Comparative Study of Coaxial Bragg Reflector with Windowing Techniques

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***Abstract*—Application of windowing techniques to a coaxial Bragg Reflector is comparatively studied. Simulation results by using the CST software show that the bandwidth, reflectivity and the smoothness of pass band is affected by the different window distribution.**

I. INTRODUCTION

BRAGG reflector in the form of waveguides periodically corrugated with shallow ripples is suitable to construct a cavity for high-power gyro-devices due to its excellent mode selectivity and good beam transport [1-7]..

As was known, the residual side-lobes are harmful to the performance of a Bragg reflector. Fortunately, in *cylindrical* Bragg reflector the suppression of undesired side-lobes has been demonstrated by employing window distribution for the corrugation amplitude [2]-[6].

In this paper we comparatively study the possibility of suppressing the residual side-lobes in a *coaxial* Bragg reflector by applying various windowing techniques

II. RESULTS

The longitudinal-section view of a coaxial Bragg reflector with window distribution for the corrugation amplitude is shown in Fig.1. The dependence of the outer-wall radius R_{out} and the inner-rod radius R_{in} on the longitudinal position z can be expressed by

$$R_{out}(z) = a_0 - h_z \cos(\frac{2\pi z}{p_b} + \varphi_{out}) \quad (1)$$

$$R_{in}(z) = b_0 - h_z \cos(\frac{2\pi z}{p_b} + \varphi_{in}) \quad (2)$$

where a_0 and b_0 are the mean outer-wall and inner-rod radii; P_{b} denotes the ripple period; h_z is the amplitude of the corrugation at position z expressed by [8]

$$h_z = l_0[0.3587 - 0.4883\cos(\frac{2\pi z}{L}) + 0.1413\cos(\frac{4\pi z}{L}) - 0.0117\cos(\frac{6\pi z}{L})] \quad (3)$$

for the 4-term Blackman window distribution,

$$h_z = l_0[\frac{I_0(\beta\sqrt{1-(1-2z/L)^2})}{I_0(\beta)}] \quad (4)$$

for Kaiser window distribution, and

$$h_z = l_0 e^{-8z^2/L^2} \quad (5)$$

for Gauss window distribution, respectively; L is the length of the reflector; l_0 is the peak amplitude of the corrugation; I_0 is the modified Bessel function of the first kind of order zero; β=10.05 is a constant.

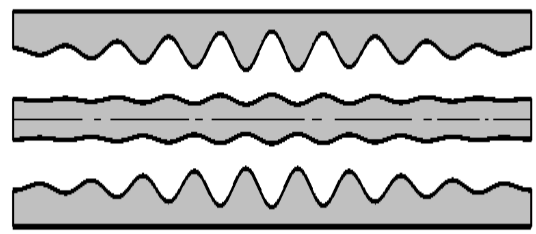

Fig.1. Longitudinal-section view of a coaxial Bragg reflector with window distribution

Without loss of generality, we design a coaxial Bragg reflector with parameters a_0 =8.0mm, b_0=5.6mm, P_{b} =11.322mm, l_0=0.3mm, L=226.44mm, the outer- and inner-conductor corrugation phase difference $|\varphi_{\text{in}} - \varphi_{\text{out}}|$ =0, the operating mode is $TE_{1,1}$ mode with a center frequency of 15 GHz.

Figures 2, 3 and 4 respectively show the simulation results in terms of the CST software for 4-term Blackman, Kaiser and Gauss window distributions. It can be found that Blackman window results in a reflectivity of 0.49 with the best smoothness of pass band and the broadest bandwidth, whereas Gauss window has a reflectivity of 0.73 with the narrowest bandwidth and the worst pass band.

