PROBE INVESTIGATIONS OF THE DISCHARGE RECONSTRUCTION AT THE DUSTING OF THE CHANNEL WORK SURFACES.

A.I.BUGROVA*, A.V.DESYATSKOV*, A.I.MOROZOV**, V.K.KHARCHEVNIKOV*.

Abstract

It was investigated the influence of external conditions upon the thruster operating. It was shown experimentally, that at the sputtering of the metal target by plasma flow, which runs out from the thruster, local parameters (φ, T) in the thruster channel are changed and the ionization zone displaces to the outlet. These facts lead to the worsening of thruster integral parameters. Formed negative ions, which enter the channel along the stream, are mainly responsible for this process.

The purpose of work was investigation of local plasma parameters in thruster channel, when the external conditions of its operating were different. Two cases were considered:

1) Plasma flow runs out easily into vacuum chamber.
2) Plasma flow runs out, the metallic plate 60 x 110 mm is placed at l=0.5 m from the truster outlet.

We used probes for measuring the local plasma parameters. There was near-wall plane faced probes with collecting surface S=0.2 mm . Four of them was mounted flush with the inner surface of outer insulator (r= 35 mm), along the truster axis at z= 8 mm, 18 mm, 22 mm and 26 mm from the anode.

The probe V-A dependence was obtained for each probe, and plasma potential and electron temperature at given point of truster channel were calculated. The truster operated at optimal, respectively to Jd, mode: Vd= 350 V, m = 3 mg/s, which kept strictly steady. When the plasma flow out easily into vacuum chamber, Jd= 3.02 A.

Distributions of plasma potential and electron temperature along the channel for clean model (case 1) are shown on fig.1a. It is seen, that plasma potential remains constant (φ= 345-347V) up to 12-13mm from the anode. After that the potential decreases, and, at the outlet (z=25mm) it is equal 45V. The point of reverse bend corresponds to z=19mm.

The distribution of electron temperature along the channel is bell-shaped (fig.1a). The maximal temperature corresponds to z= 19-20mm. Since there was no probe in this point, we don't know the precise value of temperature, but, basing on previous measurements, one may assume T 20eV.

In the second case the metal plate was placed at 0.5 m from the outlet, the truster operated for 1 hour at same mode (350 V, 3 mg/s). The discharge current settled at 3.22 A. Distribution of plasma potential and electron temperature are shown on fig.1b. It is seen, that in this case the plasma potential remains constant (at the level φ =340 V) up to z 18mm from the anode. The point of reverse bend of potential corresponds to z 22mm. The function of electrons temperature distribution along the channel has maximum T 28eV at z 22mm.

* Moscow Institute of Radio Engineering, Electronics and Automation. Russia, 117454, Moscow, prospect Vernadskogo, 78.

**Russia Scientific Center - Kurchatov Institute. Russia, Moscow, Kurchatov Sq.1.

The experiment showed, that at the sputtering of the metal the dynamics of parameters in the channel is characterized by the displacement of ionization zone to the outlet and increase of electron temperature. Obviously,these factors lead to decrease of outlet ion velocity, worsening of equipotentialisation of outlet region, owing to electron temperature increase. The worsening of magnetic force lines equipotentiality leads to the additional ion ejection on the walls,and,correspondingly, to the decrease of thruster efficiency.

Thus, one may conceive the general picture of thruster operating mode reforming as below. If the flow of particles, entering through outlet, is more, than the erosion flow from the insulator surface, than, in the ionization zone, where the role of processes on the insulator surface is high, the region with other parameters appears.

The presence of such region causes the displacement of ionization zone towards the outlet. Since the main voltage drop becomes more narrow, the electron temperature will increase,equipotentiality will become worse, the discharge current will increase. Other magnetic field are necessary for the discharge current decrease, and there is no need in the third magnet coil for their realization. The ionization zone is now placed in the erosion zone, and the regime, when J_{m_3} =0, becomes optimal.

Hence, for stable operation of thruster, one must ensure not only necessary vacuum, but its proper "purity",since "fly in" of the substance through the outlet is determined by the portion of negative ions, which appear in vacuum chamber and suck in the thruster channel under the influence of electric field.

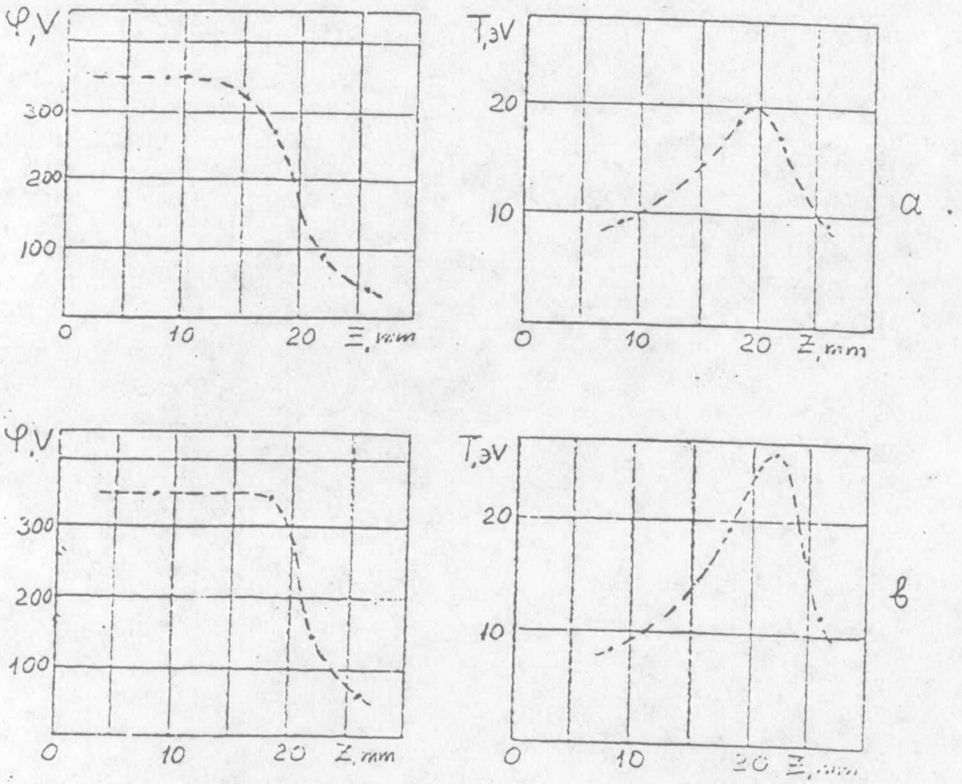

Fig.1.The distribution of plasma potential and electron temperature along the thruster channel:
a - clean model;
b - after sputtering of metal target.