Design and Experiment Test of an L-Band RF Window

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Abstract: *This paper describes the design and experiment test of an pill-box RF window for L-band klystron test application. A piece of alumina ceramic with a diameter of 220 mm and a thickness of 8.1 mm is used in the pill-box RF window to divide the microwave transmission channel into two regions, one region close to klystron, another one close to high power water load. In case the water load breaks, the RF window protects the klystron from the impact of water. Test result shows that the VSWR is 1.07 and the S21 is -0.11dB with the microwave frequency of 1300MHz.*

Keywords: cold test; RF window; L-Band; klystron; VSWR.

Introduction

Water load and RF window are widely applied for klystron test application, especially for high power klystron. Water load converts microwave energy into heat energy and take them away by flowing water. In the test process, abnormal change of water pressure, electric field breakdown, ceramic defects and welding defects may lead to ceramic fracture which results in the water flows to klystron and other test devices. Under this condition, the pressure difference on both sides of the klystron window rapidly increases. To protect the klystron, The RF window is mounted in waveguide circuit between klystron and water load to block water from the water load [1-3].

Model of the RF Window

Figure 1 shows the structure diagram of the RF window which includes two rectangular waveguides, one cylindrical waveguide and a piece of ceramic. In rectangular waveguide, the electromagnetic field mode is TE10. In cylindrical waveguide and ceramic, the electromagnetic field mode is TE11.

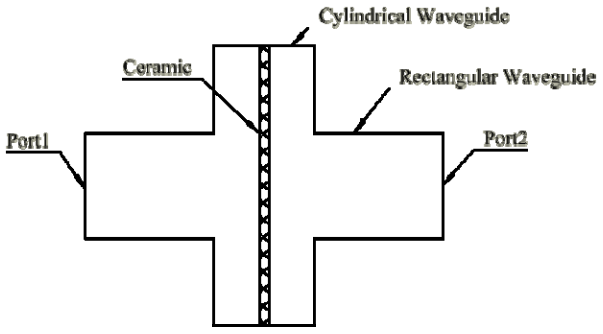

Figure 1. Structure diagram of RF isolation window..

Resonance Mode Analysis

It is shown in Figure 2 that the simulation model of the RF window was built, and optimized by changing structure dimensions. The calculated VSWR and S21 are shown in Figure 3. The reflection characteristic and insertion loss of the RF window meet our design requirements.

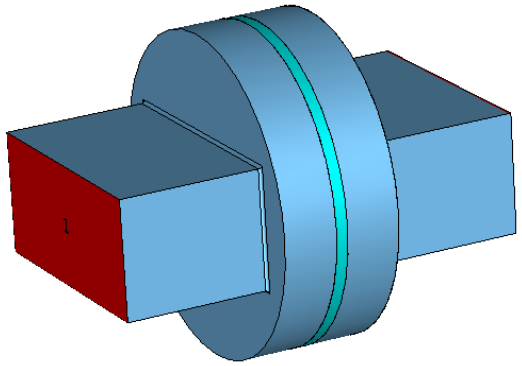

Figure 2. Simulation model of the RF window.

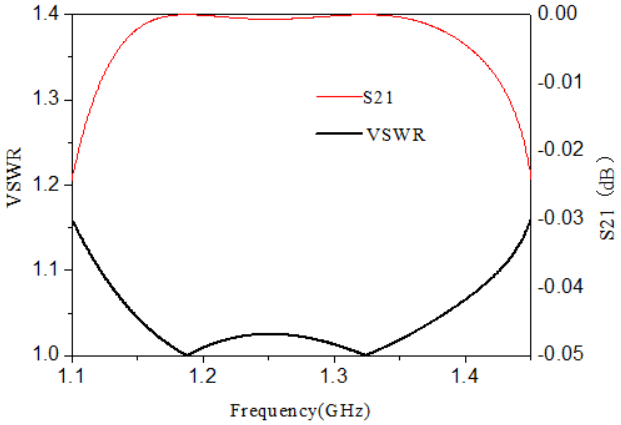

Figure 3. Calculated VSWR and S21 of the RF window.

