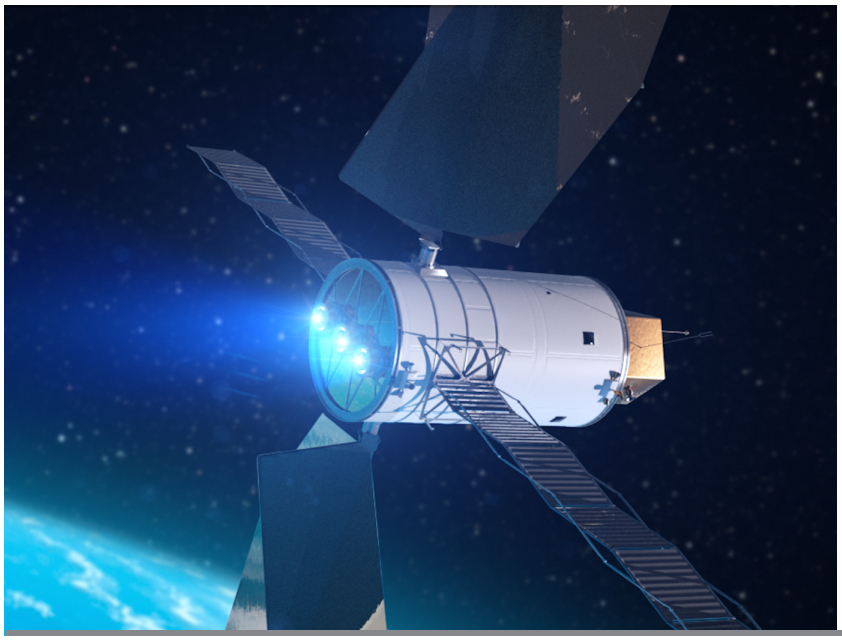


National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Propulsion

Anode Manifold Plug for Hall Effect Thrusters

Method of Manufacturing Precision Flow Restrictor Features

Innovators at NASA's Glenn Research Center have developed a suite of small spacecraft electric propulsion (SSEP) technologies critical to enabling new, ambitious missions into deep space. Advanced SSEP technologies are based on the use of exceptionally fuel-efficient electrostatic Hall effect thrusters with optimized magnetic shielding, achieving massive reductions in propellant mass relative to traditional chemical propulsion systems. NASA's low-power, high-throughput SSEP technology dramatically increases the capabilities of small spacecraft while maximizing reliability and reducing launch costs.

The Anode Manifold Plug for Hall Effect Thrusters technology is available for licensing on its own, or as a component of NASA's SSEP technology suite, which is available to U.S. companies through a no-cost, non-exclusive license agreement and companion Space Act Agreement. Click the LEW-TOPS-162: Small Spacecraft Electric Propulsion (SSEP) Technologies link in the Additional Information section for details.

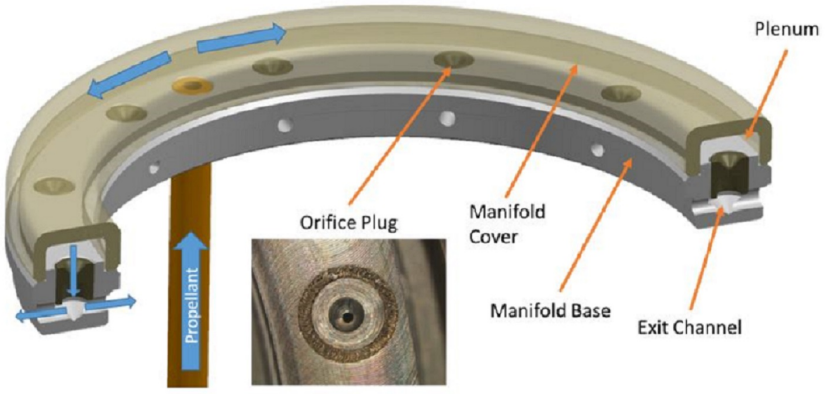
BENEFITS

- Provides better quality final products: access to additional methods of quality control that are potentially more accurate and can be used earlier in the fabricatiopn process to improve final anode assemblies
- Offers customizable anodes: allows the use of alternative manufacturing techniques to achieve the desired flow control performance
- Enables alternative methods of manufacture: this new flow restrictor plug method offers the ability to use materials for flow elements that might not traditionally be used in hall thruster anodes

THE TECHNOLOGY

Flow-restricting features in a Hall thruster anode manifold assembly, typically precision manufactured orifices, can contribute to significant flow non-uniformity if tolerances on the features are not properly controlled. Non-uniformity in flow distribution negatively impacts thruster performance. The anode assembly is usually a complex and expensive assembly to manufacture. Removing the flow restricting elements from the anode manifold structure in favor of modular insertable subcomponents (i.e., plugs) enables the use of more reliable and repeatable precision manufacturing techniques. The resulting components can be tested, characterized, and sorted for acceptance before being installed into the larger anode assembly (i.e., quality control can be performed at the subcomponent level). This may lead to increased performance and yield rate of the final assembly.

The flow restrictor plugs can be made in many different ways. The most basic flow restrictor takes the form of a precision hole machined into a cylinder, where the cylinder is then press fit into a hole drilled into the anode base. Alternate embodiments of the flow restrictor include precision machined nozzles, laminar flow elements, or sintered porous metal elements. The flow restrictor can also be made from a different material than the anode base, such as a precision ruby orifice contained in a metal carrier which is installed in a metal anode base. The plugs can be installed in a variety of ways, all of which create hermetic seals. Installation can include a press fit relying on plastic deformation or threading the plug component into the anode base. Welding on the top surface of the anode base can also be done to provide a robust hermetic seal.



A preferred embodiment of an anode manifold is shown, including laser welded orifice plugs. Orifice plugs may be fabricated from a wide range of materials (for example sintered porous material) and evaluated prior to insertion in the anode assembly, ensuring final anode assemblies provide uniform propellant delivery.

APPLICATIONS

The technology has several potential applications:

- Aerospace: anode manifold assemblies for Hall effect thrusters applicable to both low and higher power thrusters
- Commercial space: small satellite constellations, station keeping, orbit raising, spacecraft servicing, missions beyond Low Earth Orbit/ Geosynchronous Equatorial Orbit

PUBLICATIONS

Patent Pending

LEW-TOPS-162: Small Spacecraft Electric Propulsion (SSEP) Technology Suite

Development of a High-Propellant Throughput Small Spacecraft Electric Propulsion System to Enable Lower Cost NASA Science Missions, Benavides, Gabriel F., et al, August 19, 2019 https://ntrs.nasa.gov/citations/20190030739

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

LEW-19799-1, LEW-TOPS-159

More Information

National Aeronautics and Space Administration

Agency Licensing Concierge

Glenn Research Center

21000 Brookpark Road
Cleveland, OH 44135
202-358-7432
Agency-Patent-Licensing@mail.nasa.gov

www.nasa.gov

NP-2020-03-2828-HQ