DYNAMICS OF PULSED GAS FILLING OF ELONGATED CYLINDRICAL TUBE

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The teraherz-range (0.1–10 THz) electromagnetic radiation is extensively used for solving a wide variety of scientific and engineering problems and different practical applications. These include plasma heating in fusion experiments, detection and imaging of hidden objects, studying of spectral response characteristics of the materials and their exposure to electromagnetic radiation in a certain frequency range of the spectrum, fast process recording, etc. As for potential to generate fluxes of THz-range radiation and register spectral responses of the objects in a given frequency range, the 0.3–1 THz frequency range of the spectrum remains the least utilized one. An approach to solve the problem of intense radiation flux generation in this frequency range is to use the emission of electromagnetic waves from plasma due to transformation of electron plasma waves pumped by high-current relativistic electron beam (REB). Experiments at GOL-PET facility demonstrated that spectral distribution of a flux generated in a magnetized plasma column was within 0.1–0.5 THz range, while the power spectral density maximum was localized near the upper hybrid frequency 0.15–0.25 THz [1]. The pulse duration is 2 μsec; total pulse energy is up to 10 J [2]. The radiation flux escaping from vacuum into the atmosphere runs to a distance of several meters with angular spreading of less than 10° [3]. The given frequency range in a radiation flux generated at GOL-PET facility is reached by injection of REB with a current density of 1–2 kA/cm^2 into the plasma column with electron concentration of $(5–7) \cdot 10^{14}$ cm^{-3} (see [1, 2]). Based on the experience gained over many years of experimental studies [4, 5], a pulsed high-voltage discharge was applied to generate plasma column with a specified electron concentration.

This work solves the problem of fast pulsed neutral-gas filling of a vacuum cavity inside the elongated cylindrical tube. Computer simulation was performed in FlowVision using Navier-Stokes Model. Requirements to the system used for the pulsed gas filling of the above tube are formulated. The computational procedure for gas filling process is briefly described. The results of these computations are used to represent spatiotemporal dynamics of hydrogen fluxes injected into the tube from its opposite sides. The measured data on hydrogen flux propagation along the elongated tube used to generate a plasma column by a high-voltage discharge at GOL-PET facility are given.

References

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