§6. Determination of Complex Index for mm-Wave Absorber

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In general, electron cyclotron heating is an attractive heating method that has an advantage for realization of localized heating. However, when the one-pass absorption of the injected mm-wave beam is not sufficient, it is necessary to install a mm-wave absorber at the port opposite to the injection one, to remove the power transmitted through the plasma. In addition, if the temperature increase at the absorber can be measured, the subject of electron cyclotron absorption (ECA) may be investigated.

It was confirmed that Silicon-Carbide (SiC) plate is a good mm-wave absorber with a reflectometry measurement[1]. Silicon Carbide is essentially a kind of semiconductor whose resistance depends on temperature. This dependence is measured to be about 1Ω/K for a piece of SiC. Here, silver paste is used for the attachment of electric leads. A piece of SiC is one of candidates for the sensor of mm-wave for an ECA study. It is important to understand the characteristics of SiC for mm-waves. The phase of the wave changes by reflection at the plate. If the plate is a conductor, the phase difference between the electric field components parallel and perpendicular to the normal direction for the plate surface is 180 degree. In general, the difference is affected by the complex index of the reflecting plate. A mm-wave ellipsometer is used for the determination of the complex index. The ellipsometer is composed of waveguide components where the two polarizations are mixed. By a frequency scan, a sinusoidal signal with an amplitude of unity and a periodicity of the difference of waveguide length between two polarizations is obtained. The mm-wave whose frequency is 40-60GHz is injected to the SiC plate with an incident angle of 72.2 degree. The phase difference, $\pi + \Delta\Phi$, with and without reflection at the SiC plate is measured. The quantity $\Delta\Phi$ is deduced from the sinusoidal signals with and without a reflection, S and $S_{\rm ref}$, as follows:

$$\Delta\Phi \simeq \frac{|S + S_{\rm ref}|}{\sqrt{1 - S^2}} \quad \text{when } \Delta\Phi \ll \sqrt{\frac{1}{S^2} - 1}.$$

Figure 1 shows the deduced dependence of the phase difference on the frequency. From a correlation analysis, the phase difference $\Delta\Phi$ is found to be 11.9 degree around 53.2GHz where we are interested. The set of pairs of real and imaginary parts in the complex index that satisfy the phase difference $\Delta\Phi$=11.9 degree is plotted in Fig.2. The set that satisfy the reflectometry measurement is also shown. The real and imaginary parts are evaluated as 5.7 and 0.84, respectively.

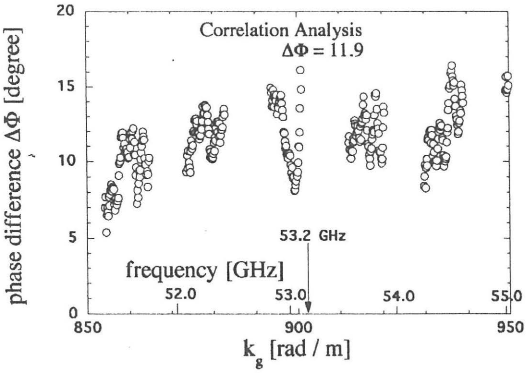

Fig.1 Dependence of the phase difference on frequency measured by the mm-wave ellipsometer.

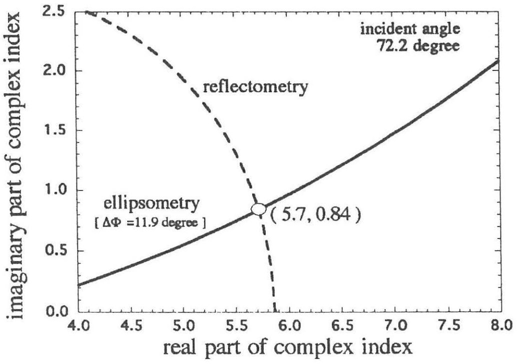

Fig.2 Set of pairs of real and imaginary parts in the complex index that satisfy the ellipsometry and reflectometry measurements

References

1)Idei, H. *et al.* Ann. Rev. in NIFS (1995)