

**SBIR Topic Number:**  
AF06-241

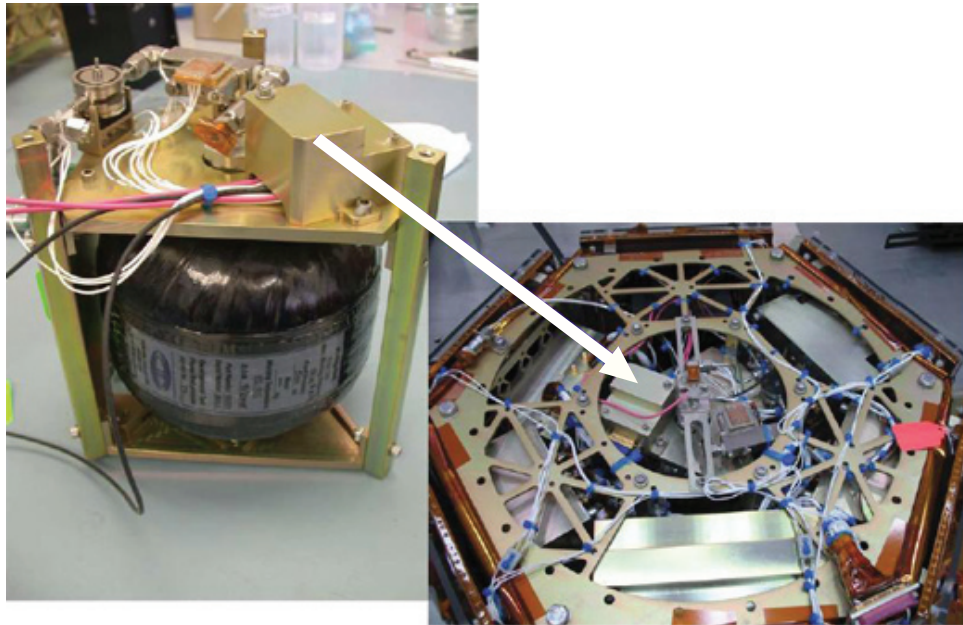
**SBIR Title:**  
Lightweight Linerless  
Cryogenic Composite  
Tanks for Near-Space  
Platforms

**Contract Number:**  
FA9453-07-C-0036

**SBIR Company Name:**  
Composite Technology  
Development, Inc.  
(CTD), Lafayette, CO

**Technical Project Office:**  
AFRL Space Vehicles  
Directorate  
Kirtland AFB, NM

An example of Air Force supported SBIR/STTR technology that has been transitioned into an Air Force or other DoD system or subsystem or used by Air Force test ranges and facilities or maintenance depots.



Linerless composite tanks integrated into the NanoSat-3 FASTRAC Thruster

## Linerless Composite Tanks Enable Nanosatellite Flight Launch Schedule

- The Air Force needs lightweight, composite satellite bus structures with integrated tanks and pressure vessels
- The fuel tanks weighed 40% less, had 18% more volume, and 12 times the pressure capability of the aluminum tanks that they replaced
- SBIR-developed linerless composite fuel tanks resolved a critical problem for the nanosatellite (NanoSat-3) research satellite launch
- Markets such as space and aerospace, where weight is paramount, are embracing CTD's tanks as an exciting new alternative

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## Air Force Requirement

The Air Force needs lightweight, composite pressure vessels for next generation satellites, aircraft, and launch vehicles. Current state-of-the-art pressure vessels and cryogenic tanks are fabricated from metals (aluminum or titanium) or are fabricated as metal-lined, composite-over-wrapped tanks. Composite Technology Development, Inc. (CTD) has developed KIBOKO® lightweight all-composite pressure vessels and cryotanks, which, due to the lack of a liner, provide for the lightest possible storage solution for a given set of requirements. The technology development has been enabled by a multi-disciplinary, concurrent approach to the design and analysis of all-composite tank structures, novel material development, and innovative manufacturing techniques.

## SBIR Technology

By way of background, the Air Force-sponsored, University Nanosatellite (NanoSat) program entails an annual competition amongst U.S. universities to develop, fabricate, and functionally test small satellites; foster research to enable NanoSat technologies; and design experiments that orbiting NanoSats can perform. The Nanosat-3 competition was won by the University of Texas with their Formation Autonomy Spacecraft with Thrust, Relative Navigation, Attitude and Cross-link (FASTRAC) NanoSat, which was designed to demonstrate technologies that enable formation flying. The FASTRAC design required micro-discharge plasma thrusters for maneuvering with fuel tanks designed to contain argon gas at 100 pounds per square inch (psi) for a period of 6 months, implying a proof pressure of 150 psi and demonstration of a suitable leak rate before integration into the satellite.

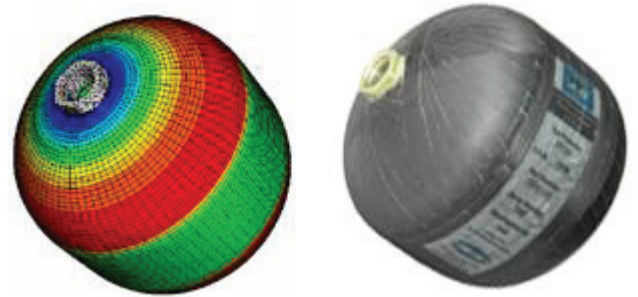
The university initially purchased custom aluminum tanks. During proof pressure testing, the dome sections yielded leaving the tanks unusable. With only six weeks remaining before full spacecraft integration, the University of Texas contacted the Air Force Research Laboratory (AFRL) for assistance in obtaining new tanks as soon as possible.

Under the guidance of AFRL, CTD acted quickly to solve this critical hardware failure by delivering four flight-ready, all-composite fuel tanks for inclusion on the University of Texas' NanoSat-3 research satellite. The tanks were manufactured by CTD at the composite manufacturing facility at Kirtland AFB, NM, with on-site support from Jackson and Tull Engineering (J&T) and United Industrial Engineering (UIE).

The AFRL-CTD team promptly designed the all-composite tanks and the required tooling, manufactured the tooling, produced 20 tanks (2 flight, 2 back-up, and 16 test articles), qualified the tanks, and delivered 4 flight articles to the University of Texas for integration into the satellite, in time to maintain the satellite integration schedule. The CTD-designed tanks weighed 40% less, had 18% more volume, and 12 times the pressure capability of the custom-built aluminum tanks they replaced.

## Transition Impact

CTD's KIBOKO® all-composite pressure vessels and cryogenic tanks provide cost-effective, lighter weight storage solutions for a variety of markets.



## CTD's advanced finite element analysis tool predicts the performance of all-composite pressure vessels

Markets such as space and aerospace, where weight is paramount, are embracing KIBOKO® tanks as an exciting new alternative. Furthermore, KIBOKO® pressure vessels are being qualified for use in automotive, aircraft, emergency safety, and medical applications with operating pressures up to 5,000 psi.

## Company Impact

This SBIR project enabled CTD to participate in a historic milestone; the flight of NanoSat-3 will mark the first use of all-composite tanks for spacecraft operations.

CTD merges the development of original materials with incisive engineering methods to provide its customers with innovative solutions for their specific technology and system needs. The firm's mission is to develop enabling engineered materials solutions for composites, insulation, adhesives, and coatings for cryogenic, space, and other harsh environments.



U.S. AIR FORCE

# SBIR/STTR

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