Topic: N16A-T007

Shepra INC.

Optimized High Performance Stainless Steel Powder for Selective Laser Melting Additive Manufacturing (AM)
Additive Manufacturing (AM) has the potential to revolutionize the way the Navy procures, maintains and utilizes aircraft, ships and submarines. SHEPRA has developed a process to incorporate nanotechnology materials in the form of carbon nanotubes in metal powders for use in metal AM. The nature of this technology allows for the use of any metal alloy and results increases in the overall Strength, Stiffness and Thermal and Electrical Conductivity. With the use of this technology it is now possible to AM fabricate components consistent with wrought metal properties. Applications include the maintenance and sustainment or new product development with enhance capabilities. SHEPRA is currently working with AM material suppliers, system manufacturers and DoD primes to create an ecosystem to most effectively deliver this technology to the Navy and other DoD services.

Technology Category Alignment:

Readiness
Sensors, Electronics and Photonics
Structures and Protection

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SYSCOM: NAVAIR
Contract: N68335-18-C-0093

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Department of the Navy SBIR/STTR Transition Program

Pending SYSCOM Review

Topic # N16A-T007

Optimized High Performance Stainless Steel Powder for Selective Laser Melting Additive Manufacturing (AM)

Shepra INC.

WHO

SYSCOM: NAVAIR

Sponsoring Program: Naval Air Systems Command

Transition Target: Support maintenance and sustainment of the Navy aircraft, ships and submarines

TPOC:
(301)342-0297

Other transition opportunities: The use of carbon nanotubes in metal Additive Manufacturing (AM) has the potential to revolutionize the way the Navy procures, maintains and utilizes aircraft, ships and submarines. This program is part of a portfolio of high performance, multi-functional metals being developed for AM. Efforts with the Navy, Army and Air Force, have demonstrated the ability AM produce components with: (1) wrought property or better strength and stiffness for maintenance and sustainment applications and new product development, (2) Increased thermal conductivity (hypersonic structures) and electrical conductivity (EMI shielding) and (3) improve the AM processability of materials such as copper and aluminum.

Top Images: Courtesy of Naval Air Systems Command, Distribution A (SPR #2018-308), Bottom Images: Courtesy of SHEPRA, Inc

Notes: SHEPRA's Additive Manufacturing research and development activities address two of the three Navy metals of interests

WHAT

Operational Need and Improvement: Additive Manufacturing (AM) has the potential to increase the overall Mission Readiness and capabilities of the Navy. One of the current limitations of AM is achieving the required wrought mechanical properties for use in maintenance and sustainment or new product development. AM of carbon nanotube metal matrix components gives the Navy an unprecedent capability to produce new components and systems with superior performance at faster speeds and lower cost at or near the theater of operation.

Specifications Required: The threshold requirement of this program is to develop a carbon nanotube metal matrix composite for use in Additive Manufacturing (AM) that can be used as a replacement for H1025 precipitation hardened 17-4 stainless steel per the ASTM A594 specification with the use of heat treatment. The objective requirement is to achieve ASTM A594 specifications for H900, 17-4 stainless steel without the use heat treatment.

Technology Developed: A process and method to incorporate nanomaterials such as carbon nanotubes into powdered metal to create a metal matrix composite for use in Powder Metallurgy applications such as Additive Manufacturing, Cold Spray, Die Casting, Metal Injection Molding, High Velocity Oxygen Flame Spray (HVOF) and other manufacturing processes. The advantage of the metal matrix composite is that the physical and chemical nature of the nanomaterials will provide increase strength and stiffness that will open up new maintenance and sustainment and new product development applications not possible with current Powder Metallurgy processes including Additive Manufacturing. In addition, these metal matrix composites will exhibit increased thermal and electrical conductivity thereby providing some measure of multi-functionality.

Warfighter Value: Additive Manufacturing provides an unprecedented opportunity to improve the Mission Readiness and Mission Capability of the Warfighter. Carbon nanotube metal matrix composites used in metal Additive Manufacturing give the warfighter the ability to make anything at any time in any place with materials that are stronger and stiffer than the conventional wrought materials currently in use now. In short, mobility, agility and lethality that is affordable and available.

WHEN

Contract Number: N68335-18-C-0093 **Ending on:** July 1, 2021

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Processing of commercially available Carbon Nanotubes	Med	Laboratory Analysis	2	November 2016
Dispersion of Carbon Nanotubes in metal powder	High	Photo Microscopy	2	November 2016
Demonstration of Wrought Properties	Med	Mechanical Testing	3	December 2018
Optimization of AM Processing Parameters	Low	Mechanical Testing	4	July 2020
Development of Mechanical Property Database	N/A	Mechanical Testing	4	January 2021
Fabrication and Demonstration of Prototype	Low	Successful operation	6	June 2021

HOW

Projected Business Model: The commercial product in question is manufacture of carbon nanotube metal matrix composite powders that can be used in a multitude of Powder Metallurgy manufacturing processes. The initial focus will be on the Additive Manufacturing market with branching into other markets (e.g. Cold Spray, Die Cast, etc) as time goes on. For metal Additive Manufacturing, a commercial raw materials supply chain of carbon nanotubes and metal powders has been demonstrated. Second, a multi-path sales channel to deliver the carbon nanotube metal matrix composite powder to the Navy via Additive Manufacturing system suppliers, DoD Prime Contractors and the General Services Agency (GSA) has been established. Given the broad application and customer base for this material a scaleable manufacturing model is required. Initial operations will begin as a tolling operation to fabricate orders on demand. Production capacity growth will occur from organic capacity expansions, the formation of joint ventures and licensing of the technology.

Company Objectives: Looking to better understand customer's needs of military and commercial markets. Identify specific use cases and determine unmet or unknown needs, specifically, what metal alloy systems are of interest to the military and commercial markets. Make connections to conventional Powder Metallurgy manufacturers to better understand needs, use cases and the market.

Potential Commercial Applications: The current lead applications in Additive Manufacturing (AM) are Aerospace and Medical implants. Commercial Aircraft companies Boeing and Airbus have announced plans to use AM in civil aviation applications. Similar to the Navy, Caterpillar (Heavy Industrial Equipment) and Baker Hughes (Oil Exploration) have identified AM as a way to do maintenance and repair in remote austere environments. General commercial applications include the fabrication of functional prototypes, fabrication and repair of tooling. Finally use as raw materials in traditional Powder Metallurgy manufacturing operations.

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