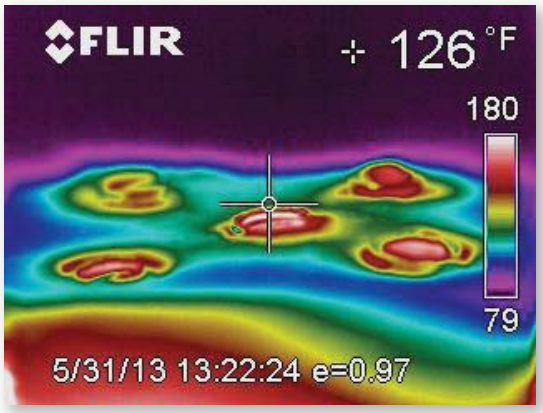
Novel Material Systems And Methodologies For Transient Thermal Management Project

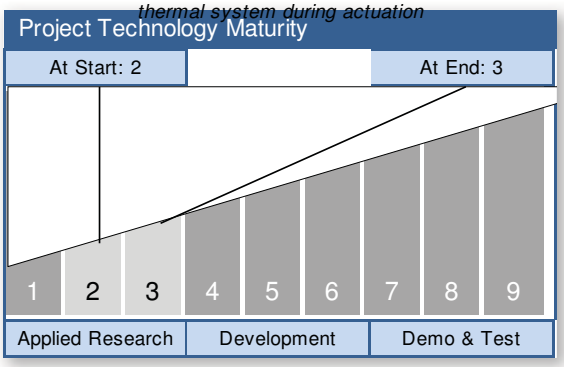
Center Innovation Fund: KSC CIF Program

Space Technology Mission Directorate (STMD)

National Aeronautics and Space Administration



Thermal Infrared (IR) image of Shape memory alloy (SMA) thermal system during actuation



ABSTRACT

Development of multifunctional and thermally switchable systems to address reduced mass and components, and tailored for both structural and transient thermal applications. Active, passive, and novel combinations of the two functional approaches are being developed along two lines of research investigation: switchable systems and transient heat spreading. The approach is to build in thermal functionality to structural elements to lay the foundation for a revolution in the way high energy space systems are designed.
Read more on the last page.

Technology Area: Launch Propulsion Systems TA01 (Primary)
Human Exploration Destination Systems TA07 (Secondary)

ANTICIPATED BENEFITS

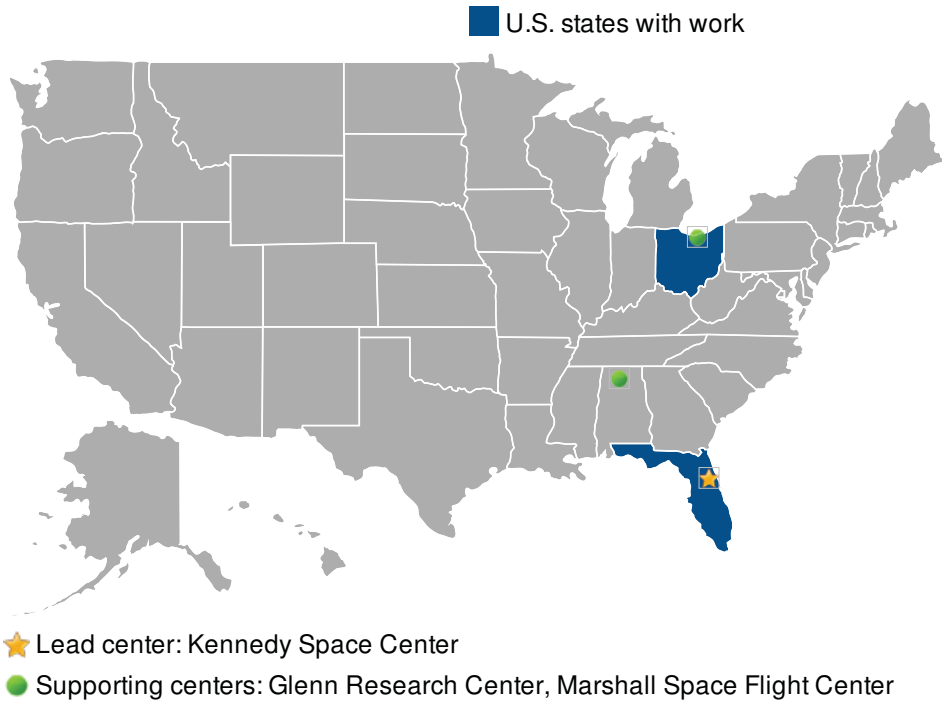
To NASA funded missions:

The benefits to NASA include the following: increased controllability, reduction in energy and power usage, improved thermal management controls, reduced turnaround time, increased system availability, a potential for 50% reduction in cryogenic loading time and reduction in commodity boil-off & helium usage.

