

§64. Surface Analysis of the LHD Divertor Tiles

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Non-destructive quantitative analyses have been carried out using RBS, and EDS-SEM on the surface of graphite tiles used in the 3'rd campaign. The main results are on (1) identification of the "footprint" on a tile surface by the 3 dimensional absolute mapping of the divertor leg and (2) microscopic morphology of deposited impurities on the tile surface exposed to the LHD plasmas.

After the 3'rd campaign (shot # 7120 - 17311), we took out 2 pieces of divertor tiles, which were exposed to the outer divertor plasma at the toroidal positions of 6.5L and 7T. The magnetic field line of the divertor leg intersects the 6.5L tile at a glancing angle of 21° from surface. However, the wetted position with the divertor leg is absolutely identified using a Langmuir probe array on another tile equivalent to the 6.5L tile. On the other hand, the angle of the field line on the 7T tile is almost normal as 78° and this condition is suitable for comparison with modeling [1].

Deposited metal impurities such as Fe of about 2×10^{17} atoms/cm² was generally observed on the tiles mainly due to re-deposition of the 316 stainless steel chamber wall sputtered under glow discharge cleaning for the total 2,300 hrs. On the 7T tile, as shown in Fig.1, there were 2 distinctive traces with little amount of metals and eroded about $9\mu\text{m}$. These traces correspond well to the hitting positions of the divertor leg within several mm in accuracy. In fact, the LHD was operated mainly at the magnetic axis R_{ax} of 3.6m and partly at 3.75m which was 17% of the all shots and carried out even at the final stage in the 3'rd campaign. Almost comparable results were observed on the 6.5L tile.

From a view point of microscopic morphology in a scale of μm , as shown in Fig.2, deposited metals were detected mainly at the edge of open pores and around grains of graphite even at significantly eroded areas. This result agreed well with the RBS analysis where the surface position of carbon did not shift regardless of deposition of metals as shown in Fig.3. This implies the wetted area with divertor leg to be not uniformly contaminated with metals as expected under the intense GDC.

Reference:

- [1] A.Sagara, et al., An Analytical Erosion Model for Divertor Plates and Limiter Experiments in CHS, J. Nucl. Mater., 196/198 (1992) 271.

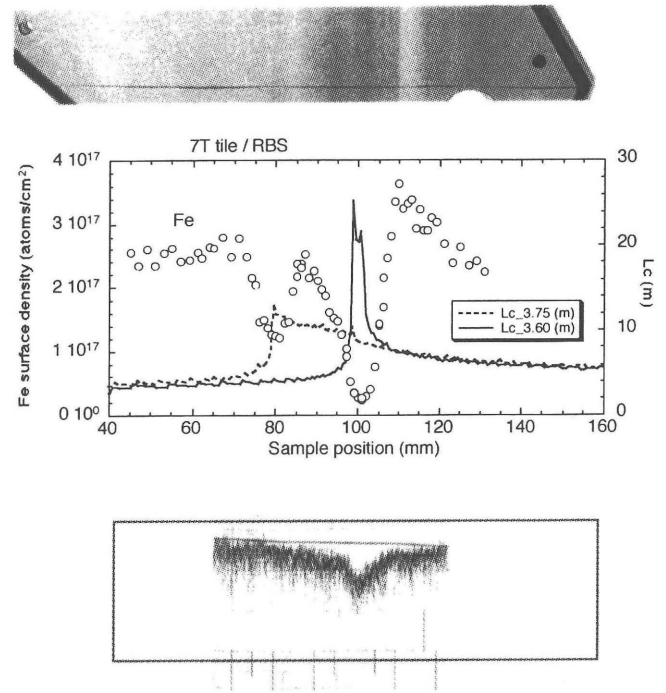


Fig.1 Surface analyses of the 7T tile: Photo, Fe -impurity distribution and surface profilometry .

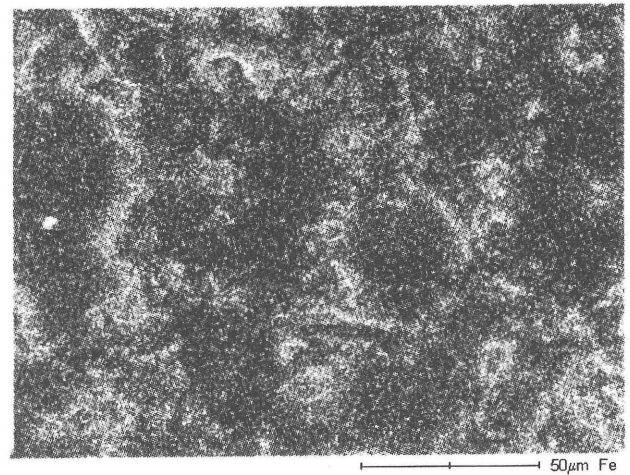


Fig.2 The EDS-SEM surface image of Fe on the 7T tile.

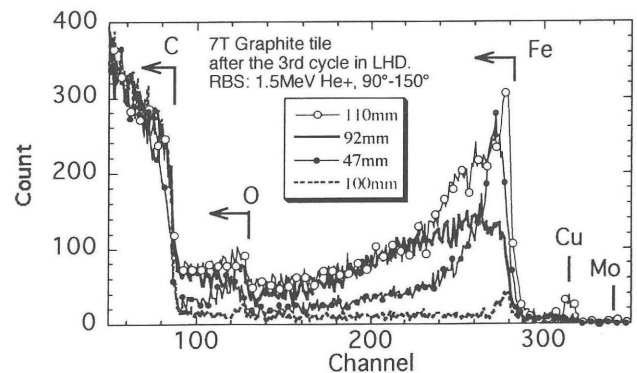


Fig.3 RBS analysis of each position on the 7T tile.