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# THRUST DEPENDENCY OF MICROWAVE ROCKET ON POWER DENSITY DISTRIBUTIONS OF AN INCIDENT MILLIMETER WAVE BEAM

**Abstract**

A Microwave Rocket is a future low-cost launcher to the space. Propulsive energy is repetitively supplied by pulsed millimeter wave beams irradiated from the ground and the atmospheric air is used as a propellant, so that it can be propelled without any energy sources or propellants on-board. Microwave Rocket consists of a reflector to ignite and a cylindrical tube to keep high pressure inside. The closed end of the cylindrical tube has a beam-focusing reflector called "thrust wall" and the other end serves as an entrance for the millimeter wave beam, from which also air is exhausted and refilled after the end of a thrust generation cycle. A propagating structure inside a Microwave Rocket is millimeter-wave supported detonation, consisting of shock wave and plasma as millimeter wave absorption layer. The propagating velocity of millimeter-wave supported detonation is one of the key parameters for thrust performance of Microwave Rocket and in previous study it was faster than that of laser supported detonation (LSD) at the same power density. This faster velocity can lead lower heating rate in the ionized region and lower pressure behind the detonation wave than LSD. Therefore the objective of this study is to control the detonation wave velocity and to enhance the thrust performance of Microwave Rocket. 170GHz gyrotron at JAEA was applied to a millimeter wave beam generator. A Gaussian profile beam was converted into a flat-top profile by quasi-optical phase correcting mirrors. Experiments were done in the condition from 200kW to 570kW power. The pressure on the parabolic reflector was measured by a high-speed pressure gauge, and the propagating velocity of the ionization front was detected by a fast-framing camera images. Plasma structures with two different beam profiles and the Plateau pressure at the thrust wall was obtained. As a result, the propagating structure of the ionization front was strongly related to the local power density distribution. According to the propagating structure of the ionization front, the fluid just following the shock wave can obtain the enthalpy converted from a millimeter wave. Therefore, the flat-

top beam could generate much higher thrust impulse than that of the Gaussian one. This result showed a possibility to enhance the energy conversion efficiency of a Microwave Rocket.