MICRO AEROSPACE SOLUTIONS, INC.

- Propulsion System Engineering
- Small Spacecraft Engineering
- Computer Data Systems
- Aerospace Software

Micro Aerospace Solutions' Nanosatellite Propulsion System Development

Micro Aerospace Solutions, Inc. (MAS) of Melbourne, Florida is developing propulsion system technology for nanosatellite applications. Thrusters developed in this effort can be used for attitude control for nanosatellites or for very fine pointing control for slightly larger spacecraft. The higher thrust thrusters can also be used for nanosatellite main propulsion, fine pointing control and small launch vehicle roll control.

A thruster modules are available comprised of a microthruster producing 0.050 N (50 milli-Newtons) thrust, an elastomeric-diaphragm tank, micro-solenoid valves, filters and tubing. The unit is designed for either hydrogen peroxide or hydrazine monopropellant usage. Tables 1 and 2 summarizes some of the thrusters. Potential future development could include a HAN (hydroxyl ammonium nitrate)-based propellant system. Tridyne (a mixture of nitrogen, hydrogen, and oxygen gas) thrusters have also been developed. These have the advantage of cold gas safety and performance comparable to hydrogen peroxide. This provides a safe, non-toxic propulsive alternative for cubesats and other nanosatellites.

The catalyst is a vital part of a monopropellant thruster and MAS has designed a unique catalyst for the hydrogen peroxide thrusters. In most monopropellant systems a bed of catalytic pellets is supported by screens. That arrangement has a tendency to degrade in performance over time and the pellets will often crack and blow through the retaining screen and is too big for a microthruster. We use an innovative metal gauze catalyst design which offers increased system performance and lifetime. Other microthrusters have had difficulty maintaining proper decomposition of the propellant in the chamber, but our system has operated for over 500,000 pulses with proper decomposition.

Hydrogen Peroxide Monopropellant Thrusters

	M010HP	**M050HP**	**M100HP**
Thrust (N)	0.1	0.5	1.0
Isp (sec.)	110	120	120
Inlet Pressure (Pa)	350000	350000	350000
Minimum Impulse bit (N-sec.)	9 x10^{-4}	4 x10^{-3}	8.5 x10^{-3}
Weight (grams)	11	15	20
Exit Diameter (mm)	5	6.35	7.6
Pulse life	>500,000	>500,000	>500,000
Power Steady (W)	0.5	1.0	2.0

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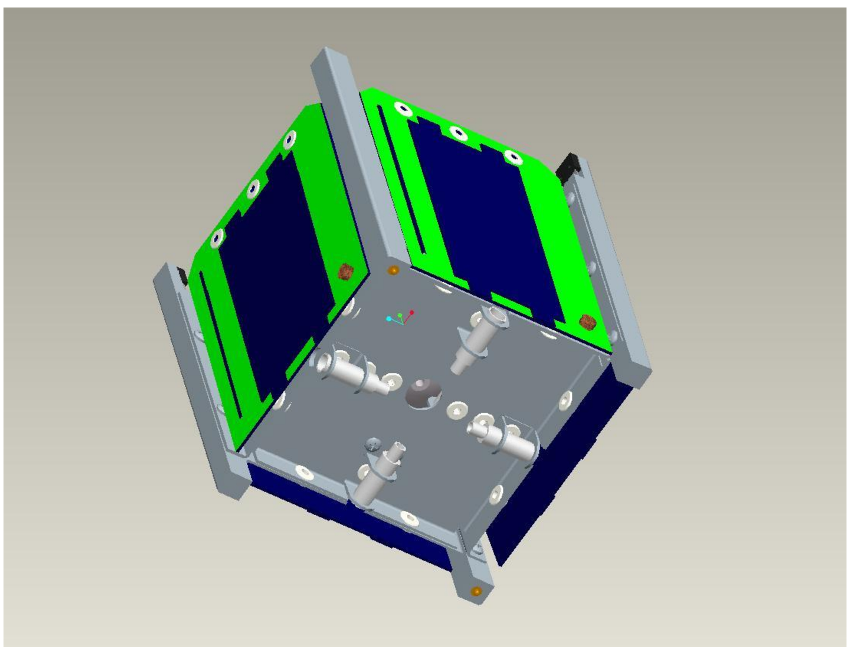
Hydrazine Thrusters

	M005	M010	M050	M100
Thrust (N)	0.005	0.05	0.5	1.0
Isp (sec.)	150	160	170	200
Inlet Pressure (Pa)	350000	350000	350000	350000
Minimum Impulse bit (N-sec.)	1.7×10^{-4}	6×10^{-3}	3×10^{-2}	3×10^{-2}
Weight (grams)	10	12	15	30
Exit Diameter (mm)	3.81	4.45	8.9	8.9
Pulse life	>100,000	>100,000	>100,000	>100,000
Power (W)	0.5	0.5	1.0	2.0

