Small Business Innovation Research/Small Business Tech Transfer

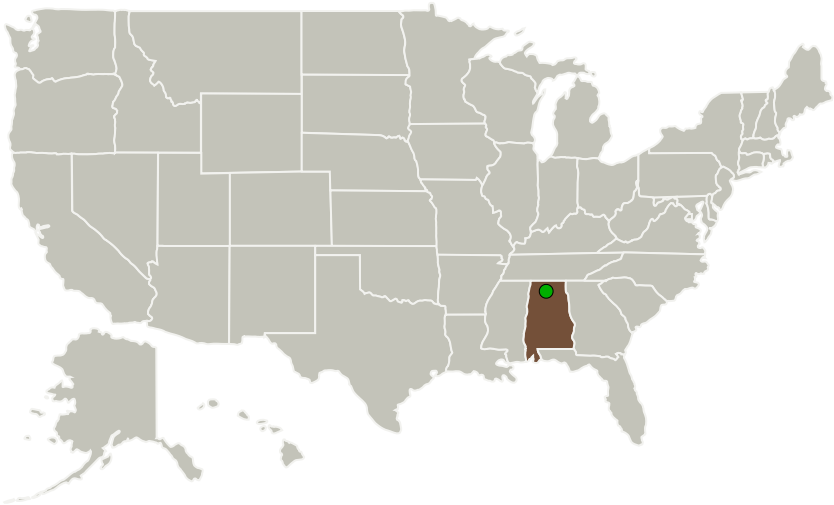
Advanced Zirconium Carbide Tie-Tubes for NTP, Phase I

Completed Technology Project (2015 - 2015)

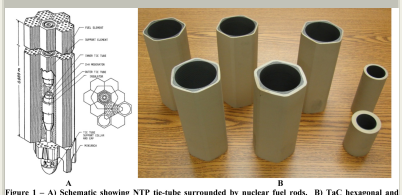
Project Introduction

Nuclear Thermal Propulsion (NTP) has been identified as a critical technology needed for human missions to Mars due to its increased specific impulse (Isp) as compared to traditional chemical propulsion systems. To achieve this high Isp, NTP reactors must operate at extremely high temperatures (i.e., >2400K) for long periods of time. However, many of the best materials for some reactor components (i.e., support rods, control drums, and the reflector) cannot operate at these high temperatures. Therefore, high temperature insulators that are chemically inert, neutronically acceptable, and structurally stable are desired. The Rover and Nuclear Engine for Rocket Vehicle Application (NERVA) program identified zirconium carbide (ZrC) as a leading candidate for NTP insulator materials. However, the inherent brittleness and high melting temperature of ZrC make fabrication of complex components such as long, hexagonal tie-tubes extremely difficult. Recently, advanced Vacuum Plasma Spray (VPS) forming techniques have been developed for producing near-net-shape components from Ultra High Temperature Ceramic (UHTC) materials such as tantalum carbide (TaC) and hafnium carbide (HfC). Building on this success, advanced VPS processing techniques will be developed for producing long, hexagonal ZrC based tie-tube support rods for NTP.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama



A B

Figure 1 – A) Schematic showing NTP tie-tube surrounded by nuclear fuel rods. B) TaC hexagonal and cylindrical tubes produced by Vacuum Plasma Spray (VPS) forming.

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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Primary U.S. Work Locations

Alabama

Project Transitions

June 2015: Project Start

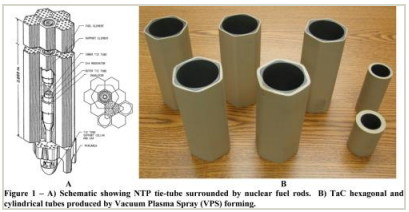
December 2015: Closed out

Closeout Summary: Advanced Zirconium Carbide Tie-Tubes for NTP, Phase I P roject Image

Closeout Documentation:

- Final Summary Chart Image*(https://techport.nasa.gov/file/138802)*

Images



Briefing Chart Image
Advanced Zirconium Carbide Tie-Tubes for NTP, Phase I *(https://techport.nasa.gov/image/136065)*

Project Management

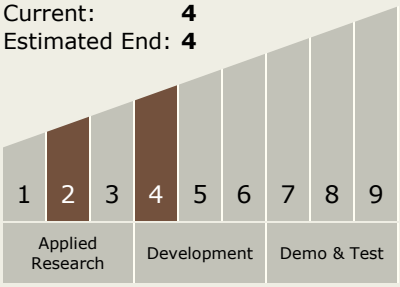
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
John Scott S O'dell

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX01 Propulsion Systems
  └ TX01.4 Advanced Propulsion
    └ TX01.4.3 Nuclear Thermal Propulsion

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System