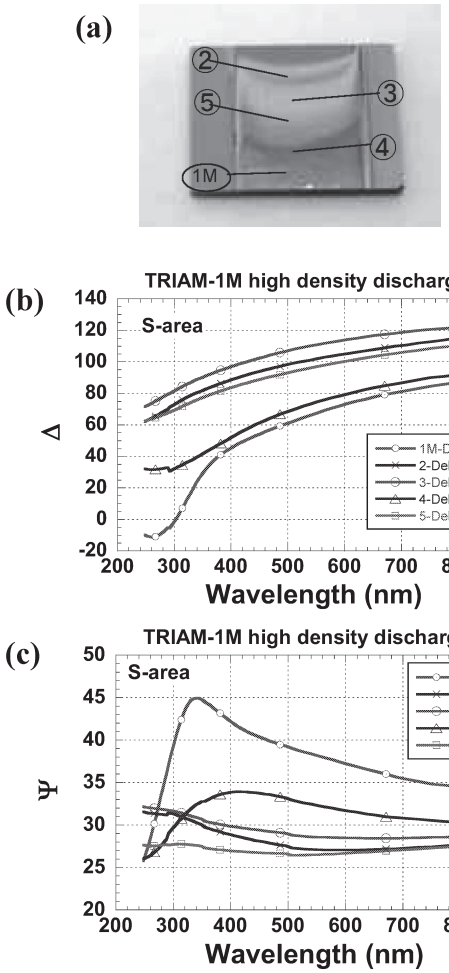

Fig.2 (a) Material specimen which was exposed to the long duration plasma in TRIAM-1M, (b) relative phase $\Delta$of p and s polarization and (c) relative amplitude Ψ of p and s polarization.

Reference

1) M. Miyamoto et al., J. Nuclear Materials, **313-316** (2006) 82-86.