Topic: N15A-T008

Applied Optimization, Inc.

In Situ, Nondestructive Inspection During Additive Manufacturing of Metallic Parts

Since 1995, Applied Optimization, Inc. (AO) has collaboratively developed innovative solutions in material science to address technical challenges for industry, NASA, and the DoD. AO is developing a hardware-software system for layer-by-layer nondestructive inspection and near-real-time determination of spatial distribution material defects in metallic parts, fabricated via selective laser melting (SLM) processes. AO's hardware is comprised of off-the-shelf laser scanners (profilometer) and precision linear motion, implemented into the deposition chamber of commercial SLM equipment. AO's software implements signal processing algorithms for data reduction and processing of collected 3-D top-surface build geometry/roughness data to predict material defects. AO's capability employs physics-based models to correlate the phenomenology of interaction between surface roughness and material defects and to provide voxel-by-voxel anomaly flagging. AO seeks to identify DoD Prime contractor and Programs focused on AM to include selective laser melting (SLM) process optimization.

Technology Category Alignment:

Test, Evaluation, Validation, and Verification

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SYSCOM: NAVAIR

Contract: N68335-17-C-0149

Corporate Brochure: https://navystp.com/vtm/open_file?type=brochure&id=N68335-17-C-0149

Department of the Navy SBIR/STTR Transition Program

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NAVAIR 2018-679

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Applied Optimization, Inc.

WHO

SYSCOM: NAVAIR

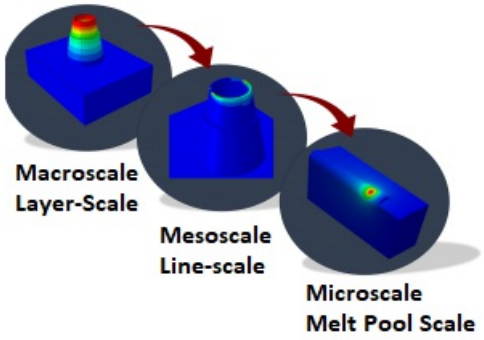
Sponsoring Program: Nondestructive Inspection Engineering Team at Naval Air Warfare Center Aircraft Division

Transition Target: Aircraft Launch and Recovery Equipment (ALRE) and Support Equipment (SE) Systems

TPOC:
(301)342-8020

Other transition opportunities: DoD adaptive manufacturing (AM) components

Notes: Applied Optimization (AO) has developed multiple software packages that focus on simulating additive manufacturing processes. Additive manufacturing (AM) is the process of building an object layer-by-layer (3D printing). 3D printing with metal can lead to a large number of defects and surface roughness issues that develop during deposition. These issues can greatly affect the integrity of the material.



WHAT

Operational Need and Improvement: Additive Manufacturing (AM) inspection and monitoring methods are desired that can inspect and collect data during the build process - an approach to inspection that allows each layer to be inspected before the next layer is built on top of it. The inspection system should, at a minimum, be able to detect physical defects that are common to that AM process. Typical physical defects include problems like porosity and lack of fusion. The ideal inspection system should not only be able to detect physical defects, but also capture information that can be used to accurately estimate material properties of the final part.

Specifications Required: Capability to: (1) Collect layer-by-layer build geometry and powder recoat data; (2) Determine the spatial distribution of the probability of material defects; (3) Characterize the probability of detection (POD); (4) Employ, physics-based models, to correlate the phenomenology of interaction between surface roughness and material defects; and (5) Demonstrate a voxel-by-voxel Anomaly Flagging System.

Technology Developed: AO has developed a prototype hardware-software system to perform layer-by-layer nondestructive inspection and near-real-time determination of the spatial distribution and probability of material defects in a metallic part as it is fabricated using selective laser melting (SLM) processes. AO's hardware is comprised of an off-the-shelf laser scanner (profilometer) with precision linear motion, implemented into the deposition chamber of commercial SLM equipment. AO's software includes signal processing algorithms to support data reduction and to process 3-D top surface build geometry/ roughness data to determine the probability of material defects. The hardware-software prototype collects and processes data in a time scale that minimally impacts the operational efficiency of the SLM process.

Warfighter Value: Advanced inspection and monitoring methods that inspect and collect data during AM build processes for Ti-6Al-4V or PH17-4 stainless steel components ensure component integrity, and potentially extends the life of AM parts.

WHEN

Contract Number: N68335-17-C-0149 **Ending on:** April 30, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Construct a prototype inspection system that collects data during the AM process	Low	Software interfaces with end user hardware that perform to specifications	TRL-4	February 2018
Demonstrate ability to collect appropriate data during the AM build and model material properties and defect locations in the part	Low	T&E of data collection processes	TRL-4	July 2018
Development of a physics-based model that correlates data collected with changes in the NDI response to a defect in the AM test part	Low	Correlation of observed data against model	TRL-4	September 2018
Validate models though additional test coupons, followed by destructive testing and metallography.	Med	Correlation between model and destructive evaluation	TRL-5	March 2019

HOW

Projected Business Model: The Additive Manufacturing (AM) team at Applied Optimization, Inc. (AO) focuses on research and development in metallurgy and metals processing. AO plans to work with government and Department of Defense (DoD) prime contractors to develop viable solutions to complex problems in the area of metal additive manufacturing (3D printing metal) in order to meet DoD AM component performance requirements.

Company Objectives: Since 1995, Applied Optimization, Inc. (AO) has collaboratively developed innovative solutions in material science to address the technical challenges of commercial industries, NASA, and the DoD. Offering the right balance between critical thinking and non-conformity, AO's team of scientists, engineers, mathematicians, and software developers strive to further the understanding and state-of-the-art of additive manufacturing (AM), materials processing. AO intends to leverage the DoD SBIR program to develop software capabilities that optimize AM process parameters, mitigating defects in AM parts and processes.

Potential Commercial Applications: AM has wide interest in manufacturing, worldwide. Quality control of AM parts is critical when facilitating the transition of AM components into critical applications. AO's technology has broad applicability in aerospace, automotive, and medical commercial industries.

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