Space Vehicles Directorate

THE AIR FORCE RESEARCH LABORATORY

Air Force Research Laboratory - Space Vehicles Directorate

Advanced Structurally Embedded Thermal Spreader II (ASETS-II)

The U.S. Air Force Research Laboratory (AFRL) will send the second Advanced Structurally Embedded Thermal Spreader (ASETS-II) flight experiment to space on Orbital Test Vehicle 5 (OTV-5).

OTV-5 is the fifth flight of an X-37B reusable space plane. The X-37B program performs risk reduction, experimentation, and concept of operations development for reusable space vehicle technologies, and is administered by the U.S. Air Force Rapid Capabilities Office (RCO).

The ASETS-II experiment is managed by the AFRL Space Vehicles Directorate and will measure the microgravity performance, startup characteristics, and long term performance of an oscillating heat pipe (OHP) on orbit.

Technology:

The OHP is a simple, wickless heat pipe capable of rejecting more than 200 times the maximum heat load of an axially grooved heat pipe, and transporting more than 45 times more heat than copper.

Cutaway of an oscillating heat pipe (OHP) showing its microchannel pattern

In addition to outperforming traditional thermal management technologies, OHPs enable low-cost manufacturing techniques due to the lack of an internal wick structure. OHPs provide a low cost method to alleviate electronics thermal constraints and allow for increased processing power, or bandwidth, for commercial and military users.

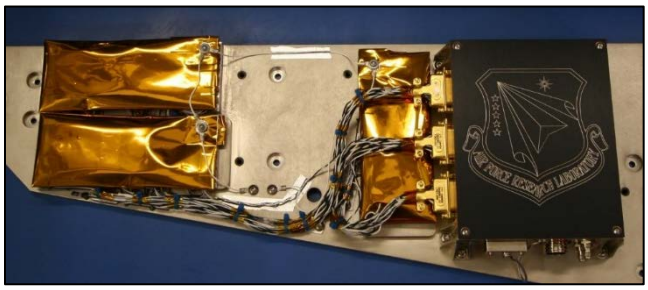
Experiment:

The ASETS-II experiment is made of three low-mass, low-cost OHPs and an electronics/experiment control box. The three OHPs are of varying configuration (center heating with single- and double-sided cooling) and working fluids (butane and R-134a) in order to isolate specific performance parameters of interest. In addition to serving as a science experiment, the ASETS-II flight experiment serves as a pathfinder for incorporating high performance OHP-based thermal spreaders into flat plate structures such as electronics chip carriers, thermal ground planes, and spacecraft panels.

Microgravity influence on fluid flow, especially two-phase flow, is significantly different than in a terrestrial environment. This is true for steady-state operations, but is more important for transient operation. In addition, the combined effects of the space environment (e.g. thermal

cycling, high vacuum, charging, vibration) are required to verify the performance of the system on orbit for long durations.

The three primary science objectives are to measure the initial on-orbit thermal performance, to measure long duration thermal performance, and to assess any lifetime degradation. Flight data will be used to validate microgravity portions of an OHP operating limits model recently published by members of the team. Returned flight experiment hardware will be subjected to post-flight testing to assess the presence of any non-condensable gas that may have formed on orbit.



ASETS-II

Collaboration:

The AFRL Space Vehicles Directorate has been investigating OHPs since 2008. In 2012, the original ASETS experiment measured the performance of an AFRL-developed OHP aboard a Space Test Program (STP) funded and NASA managed microgravity aircraft flight.

The ASETS-II OHPs were developed by ThermAvant Technologies, LLC (Columbia, MO) under a Department of Defense Small Business Innovation Research (SBIR) contract. The flight hardware was designed and built by AFRL's Space Vehicles Directorate, with support from LoadPath (Albuquerque, NM), Applied Technology Associates (Albuquerque, NM), Gulfview Research Inc. (Fort Walton Beach, FL), and Odin Engineering (St. Petersburg, FL).

Located at Kirtland Air Force Base, New Mexico, the Space Vehicles Directorate serves as the Air Force's "Center of Excellence" for space technology research and development. The directorate develops and transitions space technologies to provide space-based capabilities.

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