**Abstracts of Awards for Fiscal Year 2002 NIST SBIR Program**

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**FY 2002 Phase I Award**

**Topic:** 7.01 Advanced Biological and Chemical Sensing Technologies

**Subtopic:** 7.01.02 Laser Based Traced Gas Monitor

**Title:** Quantum Cascade Laser Monitor for N0, N02 and 03

**NIST OU:** 830 Chemical Science and Technology Laboratory

**Firm:** Aerodyne Research, Inc.
45 Manning Road
Billerica, MA 01821

**Principal Investigator:** David Nelson
**Phone:** (978) 663-9500 x231
**Fax:** (978) 663-4918

**Award Amount**: $ 75,000.00

**Abstract:** This project will develop a high accuracy monitor for the photo-chemically coupled pollutants nitric oxide, nitrogen dioxide and ozone using infrared absorption spectroscopy with quantum cascade (QC) lasers. The target molecules are monitored at air quality stations worldwide using instruments, which require frequent calibration and are not sufficiently specific (in the case of NO2). This QC monitor will initially provide a portable measurement standard to calibrate the existing network and will eventually replace existing instruments. QC lasers are spectroscopically stable and can be operated near room temperature when in pulsed mode. This allows the design of compact, rugged, monitors which are also highly accurate. The main Phase 1 research objective is to demonstrate the required measurement stability (one part per thousand). This stability will be converted to accuracy in Phase 2 using the ozone ultraviolet absorption standard and chemical titration to transfer this standard to NO and NO2.

**Commercial Applications:** There are several large markets, which will be serviced by the instrument resulting from this research. These include 1) the market to calibrate or replace the existing instruments deployed worldwide to monitor NO, NO2 and O3, 2) the research market attempting to quantify the sources and sinks of these species and their ambient concentrations, 3) the market for trading credits for pollutant emission reductions which requires quantitative documentation of these reductions, and 4) various research markets needing to quantify NOx or ozone concentrations or emissions in both laboratory and field settings.

**FY 2002 Phase I Award**

**Topic:** 7.05 Condition-Base Maintenance

**Subtopic:** 7.05.02 Development of a MEMS Viscosity Meter for Refrigerant/Lubricant Systems

**Title:** Robust MEMS Viscosity Meter for Condition-based Maintenance

**NIST OU:** 860 Building and Fire Research Laboratory

**Firm:** Boston Microsystems, Inc.
30-H Sixth Road
Woburn, MA  01801-1758

**Principal Investigator:** Jeffrey Chan
**Phone:** (781) 933-5100
**Fax:** (781) 933-5885

**Award Amount:** $75,000

**Abstract:** The use of real time, in situ measurements of lubricant/refrigerant viscosity can reduce maintenance costs and system downtime and improve system longevity, by allowing maintenance personnel to determine identify and correct mechanical problems, before they cause more serious problems. With the advent of MicroElectroMechanical Systems (MEMS), the opportunity exists to develop small and inexpensive devices to measure the fluid viscosity real time and in situ. However, the temperatures, pressures, and corrosive environments inside typical refrigerant compressors exceed the capabilities of materials typically used to manufacture MEMS devices. Boston MicroSystems' proprietary technologies for micromachining harsh environment compatible SiC and AlN materials enable, for the first time, fabrication of small, inexpensive and robust MEMS-based fluid viscosity sensors for non-intrusive health monitoring and condition based maintenance of refrigeration systems, engines, and other machinery. In Phase 1, Boston MicroSystems will leverage from work on previous and ongoing FAA, ATF and NSF programs to test three already developed devices, microresonators, SAWs and FPWs, for their applicability as in situ fluid viscosity sensors for condition based maintenance of compressors in refrigerant systems.

**Commercial Applications:** Condition-based maintenance and health monitoring of refrigerant compressors, engines, and other machinery, and fluid viscosity sensors for industrial process control and quality control.

**FY 2002 Phase I Award**

**Topic:** 7.09 Intelligent Control

**Subtopic:** 7.09.04 Optical Sensing and Control of Polymer Processing

**Title:** Optical Sensing and Control of Polymer Processing

**NIST OU:** 850 Material Science and Engineering Laboratory

**Firm:** Chemical ElectroPhysics Co. Inc.
705 Yorklyn Road
Hockessin, DE 19707-9279

**Principal Investigator:** Michael McBrearty
**Phone:** (302) 234-8206
**Fax:** (302) 239-4677

**Award Amount:** $74,278.00

**Abstract:** A NIST/industry consortium identified accurate temperature distribution measurements, as one of the major technical needs of polymer processors. NIST developed a way to make spatially resolved temperature measurements. Add a small amount of dye. During processing, focus UV illumination onto a small volume element of the process material. Use the ratio of the resulting fluorescent intensities at two wavelengths to determine the temperature. Move the focal point up and down to construct temperature profiles. The proposed Phase 1 would evaluate the feasibility of this technology for meeting the stated need. We would build a prototype with improved spatial resolution, motorized positioning and a spectrometer rather than filters for detection. Results would include the prototype, a characterization of its performance, range of operation and the influence of process and material conditions, and a comparison with the needs of industry. A negative outcome in Phase 1 would imply that some fundamental limitation exists. A positive outcome would imply that the technology can probably meet industry's needs.

