§70. Erosion and Deposition of Carbon on the Divertor Tiles and the First Wall in LHD

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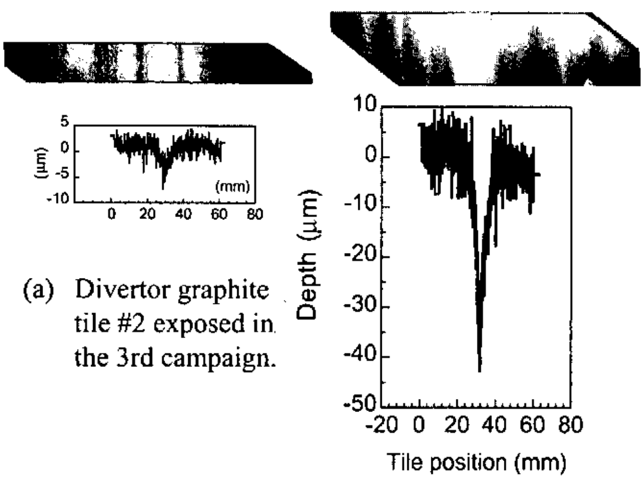
Due to high reproducibility of the divertor structure with external SC coils system in LHD, divertor footprints on graphite targets were successfully identified after 10,000 shots of the 3rd campaign [1]. The measured erosion depth on the footprint was about 5μm as shown in Fig.1, which was measured on the tile #2 at the outer mid-plane of LHD. This erosion was mainly due to heated He plasmas operated at the inward shifted Rax of 3.60m, where the total fluence and discharge time for He were $2\times10^{25}m^{-2}$ and 1,983sec and those for H were $1.2\times10^{25}m^{-2}$ and 927sec.

In order to measure the fluence dependence of erosion depth, the next tile to the tile #2 has been measured after the 5th campaign, namely exposed to the 3rd, 4th and 5th campaigns at the almost same position as the #2 tile. The total discharge time for heated He plasmas is 1,983+5,943+5,340 =13,266sec. The measured erosion depth is about 35μm as shown in Fig.1. This result means that the erosion depth is almost in proportion to the total time of heated He plasma shots, while the erosion due to H plasma may partly contribute.

Three mirrors of stainless steel type similar to 316 steel with the size of 20x10x1 mm were installed inside the LHD vacuum vessel at positions shown in Fig.2 [2]. After the 3rd campaign, the change of spectral reflectance, R(λ), at normal incidence for λ=200~700 nm was measured for each sample mirrors as shown in Fig.3. The reflectance of mirrors #1 and #5 dropped strongly whereas the reflectance of sample #3 increased significantly. From the RBS surface analyses as shown in Fig.4, the decrease of reflectance on samples #1 and #5 is due to deposition of carbon-based films. On the other hand, the mirror #3 close to the plasma confinement volume seems to become cleaner than the initial surface. The increase of reflectance of the sample #3 can be explained by full cleaning of the mirror surface from residuary organic film due to plasma impact, for example, through bombardment by charge exchange fast neutrals during main discharges and by ions during glow discharge conditioning. In other words, there was no deposition but net-erosion at the position of the #3.



(a) Divertor graphite tile #2 exposed in the 3rd campaign.

(b) Exposed in the 3rd, 4th and 5th campaign.

Fig.1 Comparison of erosion depth on the divertor tiles Measured after 3rd and 5th campaigns.

References
[1] A.Sagara et al., J. Nucl. Mater. 313-316 (2003) 1.
[2] V.S.Voitsenya et al., NIFS-801, Jun 2004.

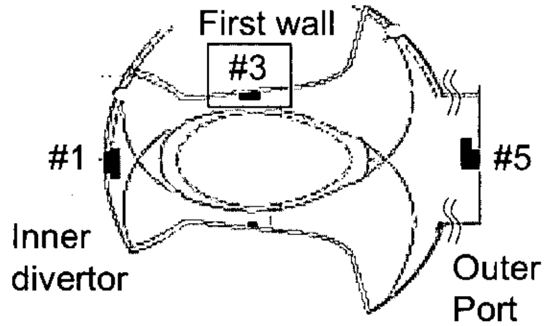


Fig.2 Locations of mirror samples in LHD.

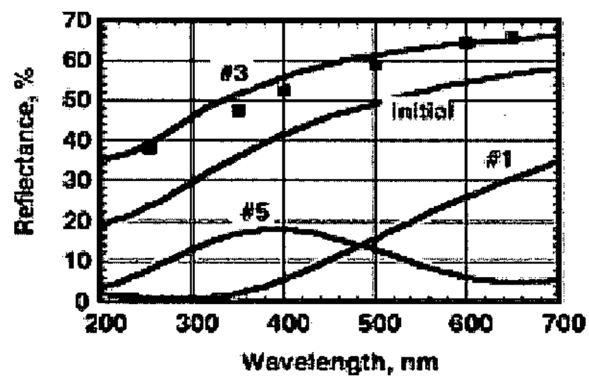


Fig.3 Spectral reflectance of SS samples before (initial) and after exposure in the 3rd campaign of LHD.

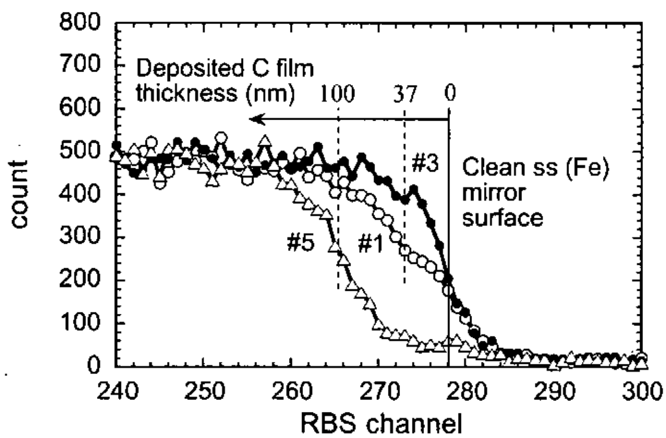


Fig.4 RBS spectra of mirror samples, where the energy-channel shift of clean surface edge of ss(Fe) is mainly due to deposition of carbon films.