

Vacuum Windows for High Power CW Operation

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Development of millimeter-wave vacuum barrier windows is one of the most important subject to accomplish windows of both high power, CW gyrotrons and ECRH systems of LHD. We began to design and develop large-area elongated sapphire double-disc windows which reduce the power density dissipated in the window materials.

The merits of these large-area elongated windows are listed as follows;

- 1) Reduction of power density dissipated in the window materials.
- 2) Mechanically stronger than circular disc windows with the same surface area.
- 3) Better cooling efficiency of the window materials.

We have been developing large-area elongated sapphire discs in collaboration with Kyocera cooperation. In this process, two new technologies are achieved; first, fabrication large-size C-cut single crystalline sapphire discs. Secondly, minimizing distortions of the disc under metallizing and brazing processes. Figure 1 shows a manufactured C-cut elongated sapphire disc with the effective area of $65 \times 240 \text{ mm}^2$. This disc still has a little bit bending along the longer axis which happened during metallizing and brazing processes. We are improving to remove these bendings.

We calculated RF characteristics of double-disc sapphire windows to determine the thickness of sapphire plate and the layer of FC-75 coolant. Figure 2 shows the reflection / transmission coefficients of the window with the input wave frequency. In this calculation, we assumed the normal incidence of plane waves on the window surface and used the permittivity of 9.5, the loss tangent $\tan\delta=2.5 \times 10^{-4}$ for a sapphire disc. The thicknesses of each layer were chosen to be 1.784mm (1.5λ) for sapphire and 2.02mm for FC-75, respectively. Tolerances of sapphire

of re-adjusting the thickness of FC-75.

Thermal-stress analyses on the basis of 3D FEM method are now being performed, compared with circular windows that have the same areas.

The high-power testings of this double disc window using an 84GHz CW gyrotron are also under preparation.

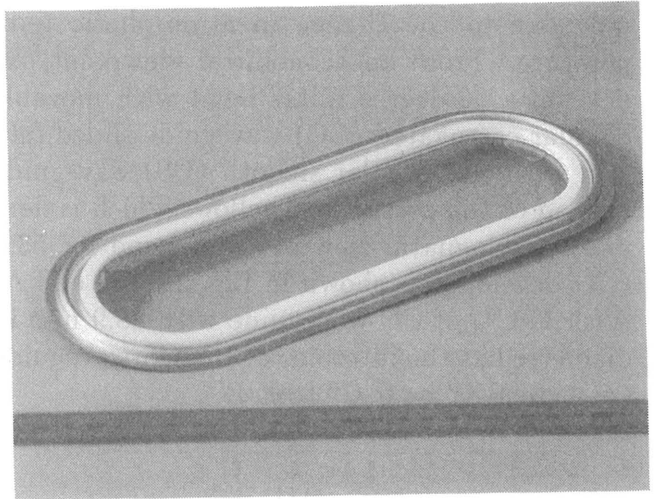


Fig. 1. A manufactured elongated C-cut sapphire disc with Kovar flange

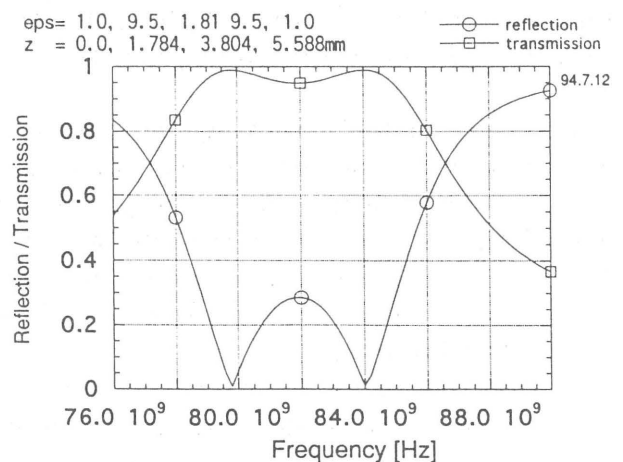


Fig. 2. Dependence of reflection / transmission coefficients on the input frequency.