EXCITATION OF A DIPOLAR AND AXIALLY-SYMMETRIC MODES OF A MICROWAVE STANDING SURFACE ELECTROMAGNETIC WAVE IN A LOW PRESSURE GAS DISCHARGE AT DIFFERENT PLASMA PARAMETERS

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The work is devoted to the study of the microwave surface electromagnetic wave (SEW) [1] on the plasma column of the low-pressure gas discharge, supported by the wave itself. By using a waveguide applicator to excite the surface wave [2], both axially symmetric and dipolar modes can be excited, depending on the tube parameters. A uniform along-axis region of the plasma column enclosed in the space between two mirrors was investigated. Such a structure forms an open-type cavity on the surface wave. The standing-wave ratio in the cavity reaches values up to 30 with the corresponding quality factor Q ≈ 60. Axial, transverse, and azimuthal distributions of the components of the electric field strength vector of the SEW were measured. When a dipolar mode is excited, the azimuthal distribution of the surface wave field is characterized by diametrically arranged lobes with Emax/Emin ratio more than 10. It is shown that the surface wave is characterized by the presence of the longitudinal component Ez, which is in antiphase with the transverse component Er. The validity of the dipolar mode excitation criterion $fr>2$ GHz×cm is confirmed: on a tube with an internal radius of 7.5 mm m = 0 mode is excited, and at r = 10.5 mm m = 1 mode. The concentration of electrons in the layer through which the surface wave propagates was determined from the dispersion dependence of the SEW wavelength on the plasma frequency for both m = 0 and m = 1 modes [3]. The longitudinal plasma density profiles were obtained from the integral plasma emission intensity proportional to the average electron concentration across the cross section [4]. When the tube is filled with argon at a pressure of 1.5 Torr, a modulation of plasma density of the order of 10-15% was registered, with maximums of density coinciding with minima of radial and maximums of longitudinal components of the electric field of the standing surface wave. In the range of pressures in air (from 0.01 Torr to 0.1 Torr) no noticeable density modulation was observed. A further increase in pressure led to an increase in the electron losses in the discharge and at ν⁄ω ≈ 1, the discharge propagation was arrested.

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