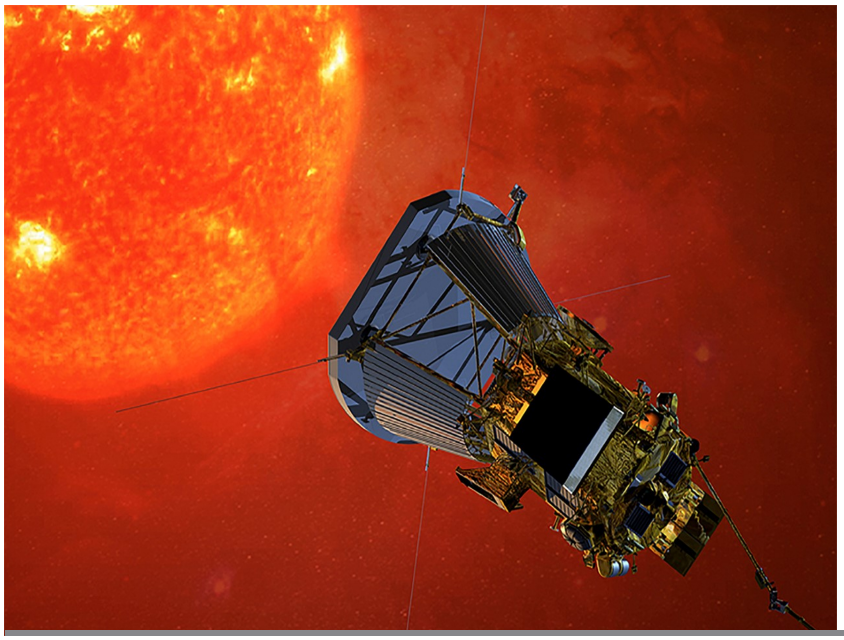


National Aeronautics and Space Administration

NASA

TECHNOLOGY SOLUTION

Materials and Coatings

Cryogenic Selective Surfaces

Maintaining Cryogenic Temperatures in Deep Space Using a Novel Thermal Coating

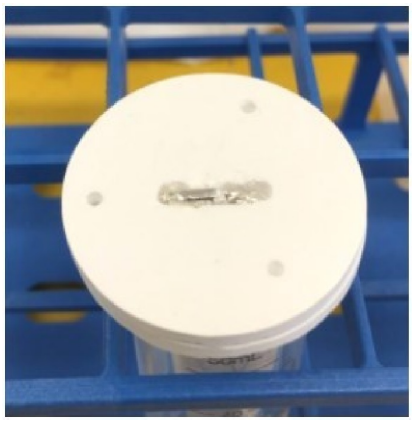
Thermal control coatings, i.e. coatings with different visible versus infrared emission, have been used by NASA on the Orbiter and Hubble Telescope to reflect sunlight, while allowing heat rejection via infrared emission. However, these coatings absorb at least 6% of the Sun's irradiant power, limiting the minimum temperature that can be reached to about 200 K. NASA needs better solar reflectors to keep cryogenic fuel and oxidizers cold enough to be maintained passively in deep space for future missions. This new thermal control coating material, developed for use as a spray on coating or rigid tiles, reflects essentially all solar radiation in the space environment. The novel material has the potential to be an enabler for long-term storage of cryogenic liquids and propellants in space. It can also support the long-term operation of low-temperature devices and systems used on space craft.

BENEFITS

- 0.1% absorption of the suns energy
- Surfaces coated with these new coatings can reach much lower temperatures than achievable through the use of existing materials
- This technology would allow superconductors to operate and would allow LOX storage to occur at higher density or at lower pressure.
- Reflects solar radiation, while maximizing infrared emittance
- On earth cooling ranges of -50 C below ambient
- Highly flexible and moisture resistant

THE TECHNOLOGY

These materials, which are composed of highly optically transmissive materials, are engineered to provide near-perfect reflection of the full solar spectrum in space. The materials are finely divided such that they scatter and reflect the incoming radiation from the UV down into the mid-IR and are also coated in some fashion with silver to extend the reflectance down into the far IR region of the solar spectrum. With this near-perfect reflectance of the complete solar spectrum, the scientists envision use of these materials for maintaining cryogenic temperatures for extended periods of time in space. The materials have also been developed into highly flexible, moisture resistant selective surface paint.The use and storage of cryogenics fluids is critical to many space operations, and while there are thermal control coatings in use today for spacecraft, none can provide this near-perfect reflection required for long-term maintenance of cryogenic temperatures.



Disk coated with highly reflective coating

Light reflecting off of the coated disk

APPLICATIONS

The technology has several potential applications:

- Coating on space vehicles for long duration trips
- Coating on liquid oxygen storage in a deep space depot.
- Coating on liquid oxygen storage tank on the surface of the Moon.
- Protection of temperature-sensitive devices for deep space missions
- Development of solar thermal control materials to enable long-term storage of cryogenics propellants for future space missions
- Passive Cooling of High Temperature Superconductors in Space

PUBLICATIONS

Patent No: 10,273,024; 10,815,129; 11,479,678

Patent Pending

"A Cryogenic Deep Space Thermal Control Coating", R.C. Youngquist, M. A. Nurge, W. L. Johnson, T.L. Gibson, J. M. Surma, 2017.

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

KSC-13994, KSC-14090, KSC-14106, KSC-14173, KSC-14189, KSC-14477, KSC-13972, KSC-TOPS-59

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NP-2015-02-1365-HQ