

Department of the Navy SBIR/STTR Transition Program

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NAVAIR JSF19-1006

Topic # N17B-T031

Materials Modeling Tool for Alloy Design to Streamline the Development of High Temperature, High-Entropy Alloys for Advanced Propulsion Systems  
Directed Vapor Technologies International, Inc.

WHO

**SYSCOM:** NAVAIR

**Sponsoring Program:** JSF

**Transition Target:** Propulsion

**TPOC:**

(301)342-8011

**Other transition opportunities:** The technology developed will have broad applicability to defense applications seeking novel high performance alloys.



Source: Air Force Research Laboratory (VIRIN: 120106-F-ZU869-008)

WHAT

**Operational Need and Improvement:** The demand for high efficiency/high thrust gas turbine engines is driving the need for higher temperature capable alloys. Efforts to extend the operational envelop of nickel based superalloy blades are approaching their known limits. It is believed that high-entropy alloys are a potential solution. However, the complexity of such systems necessitates the development of an innovative modeling tool to rapidly identify and transition candidate high-entropy alloys.

**Specifications Required:** The Navy seeks a property-oriented design tool capable of identifying complex alloys that possess a high melting temperature (>1,600 °C); phase stability between 1,200-1,400 °C; and a density lower than current refractory metal alloys.

**Technology Developed:** A materials database, which operates within the Pandat (CompuTherm, LLC) computation engine, has been utilized to identify baseline high temperature alloys meeting the Navy's goals. Physical verification of the alloy performance is on-going, both in thin-film and bulk-alloy forms. The program will conclude with delivery of the design tool and bulk alloys samples of the most promising high-entropy alloy composition for demonstration and evaluation.

**Warfighter Value:** The modeling tool will streamline the development of advanced propulsion systems capable of producing increased thrust and withstanding harsher operating conditions, contributing to air superiority and increased time-on-wing for the warfighter.

WHEN

**Contract Number:** N68335-19-C-0198 **Ending on:** January 21, 2021

| Milestone   | Risk Level | Measure of Success   | Ending TRL | Date           |
|---|------------|--|------------|----------------|
| Lab testing of coupons to validate initial modeling efforts   | N/A        | Performance of alloys aligns with predictions                        | 3          | September 2018 |
| Thermo-mechanical testing of bulk alloy to verify model   | Med        | Performance aligns with predictions and desired operational envelope | 4          | July 2020      |
| Initial alloy data compiled through direct specimen testing   | Med        | Performance aligns with predictions and desired operational envelope | 5          | January 2021   |
| Comprehensive alloy data compiled through direct specimen testing   | High       | Performance aligns with predictions and desired operational envelope | 5          | July 2022      |
| Representative test article(s) evaluated by OEM in simulated engine environment to validate modeling tool | High       | Test article survives simulated operational environment              | 6          | July 2023      |

HOW

**Projected Business Model:** Both the design tools and alloy compositions developed will be licensed to interested parties.

The design tools rely on the Pandat software produced and licensed by CompuTherm, from whom NAVAIR has negotiated non-exclusive, time-limited licensing under the subject contract. Similarly, other parties seeking to develop high entropy alloys will be able to license the databases and software resulting from this contract.

The alloy compositions developed will be separately licensable to turbine engine manufacturers and/or alloy manufacturing, casting, and forging companies.

**Company Objectives:** DVTI seeks to provide research services to commercial partners interested in the development of novel alloy systems. The Company is also interested in expanding its coating services business segment, which utilizes a unique vapor deposition process to apply high quality metal and ceramic coatings onto line-of-sight and non-line-of-sight components.

**Potential Commercial Applications:** The technology developed will have applicability to commercial aviation manufacturing firms and, more broadly, alloy manufacturers, casting, and forging companies seeking to develop high performance alloys.

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