§31. Analyses of Generation and Behavior of Fine Particles by Laser Light Scattering

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The generation and transport of dusts in a nuclear fusion reactor is one of the serious issues that should be solved. To reduce the generation and transport to out of a reactor, the in-situ analysis of dust behavior will bring a lot of information about it. We are developing a in-situ analytical method of laser light scattering in Large Helical Devise (LHD). The method applies Mie-scattering ellipsometry, which determines the change of polarization state of laser light by scattering from dusts.\(^1\),\(^2\) The change of polarization state, which are expressed by the arctangent of absolute value of ratio of two amplitude functions, $\Psi$, and the phase angle of the ratio, $\Delta$, has correlation with the complex refractive index, $m$, and size, $d$, of dusts as well as scattering angle, $\phi$. In this year, we designed and constructed the system of Mie scattering ellipsometry and examined the feasibility of the in-situ analysis.

For the in-situ measurement in LHD, polarized laser light is projected into a diverter through a view port. The polarization state of scattered light is detected at a scattering angle or some of scattering angles. To analyze the size, size distribution, optical property, and density of dusts, growing process monitoring or multi scattering-angle measurement is a possible method. Better conditions for the two analytical method was examined by simulation. Simulation was carried out for a spherical graphite sphere, of which the refractive index at the wavelength of 532 nm is 2.66+j1.33.\(^3\)

Figure 1 shows the results of calculation of $\Psi$ and $\Delta$ for spherical diameter from 10 nm to 1000 nm every 10 nm at three scattering angles, $\phi=45\degree$, $90\degree$, $135\degree$. The directions of increase of diameter are indicated by arrows in the figures. By the comparison among the three $\Psi$ - $\Delta$ trajectories, it is found that the analysis of dust growth is adequate at $\phi=90\degree$ in growing process monitoring.

Figure 2 shows the results of calculation of $\Psi$ and $\Delta$ at the diameter of 500 and 1000 nm for scattering angle $\phi=30$ to $150\degree$. For the analysis of diameter of dusts by multi scattering-angle measurement, it is found that analyzers are appropriate to be set at angles of forward scattering to $90\degree$.

Because it is difficult to observe scattered light from the outside of a diverter at scattering angles above-mentioned, analyzers should be installed in the inside. The adequate scattering angle of detection is $90\degree$ in the analysis of growing process monitoring, while adequate angles distribute in forward direction to $90\degree$ in the analysis of multi scattering-angle measurement.