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Disruptive Propulsion Concepts for Enabling New Missions (9)

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EFFICIENCY EVALUATION OF EMITTED CHARGED DROPLETS IN ULTRASONIC-ASSISTED ELECTRIC PROPULSION SYSTEM

Abstract

At present, the electric propulsion technology has become an important indicator for the measurement of a country's space technology. The electric propulsion technology based on electrospray has developed rapidly in recent years. In order to break through the technical bottlenecks, such as the small number of emitters, poor consistency and low efficiency, the Ultrasonic-assisted Electric Propulsion(UAEP) system for efficient emission of charged droplets is proposed. The UAEP system covers an ultrasonic nozzle, a liquid feed system, a high voltage power supply and a metal extractor. Its core can be described as: by controlling the liquid supply conditions, ultrasonic vibration and emission electric field, it realizes the multi-shape generation and control of the high-density micro-emitter array; and finally achieves the high-efficiency emission of charged droplets through coordinated control of the emission conditions and the optimal emission modes. In this work, the efficiency of emitted charged droplets in UAEP system is mainly evaluated by thrust measurement and research of emission mechanism.

In this study, the micro thrust of the UAEP system is measured with three kinds of extractor voltage of 5 kV, 7 kV and 9 kV. The latest results are 565.23 μN, 715.65 μN and 842.73 μN with a measurement error of less than 50 μN, and the thrust value increases with the extractor voltage at a same flow rate 5ml/h. At the same time, the formation process of capillary standing waves (CSWs) on emission surface is investigated by numerical methods. For the further research of UAEP system, formation and distribution of CSWs need to be further studied to conduct a precise control on CSWs in experiment. At the meantime, there are multiple factors affecting performance of UAEP system. That is, the optimized operation conditions, such as electric field, vibration condition and extractor structure, could be designed to produce a highly efficient UAEP system. As to the measurements of micro thrust of UAEP system, more test results will be shown and analysis of measurement error will be added in the final version of this work.

Keywords: Ultrasonic-assisted Electric Propulsion (UAEP) system, Micro-thrust measurement platform, Capillary standing waves (CSWs), Numerical simulation.