



Contribution ID: 39

Type: Poster

Plasma Generation by a Pulsed Nanosecond Discharge on a Surface of Porous Dielectric Saturated with Liquid

Tuesday 20 June 2017 13:30 (1h 30m)

Pulsed plasma thrusters utilizing solid propellants have relatively low efficiency [1]. As alternative propellants, liquids are considered to be used in PPTs. However, using of liquid arises the problem of supplying it to the discharge area [2]. This work presents the results of the estimation of plasma formation efficiency of the discharge unit utilizing vacuum pump oil as a propellant. It was supplied to the discharge area through the ceramic diffusion element which is 5 mm thick with a porosity of 20%. We used coaxial electrode system with 12-mm central anode and 30-mm ring cathode. Pulse generator used has a coaxial forming line with an impedance of 20 Ω and stored energy of 2 J. Pulse width is 10 ns, pulse repetition frequency is up to 100 pps. Voltage of 100 kV was applied to the central electrode at frequency of 3 Hz. The experiment was carried out in vacuum at pressure of 10^{-2} Pa. The liquid was pushed into the diffusion element by pressures of 500, 260, and 60 Pa. Propellant consumption at these pressures are 50, 12, and 8 $\mu\text{g}/\text{pulse}$, respectively. We consider propellant consumption efficiency as a ratio of total ion charge in a unit solid angle to the total propellant weight loss. The resulting values are 1.5, 4.0, and 4.9 C/(g·sr), respectively. We assume that the thinner the liquid layer formed at the surface of the diffusion element, the higher ionization efficiency of the propellant, because of more homogeneous heating of the layer. Higher degrees of ionization may be achieved by adjustment of pulse frequency at fixed propellant supply value.

[1] Schönherr T., Komurasaki K., Herdrich G. Journal of Propulsion and Power, 2013, vol. 29, No. 6, pp. 1478-1487. DOI: 10.2514/1.B34789

[2] Koizumi H., Kakami A., Furuta Y. et al. 28th IEPC, March 17-21, 2003, IEPC-03-087. DOI:10.1063/1.1790568

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Session Classification: Poster session II - Particle Beam and Accelerator Technologies

Track Classification: Particle Beam and Accelerator Technologies