MODELING OF A COMPLEX CAVITY RESONATOR BY THE NONFIXED FIELD THEORY FOR THE 0.4 THZ SECOND-HARMONIC FREQUENCY-TUNABLE GYROTRON

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ABSTRACT

One of the main problems of the high-harmonic operation in THz-range gyrotron is the excitation of a parasitic fundamental-harmonic (FH) mode [1]. Using complex cavity with mode conversion (CCMC) [2],[3] improves mode selectivity properties and, in particular, prevents FH oscillation [4]. Different methods for simulation gyrotrons with CCMC resonator have been proposed [5]-[6]. In [5], start-oscillation current was calculated using the fixed cold-cavity axial field profiles with taking into account only one dominant axial TE-mode in each part of the cavity. In [6], different axial modes were taken into account. Both approaches demonstrate rather close results. However, the fixed-field approximation does not allow for studying smooth frequency tuning by the magnetic field. Therefore, in this paper we develop the small-signal theory of a CCMC-resonator gyrotron with a self-consistent field profile.

We are taking into account a single transverse mode in each part of the cavity. Coupling coefficients between different axial modes are evaluated from the elements of scattering matrix on the transition between the two parts. To calculate the scattering matrix, we are using a 3-D finite-element solver. The results of simulation for the 0.4-THz second-harmonic gyrotron considered in [7] are presented. Calculation of start-oscillation currents and oscillation frequencies for different axial modes shows that the theory with cold-cavity field profile fails to describe excitation of high-order axial modes. A possibility to achieve smooth frequency tunability in nearly 1.5 GHz frequency range is discussed.

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