**Commercial Applications:** The proposed Phase 1 project is intended to determine whether the confocal fluorescent optical technique can accurately, non-invasively measure temperature profiles in flowing polymer melts at a level of performance that would make it useful for polymer processors.

At the completion in 2003 of the proposed Phase 1 project, we anticipate the following results:

1. A working prototype of an optimized confocal fluorescent temperature measurement system.

2. A characterization of it performance in terms of its precision, accuracy, range of operation and calibration range. This characterization would include both the high and low temperature dyes and a variety of resins over their standard temperature ranges.

3. Measurements of the sizes of the pressure and possible molecular weight influences, with estimates of the ranges beyond which independent pressure and/or viscosity measurements would be needed for compensation.

4. A comparison of the optimized system's performance with the industry's needs.

5. A written evaluation of the performance and range of the instrument and its calibrations.

The total cost for Phase 1 would be $75,000.

If, contrary to our expectation, the project reveals some fundamental limitation on the usefulness of the technology we would not recommend further effort on it. If, on the other hand, the project outcome were favorable, the implications would be that there are probably not any fundamental problems; the technology works and a Phase 2 project would be recommended.

Assuming favorable results from Phase 1, the objectives of a future Phase 2 project in 2003 - 2004 would be to:

1. Incorporate improvements and build an actual commercial style temperature sensor that is sufficiently rugged, accurate and economical to be commercially useful for the polymer processing industry.

2. More fully characterize the range of applicability of the technology. Characterize the pressure and temperature withstanding ability of the apparatus. Determine the range of materials with which the system will work, including an assessment of how much non-transparency it can tolerate. Determine the maximum practical measurement temperature. Characterize the pressure and temperature withstanding ability of the apparatus.

3. Evaluate the time response of the confocal fluorescent temperature measurements. There is reason to think these measurements would be fast enough to follow the transient temperature disturbances associated with the passing of screw flights and squeezing flow viscometer cams, and the flow of material into injection molding machines.

4. Explore the relationships between micro-viscosities perceived through fluorescence and electrical properties. The theoretical models for fluorescence spectra involve the viscosity in the microscopic neighborhood of the fluorescent molecule. This microviscosity similarly governs the electrical conductivity of polymer resins. Probing the same fundamental quantity using two independent measuring techniques could prove to be very revealing.

5. Determine whether the device could be produced at a reasonable cost.

6. Determine how well it performs over extended periods of time.

A negative outcome in Stage 2 would suggest that the technology's usefulness to the polymer processing industry is primarily for research and troubleshooting. A positive outcome would imply that the technology has potentially more broad application in routine production where it would bring substantial commercial value. Total costs for Phase 2 would not exceed $750,000.

Assuming favorable results from Phase 2, the objectives of a Phase 3 project starting in 2004 (funded by CEP, approximately $200,000) would be to develop demonstrated, successful commercial applications, manufacturing tooling, and procedures for producing and using the instruments. This Phase would also include market research to help identify the most promising applications for the technology.

Following a successful Phase 3, CEP would market, sell, produce and support the instruments for existing and new customers in the polymers industry. The first commercial sale would be in about year 2005.

**FY 2002 Phase I Award**

**Topic:** 7.08 Information Technology

**Subtopic:** 7.08.01 Mobile Code for Mobile Devices

**Title:** Machine-learning Based Detection of Malicious Code and Viruses for Handheld Devices

**NIST OU:** 890 Information Technology Laboratory

**Firm:** Cigital, Inc.
21351 Ridgetop Circle, Suite 400
Dulles, VA 20166-6561

**Principal Investigator:** Christoph C. Michael
**Phone:** (703) 404-9293
**Fax:** (703) 404-9295

**Award Amount:** $74,232.21

**Abstract:** The pervasiveness of handheld devices makes computational power available in diverse settings where computers were once impractical. The power of handheld devices could be improved even further if executable applications were downloaded on demand from the Internet, instead of being stored full-time in the limited memory of the handheld.

