



NIST
National Institute of
Standards and Technology

SBIR

**SMALL BUSINESS INNOVATION
RESEARCH PROGRAM**

**ABSTRACTS OF PHASE I and PHASE II
AWARDS FOR FISCAL YEAR 2016**

INTRODUCTION

Abstracts of Awards for Fiscal Year 2016 SBIR Program

Note: Certain non-ASCII characters may not be represented accurately in this document. In cases where there may be doubt, please direct your questions to sbir@nist.gov.

Fiscal Year 2016 List of Awardees

<u>Award Number</u>	<u>Company Name</u>	<u>Open Topics/Topic Areas</u>	<u>Phase</u>
70NANB16H177	Automated Precision, Inc.	Advanced Sensing for Manufacturing	Phase I
70NANB16H185	AxNano, LLC	Lab to Market	Phase I
70NANB16H182	Bridger Photonics, Inc.	Advanced Sensing for Manufacturing	Phase I
70NANB16H186	Innoveering, LLC	Advanced Sensing for Manufacturing	Phase I
70NANB16H180	MicroXact Inc.	Advanced Sensing for Manufacturing	Phase I
70NANB16H183	Omega Optics Inc.	Advanced Sensing for Manufacturing	Phase I
70NANB16H181	Optofluidics, Inc.	Biomanufacturing	Phase I
70NANB16H184	Quantum Diamond Technologies Inc.	Advanced Sensing for Manufacturing	Phase I
70NANB16H189	Symbio Robotics, Inc.	Advanced Sensing for Manufacturing	Phase I
70NANB16H179	Vermont Photonics Technologies Corp.	Advanced Sensing for Manufacturing	Phase I
70NANB16H188	XCSpec, Inc.	Cyber-Physical Systems	Phase I
70NANB16H187	XploSafe	Advanced Sensing for Manufacturing	Phase I
70NANB16H191	3DSIM LLC	Advanced Manufacturing	Phase II
70NANB16H195	AdSem, Inc.	Advanced Manufacturing	Phase II
70NANB16H178	Categorical Informatics, Inc.	Advanced Manufacturing	Phase II
70NANB16H190	InfoBeyond Technology LLC	Cybersecurity	Phase II
70NANB16H192	Object Security LLC	Cybersecurity	Phase II
70NANB16H193	Weinberg Medical Physics LLC	Advanced Manufacturing	Phase II
70NANB16H194	Z-senz LLC	Technology Transfer	Phase II

FY 2016 PHASE I AWARD

Topic: Advanced Sensing for Manufacturing

Subtopic: Absolute Interferometry with Nanometer Precision

Title: Nanometer Precision Absolute Linear Interferometer

Firm: Automated Precision, Inc.
15000 John Hopkins Dr.
Rockville, MD 20850

Principal Investigator: Yongwoo Park

Phone: (240) 269-0400

Email: Yongwoo.park@apisensor.com

Award Amount: \$98,750.00

Abstract: The goal of this Phase I project is to develop an affordable, accurate, and rapid absolute interferometric length measurement technique with improved repeatability and accuracy. API has a patent-pending technology, Frequency-Modulated Time-to-Frequency Mapping Interferometer (FM-TFMI), that is an absolute interferometer capable of measuring at high speed and with exceptionally high accuracy. The TFMI uses a fiber Bragg grating to provide great system design flexibility in terms of scalability of measurement range that no other methods can possibly afford without compromising measurement accuracy or speed. In Phase I, we demonstrate its capability in terms of range, accuracy, repeatability and speed.

Commercial Applications: Modern industrial manufacturing in defense, energy, aerospace, automobile, etc. employs more and more additive manufacturing methods where sustainability and reusability of parts are emphasized for improved durability and reduced cost. The ability to perform highly accurate and time efficient non-contact part inspection on site is becoming increasingly important for the advanced manufacturing. Combined with high speed scanning capability, this proposed technique can be used for a high speed 3D surface scanner with ultra – high resolution and high sensitivity. It will allow to perform time-efficient and accurate surface inspection by imaging and detecting defect, crack, corrosion, and wear on part.

