§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, Ψ, and the phase angle of the ratio, Δ, has correlation with the complex refractive index, *m*, and size, *d*, of dusts as well as scattering angle, ϕ. 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 Ψ and Δ for spherical diameter from 10 nm to 1000 nm every 10 nm at three scattering angles, ϕ=45, 90, 135°. The directions of increase of diameter are indicated by arrows in the figures. By the comparison among the three Ψ-Δ trajectories, it is found that the analysis of dust growth is adequate at ϕ=90° in growing process monitoring.

Figure 2 shows the results of calculation of Ψ and Δ at the diameter of 500 and 1000 nm for scattering angle of ϕ=30 to 150°. 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°.

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° in the analysis of growing process monitoring, while adequate angles distribute in forward direction to 90° in the analysis of multi scattering-angle measurement.

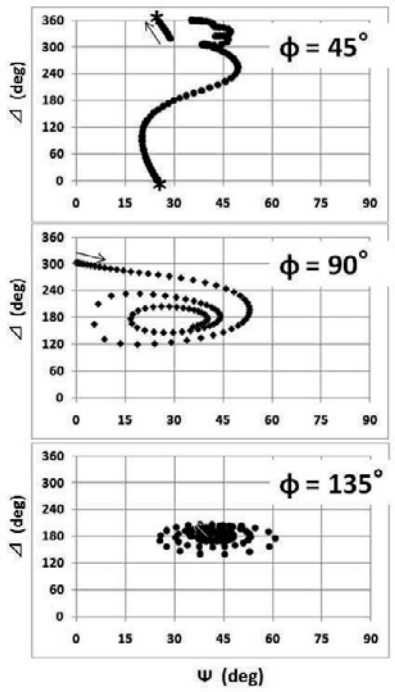

Fig. 1. Calculated results of Ψ and Δ for every 10 nm of diameter of sphere to 1000 nm at three scattering angles, ϕ=45, 90, 135°.

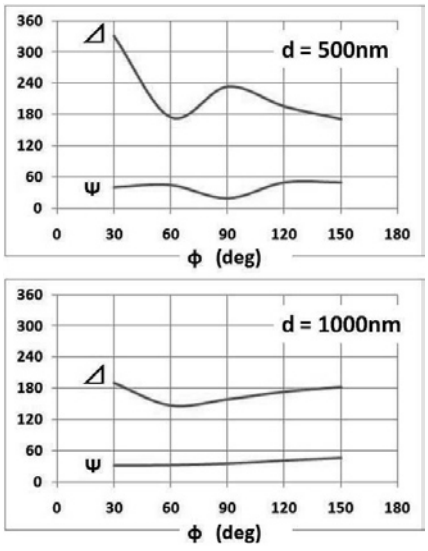

Fig. 2. Calculated results of Ψ and Δ at the diameter of 500 and 1000 nm for scattering angle ϕ=30 to 150°.

1) Yasuaki Hayashi and Kunihide Tachibana: Jpn. J. Appl. Phys. **33** (1994) L476.
2) Yasuaki Hayashi and Kunihide Tachibana: Jpn. J. Appl. Phys. **33** (1994) 4208.
3) A. Borghesi and G. Guizzetti: *Handbook of Optical Constants of Solid II* (ed. Edward D. Palik, ACADEMIC PRESS INC., 1991), p.458.