POSSIBILITY OF DETERMINING THE POTENTIAL DISTRIBUTION OF A PLASMA FROM THE CHARACTERISTICS OF THE NOISE GENERATED IN A GASEOUS DISCHARGE

A. A. ZAĬTSEV, M. Ya. VASIL' EVA, and V. N. MNEV

Moscow State University

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As is well known, the determination of the spatial potential distribution of a plasma by the conventional probe method involves a number of difficulties. If the discharge is inhomogeneous the probe curves exhibit discontinuities and the slope of the potential distribution curve is not easily distinguished.

The method reported here exploits noise effects characteristic of hot-cathode gaseous discharges. Frequently gaseous discharges generate noise voltages as high as 1 volt. These noise effects are observed over a frequency range ranging from kilocycles to megacycles.[1-3] It is assumed that the detection of discharge noise by a probe is affected by the space charge layer at the probe.[1,2] Since the conductivity of the plasma is higher than the conductivity of the space charge layer the impedance of the probe-cathode space is determined to a considerable degree by the impedance of the probe-plasma space which, in turn, depends only on the dimensions of the space charge layer.[4] When the probe potential is the same as the plasma potential the space charge layer around the probe vanishes. Under these conditions we may expect a sharp increase in the amplitude of the noise picked up by the probe since the conditions for detection become most favorable. Thus it is possible to determine the gas potential rapidly.

The measurements reported here were carried out in cylindrical tubes with oxide cathodes. The noise was measured in the probe-cathode section by means of a 1P-12M noise-measuring set. The experiments were carried out in krypton in the pressure region between 0.01 and 1 mm Hg at discharge currents ranging from 6 to 140 ma.

In Fig. 1 is shown a typical probe characteristic (curve marked pc) and the corresponding noise curves (the numbers on the curves are frequency in cps). The noise maxima measured at different

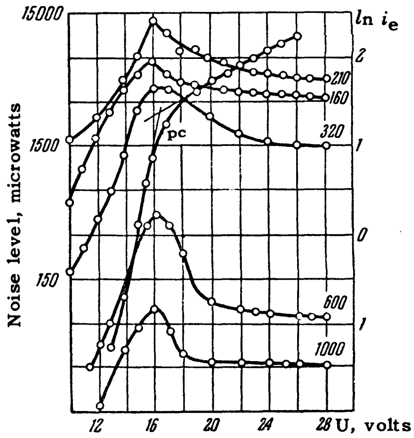

FIG. 1

frequencies are found at a probe potential of 16 volts; this value is in good agreement with the value 16.4 volts obtained from an analysis of the semi-logarithmic characteristics of the electron current to the probe (i_e). In Fig. 2 is shown the potential distribution U along the axis of the discharge as determined by the usual method (solid curve) and by the "noise" method (dashed curve). The results are in agreement to within several tenths of a volt.

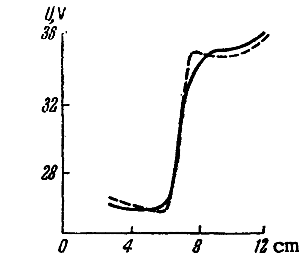

FIG. 2. The variation of potential along the axis of the discharge. The pressure is 0.1 mm Hg, the anode current is 60 ma and the cathode is to the left.

As a rule the noise curves exhibit well-defined maxima at the potentials seen by the probe. The simplicity and accuracy of the noise method make it possible to find the gas potential when the conventional probe method cannot be used to obtain an accurate determination of the discharge parameters.

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