Topic: Lab to Market

Subtopic: NIST Technology Transfer

Title: Bimetallic Zero Valent Iron-Carbon Composites for In Situ Remediation: Improving Particle Lifetime, Reactivity and Transport

Firm: AxNano, LLC
527 Bridge Street, Suite 301
Danville, VA 24051-1405

Principal Investigator: Alexis Wells Carpenter
Phone: (540) 818-2000
Email: alexis.carpenter@triadgrowthpartners.com

Award Amount: \$99,275.00

Abstract: The Environmental Protection Agency (EPA) estimates that one out of every four Americans lives within three miles of a hazardous waste site. Recent developments in advanced treatment materials has led to improvements driving increased use of In Situ Chemical Reduction (ISCR) at Superfund sites in the US and other contaminated zones around the world. Nanoscale Zero Valent Iron (NZVI) holds great potential for ISCR due to its low cost and high reactivity towards degrading halogenated and heavy metal contaminants. However, two major technical challenges prevent wide-spread NZVI adoption: 1) agglomeration, which prevents transport in the subsurface; and 2) passivation, which decreases reactivity to contaminants. AxNano, in collaboration with University of Arkansas, has developed a novel, three-component composite composed of bimetallic NZVI on a carbon-based substrate. This innovative composite design simultaneously addresses both technical challenges by preventing aggregation and slowing passivation, all while promoting reductive degradation of contaminants. This Phase I SBIR work effort will evaluate the ability of the AxNano composites to degrade trichloroethylene (TCE), transport through porous media, and to maintain composite stability under various environmental conditions. The result of this SBIR program will be a novel, low-cost remediation technology with broad-spectrum efficacy to meet market and society needs.

Commercial Applications: The global environmental remediation technology market was valued at \$61.7 billion in 2014 and is forecasted to expand to \$80.5 billion in 2019. In Situ Chemical Oxidation/Reduction are the fastest growing areas in the remediation. While nanoscale zero valent iron (NZVI) is recognized as the most promising material for In Situ Chemical Reduction, the market does not currently have a viable NZVI product. AxNano is developing an NZVI-based composite that is safer to handle, easier to deploy, and is expected to exhibit superior performance in contaminated zones for longer treatment periods with a single application.

Topic: Advanced Sensing for Manufacturing

Subtopic: Absolute Interferometry with Nanometer Precision

Title: Absolute Distance Interferometer for Manufacturing Metrology Applications

Firm: Bridger Photonics, Inc.
2310 University Way, Bldg. 4-4
Bozeman, MT 59715-6504

Principal Investigator: Michael J. Thorpe
Phone: (406) 585-2774
Email: thorpe@bridgerphotonics.com

Award Amount: \$99,732.00

Abstract: Bridger Photonics, Inc. will develop an absolute length metrology sensor that will simultaneously provide >1,000 measurements per second, <10 nm precision, and >0.5 m maximum measurement distance. Bridger's solution is will fill a gap in precision measurement technology for applications that require rapid monitoring of macroscopic distances such as positioning and calibration of surface metrology systems (CMM, AFM, SEM), aspheric and freeform optics manufacturing, wafer positioning and optic alignment for the semiconductor industry, and part mapping and positioning for laser materials processing applications. Bridger's solution will enable several measurement scenarios that are not possible using traditional interferometry such as resolving reflections from multiple surfaces, performing thickness measurements, tracking discontinuous steps, and measuring high-relief or rough surfaces.

Commercial Applications: The proposed distance measurement technology has several commercial applications in precision manufacturing. Bridger anticipates the initial applications will be surface characterization for improved manufacturing of aspheric and freeform optics, and closed-loop process control and rapid part mapping for the laser materials processing industry. Other applications include alignment, and calibration of advanced optical assemblies for the semiconductor manufacturers and manufacturers of imaging interferometers. Other potential applications involve providing calibrated and traceable positioning for advanced manufacturing and research activities that use coordinate measurement machines, atomic force microscopes, and scanning electron microscopes.

Topic: Advanced Sensing for Manufacturing

Subtopic: High Temperature In Situ Pressure Sensor

Title: High Temperature High Resolution in-situ Differential Pressure Sensor

Firm: Innoveering, LLC
100 Remington Boulevard
Ronkonkoma, NY 11779-6910

Principal Investigator: Nicholas Tiliakos
Phone: (631) 219-3483
Email: nick.tiliakos@innoveering.net

Award Amount: \$99,692.29

Abstract: Chemical manufacturers require high accuracy and high sensitivity pressure sensors to efficiently monitor the various manufacturing systems and processes in the chemical plant, to

ensure any changes proceed in a safe and reliable manner, adhering to expected standards and practices. In addition, NIST has a need for highly accurate absolute and differential pressure measurements, especially for determining the thermo-physical properties of fluids. Such measurements must be made at the highest standard possible. Since the market is currently limited in the availability of such pressure sensors, i.e. possessing a combination of high accuracy/high temperature capability with excellent accuracy, NIST is seeking a high temperature, in situ, pressure sensor that can achieve better performance than the current state-of-the-art. Innoveering will develop an innovative, compact High Temperature High Resolution (HTHR) in-situ differential pressure (DP) sensor that leverages our team's MEMS pressure die technology, which utilizes piezo-resistive elements to sense differential pressure as well as an over-pressure protection feature to ensure reliable and safe operation to meet NIST's requirements. Our team brings together experts in the design/fabrication/testing and application of harsh environment pressure sensors, MEMS microfabrication techniques as well as packaging/welding techniques for these types of high pressure high temperature sensors.

