2nd Asia-Pacific Conference on Plasma Physics, 12-17,11.2018, Kanazawa, Japan

Low ion energy plasma cleaning of single-crystal Molybdenum first mirror mock-up for ITER UWAVS: etching and material re-deposition aspects

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One of the important aspects of the plasma cleaning of the front-end mirrors (FM) in ITER Ultra-Wide Angle Viewing System (UWAVS) diagnostics is to understand surface roughness after multiple cleaning runs and to minimize possible contamination due to unwanted sputtering of the mirror surface and neighboring walls [1-5]. The capacitively coupled RF 30-60 MHz is a candidate for the UWAVS FM cleaning. It generates ion fluxes of tens of electron-volts sputtering contaminants as well as construction materials [6-7].
In the present report, we discuss materials analysis with electron diffraction spectroscopy and x-ray photo-electron spectroscopy for Al, Mo and W samples after cleaning with RF discharges in He for various locations inside the vacuum compartment.
The Front End Optics Tube (FEOT) of the UWAVS system with mirror positions is schematically illustrated in Figure 1. Typical ion energies were 50-70 eV at the RF electrode and 20-30 eV at the grounded wall. Mirror reflectivity was measured after removing W, Al, Al_2O_3 contaminants in 60-hour exposure and showed satisfactory results. Materials and their oxides sputtered from the FM were deposited at distances 2-4 cm from the electrode with rates 0.1-0.05 nm/hr. At the Second Mirror, the deposition rates were estimated 0.01 nm/hr. or lower. The experiments showed advantages of Mo a construction material due to lower sputtering. Dielectric material traces were found due to electrical damage of cable feedthrough at higher powers. Measures to prevent the sputtering of dielectrics are discussed. The Mo-mirror was etched at 0.5-1 nm/s rate. The etch rates were examined before and after plasma cleaning using the WYKO NT9300 profiler with the phase shifting interferometry mode. The etching did not change the mirror reflectivity after 100 hours of exposure. The overall effect on the reflectivity for the full service time is yet to be investigated.

References

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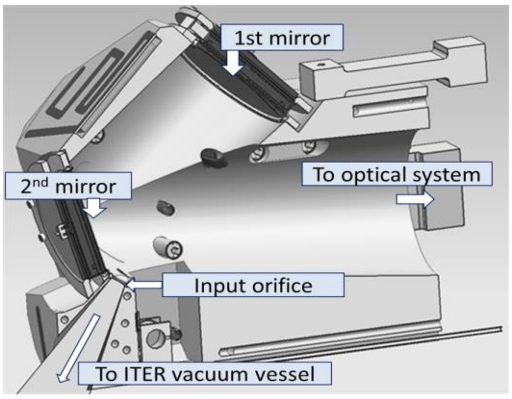

Figure 1. The FEOT of the UWAVS, with positions of the mirrors, input orifice open to the vacuum vessel and the direction toward the rest of the optical system. The positions of the RF feeds are not shown.