UDC 537.87; 621.372

I. V. Grymaliuk

Characterization of a resonant system based on a rectangular waveguide with two diaphragms

Institute of Technical Mechanics
of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine
15 Leshko-Popel St., Dnipro 49600, Ukraine; e-mail: Irysjka@email.ua

.

Microwave methods for the study and control of the dielectric properties of substances using regular and irregular rectangular metal waveguides have many applications and are of great practical interest. The dielectric properties of materials are assessed based on the determination of the reflection and transmission coefficients in a resonant system. This article considers resonant phenomena of electromagnetic oscillations in a prismatic cavity based on a length of a rectangular waveguide with two diaphragms and with a dielectric specimen in the form of a cylinder centrally positioned between them.

The goal of this work is to evaluate the resonant properties of a prismatic cavity based on a length of a rectangular waveguide with two diaphragms as a function of the geometrical dimensions of the rectangular diaphragm windows, the distance between the diaphragms, and the dimensions and dielectric properties of the specimen located at the center of the waveguide length. By computer simulation, the resonant properties of the system were determined as a function of the dielectric constant and diameter of the specimen and the geometrical dimensions of the diaphragm windows. It was found that for each value of the specimen diameter there exists a maximum allowable value of the dielectric constant at which the resonant properties of the system are kept in a selected operating frequency range. The effect of the height of the diaphragm windows on the resonant frequency of a prismatic cavity and the reflection and transmission coefficients was studied, and the behavior of the intrinsic Q factor was assessed qualitatively. A minimum possible diaphragm window height was found such that both the required coupling between the rectangular cavity and the external microwave line is provided and the maximum value of the loaded Q factor in the absence of a dielectric specimen is kept. The results of this work may be used in the design of high-frequency sensors for controlling the dielectric properties of materials in various industries.

Keywords*: rectangular waveguide, dielectric, reflection coefficient, diaphragm, cylindrical specimen.*

1. Chen L. F, Ong C. K., Neo C. P., Varadan V. V., Varadan V. K. Microwave Electronics: Measurement and Materials Characterization. New York: John Wiley & Sons, Ltd, 2004. 537 pp. https://doi.org/10.1002/0470020466

2. Collier R. J., Skinner A. D. Microwave Measurements: 3rd Edition. London: The Institution of Engineering and Technology, 2007. 484 pp. https://doi.org/10.1049/PBEL012E

3. Kapilevich B., Lipsky A., Litvak B. Application of the cut-off resonator for microwave monitoring of transformer oil. Microwave and Optical Technology Letters. 2011. V. 53. No. 1. Pp. 66-68. https://doi.org/10.1002/mop.25630

4. Karashchuk H. M., Sobolenko S. O., Hryhoriev I. S. Experimental study of the voltage standing-wave ratio of a rectangular waveguide with a longitudinal slot as a function of the slot dimensions and the excitation pin length. Visnyk Vinnytskoho Politekhnichnoho Instytutu, 2022. No. 2. Pp. 108-113. (in Ukrainian).

https://doi.org/10.31649/1997-9266-2022-161-2-108-113

5. Poplavko Yu. M., Molchanov V. I., Pashkov V. M., Prokopenko Yu. V., Kazmirenko V. A., Yeremenko A. V. Microwave waveguide methods for ferroelectric material characterization. Tekhnika i Pribory SVCh. 2010. No. 1. Pp. 39-51. (in Russian).

6. Bage A., Das S., Murmu L., Pattapu U., Biswal S. Waveguide bandpass filter with easily adjustable transmission zeros and 3-dB bandwidth. International Journal of Electronics. 2018. V. 105. No. 7. Pp. 1170-1184.
https://doi.org/10.1080/00207217.2018.1426123

7. Stevanovic I., Crespo-Valero P., Mosig J. R. Integral-equation technique for solving thick irises in rectangular waveguides. IEEE Transactions on Microwave Theory And Techniques. 2006. V. 54. No. 1. Pp. 189 - 197.
https://doi.org/10.1109/TMTT.2005.860305

8. Shestopalov V. P. Kirilenko A. A., Rud L. A. Resonant Wave Scattering. V. 2 Waveguide Inhomogeneities. Kyiv: Naukova. Dumka, 1986. 216 pp. (in Russian).

9. Doronin A. V., Grimalyuk I. V. Studies of primary microwave frequency converters based on the measuring cell with rectangular window. Teh. Meh. 2016. No. 2. Pp. 123-127. (in Russian).

10. Silvester P., Ferrari R. The Finite-Element Method for Radio Engineers and Electrical Engineers. Moscow: Mir, 1986. 229 pp. (in Russian).

Received on August 30, 2022,
in final form on September 27, 2022