Commercial Applications: The potential commercial applications for the solution we are proposing are numerous, with applications from machinery health monitoring, smart process plan control/monitoring, monitoring of processes in chemical plants, oil refineries/petrochemical sector, to power plant monitoring. Our HTHR DP sensor will be at the cutting edge of CSOTA pressure sensing capabilities, providing a need not currently available, meeting all of NIST's requirements while also accomplishing this in a very small factor and in a cost effective product. Our HTHR sensor also has the ability to behave like a smart transmitter by not requiring pressure compensation with extraneous electronics.

Topic: Advanced Sensing for Manufacturing

Subtopic: High-Density Cryogenic Probe Station

Title: High Density Semi-Auto Closed Cycle Cryoprober

Firm: MicroXact Inc.
1750 Kraft Drive, Suite 1007
Blacksburg, VA 24060-6375

Principal Investigator: Vladimir Kochergin

Phone: (540) 394-4040

Email: vkochergin@microxact.com

Award Amount: \$99,978.98

Abstract: High density wafer scale cryogenic probing solution for testing at 4.5K temperatures or below is needed for testing and characterization of devices and circuits employing superconducting electronic components (such as used for quantum processing, high speed classical processing, magnetic field sensors, etc.) as well as for testing of various particle and light detectors for astronomy, aerospace, defense and homeland security applications. MicroXact

Inc. will develop a semi-automated, closed cycle, wafer scale high density cryogenic probe station for testing at below 4.5K to 300K or higher. In Phase I MicroXact will finalize the performance specifications, will develop mechanical model and design, and will verify system performance via simulations.

Commercial Applications: Due to the unique technical advantages over competing technologies, the proposed high density cryogenic probe station is expected to find a number of applications in NIST testing sensors and electronic components for industrial materials analysis, nuclear security, concealed weapons detection, astrophysics as well as for testing classical and quantum processors employing superconducting elements. A similar need for such a solution exists at DoD, where a number of DoD laboratories and OEMs are using various sensors operating at cold temperatures as well as developing signal processing hardware employing superconducting elements.

Topic: Advanced Sensing for Manufacturing

Subtopic: Design of Fiber-coupled Waveguide Difference Frequency Generation Devices

Title: Fiber Pigtailed On-Chip Mid-infrared Difference Frequency Generation in Silicon

Firm: Omega Optics Inc.
8500 Shoal Creek Blvd.
Austin, TX 78757-6856

Principal Investigator: Swapnajit Chakravarty
Phone: (512) 996-8833
Email: swapnajit.chakravarty@omegaoptics.com

Award Amount: \$100,000.00

Abstract: Omega Optics will develop a fiber-coupled platform in strained silicon-on-sapphire (SoS) for tunable difference frequency generation in midwave infrared (MIR) with tunable continuous wave sources in the near-infrared (NIR). Stress exerted by silicon nitride on underlying silicon induces second-order nonlinear susceptibility. NIR light is coupled into silicon and MWIR light is coupled out of silicon using extensively demonstrated sub-wavelength grating couplers in both NIR and MWIR. Preliminary modal phase matched designs between pump, signal and idler indicates the potential to achieve conversion efficiency greater than 0.1 W⁻¹ with second-order nonlinear susceptibility ~10pm/V in a 1cm long silicon waveguide on sapphire. Experimentally demonstrated sub-1dB/cm propagation loss at NIR pump and signal wavelengths, ~2dB/cm propagation losses in MWIR idler wavelengths in silicon waveguides, together with less than 2.5dB insertion loss in fiber-chip polarization selective grating coupling allow high efficiency power conversion. Two-photon absorption (TPA) and in particular, TPA induced free carrier absorption (FCA), significant at MWIR will be controlled by experimentally demonstrated p-i-n geometries that reduce the silicon free carrier lifetime from nano-seconds to pico-seconds. Fabrication induced effects on coherence and geometries to achieve quasi phase

matching will also be investigated, relative merits and demerits compared for implementation in Phase II.

Commercial Applications: Frequency-mixed MWIR can be generated over a much wider wavelength range than that possible from a single quantum cascade (QCL) or interband cascade laser (ICL). QCLs/ICLs are expensive and require dependence on expensive epitaxial growth techniques. Tunable silicon chip integrated MWIR sources are very desirable for Omega Optics' on-chip absorption spectroscopy applications by slow light enhanced chemical warfare simulant sensing. The generalized design of the proposed versatile technology implies possible implementation in multiple areas and markets such as food, air and water quality, health, environment and national security via integration with demonstrated silicon passive sensors.

