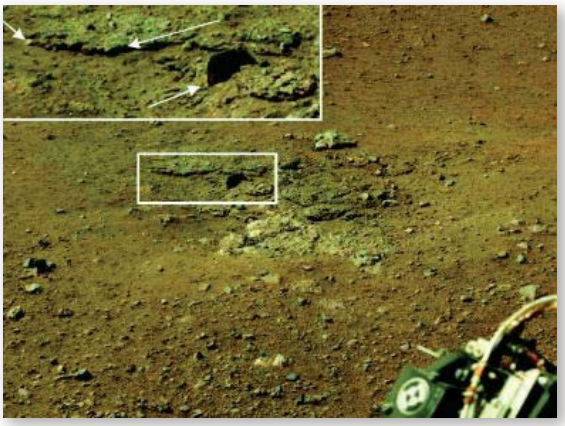
Plume Mitigation For Mars Terminal Landing: Soil Stabilization Project

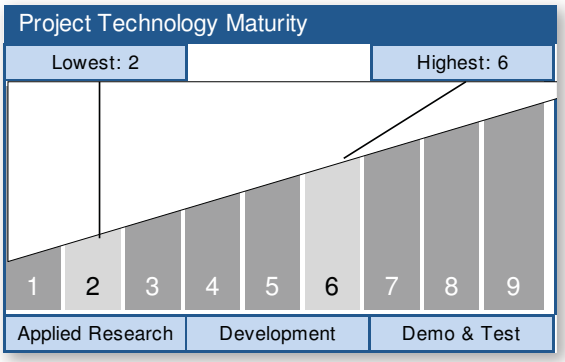
Center Innovation Fund: KSC CIF Program

Space Technology Mission Directorate (STMD)

National Aeronautics and Space Administration



Plume Mitigation for Mars Terminal Landing: Soil Stabilization



ABSTRACT

Kennedy Space Center (KSC) has led the efforts for lunar and Martian landing site preparation, including excavation, soil stabilization, and plume damage prediction. There has been much discussion of sintering but until our team recently demonstrated it for the lunar case there was little understanding of the serious challenges. Simplistic sintering creates a crumbly, brittle, weak surface unsuitable for a rocket exhaust plume. The goal of this project is to solve those problems and make it possible to land a human class lander on Mars, making terminal landing of humans on Mars ...***Read more on the last page.***

Technology Area: Human Exploration Destination Systems TA07 (Primary)

ANTICIPATED BENEFITS

To NASA funded missions:

There has been much discussion of sintering but until our team recently demonstrated it for the lunar case there was little understanding of the serious challenges. Simplistic sintering creates a crumbly, brittle, weak surface unsuitable for a rocket exhaust plume. Our research will solve those problems and make it possible to land a Human Class lander on Mars, making terminal landing of humans on Mars possible for the first time.

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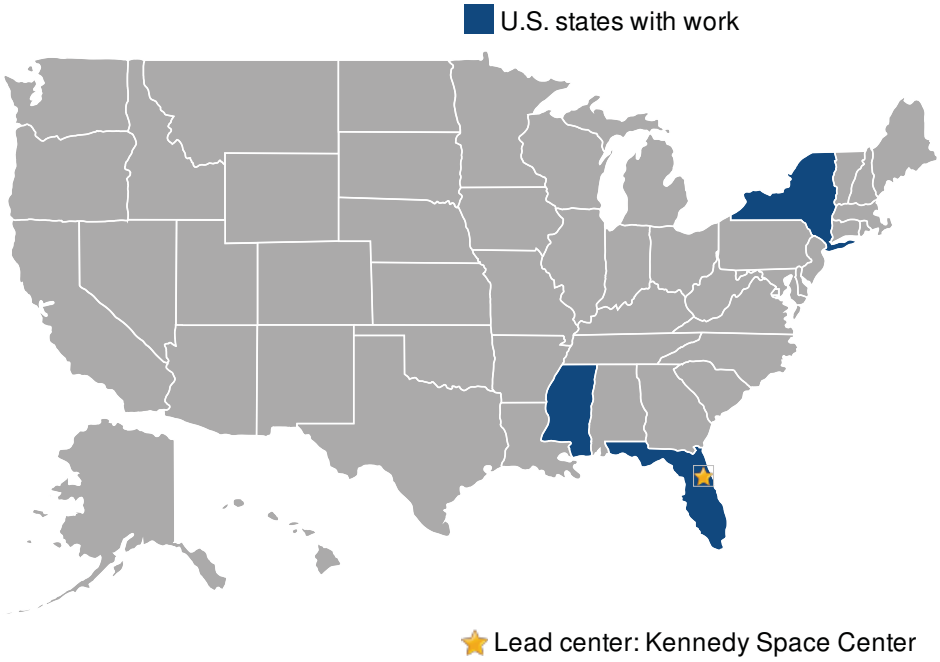
Read more on the last page.



