DEVELOPMENT OF HIGH-CURRENT RELATIVISTIC GYROTRON WITH TM-TYPE OPERATING MODE *

E.B. ABUBAKIROV[1], YU.YU. DANILOV[1], A.N. DENISENKO[1], A.N. LEONTYEV[1], R.M. ROZENTAL[1], V.P. TARAKANOV[2,3]

[1]Institute of Applied Physics RAS, Nizhny Novgorod , Russia
[2]Moscow Engineering Physics Institute, Moscow, Russia
[3]Joint Institute for High Temperatures RAS, Moscow, Russia

Currently, the development and experimental implementation of millimeter-wave microwave sources with a sub-gigawatt output power level is the subject of active research [1–3]. The use of gyrotrons for this purpose is of particular interest, since in cyclotron interaction there is no need to transport the electron flow close to the electrodynamic system surface, in contrast to Cherenkov devices. To achieve a sub-gigawatt output radiation power level, gyrotrons must be powered by relativistic helical electron beams formed by explosive emission cathodes. In this case, a significant problem is the selective excitation of the working oscillation on time scales of tens of nanoseconds, corresponding to the characteristic duration of the electron beam.

This report presents the results of the development and the first experimental tests of a high-current gyrotron with an operating frequency of 30 GHz with a new type of plate-type slitted cavity. Such a cavity provides a significant rarefaction of the mode spectrum due to a significant decrease in the quality factor of the TE-type modes while maintaining the quality factor of the TM-type modes. As a result, it becomes possible to operate in one of the TM-modes in the gyrotron.

The results of experimental studies of an electron-optical system based on a coaxial magnetically insulated diode and a kicker, which forms a beam with an energy of 500 keV, a current of up to 2 kA, and a pitch-ratio of about 1.0, are presented. Experimentally and within the framework of three-dimensional PIC-simulation, it was demonstrated that when using the classical scheme for constructing a gyrotron with separation of the beam formation space and the electron-wave interaction region, the problem of parasitic self-excitation arises in the beam formation section. Possible modifications of the gyrotron are proposed to solve this problem and achieve the expected output radiation power level.

Fig.1. Photos of the assembled gyrotron (a) and plate cavity (b).

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