Topic: Biomanufacturing

Subtopic: Measurement Tools to Advance the Development and Manufacturing of Biologic Medicines

Title: Protein Qspec: An Improved Method for Rapid Characterization of Protein Aggregates in Biologic Drugs for Increased Quality and Safety

Firm: Optofluidics, Inc.
3711 Market Street, Suite 970
Philadelphia, PA 19104-5504

Principal Investigator: Robert Hart
Phone: (215) 970-2685
Email: hart@opfluid.com

Award Amount: \$99,993.18

Abstract: Optofluidics will develop Protein Qspec, a new particle analysis QC instrument designed to characterize protein aggregates in biologic drugs. The primary concern for this class of therapeutics is that they can elicit an immune response from patients who develop anti-drug antibodies which can eliminate the therapeutic benefit. The presence of particulate matter, in these therapeutics (e.g. shed glass from a syringe or a protein aggregate) enhances this immune response and the FDA therefore regulates the amount of particles that can be present. Although these particles can be counted scientists rarely know what the particles actually are due to lack of effective analysis equipment. The proposed Qspec will fill this need by rapidly capturing particles on a microfabricated sieve followed by rapid FTIR microscopy. Early proof of concept work shows analysis to be about an order of magnitude faster than existing forensic instruments. A QA/QC tool that can identify particles and, if they're proteins, thoroughly characterize them with spectroscopy, would help pharma companies make better decisions to make stable and safe formulations of biologic drugs as well as detect problems earlier on and forestall manufacturing or safety issues.

Commercial Applications: Optofluidics will develop Protein Qspec, a new particle analysis instrument with associated consumables. The target application and benefits were discussed with biologic formulation and manufacturing experts who offered guidance on important features, system specifications and identification of the most pressing issues. The consensus is that Protein Qspec will have the biggest impact and adoption in the formulation stage of biologic product life cycle. Following commercial success there, the instrument would ultimately reach manufacturing “fill and finish” sites as a quality control tool.

Topic: Advanced Sensing for Manufacturing

Subtopic: Quantitative Magnetometry of Single Nanoparticles with High Throughput

Title: High-Throughput Single-Nanoparticle Magnetic Analysis Platform Using Diamond Magnetic Imaging

Firm: Quantum Diamond Technologies Inc.
28 Dane St.
Somerville, MA 02143-3748

Principal Investigator: Colin Connolly
Phone: (617) 440-4484
Email: cconnolly@quantumdiamondtech.com

Award Amount: \$81,000.00

Abstract: Magnetic nanoparticles are powerful tools over a wide range of industries, but have particularly powerful biomedical applications for clinical and research diagnostics, clinical therapy, and basic life science research. These applications require consistent sources for magnetic nanoparticles with narrow distributions of magnetic properties, but no technology is now commercially available for manufacturers or users to quantify single-particle magnetic properties with sufficient throughput to provide cost-effective, efficient quality control. Some particle uses, including magnetic separation and magnetic diagnostics, rely on superparamagnetism and suffer reduced performance, such as unwanted particle interactions and aggregation, due to ferromagnetic behavior in a subset of particles. However, this ferromagnetic particle subset can be obscured by ensemble measurements.

Quantum Diamond Technologies has developed a high-throughput magnetic particle analysis platform using magnetic imaging with quantum defects in diamond. Our system can quantitatively analyze, with high sensitivity and precision, thousands of magnetic particles in parallel in a matter of minutes with a simple benchtop system. We will adapt this system in Phase I to measure ferromagnetic nanoparticles smaller than 100 nm with similar high throughput. With further development, our underlying magnetic sensing technology can additionally provide vector magnetometry, time-resolved magnetic response, and measurement of particle magnetic anisotropy.

Commercial Applications: Magnetic bead products for immunoassays comprise a \$1 billion market. A lack of cost-effective commercial technology for high-throughput single-particle analysis impedes robust quality control, which hinders reproducibility and stymies novel innovative uses for magnetic particles. A benchtop particle analysis system with low cost and high throughput will enable particle manufacturers to perform needed testing and reporting of magnetic particle uniformity and monitor lot-to-lot variation, adding value to their particle product offerings and providing a means for competitive differentiation. Particle users will benefit from a low-cost means to directly probe distributions of particle parameters critical to application performance.