However, downloading new software on demand leads to greatly increased security risks. Viruses and other malicious executables pose an even greater threat to handheld devices than to desktop machines, since a handheld has limited storage and computation power with which to enforce security. Existing handhelds have virtually no protection from software that contains hidden, malicious functionality.

We will investigate a new technique for detecting malicious executables on handheld devices. Our proposed approach is based on algorithms that learn what features distinguish malicious executables from benign ones. There is reason to believe that such a system can be built not only with a smaller footprint than traditional virus detection systems, but with some ability to detect novel attacks, so that the detection software needs to be updated less often. The purpose of the Phase-I feasibility study will be to evaluate these two hypotheses.

**Commercial Applications:** Virus and malicious code detection on desktops, laptop, and handheld computers.

**FY 2002 Phase I Award**

**Topic:** 7.08 Information Technology

**Subtopic:** 7.08.04 XML Schemas for Access Control Models

**Title:** Flexible Support for Multiple Access Control Models Using XML and RDF Schemata

**NIST OU:** 890 Information Technology Laboratory

**Firm:** Civil Engines Research, LLC
545 W. 34th Street, Suite 2E
New York, NY 10001-1329

**Principal Investigator:** Paolo de Dios
**Phone:** (646) 674-0860

**Award Amount:** $72,919.90

**Abstract:** Security is of critical importance for e-business systems, in which multiple internal and external enterprise applications and data are linked into one integrated system. It is a key factor that will determine how comfortable successful companies and their associated constituents are going to be with the idea of integrated e-business systems and the virtual enterprise. Existing proprietary access control APIs, schemes and representations have made uniform access semantics a very elusive and very expensive goal in the enterprise. To address this issue, it is necessary to develop standardized, platform agnostic and semantically meaningful representations for access control models. XML has been used in great effect to interchange and model data in a platform dependent fashion and it can be effectively used to represent complex access control relationships. Civil Engines Research plans to develop schemas that will effectively model enterprise access control ontologies and semantics in an extensible and interoperable manner. We plan on developing the schema instance processors and development tools necessary to enable the enforcement of access controls in an enterprise scenario. Phase 1 of this program will focus on assessing and demonstrating the feasibility of this approach by architecting and prototyping common access control models using XML Schema and the W3C recommended system for representing lightweight ontologies, RDF.

**Commercial Applications:** The proposed set of schemas, tools and associated technologies will find widespread use in security policy specification and enforcement. It would have immediate impact in the enterprise application integration (EAI) arena where complex, cross-organization business process rules only can be realized via secure access to enterprise applications and data. These tools and technologies may be commercialized as standalone user management software or licensed for integration into existing middleware solutions.

**FY 2002 Phase I Award**

**Topic:** 7.16 Technologies to Enhance Fire Safety

**Subtopic:** 7.16.01 Advanced Building Sensors and Information Systems

**Title:** Novel Integrated System for Fire Detection, Alarms & Real-Time Fire-Ground Surveys

**NIST OU:** 860 Building and Fire Research Laboratory

**Firm:** Cyrano Sciences, Inc.
73 N. Vinedo Ave.
Pasadena, CA 91107-3759

**Principal Investigator:** Gregory Steinthal
**Phone:** (626) 744-1700 x224
**Fax:** (626) 744-1777

**Award Amount:** $73,398.96

**Abstract:** Cyrano Sciences, Inc. proposes to develop and demonstrate a distributed sensor network that uses arrays of traditional and non-traditional detectors with data fusion to improve system performance and to perform a real-time survery of the fire ground to better protect and inform firefighters. Each node consists of multiple detectors, including a polymer-composite sensor array and other detectors, to reduce the incidence of false alarms and provide faster fire detection capabilities. Data fusion occurs at each node and alarm fusion occurs at a system-wide level, providing robust alarms and the ability to locate the source of a fire. The overall architecture of the system allows sensors to be added after installation and provides a communications center for mobile devices with GUIs. We envision using non-traditional sensors, such as video and force sensors, that will be installed in the structure and integrated with the system to provide complete and new information to first responders. We also envision that firefighters will have GPS and residual life indicators (for respirators) on their person and that these sensors will communicate with the building communications center, providing full information to the firefighter command center about the fire, the building, and personnel.

**Commercial Applications:** We anticipate that the demonstrated fire detection system will provide new capabilities to eliminate false alarms and protect fire fighters in the business community. All hardware and system software are COTS, but software/algorithm development is required to meet these goals. Furthermore, the demonstrated polymer-composite sensor array with data fusion algorithms will provide a smoke detector for homes with reduced frequency of false alarms when compared to existing home smoke detectors.

