Completed Project (2012 - 2015)

Advanced In-Space Propulsion (AISP): Micro Electrospray Propulsion (MEP) Project

Game Changing Development Program | Space Technology Mission Directorate (STMD)

ANTICIPATED BENEFITS

To NASA funded missions:

•MEP modules have the potential to be 4X more efficient in terms of thrust to power (T/P) •Microfabricated components, microfluidic flow control and microelectronics enable >10X improvement in thrust range, mass, volume and cost over SOA

DETAILED DESCRIPTION

Propulsion technology is often critical for space missions. High-value missions could be done with very small spacecraft, even CubeSats, but these nanosatellites currently have little propulsion capability. After CubeSats are deployed, they usually just tumble or drift away from the transport spacecraft. They cannot transfer to higher value orbits, maintain their orbit, or even deorbit. Larger spacecraft would benefit from highprecision attitude-control systems to maintain the desired orbit and point in the desired direction. Existing attitude-control systems, like reaction wheels, are very complex and may have insufficient lifetimes. NASA is investing in Microfluidic Electrospray Propulsion (MEP) thrusters to provide the new propulsion capabilities to address both of these mission needs. Chemical propulsion systems are limited to the combustion energy available in the chemical bonds of the fuel and the acceleration provided by a converging-diverging nozzle. Electric propulsion uses electric power to accelerate propellant to very high exhaust velocities—up to 10 times greater than for chemical propulsion. This increases the momentum transfer efficiency or the fuel economy. The propellant efficiency of thrusters, which is proportional to the exhaust velocity, is referred to as the "specific impulse," or ISP, measured in seconds. The state of the art for CubeSats is cold gas propulsion with an ISP of 50 to 80 s. The chemical propulsion main engine for the space shuttles demonstrated an ISP of 450 s. However, the target ISP for MEP systems is greater than 1500

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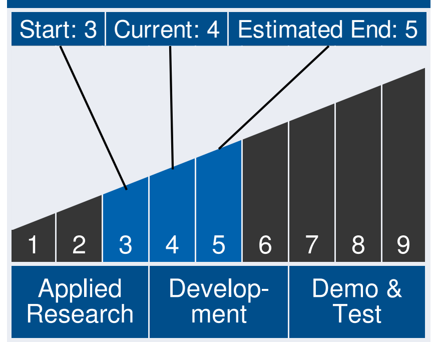
Technology Maturity



Management Team

Program Executive:

- Lanetra Tate

Program Manager:

- Mary Wusk

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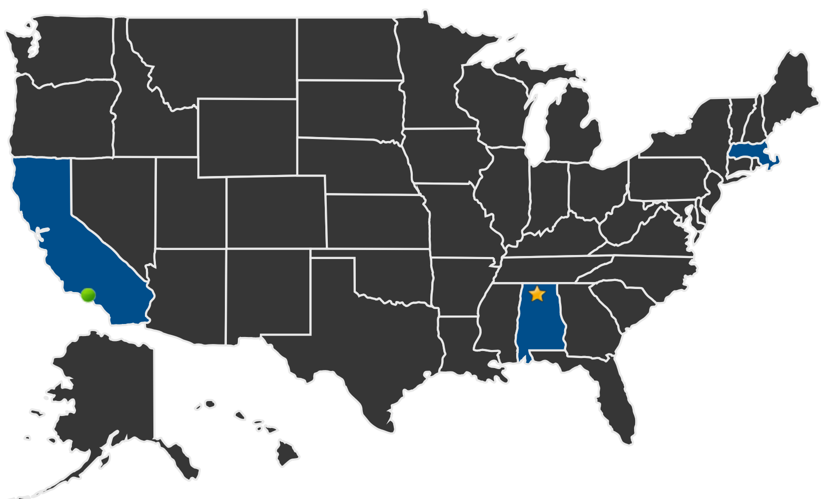
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Marshall Space Flight Center

Supporting Centers:

- Jet Propulsion Laboratory

Other Organizations Performing Work:

- Busek Company, Inc. (Natick, MA)
- Massachusetts Institute of Technology

Management Team *(cont.)*

Project Manager:

- Timothy Smith

Principal Investigator:

- Charles Taylor

Co-Investigator:

- John Dankanich

Technology Areas

Primary Technology Area:
In-Space Propulsion Technologies (TA 2)
└─ Non-Chemical Propulsion (TA 2.2)
  └─ Electric Propulsion (TA 2.2.1)
    └─ Electrospray Propulsion (TA 2.2.1.5)

DETAILS FOR TECHNOLOGY 1

Technology Title

Advanced In-Space Propulsion: Micro Electrospray Propulsion (MEP)

Technology Description

This technology is categorized as a hardware assembly for unmanned spaceflight

Chemical propulsion systems are limited to the combustion energy available in the chemical bonds of the fuel and the acceleration provided by a converging-diverging nozzle. Electric propulsion uses electric power to accelerate propellant to very high exhaust velocities—up to 10 times greater than for chemical propulsion. This increases the momentum transfer efficiency or the fuel economy. The propellant efficiency of thrusters, which is proportional to the exhaust velocity, is referred to as the "specific impulse," or I_{SP}, measured in seconds. The state of the art for CubeSats is cold gas propulsion with an I_{SP} of 50 to 80 s. The chemical propulsion main engine for the space shuttles demonstrated an I_{SP} of 450 s. However, the target I_{SP} for MEP systems is greater than 1500 s—enough to transfer a 1-kg 10-cm cube from low Earth orbit to interplanetary space with only 200 g of propellant.

Capabilities Provided

Radically change propulsion capabilities for very small satellites as well as offering a low mass and power alternative for attitude control systems for larger satellites. MEP could replace attitude control systems and reaction wheels on large spacecraft resulting in a mass savings and increase to mission reliability. This technology can also enable other game changing propulsion capabilities for micro-scale to very large deployable spacecraft structures.

Potential Applications

Small spacecraft (of particular interest are 3U-6U spacecraft) or precision thrust on larger satellites (of particular interest are space telescopes)