Topic: Advanced Sensing for Manufacturing

Subtopic: Object Identification and Localization via Non-Contact Sensing for Enhancing Robotic Systems in Manufacturing Operations

Title: Part Identification and Localization via Deep Neural Networks

Firm: Symbio Robotics, Inc.
2150 Shattuck Ave.
Berkeley, CA 94704-1345

Principal Investigator: Mitchell Adler
Phone: (248) 225-7710
Email: mitch@symbiorobotics.com

Award Amount: \$99,991.56

Abstract: Symbio Robotics is developing a robust, fast, and low-cost perception engine for identifying parts and detecting their six degree of freedom pose. Our perception engine is driven by deep convolutional neural networks and draws upon recent advances in computer vision and deep learning. Current automation systems largely run blind, without perception driven feedback. Our proposed system seeks to close that feedback loop and unlock new levels of performance in industrial automation at this time of rapid change in the domain of manufacturing.

Commercial Applications: Rising global labor costs have spurred a new wave of interest in industrial automation. The future generation of industrial automation systems will be highly flexible and adaptable to greater variability and faster product cycles. To meet these new demands, manufacturers and systems integrators systems must acquire robust, fast, and low-cost perception systems to serve as a core part of their factory automation.

Topic: Advanced Sensing for Manufacturing

Subtopic: High-Accuracy Angle Generator for Precision Measurements

Title: High-Accuracy Angle Generator for Precision Measurements

Firm: Vermont Photonics Technologies Corp.
22 Browne Court
Brattleboro, VT 05301-4428

Principal Investigator: Christian Guertin

Phone: (802) 275-5210

Email: cguertin@vermontphotonics.com

Award Amount: \$97,023.00

Abstract: A lack of extreme angular metrology accuracy better than 50 nrad is limiting progress in molecular characterization by x-ray diffraction for important industrial fields such as material science and biotechnology. If we want to advance these fields, a high-accuracy angle generator for characterizing the metrology device across its entire measuring range must be a part of the national metrology tool set. At present, no such tool exists at the 50 nrad accuracy level. Using an established calibration technique, we will use an optimized arrangement of the minimum necessary number of angle encoder read heads optimally positioned around a rotary table encoder ring to minimize calibration error propagation. An arrangement that, thus far, has not been realized by any other group. The removal of the graduation errors of the encoder ring has been shown to improve the angular position uncertainty by a factor of approximately 800 and we will compare our results to these prior results. This work will enable us to make additional improvements and extensions for a full realization of a prototype high-accuracy angle generator.

Commercial Applications: An extreme high-precision angle generator will fill a gap in metrology capabilities of the United States. It will enhance our existing calibration services and enable better characterization of off-the-shelf autocollimators. Better characterization will expand potential markets for autocollimators in general. The angle generator itself will also be attractive as a commercially available product to government and industrial laboratories.

Topic: Cyber Physical Systems

Subtopic: Novel Methods for Determining Commercial Building Envelope Airtightness

Title: Air Movement Efficiency Monitor

Firm: XCSpec, Inc.
300 Riviera Circle
Larkspur, CA 94939-1544

Principal Investigator: Jeff Aalfs
Phone: (650) 575-4238
Email: jeff@xcspec.com

Award Amount: \$95,925.00

Abstract: The Air Movement Efficiency Monitor is composed of small, inexpensive Micro-electromechanical system (MEMS) sensors, connected wirelessly to the Internet, and distributed through a building to measure pressure readings at key points. We consider this a “FitBit” for a building’s air-movement efficiency, employing many of the sensors used by a fitbit – temperature, humidity, acceleration. We expand on that concept and incorporate new emerging sensors from the drone and wearables industries, allowing our system to capture high-resolution absolute and differential pressure data, along with information from the fan shaft speed. These various sensors are deployed on a multi-sensor module and connected wirelessly to the system – exposing this previously hidden information at an affordable cost, with a small form factor and low power profile. This information is continuously monitored and can be used for a number of applications including: duct leakage, air balancing and fan efficiency measurement. The aggregated data is curated using flow network model simulations to calculate envelope leakage and duct leakage for the building, along with alerts or alarms to maintenance, building occupants or building managers. This “Performance” based approach to building efficiency provides a EM&V basis for more sustainable energy savings.

Commercial Applications: Commercial buildings are plagued by uncontrolled air movement and leakage through the buildings shell and air distribution ducts. Uncontrolled airflow leads to major increases in energy and operating costs. Existing methods to determine duct leakage are expensive and disruptive to the occupants. The Air Movement Efficiency Monitor is an in-situ monitor that can be installed with minimal disruption to the building occupants and left to collect continuous time-series data on building and duct leakage. This information is used to determine the ROI for energy upgrades to existing buildings, leading to improved energy performance and lower operating costs.

