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JOURNAL DE PHYSIQUE Colloque C7, supplément au n°7, Tome 40, Juillet 1979, page C7- 643

# THE UHF DISCHARGE WITH PRELIMINARY LOCALLY IONIZED GASEOUS MEDIUM

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When studing the interaction of intense ($E \sim 50V/cm$) focused beams of W band microwave with a low temperature plasma stream flowing out of an electroarc plasmatron into a rarefield gas [1], it is revealed that a change of power of both passed and, espessially, reflected signals has an oscillating character in the certain region of the parameters of plasma and gas (Fig.1). As a rule, oscillations begin with some delay in relation to the origin of pulse. The value of delay and period of oscillation are decreased with increasing both density of plasma and pressure of gas. The brightly luminous region ranging from the boundary of a luminous part of a plasma stream on the direction to the radiating antenna is visually observed. The more pulse duration of a microwave beam, the more distance through which the luminous region passes in this direction under other equal conditions.

The luminous region represents the area with more increased ionization moving from the stream to the source of microwave energy, i.e. the microwave discharge initiated by previous ionization in a plasma stream. This assumption is supported by direct measurements of the plasma density distribution in space between the stream axis and the antenna. The measurements are made by an interferometer with a dielectric waveguide serving as a mobile sensor [2]. On the interferograms, inside the luminous region a sharp spike corresponding to the increase of plasma density with the following slow decrease is recorded. The delay time of the spike in relation to beginning a microwave pulse increases with the displacement of the waveguide to a radiator of microwave power.

In Fig.2 is represented the plasma density space-time dependence pattern reconstructed from the oscillograms of the interferometer signal for one of the regimes in which the described phenomenon has been detected. It is seen that after switching the microwave beam on, the "hump" moving for some time towards a microwave beam is appeared on a slope of the radial profile of density distribution. Excess of consentration over the undisturbed plasma accounts for 130% (in the region of the microwave discharge origination) till 450% (at the end of a microwave pulse). With the absolute value the plasma density in the region of UHF discharge accounts for 0,7-0,9 of the critical density $n_{cr}=1,1.10^{12}cm^{-3}$. It is evident that the oscillations of the reflected signals in the regimes of the initiated microwave discharge are determined by beating between the radiating and Doppler displaced (reflected from the running front of ionization) waves. So it is easy to define the front propagation velocity: $v = c\Omega/2\omega$ where $\Omega$ - the beat frequency determined from the oscillograms. The velocity of propagation of a microwave discharge is found to depend on the undisturbed ("priming") plasma parameters and to be $(0,5\div3).10^4$ cm/sec. These data agree with the results of the measurements of the front of ionization velocity according to the delay time of peak on the interferogram corresponding to the microwave discharge on moving the sensor to the antenna.

Following Yu.P.Raiser [3], let us estimate the magnitude of the stationary electric field for a breakdown of neutral argon under experimental conditions:

$E^2(v/cm)=5{,}7\cdot10^{-16}\ I_1(\omega^2+\nu_m^2)\frac{\nu^*}{\nu_m}\Phi/(I)$

where disignations correspond to the accepted ones in [3] . According to our conditions in the range of pressures of 0,1+0,5torr, this estimation defines the value of the intensity of the breakdown field E=150V/cm, i.e. 2,5 times more than the intensity realized in the course of the experiment. The observed phenomenon has analogs in some experiments on the optical breakdown of gases and studing the microwave discharges in waveguides [3,4].

As shown in [4] , the diffusion of optical resonance radiation is responsible for the formation and propagation of the initiated microwave discharge in a waveguide. In our conditions except this mechanism, two more physical phenomena seems to be of concern. First, the change of fast free diffusion determining the particle runaway in conditions of the neutral gas breakdown by the ambipolar one (peculiar to plasma) facilitates the possibility of the avalanche breeding the particles. Second, the increase of the ionizing microwave electric field due to both "swelling" the field in the nonuniform plasma near the resonance point and reflecting the wave from the gradient of plasma concentration has great sagnificance. The determination of a comparative importance of these mechanisms for the described phenomenon will be the subject to be investigated.

REFERENCES:


1. N.A.Armand, S.A.Rogashkov, E.G.Shustin. Interaction of the intense microwave beam with the flow of the low temperature plasma. Proceedings of the 14th Conference on PIG, Grenoble, France, 1979.
2. E.A.Shustin, A.A.Lisitskaya. The microwave interferometer with enchanced resolution for observing the plasma in a microwave field. The report of the All-Union Conference on physics of the low temperature plasma, Kiev, 1979.
3. Yu.P.Raiser. The laser spark and propagation of discharges, M., "Nauka", 1974.
4. G.W.Bettke, A.D.Ruess and oth. Phys.Fluids, 1963, v.6, p.594; 1966, v.9, p.1430; 1969, v.12, p.822.


Fig 1

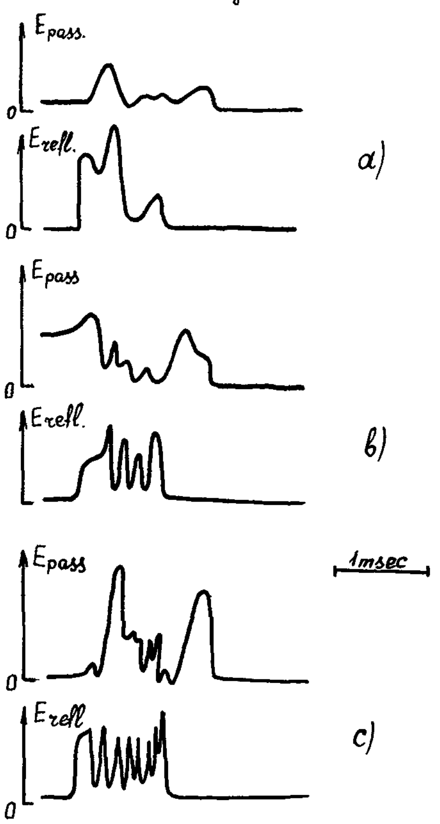


Fig 2