Active Project (2014 - 2015)

LOx / LCH4: A Unifying Technology for Future Exploration Project

Center Innovation Fund: JSC CIF (Also Includes JSC IRAD) Program | Space Technology Mission Directorate (STMD)

ABSTRACT

Reduced mass due to increasing commonality between spacecraft subsystems such as power and propulsion have been identified as critical to enabling human missions to Mars. This project represents the first ever integrated propulsion and power system testing and lays the foundations for future sounding rocket flight testing, which will yield the first in-space ignition of a LOx / LCH_4 rocket engine.

ANTICIPATED BENEFITS

To NASA unfunded & planned missions:

The Human Mars Design Reference Architecture (DRA 5.0) study shows insitu-resource utilization (ISRU) and liquid oxygen / liquid methane (LOx / LCH_4) as enabling technologies for human-scale Mars missions. Due to the very high cost of getting mass to Mars, it is critical that spacecraft components be mass and volume efficient. A spacecraft design which emphasizes a highly integrated architecture, with a reduced number of fluids across spacecraft subsystems, stored in common tankage, and sharing common components and processes has the potential to result in a smaller, lower mass, operationally flexible spacecraft, with reduced design, development, testing and operational costs. This project takes the initial steps towards demonstrating this integrated architecture with focus on propulsion and power operated from LOx / LCH_4 commodities.

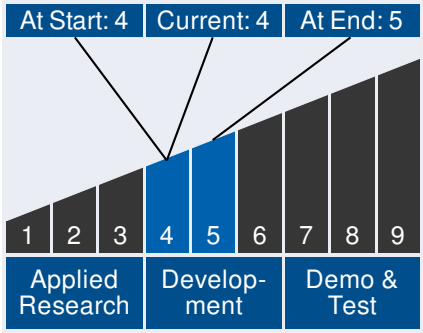
To other government agencies:

Green propellants, such as liquid oxygen / liquid methane, offer a safer, lower-cost, higher performance option for in-space propulsion when compared to traditional propellants such as nitrogen tetroxide / monomethylhydrazine (NTO / MMH). These savings could benefit various Department of Defense (DoD) spacecraft applications.

Table of Contents

Abstract 1
Anticipated Benefits 1
Technology Maturity 1
Detailed Description 2
Management Team 2
Technology Areas 2
U.S. Locations Working on this Project 3
Image Gallery 4
Details for Technology 1 5

Technology Maturity



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Furthermore, Solid-Oxide Fuel Cell (SOFC) technologies enable high-density, portable power options which do not rely on high purity reactants. SOFCs have applications in DoD systems as well as in the commercial transportation industry (Department of Transportation).

To the commercial space industry:

Green propellants such as liquid oxygen / liquid methane propulsion technologies offer a safer, lower-cost, higher performance option for in-space propulsion when compared to traditional propellants such as nitrogen tetroxide / monomethylhydrazine (NTO / MMH). These savings could benefit various commercial launch (upper-stage) and satellite applications.

Furthermore, Solid-Oxide Fuel Cell (SOFC) technologies enable high-density, portable power options which do not rely on high purity reactants. SOFCs have applications in the commercial transportation industry, where they are being used as the both primary and secondary power sources for automobiles / commercial trucks.

To the nation:

Developing technologies which enable safer, lower cost human space exploration ensures the United States remains the world leader in space.

DETAILED DESCRIPTION

A brass-board liquid oxygen / liquid methane (LOx / LCH4) pressure fed propulsion subsystem sized to eventually fit on a sounding rocket will be developed and tested. The subsystem will feature active helium re-pressurization and integrated main engine and reaction control systems (RCS). Concurrently, a brass-board fuel cell power system will be developed and tested. The power system features a Solid-Oxide Fuel Cell (SOFC)

