Study of Circular Waveguide Window for Millimeter Wave Transmission Line

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Abstract

This paper discusses analytical method and numerical simulation for studying transmitivity and reflectivity of various dielectric window materials used in millimeter wave transmission line for low power application. Simulation is done in RF module of COMSOL Multiphysics®. A multiple reflection model of the electromagnetic scattering is introduced. It focuses on how multiple reflections of an EM wave occur inside the window due to the material discontinuity at the interfaces between air and window. Using the method presented in this paper, we have calculated Transmission and reflection of various dielectric materials for TE01 mode to choose window material with minimum attenuation over D-band frequency range (110-170 GHz). Results show that Fused Silica offers better transmission then other materials. We have studied propagation of TE01 through Fused Silica window kept inside an oversized circular waveguide using 2D axial symmetrical modeling in RF module. The analytical and simulation work is also carried out by varying thickness of Fused Silica window to study the effect of window thickness on power transmission. Results show excellent agreement between analytical and numerical approach.

Reference

[1] Ramakrishnan Baskaran, “Double window configuration as a low cost microwave waveguide window for plasma applications”, Review of scientific instruments, December 1997

[2] V. V. Parshin, “Dielectric materials for gyrotron output window,” Int. J. Infrared Millimeter Waves, vol . 15, no. 2 pp. 339-348, 1994

[3] Paul Goldsmith, Quasi Optical Systems (IEEE Press/Chapman & Hall Publishers Series on microwave and RF, New York, 1948) p.79.

[4] R.Nesti, V. Natale , Notes on dielectric characterization in waveguide (IRA-INAF Arcetri Astrophysical Observatory, Florence, 2005)

[5] Constantine A. Balanis, Advanced Engineering Electromagnetics, Wiley, New York, 1989, circular waveguides pp 643- 653

[6] W. W. Ho, Millimeter-Wave Dielectric Property Measurements of Gyrotron Window Materials (U.S. Department of Energy, Thousand Oaks, 1985)

[7] James W. Lamb, Miscellaneous data on materials for millimeter and sub millimeter optics (Insitut de Radioastronomie Millimetrique, France, 1996)

[8] COMSOL Multiphysics support, online: www.comsol.co.in

[9] A. Leggieri, D. Passi, and F. Di Paolo1 in Virtual Prototype of a Dielectric Window for High Power Microwave Tubes: Proceedings of the COMSOL Conference, Cambridge, 2014

[10] COMSOL RF Module User’s Guide: COMSOL 4.4.

Figures used in the abstract

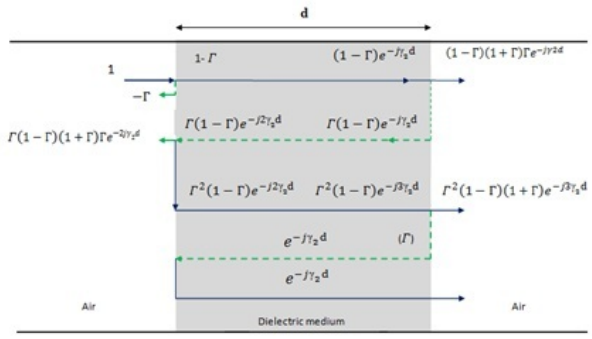

Figure 1: Multiple Reflection Model of the Electromagnetic Scattering of a Waveguide window in circular waveguide.

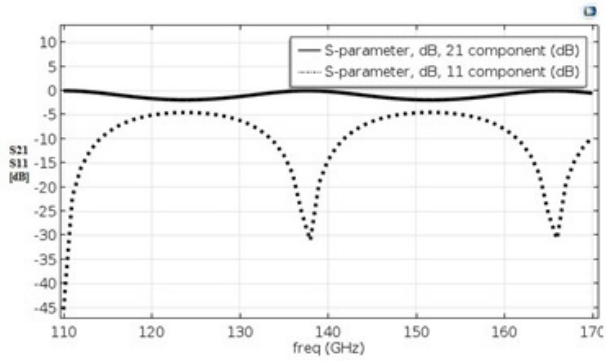

Figure 2: Simulation Results of S-parameters Magnitude (dB).

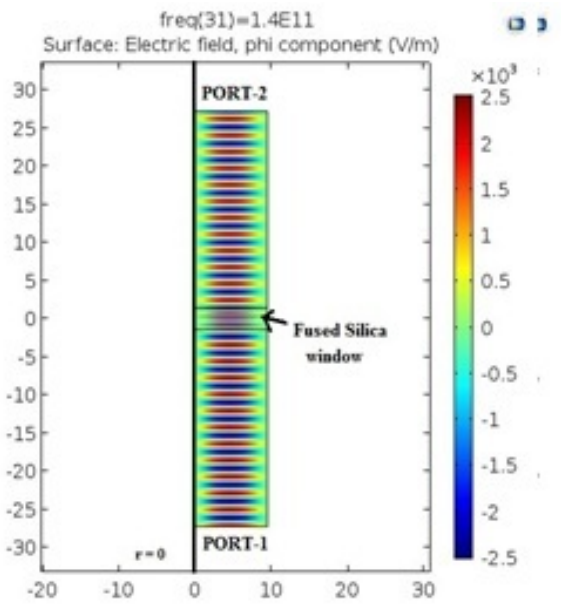

Figure 3: Propagation of EØ Component at 140 GHz Frequency for TE01 Mode Through Circular Waveguide with Fused Silica.

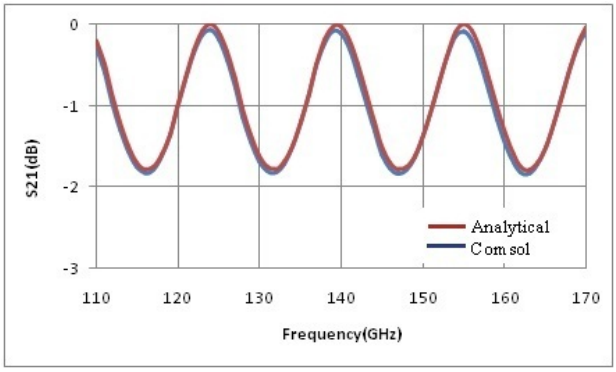

Figure 4: Comparison of Transmission of Fused Silica Window.