# DESIGN, SIMULATION AND FABRICATION OF AN ELECTRON OPTIC SYSTEM WITH SHEET ELECTRON BEAM FOR A SUB-THZ TRAVELING-WAVE TUBE

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## ABSTRACT

Miniaturized vacuum tubes operating at sub-THz and THz frequencies are of great interest for various applications, such as high-data-rate wireless communication, high-resolution radar, and spectroscopy. Since the transverse dimension is reduced, the tubes require electron beams with a very high current density [1]. Thus, devices with spatially extended electron beams, such as sheet-beam and multiple-beam ones have attracted a strong interest [2]-[4]. In this paper, we present the results of research aimed at development of the electron-optic system (EOS) for a microfabricated G-band (0.2 THz) traveling-wave tube (TWT) with a high-current-density sheet electron beam. An electron gun with a converging sheet electron beam provides a substantial improvement of the TWT performance [5] as compared with the EOS with straight beam immersed in a uniform magnetic field [4]. The former one facilitates beam focusing and allows reduce of the focusing magnetic field and cathode current density, which, in turn, allows increase of the lifetime. The diode-type electron gun with a $0.8\times0.8\ \mathrm{mm}^2$ curved cylindrical cathode is designed. The beam thickness at waist position is ~ 0.05 mm, i.e. a compression ratio ~16 is provided. The beam-focusing electrode (BFE) has the form of a rectangular horn. For the experimental study, the electron gun was fabricated. The cathode pellet was manufactured from porous tungsten matrix impregnated by BaO and coated with Os nanoparticle film, which lowers the work function and increases the emission uniformity. Operating temperatures of the cathode are 1100–1300ºC. The BFE was manufactured from hafnium by electron discharge machining (EDM). Electron current density was experimentally measured by a pinhole analyzer. The beam thickness at waist position was less than 0.1 mm. Peak measured current density was about 200 $\mathrm{A/cm}^2$. The reversal magnetic focusing system is designed and simulated. Such a magnetic system has a significantly smaller size and weight compared to the permanent magnet. Over 95 % beam transmission was obtained in the simulation.

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