Management Team

Program Director:
- John Falker

Program Executive:
- Douglas Terrier

Program Manager:
- Ronald G Clayton

Project Manager:
- Brian Banker

Principal Investigator:
- Brian Banker

Co-Investigator:
- Abigail Ryan

Technology Areas

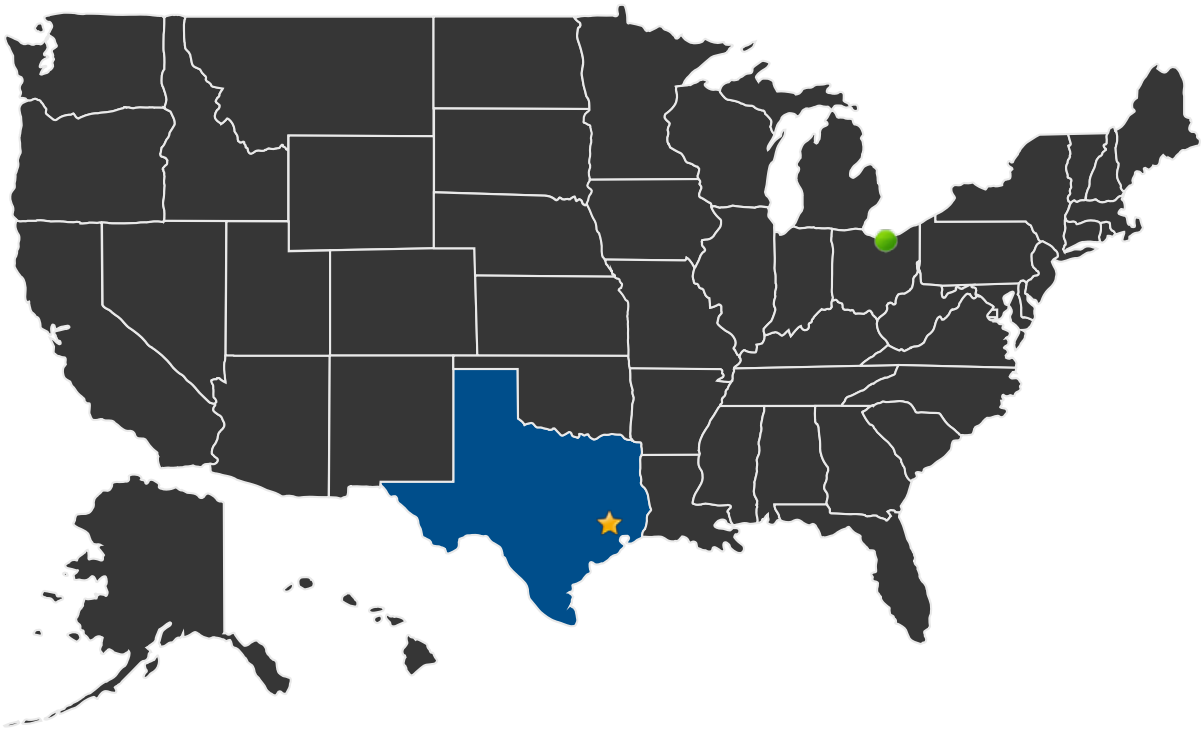
Secondary Technology Area:
In-Space Propulsion Technologies (TA 2)

Other Technology Areas:
- Space Power and Energy Storage (TA 3)

manufactured by Delphi capable of producing 1 kW of power from Oxygen and Methane reactants.

Once characterization testing of the propulsion and power subsystems is complete, the subsystems will be integrated and further testing will be performed. LOx / LCH_4 stored cryogenically in the propulsion subsystem propellant tanks will be used by the SOFC subsystem to produce power which will be used to operate valves, sensors, etc. on the propulsion system. A flight-like firing profile will be performed featuring both main and RCS engines to provide a space-power profile to the SOFC.

U.S. LOCATIONS WORKING ON THIS PROJECT



U.S. States With Work

Lead Center:
Johnson Space Center

Supporting Centers:

- Glenn Research Center

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Contributing Partners:

- Delphi

IMAGE GALLERY

1 kW SOFC to be used in testing

LOx / LCH4 Rocket Engine similar to that which will be used to simulate the main engine in the propulsion subsystem

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DETAILS FOR TECHNOLOGY 1

Technology Title

Integrated Spacecraft Power & Propulsion

Technology Description

This technology is categorized as an architecture for manned spaceflight

Utilizing common commodities across spacecraft subsystems (power & propulsion), stored in common tankage, sharing common components and processes. Power and propulsion subsystems are traditionally separated having no system/component commonality.

Capabilities Provided

Common tankage, components, and processes across spacecraft subsystems could result in lower volume, lower mass spacecraft which lowers the design, development, testing and operational costs associated with space exploration, especially of Mars.

Potential Applications

Mars exploration spacecraft (human and robotic).