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大型ヘリカル装置(LHD)における方向性マテリアルプローブによって観察された炭素堆積層分布のERO2.0コードによるシミュレーション解析

Simulation of the Carbon Deposition Profile on Directional Material Probes in the Large Helical Device using the ERO2.0 code

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In the Large Helical Device (LHD), directional material probes (DMPs) have been installed on the surface of the vacuum vessel for investigating the erosion/deposition processes and material migration. The DMP consists of a pin and a flat disk which are assembled for identifying the direction of the particles coming to the DMP positions. One DMP was set on the surface of a side wall of a helical coil can in the inboard side of the torus close to isotropic graphite divertor plates. After a previous campaign of plasma discharge experiments, it was found that carbon dominant layer was formed on the surface of the flat disk of the DMP, which showed that the profile of the deposition layer was anisotropic and non-uniform around the pin.

For understanding the process for the anisotropic carbon deposition profile on the DMP, the three-dimensional Monte-Carlo impurity transport and plasma-surface interaction code ERO2.0 was applied. The background plasma parameter profile for the ERO2.0 simulation is provided by EMC3-EIRENE. Figure 1 presents the simulation result of the net carbon deposition flux density profile in the inboard side of the torus around the DMP in a three-dimensional LHD model for a half of one helical section ($0 \leqq \phi \leqq 18$: ϕ is a toroidal angle) in the case of a low plasma density ($n_e^{LCFS}=1 \times 10^{19}$ m^{-3}: n_e^{LCFS} is the plasma density near the Last Closed Flux Surface). This figure shows the high carbon deposition flux density on the side wall of the helical coil can in the inboard side. Figure 2 shows an enlarged image of the simulation of the carbon flux density deposited on the DMP, which clearly reproduces the anisotropic carbon deposition profile around the pin. This figure proves that the simulation has successfully reproduced the observed deposition profile on the DMP. The physical mechanism forming the anisotropic profile will be discussed in the annual meeting.

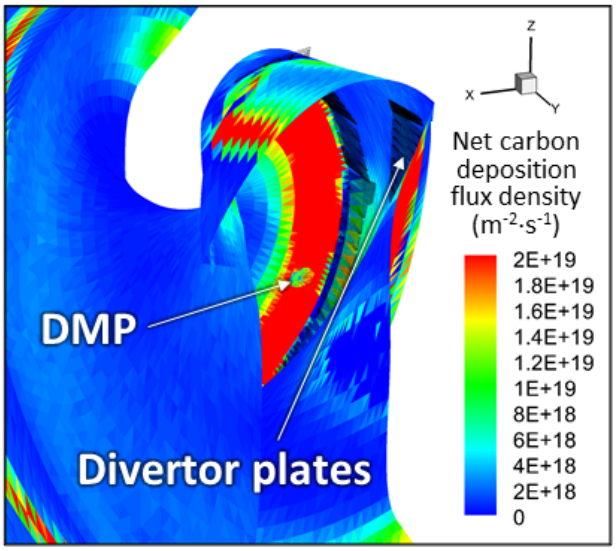

Figure 1: The ERO2.0 simulation of the net carbon deposition flux density profile in the inboard side of the torus for a low plasma density of $n_e^{LCFS}=1 \times 10^{19}$ m^{-3}).

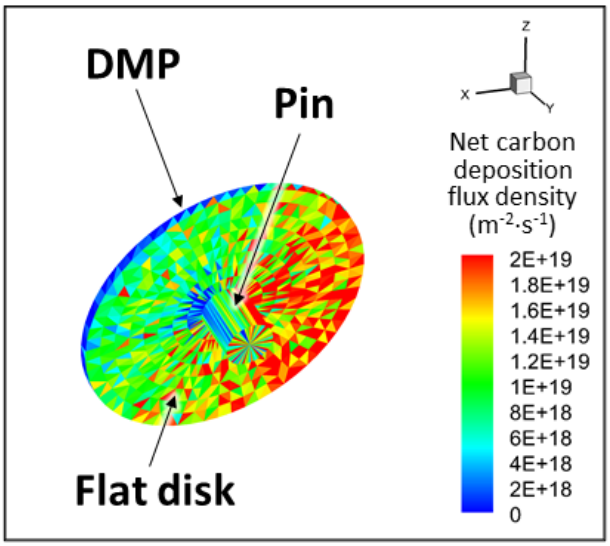

Figure 2: The ERO2.0 simulation of the net carbon deposition flux density profile on the DMP installed in the inboard side of the torus.