TO THE THEORY OF IONIZATIONAL INSTABILITY OF PLASMA SLAB

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For the first time ionization scattering in infinite plasma with a low electron density was considered in [1]. Linear and nonlinear modes of ionization scattering of a plane wave by a cylindrical overdense plasma column in the waveguide, along which surface wave can propagate, was studied in [2, 3]. Comparison of the results [2, 3] with experiment was carried out in [4]. In this study, we conducted in a general way the solution of the problem of stimulated ionization scattering of plane wave on an infinite plasma column.

We assume that microwave, which supports plasma, is normally incident on the plasma column of radius R, which is described by electrons balance and heat conductivity equations. The electromagnetic field satisfies Maxwell's equations in cold plasma approximation. We use Laplace transform method to solve the problem of the excitation of ionization instability, caused by fluctuations of the electron density in the plasma column. We separate the field perturbations, which is connected with total current conservation in solving Maxwell equations. Instability evolution is described by the equations for the "slow" amplitude perturbations of electrons density and temperature and electromagnetic field strength of the respective modes.

The solution to the instability problem, initiated an external periodic perturbation, allows to allocate the three type of excited vibrations: one resonance mode, associated with the excitation natural waves of the electromagnetic media and two diffusion-heat-transfer modes. Depending on the characteristics of discharge kinetics both latest modes will be damped, or one of them will describe diffusion-ionization instability (striation), and the second is strongly damped disturbance.

Change the path of integration allows us to select the resonant mode associated with the excitation of eigen (surface) electromagnetic waves, leaky waves [5, 6] (for subcritical density of electrons in the plasma) and a continuous spectrum. The number of leaky waves, which contribute to the scattered field, depends on the space position of observation point and scattering area parameters. The contribution of the continuous spectrum is calculated by saddle point approximation.

We also consider the problem of free oscillations and obtain expressions for the instability increment for different vibration modes. Calculations show that a similar instability may also occur in low pressure plasma chemical reactors.

References

1. Gildenburg V.B., Kim A.V., Khazanov I.V. Sov. Physics: Fizika plasmy, 1983, 9, 1303.
2. Dvinin S.A., Dovzhenko V.A., Solntzev G.S. Sov. Physics: Fizika plasmy, 1982, 8, 1228.
3. Dvinin S.A., Dovzhenko V.A., Solntzev G.S. Sov. Physics: Fizika plasmy, 1983, 9, 1058.
4. Dvinin S.A., Postnikov S.A., Solntzev G.S., Tsvetkova L.I. Sov. Physics: Fizika plasmy, 1983, 9 №6, 1297–302
5. Tamir T., Oliner A.A. Proceedings IEE, 1963, **B110**, №2, 310, 325.
6. Шевченко В.В. Плавные переходы в открытых волноводах. М.: Наука, ГРФМЛ, 1969.