Department of the Navy SBIR/STTR Transition Program

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Topic # N22A-T019
Enhanced Thermal, Mechanical, and Physical Properties of CMC's Through Novel Additives
Advanced Ceramic Fibers, LLC

WHO

SYSCOM: ONR

Sponsoring Program: ONR Code 35

Transition Target: Rotation Detonation Engines (RTE/RDER) and Turbine Engines with temperature performance utility to >2000°C

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F-35C Lightning II (U.S. Navy photo, Released Navy.mil photo gallery/201006-N-NO101-176.JPG)

Other Transition Opportunities: Fiber reinforced Ceramic Matrix Composite (CMC) development applicable to hypersonic leading edges and airfoils, high efficiency turbine generator power supplies, shipboard components requiring sustained ultra high temperature (UHT) performance utility. This also includes, high temperature materials for reusable space reentry vehicles as wells as space defense components. Additional applications are in the areas of high efficiency heat exchangers, body armor and high-performance braking components. Beyond military applications, commercial airlines are continuously compelled to reduce fuel consumption, increase range, reduce emissions and improve profitability through development and application of higher performance, more efficient and environmentally friendly gas turbine engines. The need to meet or surpass increasingly stringent emissions standards set by federal, state and local requirements as required industrial and commercial gas turbine manufactures to develop cleaner burning turbine engines. The high performance charterisitics of both our Fi-Bar™ and Quad-XE™ CMC variants would benefit multiple military and commercial industries. Finally, commercial space exploration would also benefit.

Notes: Another goal during this development effort is to create multiple CMC types that can be used in multiple aircraft internal components such at rocket nozzles, turbine vanes and combustion chamber liners that can not only be used in the development of new systems but may also be used to upgrade current Navy systems fleetwide. These same challenges can be addressed and benefit other evolving technologies such as power generation and heat exchanger development and advanced armor protection.

WHAT

Operational Need and Improvement: This is a materials development project focused on improved Ceramic Matrix Composite (CMC) performance capabilities and increased utility beyond 2,000°C. CMCs in general have many applications related to advanced warfighter technologies, such as increasing efficiency and performance capabilities in advanced turbine engines and developed for higher performance Rotating Detonation Engines (RDE). In addition, more advanced applications, i.e., hypersonic aircraft and missiles, will benefit through major advances in CMC fabrication and testing to extremely high temperatures. ACF partnered with Montana State University (MSU) to develop low density, machinable base CMC materials that can provide solutions to these technical limitations. ACF and MSUs goal for this project is to develop several variations of high robust CMCs that can be modeled and developed into specific “recipes” for specific applications, extreme temperature capabilities and highly oxidative operating environments.

Specifications Required: The Navy's performance objective is to develop more robust CMC materials with sustained performance utility to 2,000°C and beyond. Increased reliability, higher performance capabilities and higher speeds are needed to achieve sustained hypersonic capabilities.

Technology Developed: ACF's technological capabilities incorporate both its Fi-Bar™ converted carbon fiber technology and its Quad-XE tm CMC technologies. ACF's Fi-Bartm is a unique process that provides a protective metallic carbide protective coating around commercially available carbon fiber which allows higher oxidative resistance with higher temperature capabilities when used in many types of CMCs. This, in conjunction with AFC's Quad-XE tm CMC compositions, allows development of CMCs with enhanced thermal and mechanical capabilities such as higher strain to failure rates then current technologies can reach, low thermal conductivity and high Foreign Object Damage (FOD) resistance through its unique matrix formulations that includes hot temperature oxidation resistant, and self-healing characteristics.

Warfighter Value: With increased sustained performance through higher operating temperatures in turbine engines, RTEs and leading-edge airfoils, warfighters can achieve enhanced tactical advantage through higher sustained speeds, and increased reliability. Working with the major OEMs, ACF plans to engage and seek out areas for improvement in these developing technologies across all related market sectors. In addition, all these combined advances in materials development will increase warfighter readiness levels though more robust high performance weapon platforms while saving costs though reduced maintenance demands and increased fuel efficiency.

WHEN

Contract Number: N68335-24-C-0071 **Ending on:** Dec 15, 2025

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Finalize CMC Manufacturing and Process Optimization	Low	Frabricate hardware prototypes completed and tested to 2,000C	4	1st QTR FY25
Complete Oxidation Models predicting CMC performance to 2,000C	Medium	Validate Models against independent test data	4	1st QTR FY26
Complete Mechanical Testing, Tensile, Creep Resistance, Cyclic Fatigue, thermal performance	Medium	Mechanical testing to ASTM standards, validated by third-party testing	5	1st QTR FY26
Optimize process formulations for use as UHT coatings	High	Combined process development effort through ACF and MSU	6	4th QTR FY26
Produce fully processed machined prototype parts for OEM testing	High	Successful performance test CMC hardware in a relevant environment	7	1st QTR FY28

HOW

Projected Business Model: ACF is a small, advanced materials company focusing on continued development of high-performance fiber reinforced CMCs. The key to this technology development is our Direct Conversion Process (DCP™™) system, producing our patented Fi-BarTm metallic carbide conversion layered carbon fiber. This is accomplished by working with our university partner, MSU, to further develop our CMCs and provide advanced solutions to many technical limitations being experienced in aerospace propulsion systems development, space vehicles, rocket technologies and hypersonics.

Company Objectives: Enabling our customers to dominate their marketplace by using our Fi-Bar™ along with our Quad-XE™ CMC products is our primary objective. In turn, provide our warfighters significant advantages in terms of speed, reliability and efficiency at a reasonable cost. These technologies will also have the added benefit of providing higher efficiency and performance in commercial applications such as transportation, commercial airlines, and commercial power generation, including emergency situations where high power land-based portable turbine generators would be employed.

Potential Commercial Applications: Many of the development projects funded though the Navy and commercially by OEMS, are searching for solutions in the form of materials that are cost effective, light weight and provide a longer service life at extremely high temperatures above 2,000°C.

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