plasma distribution in a microwave disharge column sustained by a standing surface wave [[1]](#footnote-1)\*)

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A standing surface electromagnetic wave (SEW) in a m = 0 mode [1] is excited on the plasma column of a microwave discharge between two metal mirrors. A distinctive feature of this experiment is the self-consistent mode: a standing surface wave is excited, which itself creates and maintains the plasma. Surface-wave-sustained discharge was initiated in a long quartz tube ($>10λ\_{0}$) by a surfaguide applicator [2] with a power of 800 W, generating single rectangular pulses up to 50 ms at a frequency of 2.45 GHz. The measurements were carried out in argon in the pressure range from 0.02 Torr to 7 Torr. In this work, the discharge parameters, such as the plasma density profile and the characteristics of the electric field of the surface wave, are measured for the case of a free discharge and for a discharge between mirrors supported by a standing wave.

Standing wave excitation on a plasma column leads to the formation of local minima and maxima of the plasma density. Period of this modulation is equal to half the length of the surface wave. It has been found that the formation time of the modulated structure is close to the characteristic diffusion time, and the degree of modulation increases with pressure. The possibility of creating a plasma column with plasma density modulation $n\_{max}/n\_{min}≈5$ and a length of about 10 wavelengths is demonstrated experimentally.

To study the standing surface wave electromagnetic field features, a numerical model was created in the CST Microwave Studio program with predetermined values of the plasma density $n\_{e}$ and the electron-neutral collision rate $ν\_{n}$. The experiment and numerical simulation demonstrate that the longitudinal *E*z and radial *E*r components are phase-shifted relative to each other by $π/2$. Thus, the *E*z is the main contributor to sustain the plasma, which determines the density distribution. Based on the measured electron concentrations, the simulation makes it possible to estimate the SEW field ratio between the parts of the energy in vacuum *W*vac and inside the plasma *W*pl. So, in the tail part of the discharge, where the electron concentration tends to $n\_{min}=4⋅10^{13} см^{-3}$ (where$ n\_{min}$ is the critical concentration for SEW propagation), the ratio *W*pl/*W*vac tends to unity. At the maximum plasma density achieved in the experiment, $n\_{e}=4⋅10^{13} см^{-3}$, the ratio *W*pl/*W*vac ≈ 0.02, i.e. the vast majority of the SEW field energy does not penetrate into the plasma. In this case, the radial density profile of the plasma column is strongly inhomogeneous with a maximum electron concentration near the wall.

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References

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Lt/ru/EM-Zhukov.docx) [↑](#footnote-ref-1)