Topic: N161-052

ThermAvant Technologies LLC

Advanced Heat Spreader Technology for Gallium Nitride (GaN) Monolithic Microwave Integrated Circuits (MMICs)
The oscillating heat pipe (OHP) heat spreader is a highly efficient passive thermal device capable of transferring extremely high heat fluxes from a small source to a larger, lower heat flux rejection surface. This technology will allow high power operation of electrical components without altering the system design. ThermAvant Technologies is a leading developer of the OHP with applications to Navy radar and electronic warfare systems. ThermAvant's competitive advantage is the advanced manufacturing, predictive modeling capabilities, and design experience with this technology. These advantages also minimize the risk for producing the OHP. ThermAvant's OHP technology can be used in a wide range of high heat flux, small form factor, and structurally integral applications thereby allowing increased performance and reduced weight of high power devices.

Technology Category Alignment:

Electronic Materials
Electronics Integration
RF Components for sensing, transmission and communication
Advanced Electronic Protection Techniques and Technology

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SYSCOM: NAVSEA
Contract: N00178-18-C-7000
Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N00178-18-C-7000

Department of the Navy SBIR/STTR Transition Program

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NAVSEA #2018-0528

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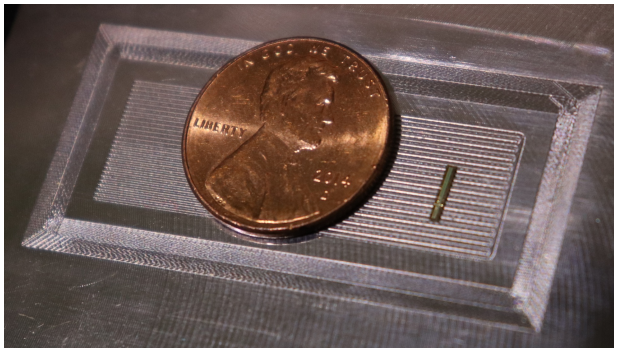
WHO

SYSCOM: NAVSEA

Sponsoring Program: PEO IWS 2.0, Air and Missile Defense Radar (AMDR)

Transition Target: Various (GaN MMIC Power Amplifiers)

TPOC:
(812)854-8937



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Other transition opportunities: ThermAvant's microscale Oscillating Heat Pipe (OHP) device minimizes thermal hotspots by efficiently spreading heat from highly concentrated thermal loads and therefore reducing the Size, Weight, and Power (SWaP) of the system. This device will improve the capabilities of GaN MMIC Power Amplifiers used in radar and electronic warfare systems of all branches of the military including the Navy, Air Force, and Army for shipboard, spacecraft, and terrestrial platforms. In addition, it will enable SWaP improvements to laser diodes, LEDs, integrated circuits and other small scale extremely high thermal flux components in all military branches.

Notes: Image depicts an Oscillating Heat Pipe heat spreader internals with commercial GaN MMIC chip and a penny for scale.

WHAT

Operational Need and Improvement: Future Navy radar and electronic warfare systems will require transmit and receive modules with increased density and power. Current heat dissipation methods are bulky, costly, and require significant energy. ThermAvant is developing a passive high heat flux heat spreader based upon oscillating heat pipe technology that will spread the thermal load and enable cooling via lower cost solutions all while maintaining the same footprint as the current heat spreader. Therefore, without altering the current system, the solution will provide a significant reduction of Size, Weight, and Power (SWaP).

Specifications Required: The design is required to be a drop-in replacement for the current heat spreaders which can not acquire/spread/reject the heat of next generation GaN MMICs. ThermAvant's heat spreader is required to remove heat fluxes >1000 W/cm2 at operating temperatures of 100-200 C without changing the form factor. The device must be completely passive, have a 15 year service life, and not increase current MMIC assembly costs more than 10%.

Technology Developed: ThermAvant has developed a miniaturized Oscillating Heat Pipe (OHP) to allow near-junction heat transfer of high heat flux sources. By reducing the size, ThermAvant expects to significantly increase the heat transfer coefficient inside of the OHP and therefore be able to receive the extreme fluxes of next generation GaN MMICs and similar heat sources.

Warfighter Value: The advanced heat spreader for the GaN MMIC HPA will provide significantly increased capabilities to the Warfighter. By efficiently removing heat from the GaN MMIC HPA, next generation radar and jammers will be able to have increased output power while rejecting heat to ambient conditions. This will eliminate or reduce the need for refrigeration of these next generation GaN MMIC HPAs. Therefore significantly decreasing size, weight and power requirements for support systems while allowing increased power output of the antenna.

WHEN

Contract Number: N00178-18-C-7000 **Ending on:** November 30, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Initiate and sustain fluid oscillations within microchannels at high heat fluxes	Low	>1.2 kW/cm2 with channels smaller than 500 micrometers	TRL 6	November 2019
Demonstrate extremely high heat transfer coefficients in microscale OHP channels	Med	>30 kW/m2K in channels	TRL6	November 2019
Improve performance/cost ratio of GaN MMIC OHP heat spreader	Low	Demonstrate high-volume process with high performance	TRL 6	June 2019
Integrate OHP heat spreaders into GaN HPA manufacturing processes	High	Die attachment with charged OHP	TRL 6	June 2019

HOW

Projected Business Model: ThermAvant Technologies will utilize its in-house specialized machine shop to manufacture the OHP heat spreader to exacting standards of the Navy and Prime. During the research phase, improved manufacturing techniques will be developed to aide mass production. An initial production effort will take 6-10 months with a full rate of production of 250/month with current manufacturing capacity. Capacity will be rapidly expanded as needed. Production heat spreaders designs will be developed with the customer to enable seamless integration into their current assembly process.

Company Objectives: ThermAvant Technologies is the leading developer of OHP technology; enabling a wide range of unique capabilities from dissipating extremely high heat fluxes at the transistor level to carrying kilowatts of heat over distances >1 m irrespective of gravitational orientation. ThermAvant will continue to develop, investigate and improve the unique capabilities of the OHP. This enabling technology will bring high flux devices to areas and fields previous unattainable due to SWaP requirements.

Potential Commercial Applications: ThermAvant's high heat flux Oscillating Heat Pipes will benefit many industries where ever decreasing component size and increasing power levels result in temperature constrained components. These applications include microwave cellphone towers, commercial radar systems, satellite communication systems, laser diodes, LEDs, and a wide variety of microelectronics. OHP-based heat spreaders are also finding commercial applications for the thermal management of current- and next-generation semiconductors manufactured with low-nanometer transistors and ultra-high heat fluxes. By utilizing this technology, these devices can operate at higher power and reject heat to ambient conditions.

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