UDC 533.9.08; 537.87

P. I. ZABOLOTNY

AZIMUTHALLY SYMMETRIC MICROWAVE CAVITIES FOR ASSESSING THE ELECTRON DENSITY IN A LOW-TEMPERATURE PLASMA

Institute of Technical Mechanics
of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine
15 Leshko-Popel St., 49005,Dnipro, Ukraine; e-mail: mwave@ukr.net

This paper considers the efficiency of azimuthally symmetric microwave cavities in assessing the electron density in a low-temperature plasma. In free-space low-temperature plasma diagnostics, the shape of the plasma area under study usually does not have any pronounced azimuthal symmetry. So the use of partially open microwave cavities, whose design allows arbitrarily shaped plasma blobs to penetrate inside them, seems to be more efficient. The choice of a coaxial quarter-wave and a biconical microwave cavity for low-temperature plasma characterization in the absence of magnetic fields is substantiated. The aim of this work is to compare the maximum possible sensitivity of the resonance parameters of a quarter-wave cylindrical and a biconical cavity to a variation in the electron density of a low-temperature plasma. Using the finite-element method, electrodynamic processes in a coaxial quarter-wave and a biconical microwave cavity filled with a low-temperature plasma were simulated. The effect of a variation in the plasma parameters on the complex coefficients of reflection and transmission of electromagnetic waves in the microwave cavities under study was estimated. The simulation was run for the plasma electron density ranging between 10^{10} m^{-3} and 10^{13} m^{-3}. The efficiency of the use of measuring systems based on the microwave cavities under study in low-temperature plasma electron density measurements was demonstrated, The maximum possible sensitivity of the resonance frequencies of the coaxial quarter-wave cavity to a variation in the plasma electron density was compared to that of the biconical cavity. It was shown that the expected maximum possible sensitivity of the resonance parameters of the biconical microwave cavity is almost twice that of the coaxial quarter-wave cavity.

Keywords: *microwave cavity, low-temperature plasma, electron density.*

1. *Golant V. E.* Microwave Methods in Plasma Diagnostics (in Russian). Moscow: Nauka, 1968. 372 pp.
2. *Makimoto M., Yamashita S.* Microwave Resonators for Wireless Communication. Theory, Design and Application. Verlag Berlin: Springer, 2001. 162 pp.
3. *Drobakhin O. O., Zabolotny P. I., Privalov E. N.* Influence of the dimensional and form precision of the constructional elements of biconical coaxial microwave resonator of the parameter of sensor of movement. Telecommunications and Radio Engineering. 2009. No. 68(9). Pp. 827–833.
4. *Heald M., Wharton C.* Plasma Diagnostics with Microwaves (*in Russian*). Moscow: Atomizdat, 1968. 392 pp.
5. *Lebedev I, V.* Microwave Techniques and Devices (*in Russian*). Moscow: Vysshaya Shkola, 1972. 374 pp.
6. *Silvester P., Ferrari R.* Finite Elements for Electrical Engineers (*in Russian*). Moscow: Mir, 1986. 229 pp.
7. *Kurushin A. A., Plastikov A. N.* Microwave Device Design in CST Microwave Studio (in Russian). Moscow: MAI, 2010. 160 pp.

Received on February 6, 2019,
in final form on February 28, 2019.