Thrust measurement system based on strain gauge for high-power plasma thrusters [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2023.50.2023.1.1.126

Bragin E.Y., Veselovzorov A.N., Kazeev M.N., Kozlov V.F.

National Research Center “Kurchatov Institute”, Moscow, Russia, [Bragin\_EY@nrcki.ru](mailto:Bragin_EY@nrcki.ru)

As known, laboratory models of stationary Electrodeless Plasma Thrusters (EPT) have a large mass and are associated with an external structure. Therefore, the well-known thrust meters used to determine the thrust of plasma thrusters, based on torsion balance and an inverted pendulum, are not feasible. In this case, strain gauge transducers of a plasma pressure force on the target can be used [1]. This method can measure the force of pressure produced by the flow of plasma in the range from 10-3 N to several Newton, as long as the linearity of the load cell takes place. The purpose of this work is to determine the possibilities of measuring the thrust characteristics of stationary and quasi-stationary EPT in the range of 0.01 - 1 N using a strain gauge beam. The diagram of the device is shown in Figure 1. A target perpendicular to the plasma velocity is attached to the end of an aluminum oxide rod, while the opposite end of the rod is connected to the beam on which four strain gauges are mounted. The force caused by a plasma flow incident on the target creates a torque that causes deformation of the beam. The resulting data are associated with the acting on the target. The target size and position in the flow can be varied, resulting in a radial thrust density profile. Under certain assumptions, the data used can be used to calculate the integral thrust of the thruster.

Tests of the thrust meter based on a strain gauge sensor were carried out at the experimental stand with an SPT-100 stationary plasma thruster with a discharge power of up to 2.5 kW. Comparison of the results obtained with the use of a strain gage, and traditionally used meter based on a torsion balance with an electromagnetic compensation, is carried out. The SPT-100 mode with a thrust of about 100 mN was used. A comparison of the measurement results carried out by the two considered methods showed that the difference in the measurement results is about 15%. It is known that thrust meters based on torsion balance have a thrust measurement error of about 2%. The analysis showed the inaccuracies in measuring the thrust by a strain gauge are connected with integrating of the thrust density, determining the direction of thrust and ion sputtering of the target material. The estimates of each of the listed effects on the measured thrust accuracy by this method are given.

Figure 1. Thrust meter. 1 - plasma flow, 2 - target, 3 - alundum rod, 4 - load cell, 5 - strain gauges, 6, 7 - clamps, 8 - console

References

1. West M. D., Charles C., and Boswell R. W., “A high sensitivity momentum flux measuring instrument for plasma thruster exhausts and diffusive plasmas, ”Rev. Sci. Instrum. Vol.80, No. 5, 2009. doi: 10.1063/1.3142477

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Lt/ru/EJ-Bragin.docx) [↑](#footnote-ref-1)