To keep the RF window stable and reliable, we analyzed the resonance mode of the RF window, and adjusted structural parameters to make the frequency of resonance mode kept away from the operation frequency of the RF window. As the frequency of the klystron tested was 1300 MHz, we elaborately studied two resonance modes. The first resonance mode shown in Figure 4 is TE21 mode with a frequency of 1245MHz. the second resonance mode shown in Figure 5 is TE01 mode with a frequency of 1372MHz.

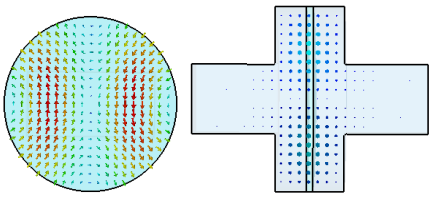

Figure 4. TE20 mode.

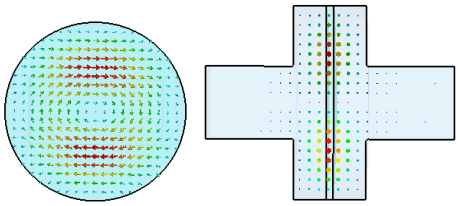

Figure 5. TE01 mode.

Engineering Design and Experiment Test

In the pill-box RF window shown in Figure 6, two sealing flanges are mounted on the two waveguide ports to obtain vacuum or high pressure condition, an annular water channel is used for ceramic cooling.

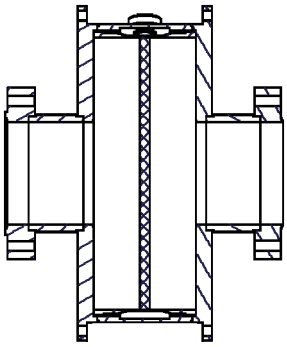

Figure 6. Sectional view of the RF window.

The VSWR and S21 of the RF window are tested with vector network analyzer N5224A. Test results show that the VSWR is 1.06 and the S21 is -0.15dB with the microwave frequency of 1300MHz.

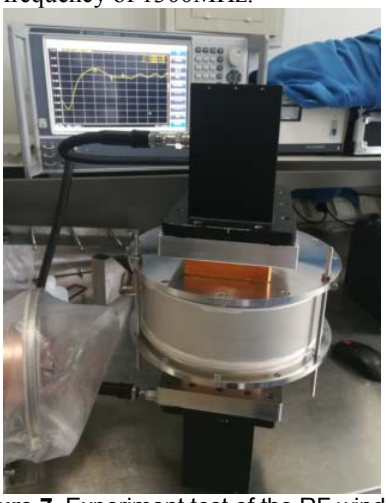

Figure 7. Experiment test of the RF window.

For high power klystron test, the waveguide needs to be in vacuum or filled with high pressure gas (about 0.3MPa). So we carried out two hours high pressure (up to 0.45MPa) test to verify the structural reliability.

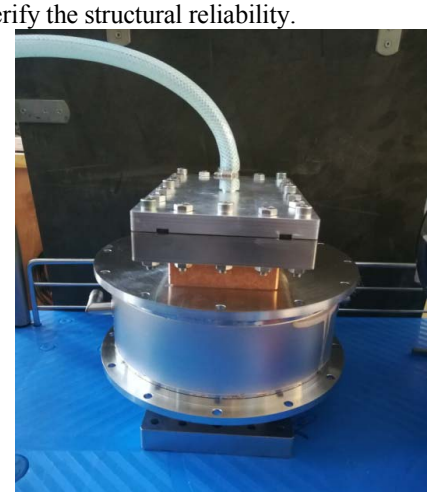

Figure 8. High pressure test (0.45MPa).

Conclusion

In this paper, an L-band RF window is designed and experiment tested for high power klystron test application. Resonance modes were elaborately studied to keep the window stable and reliable. High pressure test was carried out to verify the structural reliability.

References

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