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Microwave-Excited Microplasma Thrusters Using Surface Wave and Electron Cyclotron Resonance Discharges DAISUKE MORI, TETSUO KAWANABE, YOSHINORI TAKAO, KOJI ERIGUCHI, KOUICHI ONO, Department of Aeronautics and Astronautics, Graduate School of Engineering, Kyoto University — Downsizing spacecrafts has recently been focused on to decrease mission costs and to increase launch rates, and missions with small satellites would bring a great advantage of reducing their risks. Such a concept supports a new approach to developing precise, reliable, and low-cost micropropulsion systems. We have studied two types of microwave-excited microplasma thrusters, using surface wave-excited and electron cyclotron resonance-excited discharges. Microwaves of S-band (4 GHz) and X-band (11 GHz) were employed to excite the plasma in these experiments, with the feed or propellant gases of Ar and He. A microplasma thruster of electrothermal type consisted of a surface wave-excited microplasma source, and a converging-diverging micronozzle to obtain the thrust. For 11-GHz microwaves at a power of 6 W, a thrust of 1.1 mN and a specific impulse of 90 s were obtained at an Ar gas flow rate of 40 sccm, where the plasma electron density was 1.2×10^{20} m^{-3}, and the gas temperature was 1.5×10^{3} K; under the same conditions for 4-GHz microwaves, the thrust, specific impulse, electron density, and gas temperature were 0.93 mN, 80 s, 7.0×10^{19} m^{-3}, and 8.0×10^{2} K, respectively. A microplasma thruster of electromagnetic type had a microplasma source excited by electron cyclotron resonance with external magnetic fields, to obtain the thrust through accelerating ions by ambipolar electric fields. Optical emission spectrum was dominated by Ar^{+} ion lines in the microplasma thruster of electromagnetic type, owing to higher electron temperatures at lower feed-gas pressures.

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