To NASA unfunded & planned missions:

This concept is expected to translate to game changing approaches for NASA's ...

Read more on the last page.



MANAGEMENT

Program Executive:
Burton Summerfield

Program Manager:
Nancy Zeitlin

Project Manager:
Nancy Zeitlin

Principal Investigator:
Martha Williams

DETAILED DESCRIPTION

The research team plans a fully collaborative approach with NASA, the University of Central Florida and Embry Riddle Aeronautical University, and a global research commercial partner on the development and application of novel materials. Information gained in this study will be leveraged to propose future funding to advance the TRL for extreme conditions applications.

The three materials research tasks and associated partners that were explored during this project are summarized as follows:

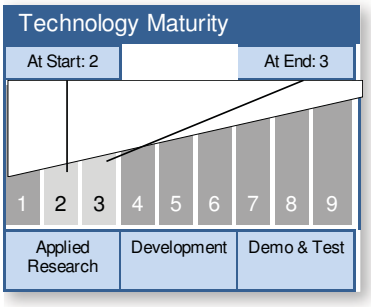
A. Two-way Shape Memory Alloys systems with University of Central Florida and NASA Glenn Research Center (GRC)

B. Gradient Cellular solids with Embry Riddle Aeronautical University

C. Tunable composites/laminates with NASA-GRC

TECHNOLOGY DETAILS

Novel Material Systems and Methodologies for Transient Thermal Management



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This technology is categorized as a material for other applications

- Technology Area
  - TA01 Launch Propulsion Systems (Primary)
  - TA07 Human Exploration Destination Systems (Secondary)
  - TA02 In-Space Propulsion Technologies (Additional)
  - TA12 Materials, Structures, Mechanical Systems & Manufacturing (Additional)
  - TA13 Ground & Launch Systems Processing (Additional)
  - TA14 Thermal Management Systems (Additional)

CAPABILITIES PROVIDED

Current architectures require multiple systems and processes to perform different activities. This technology is enabling for multi-functionality in thermal and mechanical capabilities and can be tuned by the design of the material systems architecture. Significant knowledge can be gained in understanding material systems performance under transient temperature modes and how designs can be improved to decrease energy usage and losses.

The development of novel experimental approaches/methodologies capabilities for measuring transient thermal responses and heat loads was also carried out. The methodologies are basic and fundamental to understanding thermal management systems performance under actual-use conditions.

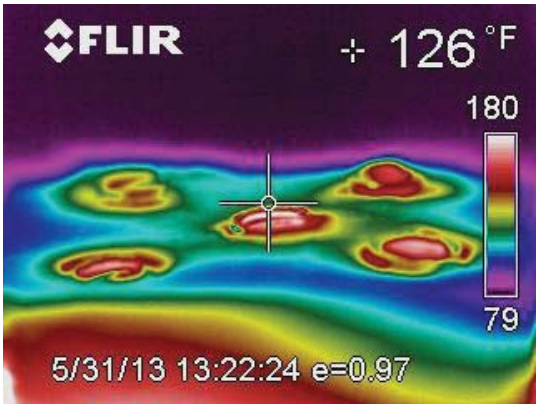
This concept is expected to translate to game changing approaches for NASA's exploration and habitations ...

TECHNOLOGY DETAILS

POTENTIAL APPLICATIONS (CONT'D)

missions, significant reduction in life cycle costs, decreased energy and power consumption, while increasing safety and reliability. The potential industrial and even consumer applications are numerous. Key to proving out any application is understanding the thermal performance of the total system along with the thermal characterization of the constituent materials under relevant conditions. Thus, methodologies, from thermophysical test apparatus to systems analysis to engineering data for design, is an essential part of this innovation research work in the area of intelligent or tunable thermal materials.

IMAGE GALLERY



Thermal Infrared (IR) image of Shape memory alloy (SMA) thermal system during actuation

ABSTRACT (CONTINUED FROM PAGE 1)

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ANTICIPATED BENEFITS

To NASA unfunded & planned missions: (CONT'D)

exploration and habitations missions, significant reduction in life cycle costs, decreased energy and power consumption, while increasing safety and reliability. The topic of transient thermal management present a wide range of applications and revolutionary approaches to the architectures, designs, and operations of high energy space systems, life support equipment, and human habitats.

To other government agencies:

Benefits to military are also anticipated.

To the commercial space industry:

Benefits to industries, such as cryogenics, satellites, and commercial aircraft could be realized.

To the nation:

A global effect could be realized in smart building materials and methodologies for evaluating transient thermal effects on energy losses. Benefits to the cryogenic storage and transporation industry could be significant.