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Low Mass Vacuum Arc Thruster System For Station Keeping Missions

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Low mass vacuum arc thruster system for station keeping missions

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The development of micro- and nano-satellites is presently of strong interest to the NASA and Air Force. The design of a microspacecraft affects the propulsion system by limiting its power, mass and fuel system complexity. Advanced propulsion systems are required for orbit transfer and station keeping, maximizing payload and minimizing launch costs. For future space missions, micro- and nano-propulsion could be an enabling factor in space force enhancement, space control and space force applications.

A vacuum arc thruster in combination with an innovative inductive energy storage power processing unit (PPU) has been developed that promises to fulfill this need. The developed vacuum arc thruster can be operated with a variety of materials, each of which provides ions with a different specific impulse ranging from 1100 s for Ta to close to 3000 s for Al (corresponding to velocities of 11000 and 30000 m/s respectively). Initiation of the arc only requires a few hundred volts due to the innovative 'triggerless' approach in which a conductive layer between the cathode and the anode produces the initial charge carriers needed for plasma production. The initial starting voltage as well as the energy to operate the vacuum arc is generated by a low mass (<300 g) inductive energy storage PPU which can be controlled with TTL level signals. Calculations have shown that the expected thrust efficiency can reach up to 15 μN/W.

The vacuum arc thruster has been tested at JPL to verify the predicted performance using Ti as cathodes material. Thrust measurements with a resolution down to 1 μN-s will be presented as well as efficiency measurement.