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大型ヘリカル装置（ＬＨＤ）における閉ヘリカルダイバータ領域の炭素堆積シミュレーション解析

Simulation Analysis of Carbon Deposition in the Closed Helical Divertor Region in the Large Helical Device using the ERO2.0 code

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Long pulse discharges in the Large Helical Device (LHD) has often been interrupted by dust emission from the closed helical divertor region. It has been found that the dust is produced by the exfoliation of the carbon-rich mixed material deposition layers accumulated by the plasma wall interactions on the divertor plates. It is likely that the exfoliation occurs for thick deposited carbon-rich layers formed on the plasma-facing components. The investigation of the three-dimensional distribution of the carbon deposition in the divertor region is essential for predicting the position of the dust sources and an optimized design for performing stable long pulse discharges with controlled dust emission.

The Monte-Carlo based plasma wall interaction code ERO2.0 was applied to the analysis of the distribution of the carbon flux density in the divertor region. A 3-d grid model for the ERO2.0 simulation was constructed, in which the closed helical divertor components (dome, target, and divertor plates) and the vacuum vessel are included for one helical pitch angle (18° in toroidal direction). Figure 1 (a) gives the simulation of the 3-d distribution of the carbon density flux on the dome plates, showing the highest carbon flux density at the edge of the dome plates in the inboard side near the equatorial plane. Long pulse discharges in recent experimental campaigns have often been terminated by dust emission from the closed divertor region near the equatorial plane. Figure 1 (b) indicates a photo of the dome plates near the equatorial plane after the long pulse discharges. It shows the exfoliation of the deposition layers at the edge of the dome plates due to the high carbon flux density in this area. It proves that the ERO2.0 code is applicable for predicting the position of the dust sources.

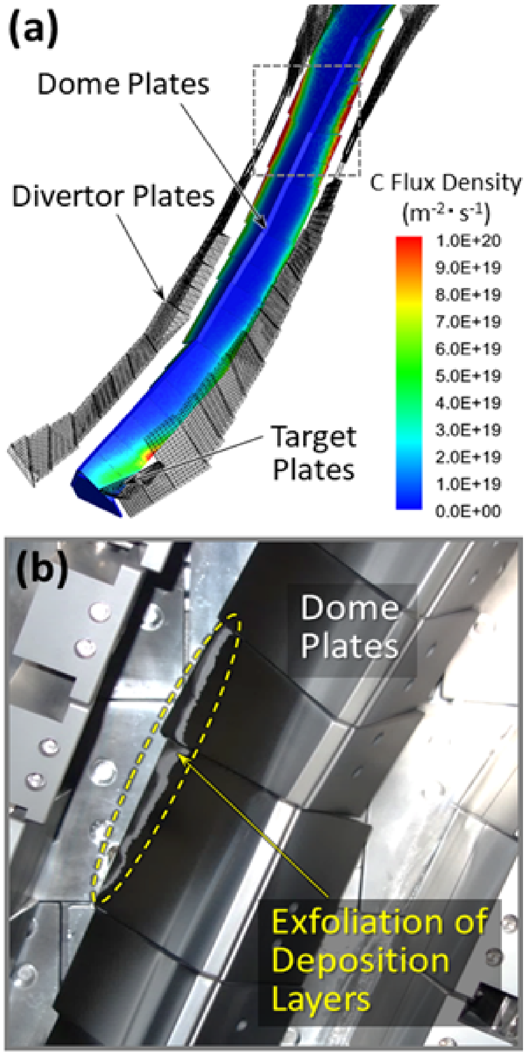

Fig 1 (a) The simulation of the 3-d distribution of the carbon flux density on the dome plates. (b) A photo of the dome plates near the equatorial plane after recent long pulse discharges.