Other Organizations Performing Work

Ceralink, Inc. (Troy, NY)
U.S. Army Corps of Engineers Engineer Research and Development Center

DETAILED DESCRIPTION

A sustained human presence on the Moon, Mars, or other celestial bodies, will require numerous disciplines to create technologies, solve current known problems, and anticipate new ones. One problem identified during the Apollo missions is plume ejecta: the expulsion of dust, regolith, or other loose material from the force of launch or landing. Rocket plume effects on Mars will be different from those on the Moon. Because Mars has an atmosphere, ejected particles will not travel as far, meaning that infrastructure could be placed at a safe distance from the launch pad and not receive blast effects. However, the presence of an atmosphere will cause the rocket exhaust to collimate, which will probably produce much deeper craters than the Apollo missions produced on the Moon. Plume ejecta was observed and photographed during the recent landing of the Mars rover, Curiosity. Even though the sky crane landing system was designed to minimize plume effects on the Mars surface, areas of surface erosion were observed after landing. Curiosity is the largest vehicle that has landed on Mars. A humansized lander will be considerably larger, will have more powerful rockets, and therefore, will probably disturb the surface soil much more. Deploying a landing ...

MANAGEMENT

Program Director:
John Falker

Program Executive:
Burton Summerfield

Program Manager:
Nancy Zeitlin

Project Manager:
Paul Hintze

Principal Investigator:
Paul Hintze

DETAILED DESCRIPTION (CONT'D)

pad or stabilizing the soil can mitigate this problem.

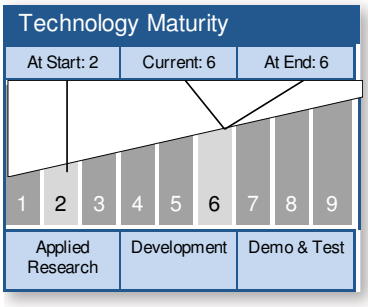
The goal of this project is to develop technology for building a landing pad through the following tasks:

- Demonstrate microwave sintering under Mars like conditions.
- Investigate surface stabilization methods used for terrestrial applications and develop recommendations for a Mars landing pad based on these methods.
- Develop a plan for implementing a microwave sintering system on a mobile rover.

The project was completed succussfully, achieving the first ever sintering of a Mars simulant under Mars like conditions. In addition, a design for a rover mounted sintering system was created. Recommendations for initial soil measurements were developed based of off terrestrial experience.

TECHNOLOGY DETAILS

Ceralink Mars Simulant



TECHNOLOGY DESCRIPTION

Initial evaluation of the existing Mars simulant showed that the simulant was not appropriate for microwave testing and did not reflect the recent chemistry and mineralogy related findings from the Mars rovers. A new simulant was developed that better approximated Mars regolith.

This technology is categorized as a material for other applications

- Technology Area
    - TA07 Human Exploration Destination Systems (Primary)

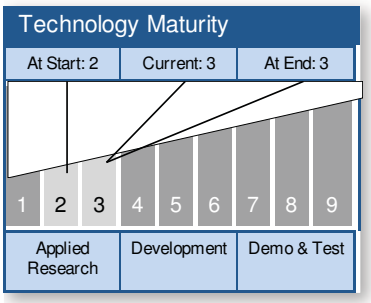
CAPABILITIES PROVIDED

The new simulant more accurately reflects the chemistry and mineralogy of Mars regolith as identified by the Mars rovers.

The new simulant can be used for tests and experiments that require a simulant with more accurate chemistry and mineralogy.

TECHNOLOGY DETAILS

Microwave Sintering System



TECHNOLOGY DESCRIPTION

The project team achieved the first ever microwave sintered Mars simulant in a Mars-like atmosphere. The process had to overcome microwave plasma problems and problems related to dust contamination. Following the experimental work, a microwave waveguide was designed that would minimize dust problems and plasma formation. The team then developed a design for the microwave system on a model rover that incorporated the new waveguide and thermal controls for the system.

This technology is categorized as a hardware system for other applications

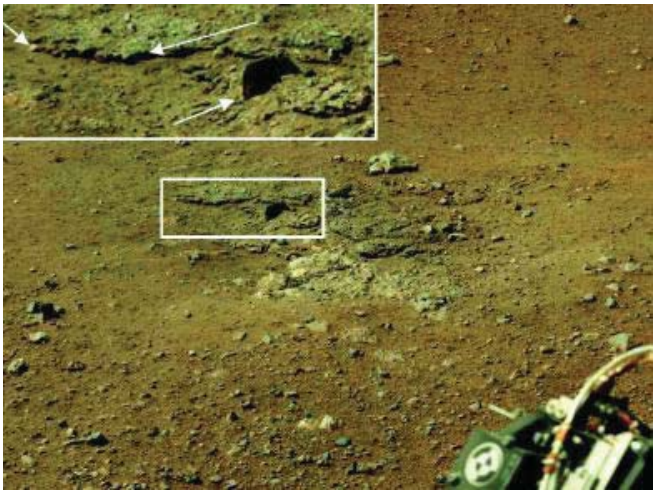
- Technology Area
    - TA07 Human Exploration Destination Systems (Primary)
    - TA09 Entry, Descent & Landing Systems (Secondary)

CAPABILITIES PROVIDED

The technology could be mounted on a rover and used to solidify Mars regolith. The technology incorporates measures to reduce microwave plasma formation and dust contamination.

Microwave sintering is a promising technology for stabilizing surfaces on the Moon and Mars.

IMAGE GALLERY



Rocket erosion observed near the landing of the Mars Science Laboratory

ABSTRACT (CONTINUED FROM PAGE 1)

possible for the first time.

ANTICIPATED BENEFITS

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

The project has developed microwave sintering methods that are applicable to multiple fields outside of NASA.

To the commercial space industry:

The outcome of this project will demonstrate the way forward to develop other technologies for landing pad construction, including the necessary robotics and the other EDL technologies(pinpoint landing requirements).It will provide focus for that further work.