Topic: Advanced Sensing for Manufacturing

Subtopic: Pre-Concentration Technology for Analysis of Halocarbon Gases at Trace Levels

Title: Pre-concentrator for Capture of Trace Fluorocarbons

Firm: XploSafe
3514 N Park Drive
Stillwater, OK 74075-2505

Principal Investigator: Evgueni Kadossov
Phone: (400) 533-45720
Email: evgueni@xplosafe.com

Award Amount: \$100,000.00

Abstract: While fluorocarbons are released in relatively small amounts, they can have half-lives in the atmosphere as long as 50,000 years. However, they have extremely high global warming potential relative to other greenhouse gases, so that even small atmospheric concentrations can have large effect on global temperatures. For this reason, monitoring atmospheric concentrations of these compounds, identifying the sources of their emission, and estimating the quantities released is extremely important. Due to their very low atmospheric concentrations, a method to pre-concentrate the gases to significantly improve detection limits and quantification capabilities is necessary. The proposed research will aim to demonstrate the technical feasibility of novel sorbents that have very high affinity and selectivity for sorption of fluorocarbons due to nanoconfinement and fluororous phase molecular interactions. The sorbent will be used to produce and test a pre-concentrator for these target compounds.

Commercial Applications: XploSafe envisions the successful implementation of the proposed technology as a leading innovation that can enable field analysis of air samples in atmospheric monitoring applications. The need for the proposed portable technology specifically in the pre-concentration and sampling of fluorinated gases arises from personnel engaged in the installation, servicing, charging and leak testing of chillers, refrigeration systems and air-conditioning systems. The proposed field deployable pre-concentrator has the potential to expand the application of advanced analytical measurement and quantification devices by facilitating an active, in-situ approach towards emission source identification and estimation of the quantity released.

Topic: Advanced Manufacturing

Subtopic: Predictive Modeling Tools for Metal-Based Additive Manufacturing

Title: Predictive Modeling Tools for Metal-Based Additive Manufacturing: A Composable Simulation Model for Metal Powder-bed Fusion Additive Manufacturing Processes

Firm: 3DSIM LLC
1794 Olympic Pkwy.
Park City, UT 84098-6388

Principal Investigator: Nachiket Patil
Phone: (502) 619-4035
Email: nachiket.patil@3dsim.com

Award Amount: \$300,000.00

Abstract: Additive manufacturing lacks efficient, composable physics-based computational frameworks to predict quality and performance for arbitrary geometry, orientation, location and process parameter combinations. A new set of composable computational tools capable of accurately predicting the geometrical accuracy, residual stress and microstructure of the parts

made using metal based AM has been developed. The tool(s) demonstrate scaling and composability of models to support geometry-independent reusability while providing a range of parameter values (e.g. user-defined build orientation, laser power, scan speed, hatch pattern, recoat time, material properties, powder layer thickness, choice of mesh motifs, and more) supporting reliability and accuracy.

Commercial Applications: It is estimated that tens of thousands of dollars are wasted per machine per year in unnecessary support material costs, post manufacturing labor part finishing, and material lost due to failed builds. A composable set of simulation tools would help predict residual stress and strain data to identify the minimum amount per part. There is a significant demand for software simulation tools to optimize the economics of Additive Manufacturing.

FY 2016 PHASE II AWARD

Topic: Advanced Manufacturing

Subtopic: Tuning Germanium Crystal Reflectivity and Mosaic

Title: Tuning Germanium Reflectivity and Mosaic

Firm: AdSem, Inc.

855 Sevely Dr.

Mountain View, CA 94041-1601

Principal Investigator: Michael Kozhukh

Phone: (650) 625-0642

Email: mkozuhk@sbcglobal.net

Award Amount: \$300,000.00

Abstract: Mosaic crystalline monochromators define performance of neutron scattering devices employed in condensed matter research on research nuclear reactors. This project is devoted to development of a manufacturing technique for slow neutron Germanium mosaic monochromators with reflectivity exceeding reflectivity of pyrolytic graphite crystals. Germanium has small slow neutron absorption; its diamond crystal structure has a many more crystallographic orientations useful for neutron and x-ray scattering than pyrolytic graphite and for many orientations second orders of reflections in Germanium are prohibited. The proposed manufacturing technique utilizes optimized high temperature plastic deformation of large single Germanium crystals to produce mosaic monochromators.

Commercial Applications: Large size Ge mosaic slow neutron monochromators with high neutron reflectivity will significantly increase efficiency of the U.S. research nuclear reactors for condensed matter research, improve quality of diffraction experiments and extend flexibility of neutron scattering measurements. Such mosaic Ge crystals also are highly reflective for x-rays and γ -rays. They are well suited for x-ray and γ -ray focusing systems in astrophysics and for

medical applications, where they can improve quality of x-ray images. In x-ray microanalysis mosaic Ge monochromators can increase sensitivity of the method. These are the markets with potential need for the Ge mosaic monochromators.

