Air Force SBIR STTR IMPACT
FUELING THE ECONOMY

IMPROVED THERMAL MANAGEMENT OF SPACECRAFT ELECTRONICS

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Next-Generation Microchip Carrier for Cooling of Satellite Payload Electronics

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SBIR COMPANY NAME:
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TECHNICAL PROJECT OFFICE:
AFRL Space Vehicles Directorate
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Michael Hurtman and Roger Davis of ThermAvant Technologies inspect a part at the company's Missouri facility. With support from the Air Force SBIR/STTR Program, ThermAvant has demonstrated advanced thermal management solutions for spacecraft electronics using an emerging technology. (Courtesy photo)

SOLUTION TO MICROCHIP OVERHEATING IN SPACE APPLICATIONS DRIVES COMMERCIAL SUCCESS

A new microchip cooling technology that paves the way for higher-performance electronics on spacecraft is spurring growth at a Missouri-based small business.

With support from the Air Force Small Business Innovation Research/Small Business Technology Transfer Program, ThermAvant Technologies successfully demonstrated advanced thermal management solutions for spacecraft electronics based on an emerging, but mostly untapped technology. Since its initial research project for the Air Force, the company has entered dozens of agreements to supply the solution for aerospace and defense applications.

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These types of transitions – supported by the Air Force SBIR/STTR Commercialization Readiness Program – help bring down the cost of the technology while making it more readily available to both military and civilian customers.

According to ThermAvant officials, this project allowed the company to create more than a dozen jobs and attract outside investment. ThermAvant has also applied for multiple patents that directly and indirectly resulted from work on Air Force SBIR/STTR efforts, positioning it to be a long-term, stable supplier of thermal management products.

BEHIND THE TECHNOLOGY

Improved heat transfer technologies are important because as microchips' internal circuits overheat, their resistance increases and their efficiencies, outputs and lifespans decrease exponentially. This problem is becoming more of a challenge every year as the number of transistors packed into an integrated circuit grows. As microchips get smaller and more powerful, they are more susceptible to overheating.

Electronics cooling is an issue that is particularly difficult to solve in space vehicles, which – unlike terrestrial or shipboard applications – do not have access to air- or liquid-cooled heat sinks.

To address the issue, the Air Force Research Laboratory's Space Vehicles Directorate went searching for a new class of microchip heat spreaders that were thin, lightweight and could be manufactured from a variety of materials. Another key feature would be high-thermal conductivity, so that when attached to small, high-powered microchips, the waste heat generated would be efficiently dissipated across the spreader's larger surface area without creating hot spots at the microchip interface.

ThermAvant chose to build heat spreaders based on the promising, but rarely applied, oscillating heat pipe technology, also known as OHP.

OHPs are built from a base material with internal serpentine micro-channels filled and sealed with a saturated working fluid. They operate by converting the device's thermal energy – waste heat – into the internal working fluid's kinetic energy. Expansion and contraction forces move, or oscillate, the fluid to-and-from hot and cool channel areas. And when the fluid flows, so does the heat. Using the fluid's two-phase heat transfer mechanism, OHPs can have effective thermal conductivities more than 100-times greater than its base materials.

AIR FORCE SUPPORT WAS CRITICAL

According to Joe Boswell, co-founder and CEO of ThermAvant, funding from the Air Force SBIR/STTR program supported the company's advancement of OHP technology in four critical areas: Predictive modeling and theoretical investigation of the OHP's complex heat transfer mechanisms; multiple rounds of empirical prototyping and testing; manufacturing, processing and quality-assurance advancements to meet the reliability requirements of real-world spacecraft programs; and gathering of a multi-disciplinary research team that included experts from ThermAvant, the Air Force, the University of Missouri and a large defense contractor.

ThermAvant is now supplying OHPs and micro-channel cooling solutions for a wide range of platforms, from aerospace electronics to data center enclosures and energy storage systems. Since the initial Air Force SBIR/STTR award, the company also has engaged in more than a dozen government-led research projects focused on removing existing thermal solutions to be replaced by OHP technology.