#00257

HIGH PERFORMANCE RESISTOJET THRUSTER: STAR STATUS UPDATE

F. Romei [1], A. Grubisic [1], G. Dave [2].
[1]University of Southampton - Southampton (United kingdom), [2]Surrey Satellite Technology Ltd - Guildford (United kingdom).

Introduction

This paper presents performance testing and evaluation of the Super-high Temperature Additive Resistojet (STAR), the first additively manufactured breadboard model resistojet thruster with a novel design of heat exchanger. The attached image shows a radiograph of the thruster assembly prior testing performed at the University of Southampton. The thruster is characterized at both constant flow rate and constant pressure with argon and xenon, in both cold gas mode and at a range of electrical power inputs with current and voltage regulation.

Discussion

Presently, the primary driver of resistojet technology is a requirement for the all-electric propulsion spacecraft bus. Geostationary telecommunication satellites typically use chemical propulsion for attitude control as well as orbit–raising and station-keeping. The benefit of using a STAR thruster is in fuel load reduction, cost savings in launch vehicle option for lighter spacecraft and further reduction of integration and testing costs by eliminating the use of hazardous propellants. A second driver of the resistojet technology is the small Low Earth Orbit (LEO) platform. These satellites have limited resources, such as low volume and power budgets, therefore, they depend upon high propellant storage density – ISP product, and rely on inert propellants to lower assembly integration and testing (AIT) costs. The resulting propulsion system has low ISP, low total impulse and therefore limited on-orbit/deorbit capability. As a result, a low power STAR would meet both of these applications.

Conclusion

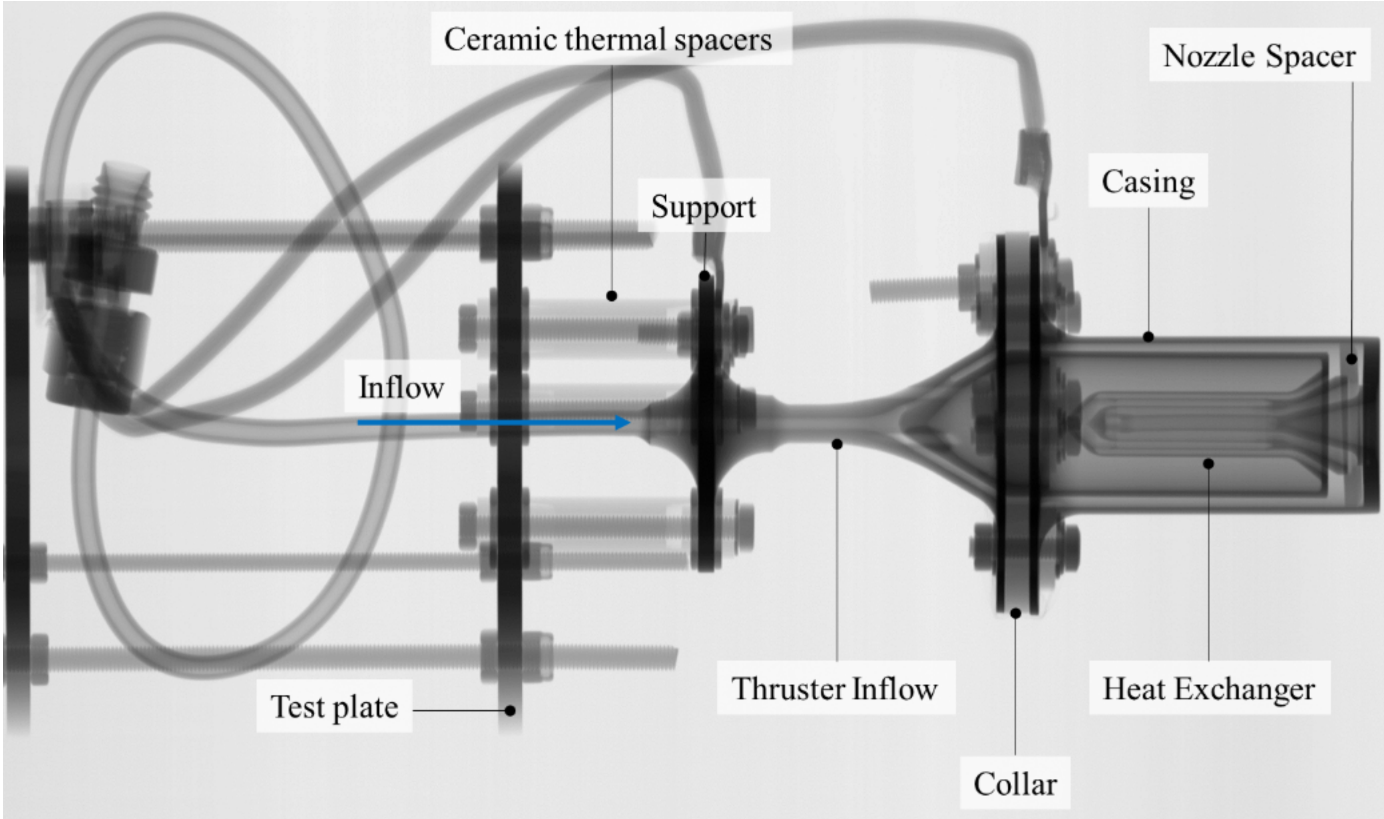
The STAR breadboard model was tested at the David Fearn Electric Propulsion Laboratory. This facility has a main test chamber 4m long by 2m diameter, pumped by two cryopumps, 3 turbo-molecular pumps and 2 backing pumps, maintaining less than 5.5×10^{-5} mbar up to 30 sccm xenon and with a base pressure of $< 9 \times 10^{-8}$ mbar. The test rig is placed in the small hatch of the chamber, which can be isolated from the test chamber using a gate valve. This allows rapid test set up and preparation. The test results presented in this paper are performed in the main test chamber. Thrust is directly measured with a Mettler-Toledo weighing module, with the resistojet mounted vertically. The 1/8" stainless steel inflow and the electrical terminal are fixed on a second aluminum configuration plate, to avoid their thermal effects on the thrust measurement. A Bronkhorst-based flow system provides either mass flow-controlled or pressure-controlled inflow to the thruster. A high-current DC power supply is used for current monitoring with voltage monitoring through oscilloscopes.

Bibliography

Romei, F., Grubišić, A., Gibbon, D. Manufacturing of a High-Temperature Resistojet Heat Exchanger by Selective Laser Melting. Acta Astronautica, Vol. 138, Sep. 2017, 356-368

Romei, F., Grubišić, A., Gibbon, D. Performance Testing and Evaluation of a High Temperature Xenon Resistojet Prototype Manufactured by Selective Laser Melting. 35th IEPC, Atlanta, Georgia, USA, Oct. 2017

Romei, F., Grubišić, A., Lasagna, D., Gibbon, D. Multiphysics Model Validation of Resistojets with Concentric Tubular Heat Exchanger. 7th EUCASS, Milan, Italy, Jul. 2017


Ceramic thermal spacers
Nozzle Spacer
Casing
Support
Inflow
Thruster Inflow
Heat Exchanger
Test plate
Collar