# Microwave window design for 90 GHz-100 GHz TWT

Gangzhang *, Zongfei Jin, Huarong Gong, Tao Tang and Yubin Gong
National Key Laboratory of Science and Technology on Vacuum Electronics
University of Electronic Science and Technology of China, Chengdu, Sichuan, China, 610054
* Email: zhgang1314@sina.com

(Received May 31, 2014)

**Abstract:** This paper mainly discusses 90 *GHz*-100 *GHZ* pillbox window whose window chip uses sapphire for TWT. We simulated and optimized it by HFSS, and the result shows that the VSWR of the two kinds of windows are less than 1.27, and the second kind of the window uses bigger cylindrical wave guide which can make it easer to process than the first kind. We made the first kind of window, and tested it.

**Keywords:** Pillbox window, VSWR, Sapphire, THZ.

**doi:** 10.11906/TST.198-201.2014.12.20

## 1. Introduction

Microwave window is an important component of traveling wave tube, which is used to isolate the high vacuum inside of such devices from the atmospheric pressure [1]. The window designing becomes much more difficult when the frequency shifted up to W-band because of the very thin window disk and the small size of metal parts. There are many kinds of window configurations that are designed, but pillbox type [Fig1] shows better performance over other types of window in terms of higher power handling capacity, and easier for brazing of window piece with related waveguide.

The pillbox type window includes standard input/output rectangular waveguide and cylindrical waveguide with metalized window chip. The rectangular waveguide is BJ900 whose internal dimension is 2.54 *mm* wide and 1.27 *mm* high. Because of the small size, it is hard to weld the window disk, and the window easily generates change.

## 2. Dsign and simulation

### Ⅰ.The initial kind of window design with sapphire chip

In initial design,the radius of the cylindrical wave guide is the maximum outer radius of rectangular wave guide [Fig3-a]. Cylindrical waveguide will match the impedance of window piece. The radius of cylindrical is $r = r_1 = \sqrt{a^2 + b^2}/2$. The material of window disk is sapphire which is of high hardness, no poison, high microwave transmission and its easy to process.

VSWR is an important factor to TWT, and was simulated in our model. Considering the machining accuracy, the simulation step is 0.01 *mm*.

The curve of VSWR [Fig2] shows that when L=0.37 *mm*, t=0.14 *mm*, L=0.36 *mm*,and t=0.15 *mm*, the curve reaches a minimum point around 97.5 *Ghz* and VSWR rises to the top around 90 *GHz*, while it reaches to 1.19 near 100 *GHz*. The curve stays lower and smoother in the middle part of this band than both ends with the decrease of L and the increase of t, so the curve moves right. And when the VSWR is less than 1.27, it can meet the requirements of general TWT in this band.

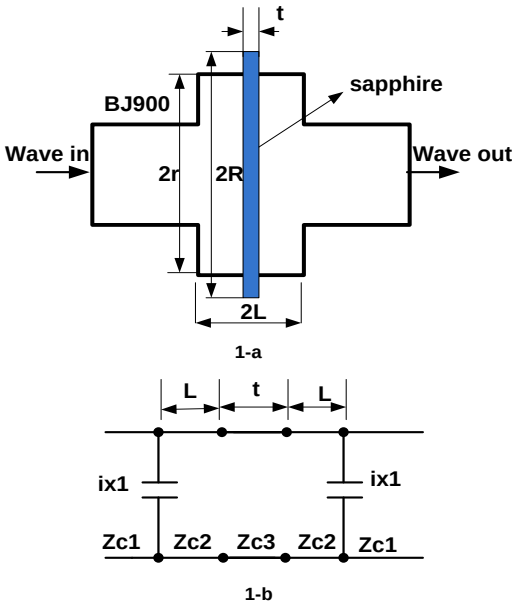



Fig. 1 Pillbox window: [1-a] schematic view. [1-b] the equivalent transmission line model

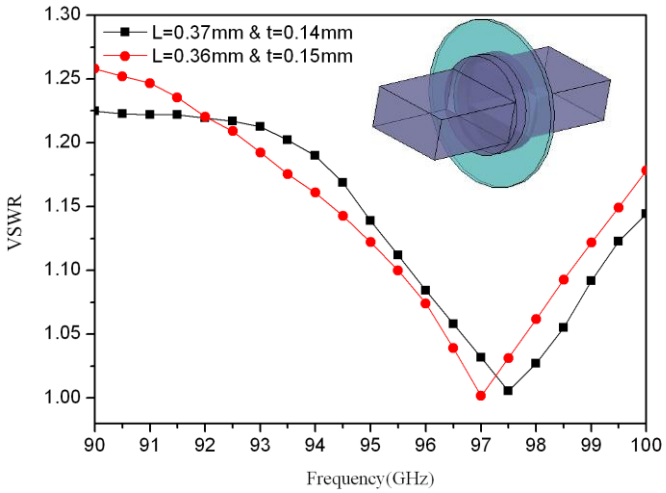



Fig. 2 VSWR curve of the pillbox window simulated by HFSS

## Ⅱ.The improved window design

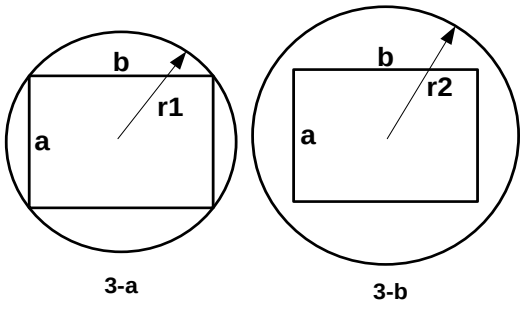



Fig. 3 schematic view of cross section of different radius of cylindrical waveguide with rectangular waveguide BJ900

In the improved window design, we expanded the radius of the cylindrical waveguide to 1.9 *mm* to increase the power capacity [Fig3, 3-b]. Considering the machining accuracy, the simulation step is still 0.01 *mm* [Fig4]. The simulation result is shown in Figure 4.

