Low-Cost, High-Performance Combustion Chamber

For use with cryogenic liquid oxygen/methane (LOX/CH_4) propellant

Ultramet designed and fabricated a lightweight, high-temperature combustion chamber for use with cryogenic LOX/CH_4 propellants that can deliver a specific impulse of ~355 seconds. This increase over the current 320-second baseline of nitrogen tetroxide/monomethylhydrazine (NTO/MMH) will result in a propellant mass decrease of 55 lb_m for a typical lunar mission. The material system was based on Ultramet's proven oxide-iridium/rhenium architecture, which has been hot-fire tested with stoichiometric oxygen/hydrogen for hours. Instead of rhenium, however, the structural material was a niobium or tantalum alloy that has excellent yield strength at both ambient and elevated temperatures.

Phase I demonstrated alloys with yield strength-to-weight ratios more than three times that of rhenium, which will significantly reduce chamber weight. The starting materials were also two orders of magnitude less expensive than rhenium and were less expensive than the C103 niobium alloy commonly used in low-performance engines.

Phase II focused on the design, fabrication, and hot-fire testing of a 12-lb_f thrust class chamber with LOX/CH_4, and a 100-lb_f chamber for LOX/CH_4. A 5-lb_f chamber for NTO/MMH also was designed and fabricated.

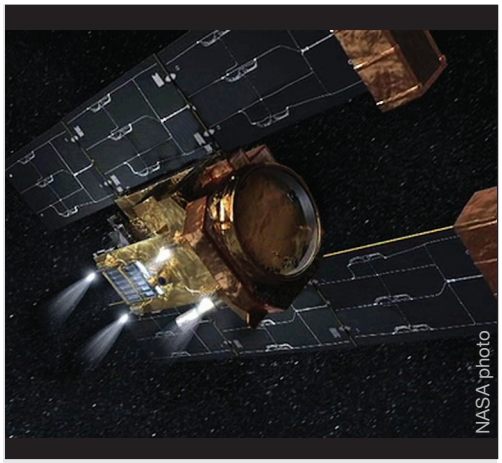
Applications

NASA

- Reaction control systems for lunar or Martian ascent/descent vehicles
- Lunar or Martian sample return vehicles
- Main engines for interplanetary spacecraft and spacecraft being placed into geostationary orbit
- Apogee topping engines and attitude control systems for Earth-orbiting satellites
- Launch vehicles for attitude control

Commercial

- Apogee topping engines for commercial satellites
- Attitude control thrusters for launch vehicles
- Primary propulsion as well as divert and attitude control system functions for ballistic missile defense and tactical missiles
- Drop-in replacements for iridium/rhenium engines currently being manufactured and flown



Phase II Objectives

- Optimize the alloy composition and deposition conditions and perform extensive mechanical characterization of the resulting alloys
- Design and fabricate a flight-weight 12-lb_f combustion chamber for hot-fire testing
- Perform hot-fire testing of the 12-lb_f chamber with LOX/CH_4
- Design and fabricate a high-performance 100-lb_f combustion chamber for use with LOX/CH_4
- Design and fabricate a 5-lb_f chamber for use with NTO/MMH

Benefits

- Reduces combustion chamber weight
- Lowers costs of materials
- Increases yield strength at ambient and elevated temperatures

Firm Contact

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