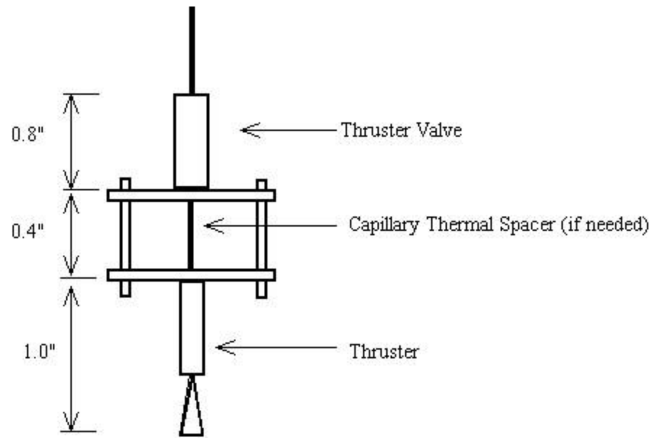
Micro Aerospace Solutions' Microthruster System

We have demonstrated a complete thruster system that fits well within the body of a 10 cm cube cubesat configuration. This system uses a positive expulsion blowdown system to feed hydrogen peroxide to four thrusters around the base of the vehicle. The image below shows the system.



A Cubesat with 4 Microthrusters

We can tailor the thruster configuration to vehicle design requirements as well as plumbing and tank arrangements. We have been working on multifunctional structures that use smallsat structural walls as propellant tanks and to house valving and plumbing to save space. Below is a typical dimensional diagram which can be customizable.



0.050N Thruster Dimensions

Other Propulsion System Development

We are always interested in evaluating new and promising propulsion systems and work with universities and other research organizations to evaluate these technologies.

MAS has years of gel-based propulsion system development experience. A gel propellant system offers a microspacecraft propulsion module with lower mass and volume yet the same performance as a solid motor (Isp currently of a solid is approximately 290 seconds). It is also safer since it is not susceptible to electrostatic discharge or leakage. It is safe and versatile to fit the delta-v requirements of many different microspacecraft missions. It is more efficient than hybrid propulsion modules since it does not suffer from a change from optimum mixture ratio as it is throttled or variations in propellant burn rate.

The gel-propellant makes it possible to use the addition of inert gels to permit programming of the oxidizer and fuel. A single pressurization system can be incorporated with the novelty of pressurizing both components in one tank, decreasing both system mass and volume. This project characterized gel-propellants and provided a recommendation for a propellant combination.

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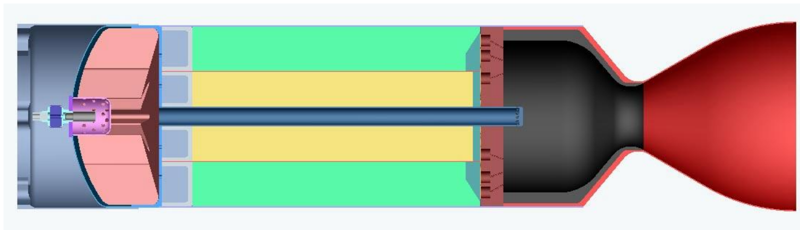

An Example Gel Propellant System Showing Concentric Propellant Tanks and a Piston Expulsion System Driven by a Gas Generator

Some missions require the higher performance of a bi-propellant propulsion system. We have used our experience with hydrogen peroxide propulsion systems to create a bi-propellant hydrogen peroxide-kerosene engine system. This unit can operate at 150 pounds of thrust in bi-prop mode using the heat of decomposition of hydrogen peroxide to autoignite kerosene injected into the chamber. The system can also operate in monoprop mode as a simple hydrogen peroxide thruster. Beside this configuration MAS is completing testing of a 14,400N bi-prop hydrogen peroxide/kerosene system.

Micro Aerospace Solutions has experience with various forms of spacecraft propulsion including cold gas systems, monopropellants, bi-propellants and gel systems. We are a small company with rapid response to customer needs and low-cost but effective solutions. Please contact us for more information.

Tridyne or cold gas 1N thruster triad(left) Testing a biprop 50lbf thruster (right)

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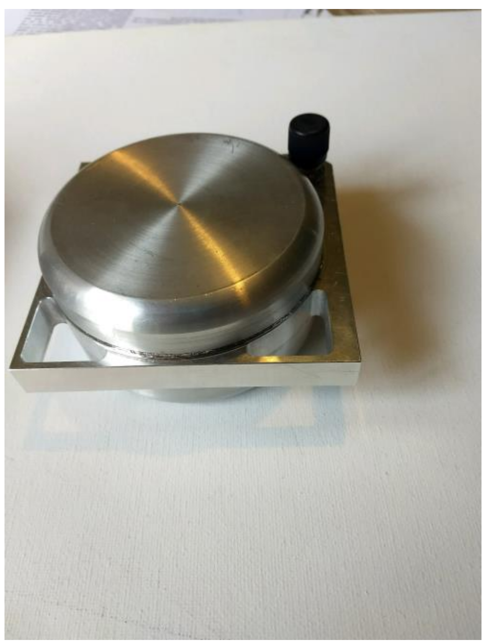
Below are several pictures of cubesat cold-gas or tridyne thruster systems we have built. The first picture shows a three axis 0.5N cold gas or tridyne thruster system. These thrusters can be reconfigured as needed for axial or divert maneuvers.

Cubesat tridyne/cold gas thruster triad system



Cubesat propellant gas tank (98 x 98 x 50 mm)

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MAS-developed Small launch vehicle roll control system with integrated tridyne thrusters, inertial sensor system and GPS receiver. This unit can provide roll control or other orientation and navigation control options for small launch vehicles