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Development of a prototype of a pulsed plasma thruster with solid propellant

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A solid-state pulsed plasma thruster (PPT) was designed and constructed. The solid-state PPT has the following design features: the coaxial electrodes are made of copper; the distance between the electrodes is 4 mm; the ignition electrode is made of graphite and is used as a solid propellant. IPD finds wide application in tasks such as spacecraft orbit maintenance and nano-satellite servicing [1-4].

The electrical, structural and thrust characteristics of the solid state IPD were obtained in the experimental study. The measured thrust impulse bit value was 18 μN s at charged voltage of 1.5 kV. The mass exhaust of the electrodes (propellant) in the solid-state PPT model was measured by using the aluminum foil trap. CPA 225D scales with an accuracy of 0.01 mg were used to measure the trap mass before and after the experiments. The measured total trap mass (exhausted from the solid-state PPT) was of 6 mg after exposure to 5400 pulses. Consequently, the plasma propellant consumption rate is 0.0011 mg/pulse. The instant images of the spark discharge formation and plasma acceleration captured by a high-speed CMOS camera. The velocity of the initial plasma flow ejected from the thruster was estimated using two subsequent frames shown in Fig. 1. Therefore, taking into account the distance shift and the time interval between the frames we measured the velocity of the initial plasma flow, which was equal to 4.5 km/s.

The obtained results show the possibility of such device application in space technology. In particular, it can be used to correct and control the orbits of nano-satellites.

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References

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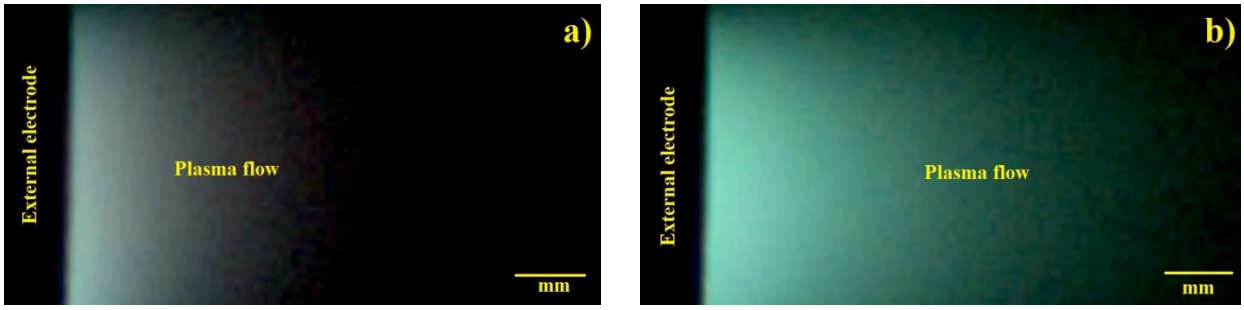

Figure 1. The instant images of the plasma acceleration. a) 0 mks. b) 1.47 mks.