Department of the Navy SBIR/STTR Transition Program

Topic # N211-085
Developing Alloy Compositions Conducive to Additive Manufacturing
Elementum 3D Inc.

WHO

SYSCOM: ONR

Sponsoring Program: ONR SBIR

Transition Target: Air Platforms; Ground/Sea Vehicles

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Other Transition Opportunities: Gas turbines components for propulsion and energy generations
Drones
High velocity missile technologies
Structures requiring corrosion and temperature resistance

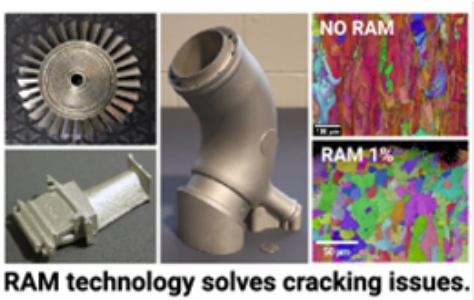

Image Courtesy of Elementum 3D

Notes: The key target industries for Elementum 3D's Reactive Additive Manufacturing (RAM) metal 3D printing feedstocks are military, aerospace, medical, automotive and tooling/heavy machinery. Each market is keenly focused on continued development of existing qualified materials and process and currently use additive manufacturing for current and future work. The image above shows examples of components printed using RAM-containing nickel superalloys, and the colored images are electron backscattered diffraction images showing the grain structure of crack-prone Alloy 230 without RAM (above) and with 1 vol% RAM constituents (below).

WHAT

Operational Need and Improvement: The Navy needs the ability to print reliable, high performance spare parts and components in short lead times to repair and maintain critical equipment and readiness. The project funds the development of a computational modeling framework for rapid alloy development and testing for maximizing alloy printability and performance.

Specifications Required: Development of solidification model that accounts for alloy chemistry; apply model to develop superior materials and validate experimentally.

Technology Developed: A model was developed that considers alloy chemistry and use of RAM to predict the extent of cracking during printing. The initial application of the model was to solve cracking in Alloy 230, and the resulting formulation (Ni230-RAM1) showed no cracking and 60% higher yield strength than wrought Alloy 230. Crack free IN738LC and Rene80 formulations are in development currently.

Warfighter Value: The RAM process has expanded the library of high-performance AM materials. These products deliver fast and flexible Additive Manufacturing (AM) capability to the supply chain to reduce lead times and improve force readiness while improving materials performance compared to traditional manufacturing. RAM enhanced nickel alloys have improved stiffness, strength, hardness, thermal and electrical conductivity, thermal stability, dampening capacity, high cycle fatigue resistance, wear resistance, and elevated temperature properties relative to comparable alloys currently available for additive manufacturing. Proven success in other industries requiring exact material property ranges for mission-critical projects with repeatability and access to large quantities of feedstock (currently supply an automotive customer with over 20 tons of feedstock per year).

WHEN

Contract Number: N68335-22-C-0443 **Ending on:** Aug 15, 2024

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Demonstrate microstructure control through nucleation as predicted by model	Low	Successful testing of Alloy 230 plus inoculation demonstrating a performance increase in mechanical behavior	2	1st QTR FY22
Commercialization of printable Ni230-RAM	Medium	Scaled feedstock production, post processing procedures developed, and marketing materials generated.	4	4th QTR FY22
Apply model to develop IN738LC-RAM and Rene80-RAM	Medium	Successful testing of inoculated IN738LC and Rene80 demonstrating performance increases in mechanical, fatigue, and creep.	3	4th QTR FY23
Commercialization of printable IN738LC and Rene80	High	Scaled feedstock production, post processing procedures developed, and marketing materials generated.	4	2nd QTR FY24
Navy/commercial application testing	Medium	Generate full specimen- and component-level test data and performance ratings and gather feedback from industrial and government partners.	6	4th QTR FY24

HOW

Projected Business Model: Innovative AM feedstock material development and supply to commercial and defense markets; Small scale application development in service of material sales efforts.
• Target mission-critical applications in government, aerospace and motor sport where performance, speed-to-market and resilience are at a premium. Expand product adoption with OEMs, Tier 1 suppliers, printer manufacturers, contract manufacturers, and strategic partners. Supply AM industry with the widest range of high-performance metal-based materials.

Company Objectives: Deliver the most consistent and highest performance aluminum, nickel and copper alloy products in the industry. Capitalize on the RAM process and the company's AM materials experts to ensure the materials are commercially practical and quality and performance are meticulously maintained. Establish aerospace quality verification for mission-critical applications.

Potential Commercial Applications: • Aerospace – jet engine components, heat shields
• Energy production – gas turbine components & heat exchangers
• Commercial marine - propulsion, exhaust, cooling components

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