Topic: Advanced Manufacturing

Subtopic: Category-Theoretic Tools to Support Manufacturing Information Integration

Title: A Category-theoretic Tool for Manufacturing Information Integration

Firm: Categorical Informatics, Inc.
250 Main St.
Cambridge, MA 02142-9998

Principal Investigator: Ryan Wisenesky
Phone: (650) 387-9782
Email: ryan@catinf.com

Award Amount: \$300,000.00

Abstract: Category theory has recently been successfully applied to translate information from one computer system to another. Researchers at MIT have developed a prototype software tool based on category theory for solving information-integration programs. The tool has successfully solved small-scale information-integration problems including a problem identified by NIST about enriching the manufacturing service capability of a distributed supply chain with additional 3rd party information. The goal of this Phase II effort is to build the core of an industrial-strength categorical data integration tool capable of solving manufacturing-related information-integration problems identified by NIST.

Commercial Applications: Existing tools for information integration do not adequately solve next-generation data integration problems such as those encountered by NIST in its standard mission in manufacturing. An information integration tool based on category theory has the potential to solve such previously intractable problems as well as compete with existing information integration tools on the basis of data quality. The total market for information integration software is \$4.7B annually.

Topic: Cybersecurity

Subtopic: Access Control Policy Tool

Title: Access Control Policy Tool

Firm: InfoBeyond Technology LLC
320 Whittington Pkwy.
Louisville, KY 40222-4917

Principal Investigator: Bin Xie
Phone: (502) 371-0907
Email: Bin.Xie@InfoBeyondtech.com

Award Amount: \$300,000.00

Abstract: Access Control (AC) determines the permission of a request in attempt to access certain resources in a software system. It has been greatly used for financial, security, privacy, safety, defense, and many other applications. However, there is no commercial-ready tool to conveniently and thoroughly compose, test, and verify the policies against potential vulnerabilities. In this project, InfoBeyond advocates the development of a user-friendly, efficient, reliable, and generic Access Control Policy modeling, verification, and Testing (ACPT) Tool. Our ACPT enhances the NIST's ACPT design and add several advanced features for achieving high security confidence AC levels such that it can be commercialized. It provides user-friendly GUI templates for user to compose attributes, enable property tests by a model checker, perform combinatorial tests, and generate XACMAL policies. It specifically improves the NIST's ACPT design to provide a robust, unified, and generic model checker in an ABAC (Attributed-based Access Control) framework. Our ACPT will be developed as a standalone software package and web-based services. The standalone software package can be run in a private server for government and enterprise customers. The web service design facilitates the ACPT webification and evolution in a distributed computing environment for a large number of customers.

Commercial Applications: Access Control (AC) is to ensure that the unexpected (i.e., unauthorized or unintended authorized) parties cannot get into a security system. Our ACPT is a user-friendly, efficient, and reliable AC tool to verify and test if the AC policies will be correctly enforced as the intention in a system, eliminating the potential security leakages. It can be used for federal and state agencies to provide high security confidence levels for the national critical IT resources. It can also be widely used for commercial resource protection in the financial and stock companies, enterprises, hospitals, insurances, organizations, and other business domains.

Topic: Cybersecurity

Subtopic: Access Control Policy Tool

Title: Automated Access Control Policy Testing System (A-ACPTS)

Firm: Object Security LLC
1855 First Ave Ste 103
San Diego, CA 92101-2650

Principal Investigator: Ulrich Lang
Phone: (650) 515-3391
Email: ulrich.lang@objectsecurity.com

Award Amount: \$299,969.00

Abstract: A-ACPTS Phase 2 transitions NIST Access Control Policy Tool (ACPT) R&D with innovative enhancements into commercialization, developing a commercially successful access control policy testing product that improves access control policy testing (minimizes error potential, faster, more usable, more efficient). A-ACPTS Phase 2 extends ACPT through a number of innovations that improve testing beyond the state of the art, including: (1) A-ACPTS supports the specification of testing properties and policies at a generic, intuitive “high level” of abstraction. With A-ACPTS, testing properties can be automatically verified against the policy even if they are authored using differing attributes. (2) A-ACPTS ingests, analyzes, merges, and normalizes information about the functional environment and flexibly relates access policy testing closer to the actual access control policy implementation on the functional environment. (3) A-ACPTS automatically ingests many information sources required for testing with semantic consistency, so that the policy testing becomes more automated, fast, easy, and correct. (4) A-ACPTS can automatically re-test when the ingested information changes, minimizing re-testing efforts. A-ACPTS has already been partly implemented during Phase 1, and will be rapidly developed towards commercial viability during Phase 2 as both a cloud service (SaaS) and an on-premises installed product based on the Eclipse/OpenPMF platform.

