TRANSVERSE IMPEDANCE OF LOSSY CIRCULAR METAL-DIELECTRIC WAVEGUIDE

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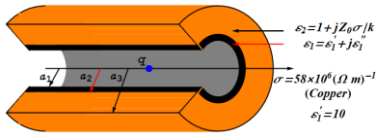
Abstract

The properties of transverse impedance of a dielectric-loaded metallic circular waveguide are investigated with taking into account losses in outer metallic pipe and in the inner dielectric layer. The dispersion curves, impedances and wake functions for dipole TM modes are analysed and compared for thin and thick dielectric layer cases. The correspondence between the resonant frequencies of the longitudinal monopole and transverse dipole impedances is established.

INTRODUCTION

Theoretical studies of the radiation characteristics of metal-dielectric structures are often limited for simplicity to the consideration of ideal waveguides covered from inside with a lossless dielectric layer. Meanwhile, using the example of a comprehensive study of the longitudinal impedances of such structures [4], we have shown the fundamental importance of taking into account the finite conductivity in the metal of the waveguide walls and losses in the dielectric. Ignoring them leads to a rough interpretation of the radiation processes, and many regularities actually fall out of consideration.

Metal-dielectric waveguide.



$$a_1 = 2mm, d = \begin{cases} 200\mu m, thick\ layer \\ 2\mu m, thin\ layer \end{cases}$$

$$\varepsilon_1'' = \begin{cases} 0, 0.1, 0.5, & low\ losses \\ 3, & high\ losses \end{cases}$$

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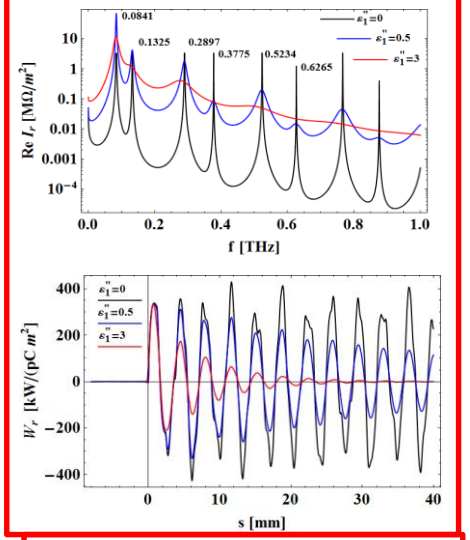
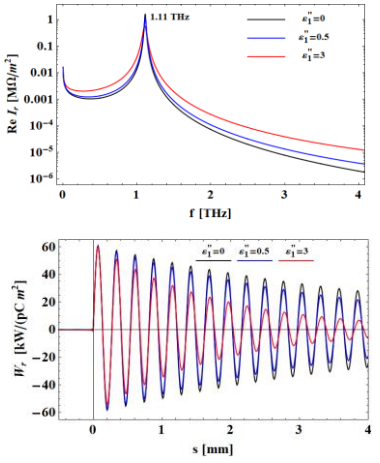
IMPEDANCES AND WAKES

Thick layer, d = 200mk

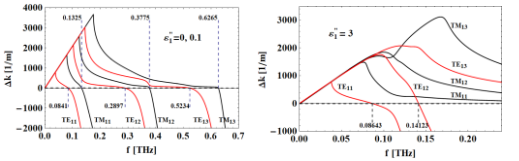


Thin layer, d = 2mk

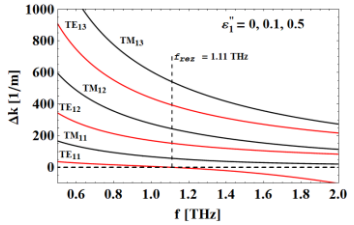


DISPERSION CURVES

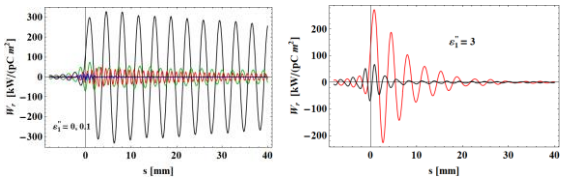
Thick layer, d = 200mk, multimode



Thin layer, d = 2mk, single mode



Contributions of individual resonances, thick layer



Comparison with longitudinal impedance resonances (THz), thick layer

i	$I_{\|\|,TM_0}$	$I_r,TE_{1,i}$	$I_r,TM_{1,i}$
1	0.0877	0.0841	0.1325
2	0.2901	0.2897	0.3775
3	0.5234	0.5234	0.6265

CONCLUSION

The work is devoted to the development of a technique for studying the transverse characteristics of the radiation of a particle in a metal-dielectric waveguide. In combination with the work in [Ł], where its longitudinal characteristics are considered, it provides an opportunity for a comprehensive study of radiation characteristics with the inclusion of losses in the metal wall and in the dielectric layer, which is necessary for the development of new applications.

[1] M. I. Ivanyan, L. V. Aslyan, K. Floettmann, F. Lemery, and V. M. Tsakanov, "Wake Fields in Conducting Waveguides with a Lossy Dielectric Channel", PRAB 23, 041301, 2020.