NASA Technology Summary

National Aeronautics and
Space Administration

Marshall Space Flight Center
Huntsville, Alabama 35812

Ultra-Light Tank Technology for In-Space Applications

NASA solar system exploration missions are undergoing a transition from fly-by observers to missions that orbit, land on and return samples from planetary bodies. These new missions are often more demanding of propulsion capabilities, increasing the need for more efficient propellant management to accomplish mission objectives. To meet this challenge, NASA scientists are looking at new and improved systems that not only will maintain propellants long-term, but also reduce overall propulsion system mass.

Research is underway to advance material and manufacturing technologies and related design methodology for lighter-weight in-space propulsion system tanks. Sponsored by the In-Space Propulsion Technology Project, NASA's Jet Propulsion Laboratory in Pasadena, Calif., and its industry partners are maturing composite, over-wrapped tanks to greatly reduce their weight. A composite over-wrap provides added strength to the tank, which is an essential element that stores spacecraft propellant and pressurant in a propulsion system.

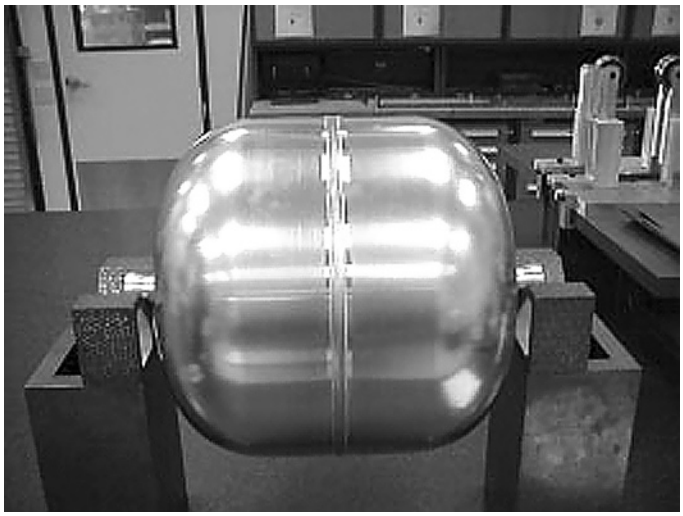
An ultra lightweight composite overwrapped tank, designed and fabricated by Carleton Pressure Technology Division of Westminster, Md., and NASA's Jet Propulsion Laboratory in Pasadena, Calif., during the development phase of the Mars Exploration Rover Program. Research of lightweight in-space propulsion system tank technologies is sponsored by the In-Space Propulsion Technology Project at the Marshall Space Flight Center in Huntsville, Ala.

Improvements in the area of composite over-wrapped propellant and pressurant tanks could result in a reduction of overall spacecraft propulsion system weight. This weight reduction could allow additional payload and scientific instrumentation to be flown—potentially resulting in greater scientific return.

Typically, propellant tanks are the largest component of in-space chemical propulsion systems. A state-of-the-art propellant tank is usually made from titanium alloy—a high strength, low weight metal alloy that is 40 percent lighter than steel and has high resistance to corrosive environments, such as salt air. New, ultra-light tank technology (ULTT) could offer not only the same level of strength and corrosion resistance, but also reduce propellant tank mass by as much as 50 percent as compared to an all-titanium tank.

Propellant tanks normally are made with a thick metal liner and a composite fiber over-wrap. ULTT utilizes an ultra-thin (0.005 to 0.010 inch) chemically etched metallic liner over-wrapped with a new ultra-high-strength, ultra-thin, low-density composite fiber, T1000. The liner provides hermetic sealing—to prevent the escape of propellant or entry of air—and propellant compatibility, while stresses due to pressure and external loads are efficiently carried by the T1000 graphite composite. This tank

technology could significantly reduce the mass of pressurant tanks. Overall, ultra-light tank technology could result in mass savings ranging from about 10 kilograms to 40 kilograms for most missions.



An aluminum liner for ultra-lightweight tank technologies, designed and fabricated by Carleton Pressure Technology Division of Westminster, Md., and NASA's Jet Propulsion Laboratory in Pasadena, Calif., during the development phase of the Mars Exploration Rover Program. Research of lightweight in-space propulsion system tank technologies is sponsored by the In-Space Propulsion Technology Project at the Marshall Space Flight Center in Huntsville, Ala.

Current tasks in ultra-light tank technology include acceptance and margin testing of state-of-the-art propellant tanks and stress rupture life testing to expand the database on fiber over-wrap material properties. This will establish lower allowable design margins and ensure long-term performance with minimum fiber mass—enabling ultra-lightweight propellant tanks.

The Advanced Chemical Propulsion Technology Area in the In-Space Propulsion Technology Office at the Marshall Center is partnering with NASA's Jet Propulsion Laboratory in Pasadena to advance ultra-light tank technology for in-space application.

Research in advanced chemical propulsion is being conducted by the In-Space Propulsion Technology Program, which is managed by NASA's Science Mission Directorate in Washington and implemented by the In-Space Propulsion Technology Office at the Marshall Space Flight Center in Huntsville, Ala. The program's objective is to develop in-space propulsion technologies that can enable or benefit near and mid-term NASA space science missions by significantly reducing cost, mass and travel times.

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For more information, visit:
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