Department of the Navy SBIR/STTR Transition Program

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ONR Approval #43-4388-18

Topic # N151-070

Development of Marinized Protective Coatings for Higher Temperature Operations of Marine Gas Turbine Engines

Directed Vapor Technologies International, Inc.

WHO

SYSCOM: ONR

Sponsoring Program: Code 33 Propulsion Materials

Transition Target: PEO Ships

TPOC:
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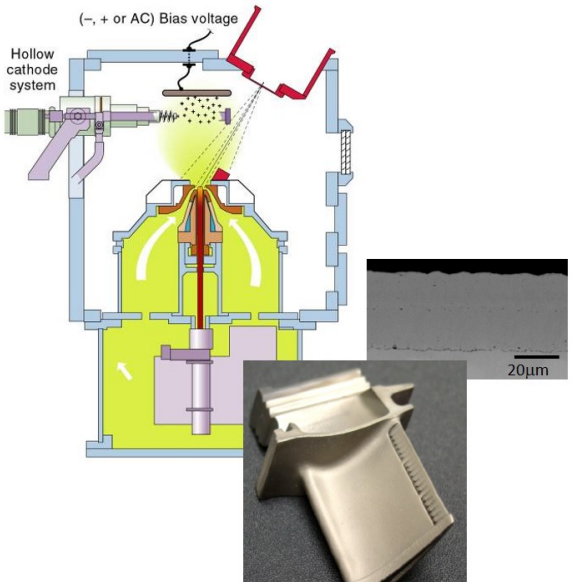
Other transition opportunities: Complex geometry parts/components requiring high temperature durable coatings.

Notes: Plasma activation of the coating vapor can be utilized to enhance coating density, as desired. Here, a fully dense nickel alloy is shown applied on a turbine blade.



WHAT

Operational Need and Improvement: It is the Navy's goal to increase the operational capabilities of its gas turbine engines that are used in Surface Fleet propulsion and auxiliary electrical power generation. Higher temperatures and environmental changes will increase engine corrosion and oxidation rates, thereby shortening engine life and increasing engine maintenance and repair costs. Current USN Hot Section Materials were designed for Low Temperature Hot Corrosion (~700 deg C), but new USN operations may require engine materials to withstand higher sustained temperatures (950-1050 deg C) and cycle more often reducing engine life severely.

Specifications Required: Operational changes and future needs will require increased gas turbine operating temperatures and change the associated operating environment to one where Type I and Type II hot corrosion AND oxidation will be prevalent in newly anticipated operational profiles.

Technology Developed: Candidate systems have been identified through computational methods and are being validated through a production-scale coating process, Directed Vapor Deposition (DVD). These coatings, processed using DVD, have been tested in salt-laden environments using a 100-hour combined cycle without signs of damage to the underlying substrate.

DVD is an advanced coating process that enables the development and deposition of complex alloys onto components with non-line-of-sight (NLOS) areas such as turbine blades and vanes. DVD uses an electron beam to evaporate a solid source material that is then directed by a high velocity gas. Due to conditions in the coating chamber, the DVD process is capable of creating high quality coatings onto complex shapes. The ability to simultaneously evaporate from sources with widely varying vaporization points provides further capabilities, such as the creation of a wide range of coating chemistries.

Warfighter Value: The new coating composition will enable marine gas turbines to operate at higher temperatures, achieving greater thrust, without risks to component damage, thereby maintaining fleet readiness.

WHEN

Contract Number: N68335-17-C-0057 **Ending on:** January 23, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Coated coupons undergo combined cycle testing in salt-laden environment	N/A	Survive 100-h without damage to underlying substrate	4	2nd QTR FY18
Coating and process demonstrated on a coated part or representative part	Med	Uniform, high-quality coating applied to line-of-sight and non-line-of-sight regions of component	4	1st QTR FY19
Coated engine components evaluated in thermal cycle testing	Med	Coating survives test cycle without damage to underlying component	5	4th QTR FY20
Coated test specimens evaluated in burner rig	Med	Bond coat functions as part of a total thermal barrier coating (TBC) system, while also protecting from oxidation/hot-corrosion	6	2nd QTR FY22
Coated components evaluated in engine test	High	Uniform, high-quality bond coat functions as part of a total TBC system under operation conditions	7	3rd QTR FY23

HOW

Projected Business Model: DVTI seeks to perform coating services for interested parties or discuss licensing options for the technology. DVTI is operating production scale DVD coating equipment that has been utilized for qualification testing of other turbine coating systems and is in the process upfitting a new manufacturing facility for a separate product line.

Company Objectives: DVTI seeks Original Equipment Manufacturer partners such as General Electric, Rolls-Royce, or others for testing and evaluation programs to qualify and transition this coating and related process. We are also looking for opportunities within the Department of Defense to pursue application of this technology in Maintenance, Repair, and Overhaul of gas turbine engines.

Potential Commercial Applications: Similar coating systems are also applicable to commercial shipbuilding, where gas turbine engines provide propulsion and auxiliary power to such craft as fast ferries, cruise ships, high-speed yachts, and oil and gas carriers.

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