Commercial Applications: Today usable access control policy testing tools are commercially unavailable, making AC policy implementation and testing error-prone, costly and difficult. A-ACPTS addresses a significant gap in the fast-growing cyber security market: Conventional reactive cyber defenses are failing. Preventive AC policy implementation improves protection, but is often too complex, time-consuming and expensive to implement. A-ACPTS enables manageable, easy-to-use, advanced AC policy testing. A-ACPTS can be flexibly bought (SaaS + on-premises) and used by most organizations. It is most useful for organizations that operate large, interconnected IT landscapes, critically rely on IT for their operation, process confidential information, are critical/safety-critical or regulated.

Topic: Advanced Manufacturing

Subtopic: High-Throughput Manufacturing Methods for Engineered MRI Contrast Agents

Title: High-Throughput Low-Cost Manufacturing of Engineered MRI Contrast Agents

Firm: Weinberg Medical Physics LLC
5611 Roosevelt Street
Bethesda, MD 20817-6739

Principal Investigator: Lamar Mair
Phone: (202) 568-1608
Email: Lamar.Mair@gmail.com

Award Amount: \$298,706.00

Abstract: New shape-engineered iron-based microscopic contrast agents (MCAs) for magnetic resonance imaging promise to increase diagnostic accuracy while reducing side effects, and enhance scientists' ability to track stem cells. Currently, techniques used for making multispectral microscale contrast agent particles are cost prohibitive. In Phase I, an innovative technique (employing template-guided electroplating in a roll-to-roll construct) which combines the low cost of chemical synthesis methods, the high uniformity of template-based methods, and the high throughput of automated manufacturing methods to deliver a process for large-scale, cost-effective manufacturing of the new MCAs was described. In Phase II, the Phase I prototype process will be upgraded to include a section that will metallize PCTE reel stock in order to reduce costs, and another section which will measure the NMR resonance shift properties of the particles *in situ* in order to achieve high particle uniformity. Low-cost production and development of standard operating procedures that will assist in Phase III migration to contract manufacturing facilities will be demonstrated.

Commercial Applications: Products manufactured with the new manufacturing process address the needs of bioscience and clinical markets and suppliers of components for consumer electronics, with markets totaling over \$9 billion including: MRI contrast agents to improve diagnostic imaging and drug development, cell tracking particles for regenerative medicine, therapeutic particles for hyperthermia, and conductive nanowires for computer tablets and smart phones. Strategic partners and investors have been identified who are willing to leverage future SBIR funding in this project.

Topic: Technology Transfer

Subtopic: NIST Tech Transfer

Title: Resonant Scan Lens for Scanning Beam LIDAR

Firm: Z-senz LLC
67 Oak shade Rd.
Gaithersburg, MD 20878-1049

Principal Investigator: Christopher Brown
Phone: (206) 963-7522
Email: seebrown@gmail.com

Award Amount: \$300,000.00

Abstract: The objective of this Phase II project is to research, develop, and commercialize a resonant scan lens (RSL) for use in a resonant light detection and ranging (R-LIDAR) distance sensor. R-LIDAR uses a resonant optomechanical system to generate a beam scan. While resonant optomechanical systems produce high-speed and large field-of-view (FOV) scans from a miniature form factor, the beam scans lack uniformity across the FOV. Poor scan uniformity is typically addressed by clipping the scan periphery to remove the most non-uniform regions. Z-senz proposes to research and develop an RSL to linearize a resonant scan thereby increasing the FOV and duty-cycle of an R-LIDAR sensor. This project builds upon the NIST Phase I SBIR effort that demonstrated a 25% average improvement in linearity from a 90% duty-cycle scan compared to an unmodified resonant beam scan. This project proposes to iterate the RSL design to achieve a 75% average improvement in linearity from a 90% duty-cycle scan and develop this technology for use in an R-LIDAR sensor. While the RSL research improves the performance of the R-LIDAR system, this technology has utility to a large number of high speed imaging and display applications, including: microscopy, endoscopy, ophthalmology, scanning displays, and laser machining.

Commercial Applications: Customer interviews indicate a significant unmet near-term need for high-accuracy distance sensors for use in small unmanned aerial system (S-UAS) surveying. R-LIDAR sensors enabled by RSL technology offer a solution for S-UAS surveying in construction, mineral extraction, ecological surveying, and defense industries. This commercial opportunity is significant as the S-UAS light detection and ranging market is estimated to reach \$100 million with a 51% CAGR in 2019 when the R-LIDAR sensor reaches market. Commercialization of RLIDAR technology for the S-UAS market will support subsequent R&D and commercialization activities in large future markets such as driver assist and automation.