Fine Grained Tungsten Claddings for Cermet Based NTP Systems, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

In October 2011, NASA initiated the Nuclear Cryogenic Propulsion Stage (NCPS) program to evaluate the feasibility and affordability of Nuclear Thermal Propulsion (NTP). A critical aspect of the program is to develop a robust, stable nuclear fuel. One of the nuclear fuel configurations currently being evaluated is a cermet-based material comprised of uranium dioxide (UO2) particles encased in a tungsten matrix (W). To prevent excessive fuel loss from reaction with the hot hydrogen gas and uranium hydride formation, dense, fine-grained tungsten claddings are needed. Recently, advanced additive manufacturing techniques (EL-Form and Vacuum Plasma Spray Forming) have been developed that enable the deposition of coatings and near-net-shape refractory metal components with high density and tailored microstructures. The Phase I investigation produced fine-grained W claddings using EL-Form and VPS processing techniques. Testing showed the W claddings were well bonded to surrogate nuclear fuel element materials, and the W claddings were vacuum tight. During Phase II, the techniques developed during Phase I will be optimized, and W claddings on full size cermet fuel elements will be developed and characterized. Subscale and full-size test articles will be produced and delivered to NASA-MSFC for hot hydrogen testing in the Compact Fuel Element Environment Test (CFEET) facility and the Nuclear Thermal Rocket Element Environment Simulator (NTREES).

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: NASA applications that would directly benefit from this technology include Nuclear Thermal Propulsion (NTP) and Nuclear Electric Propulsion (NEP). Space nuclear power and propulsion are game changing technologies for space exploration. Initial NTP systems will have specific impulses roughly twice that of the best chemical

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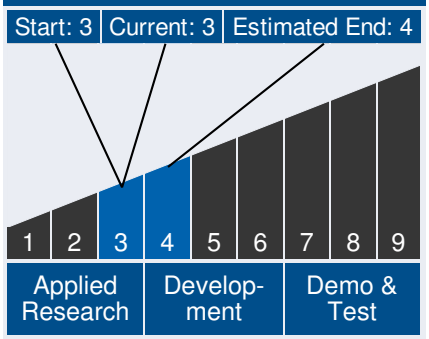
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

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systems, i.e., reduced propellant requirements and/or reduced trip time. Currently, NASA's Nuclear Cryogenic Propulsion Stage (NCPS) project is working to demonstrate the viability and affordability of NTP. The proposed Phase II effort would greatly assist NASA with achieving the goals of the NCPS project. Potential NASA missions include rapid robotic exploration missions throughout the solar system and piloted missions to Mars and other destinations such as near earth asteroids.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Both government and commercial entities in the following sectors use advanced high-temperature materials for the following applications: coatings, defense, material R&D, nuclear power, aerospace, propulsion, automotive, electronics, crystal growth, and medical. Targeted commercial applications include net-shape fabrication of refractory rocket nozzles, crucibles, heat pipes, fuel rods, and propulsion subcomponents; and advanced coating systems for x-ray targets, sputtering targets, turbines, and rocket engines.

Management Team *(cont.)*

Project Manager:

- Jeramie Broadway

Principal Investigator:

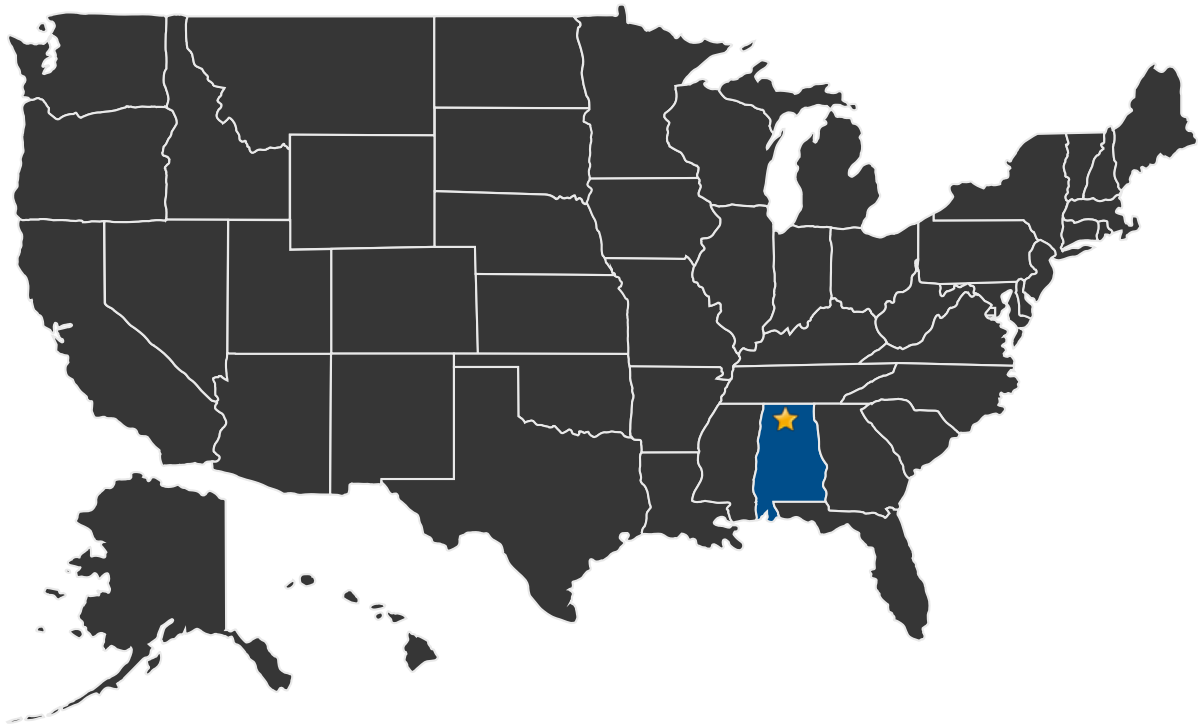
- John Scott O'Dell

Technology Areas

Primary Technology Area:

In-Space Propulsion Technologies (TA 2)
└ Non-Chemical Propulsion (TA 2.2)
  └ Thermal Propulsion (TA 2.2.3)
    └ Nuclear Thermal Propulsion (NTP) (TA 2.2.3.2)

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Marshall Space Flight Center

Other Organizations Performing Work:

- Plasma Processes, LLC (Huntsville, AL)
- Plasma Processes, LLC. (Huntsville, AL)

PROJECT LIBRARY

Additional Images

- Briefing Chart Image
  - (This image is a .tif file. Please visit http://techport.nasa.gov:80/file/21970 to download this image to view it.)

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23092)

DETAILS FOR TECHNOLOGY 1

Technology Title

Fine Grained Tungsten Claddings for Cermet Based NTP Systems

Potential Applications

NASA applications that would directly benefit from this technology include Nuclear Thermal Propulsion (NTP) and Nuclear Electric Propulsion (NEP). Space nuclear power and propulsion are game changing technologies for space exploration. Initial NTP systems will have specific impulses roughly twice that of the best chemical systems, i.e., reduced propellant requirements and/or reduced trip time. Currently, NASA's Nuclear Cryogenic Propulsion Stage (NCPS) project is working to demonstrate the viability and affordability of NTP. The proposed Phase II effort would greatly assist NASA with achieving the goals of the NCPS project. Potential NASA missions include rapid robotic exploration missions throughout the solar system and piloted missions to Mars and other destinations such as near earth asteroids.