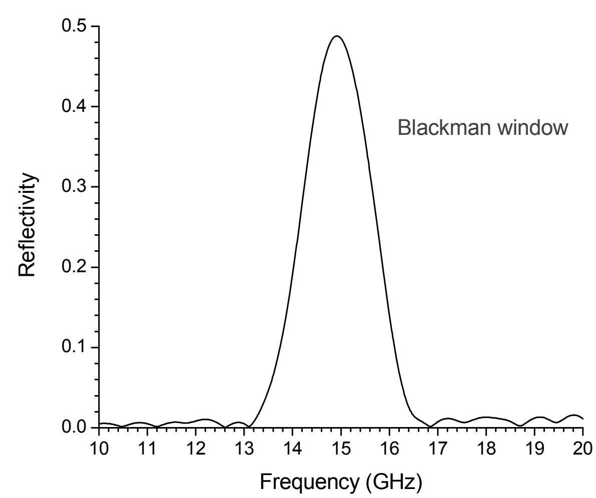

Fig.2. Reflectivity of the coaxial Bragg reflector with 4-term Blackman window

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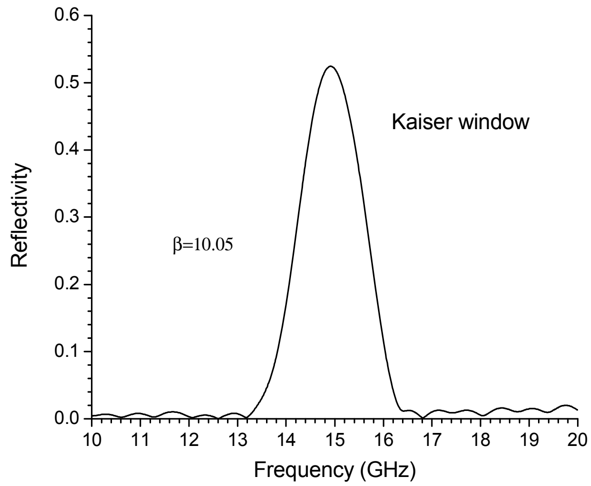

Fig.3. Reflectivity of the coaxial Bragg reflector with Kaiser window

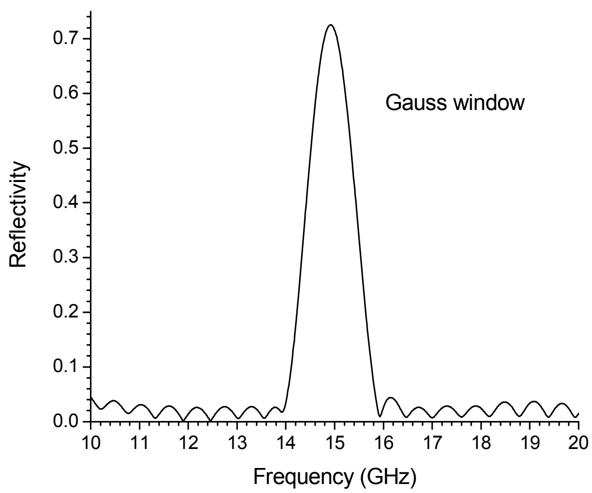

Fig.4. Reflectivity of the coaxial Bragg reflector with Gauss window

III. CONCLUSIONS

In summary, undesired side-lobes interactions in a coaxial Bragg reflector can be successfully eliminated by employing window distribution for the corrugation amplitude. However, the reflectivity performance of the coaxial Bragg reflector is substantially affected by different window distributions.

ACKNOWLEDGMENT

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REFERENCES

[1] C. K. Chong, et al., "Bragg reflectors", IEEE Trans. on Plasma Sci., 20, 393-402 (1992)

[2] J. Pretterebmer and M. Thumm, "Design of Improved Bragg Reflectors For Resonators In Overmoded High-Power Microwave Oscillators", Dig. Infrared and Millimeter Wave Conf. SPIE 1514, 298-300(1990)

[3] Xiao-Hui Chen, S.C. Zhang, and Y.X. Lai, "Suppression of residual side-lobes in a coaxial Bragg reflector", Int. J. Infrared and Millimeter Waves, vol.29, no.6, pp.552-557 (2008)

[4] Tae-Yeoul Yun and Kai Chang, "Uniplanar One-Dimensional Photonic-Bandgap Structures and Resonators", IEEE Trans. on Microwave Theory and Tech., 49, 549-553 (2001)

[5] Y. X. Lai and S.C. Zhang, "Separation of band-gap overlap in a coaxial Bragg structure operating in higher-order mode at Terahertz frequency", Physics of Plasmas, vol.15, no.3, 033301 (2008)

[6] Xiao-Hui Chen, Y.-X. Lai, and S.-C. Zhang, "Comparative Study of a 15 GHz Coaxial Bragg Reflector", The 2008 Global Symposium on Millimeter Waves Proceeding. pp.369-371(2008)

[7] Shi-Chang Zhang, Xiao-Hui Chen, and Ying-Xin Lai, "Effect of Eccentricity on Transmission in a Coaxial Bragg Structure", Int. J. Infrared Millimeter Waves, 28,1043-1050 (2007)

[8] Fredric J. Harris, "On the Use of Windows for Harmonic Analysis with the Discrete Fourier Transform", Proceedings of The IEEE, vol. 66, no. 1, 51-83 Jan. (1978)

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