The result reveals that when L=0.6 *mm*, t=0.2 *mm*, L=0.62 *mm*,and t=0.19 *mm*, compared with the initial design, the improved design has a lager vibration amplitude in this band and it has an approximate VSWR at both ends. The curve stayed low in the middle part. And the VSWR is less than 1.25 from 90 *GHz* to 100 *GHz*.

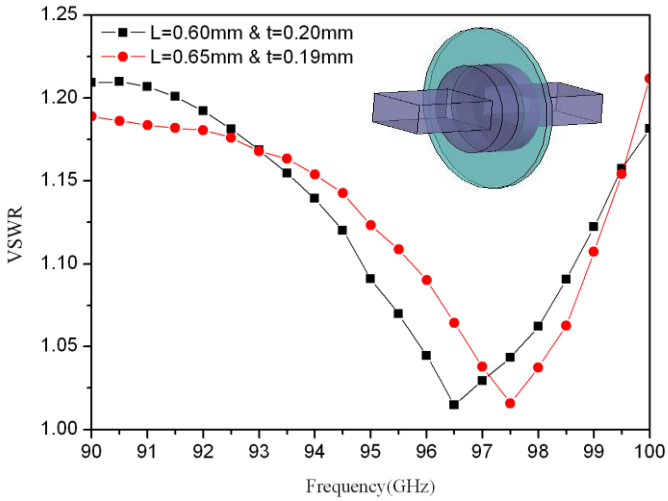
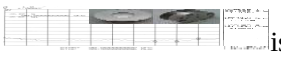



Fig. 4 VSWR curve of the pillbox window whose  is simulated by HFSS

## 3. Experimental results

In 90 *GHz*-100 *GHz* band, the VSWR is no more than 2.0. The curve stayed lower and smoother in the middle part of this band than both ends. The VSWR curve is mostly consistent

with the simulation curve despite that there is a little thickness change caused by the metallization of the window chip. The size of window and the accuracy of the size of processing affect the performance of final product. Under the premise of certain precision of processing,improving the size of window will be helpful.

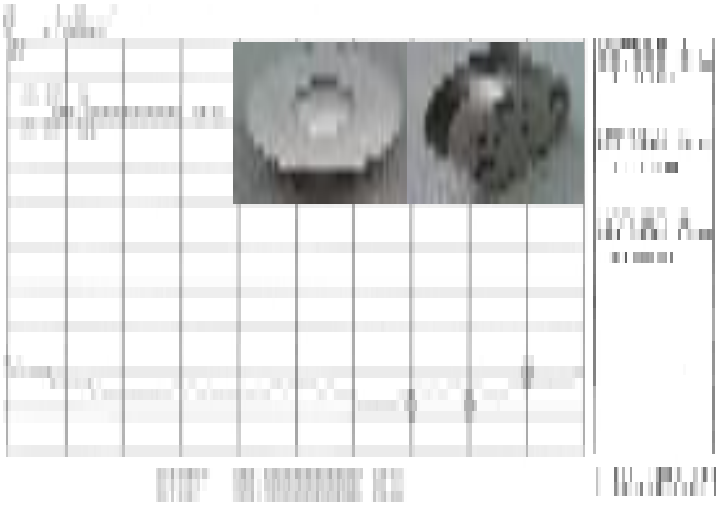


Fig. 5 VSWR curve of the window after welding

## 4. Conclusion

Two kinds of 90 *G*-100 *G* band pillbox window whose window disc is made of sapphire disk were designed in this paper. The experiment results demonstrate that the designing is feasible.

## References

[1] Richard Kowalczyk, Andrew Zubyk, et. al.. "A 100 Watt W-Band MPM TWT". IVEC 2013 Conference Record.

[2] Tao Tang, Huarong Gong. "Design of transition waveguide for millimeter wave folded waveguide traveling wave tubes[J]". *High Power Laser and Particle Beams*, 22 (5), 1104-1106 (2010).

[3] Khanh Nguyen, Lars Ludeking, et. al.. "Design of a Wideband High-Power W-band Serpentine TWT". IVEC 2013 Conference Record.

[4] B. Wang. "Design for Q-Band Folded Waveguide Traveling-Wave Tube [D]". *Univ. Electron. Sci. Techol. China*, Chengdu, Sichuan, China, 15-18 (2013).

[5] S. Bhattacharjee, J. H. Booske, C. L. Kory, et. al.. "Folded waveguide travelingwave tube sources for terahertz radiation". *IEEE Trans. Plasma Sci*., 32, 3, 1002-1014 (2004).

[6] H. Gong, J. Xu, T. Tang, et. al.. "A 1-kW 32–34-GHz Folded Waveguide Traveling Wave Tube". *IEEE Trans. Plasma Sci*., 42, 1, 8-12 (2014).