Department of the Navy SBIR/STTR Transition Program

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Topic # N212-127
High-Temperature Fuel Coking Mitigation Frangible Coatings for Fuel Nozzles and Screens
Precision Combustion, Inc.

WHO

SYSCOM: ONR

Sponsoring Program: ONR SBIR

Transition Target: Jet engines for Navy aircraft

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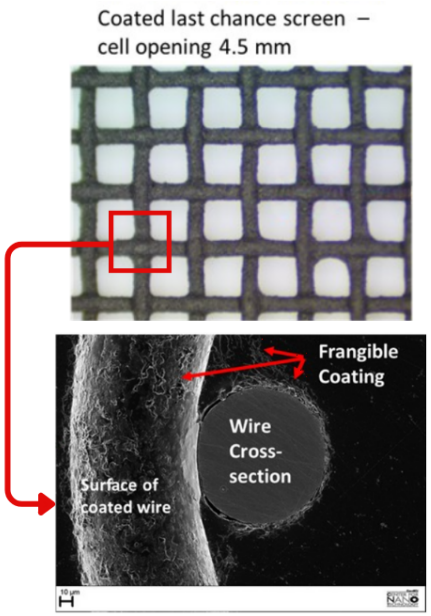
Other Transition Opportunities: Other high temperature engines, shipboard and stationary power generation gas turbines

Notes: With over 5000 jet aircraft in the DoD, nearly 3000 of which are deemed as fighter or multi-role aircraft, the need for reliable, long-lived solutions are of great importance and high impact on mission effectiveness as well as operational and maintenance costs for the services. Beyond “last chance” filters, we are also evaluating coating nozzles and other small fuel passages and our solution has applications in other filtration applications, offering additional markets and derivative products. The active global commercial aircraft fleet has over 25,000 aircraft that can benefit from this technology.



Frangible Coating on Last Chance Screen - Images Courtesy of Precision Combustion, Inc.

WHAT

Operational Need and Improvement: Fuel deposit issues currently prevent long-term fuel system operation at temperatures over ~300F. Increasing heat loads, projected for advanced aircraft of the near future, will lead to higher average fuel system temperatures for both commercial and military aircraft. Formation of carbonaceous deposits can be problematic for several components of an aircraft fuel system, with "last-chance screens" and fuel injectors, which are wetted by fuel with the highest time-at-temperature exposure sufficient for coke formation. Blockage of these fuel system component passages can have serious consequences in terms of aircraft propulsion control.

Specifications Required: - "Frangibility": Low cohesive strength of nano-layers prevents build-up by shedding adhered varnish precursors.
- Nano-scale, conformal coating for complex geometries applied via vapor deposition.
- Lubricity equal to or higher than underlying material, coefficient of friction equal to or lower than underlying metal, chemical inertness.
- Temperature stability up to 600F.
- Nano- to micro-meter coating thickness.
- No off-gassing or other contamination.
- The thickness of the coating and its erosion rate should be adjusted such that it can remain operational for a time frame comparable to a typical fighter aircraft engine service interval, targeting a 5X increase in Mean-time Between Overhaul (MTBO) compared to the baseline at 400F fuel operation.

Technology Developed: A frangible coating that can slough off carbonaceous deposit precursors adhering and growing onto fuel-wetted surfaces, thus preventing blockage on the most critical, most susceptible aircraft fuel system components.

Warfighter Value: Application of the technology offers to reduce maintenance costs, improve reliability, and increase Mean Time Between Overhauls (MTBO) for high temperature Navy jet engines.

WHEN

Contract Number: N68335-23-C-0015 **Ending on:** Jan 15, 2025

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Optimize material and coating process	Medium	Standard coating procedure established	4	4th QTR FY23
Fabricate coated components (last chance screens and fuel nozzles) for testing.	Low	Coated prototypes ready for testing	4	4th QTR FY23
Demonstrate 5 X increase in MTBO for coated samples compared to uncoated and report coating performance as a function of operating conditions.	Medium	Test report with results of evaluation	5	3rd QTR FY24
Finalize coating parameters, test against MIL-SPECS	Medium	Process design documented and approved	5	4th QTR FY24
Fabricate and deliver prototype coated last chance screens to ONR	Medium	Last Chance Screens coated and delivered for evaluation by ONR	5	2nd QTR FY25

HOW

Projected Business Model: Deliver TRL 5/6-ready prototypes to enable OEM and military evaluation of the operational capability of the technology in engine test rigs, followed by an EMD program to advance the system to procurement availability.

Focus on Navy Customers until success is met, with ongoing activities to expand the market and customer bases on both the DoD and commercial applications.

Develop key relationships to license the technology or partner with appropriate manufacturing and integration companies to offer cost effective, high quality, frangible coated products to serve customer needs.

Company Objectives: Commercialize the technology within the Navy, and more broadly within all of DoD.

PCI plans a staged applications development and commercialization schedule aligning with the SBIR program, seeking spin-offs into various applications funded either by BAA’s or other development programs.

The primary markets for this frangible coated last chance screen and fuel nozzle product will be for current Navy jet engines and shipboard gas turbines. Other DoD engines will be addressed once the technology is proven for the initial Navy applications. The technology is even more attractive for future high-temperature engines.

Potential Commercial Applications: Commercial jet engines and gas turbines for marine and power generation applications.

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