**FY 2002 Phase I Award**

**Topic:** 7.17 X-Ray System Technologies

**Subtopic:** 7.17.03 High Efficiency Circular Array Secondary Electron Yield Detectors

**Title:** Improved Manufacturing Processes for Circular Array Detectors

**NIST OU:** 850 Material Science and Engineering Laboratory

**Firm:** Detector Technology, Inc.
9 Third Street
Palmer, MA 01069-1542

**Principal Investigator:** Jay S. Ray
**Phone:** (413) 284-9975
**Fax:** (413) 284-9979

**Award Amount:** $68,664.25

**Abstract:** Channel electron multipliers are used in a variety of applications including synchrotron research facilities. It is imperative that channel electron multiplier technology be improved for this type of application. Currently, the manufacturing process of channel multipliers is very inconsistent. When running an array of detectors each detector must act similarly. If the detectors are not matched then results may be skewed. During the shaping processes of the glass, contamination and surface imperfections can occur. Both causes inconsistency in the electrical characteristics of channel electron multipliers. In this project Detector Technology, Inc. will specifically concentrate on perfecting the manufacturing processes that contribute to inconsistencies. The resulting technology will provide a manufacturing process that will produce array detectors with matched electrical characteristics.

**Commercial Applications:** Time of flight; Hemispherical analyzers; Magnetic sectors; Mass spectrometers; Residual gas analyzers.

**FY 2002 Phase I Award**

**Topic:** 7.14 Optics and Optical Technology

**Subtopic:** 7.14.01 Blackbody Radiation Sources Based on Carbon Nanotubes

**Title:** Uniform Large Area, High Emisivity Blackbody Radiation Source Based on Single Wall Carbon Nanotubes

**NIST OU:** 840 Physics Laboratory

**Firm:** Foster-Miller, Inc.
350 Second Avenue
Waltham, MA 02451-1196

**Principal Investigator:** Thomas M. Tiano
**Phone:** (781) 684-4118
**Fax:** (781) 290-0693

**Award Amount:** $74,966.00

**Abstract:** In this program Foster-Miller (FMI)proposes to build on its extensive experience with processing and characterization of Single Walled Carbon Nanotubes (SWNT) to develop a high emissivity (>0.999), large area (>600 cm2), variable temperature (330-600K), uniform emitting, black body radiation source that takes advantage of the unusually high emissivity of carbon nanotubes. Using SWNT's furnished by teaming partner Carbon Nanotechnologies, Inc three different SWNT structures will be evaluated on candidate substrates: random or well-ordered deposited SWNT's using proprietary exfoliation / polymer wrapping techniques previously developed by FMI; assembling the SWNT's in an ordered array perpendicular to the substrate surface, using technology developed by teaming partner Dr. Fotios Papadimitrakopoulos of the University of Connecticut; and a combination of these two techniques. During the Phase 1 effort FMI will produce and test small articles with uniformly dense SWNT thin film coatings in the three different geometries mentioned above.. The geometry yielding the highest emissivity and most uniform radiation shall be selected for further development in Phase 2 to produce prototype large area SMNT blackbody sources to be tested and delivered to NIST for evaluation as sources for high-accuracy radiometric calibrations of infrared cameras, IR focal plane arrays, and spectroradiometers.

**Commercial Applications:** The most immediate commercial application of this research program is the development of large area NIST traceable blackbody sources for the high-accuracy radiometric calibration of infrared cameras and imaging devices, IR focal plane arrays and spectroradiometers.

Potential Commercial Application and Follow-On Funding Commitment

The principal commercial application for the proposed advanced large area blackbody source is for NIST traceable sources for the calibration of infrared cameras, focal plane arrays and spectroradiometric instruments. While this is a niche market primarily for U.S. Government (NIST) and DoD use, Foster-Miller's infrared products group has had significant success in marketing specialized infrared products, such as IR fiber optic probes, on-line oil condition monitors and remote reflectance probes and systems to other niche markets. Working closely with team member CNI., FMI during Phase 2 will evaluate the market potential for the advanced blackbody source and determine whether to invest in a commercial product development program for Phase 3. The technology to be developed in the proposed program will have great value for applications other than blackbody sources.

**FY 2002 Phase I Award**

**Topic:** 7.12 Microelectronics Manufacturing

**Subtopic:** 7.12.04 On-Wafer Measurement System for Combinatorial Magnetic Thin-Film Libraries

**Title:** On-Wafer Measurement System for Combinatiorial Magnetic Thin Film Libraries

**NIST OU:** 810 Electronics and Electrical Engineering Laboratory

**Firm:** Industrial Measurement Systems, Inc.
2760 Beverly Drive #4
Aurora, IL 60504

**Principal Investigator:** Donald E. Yuhas
Phone: (630) 236-5901
Fax: (630) 236-5982

**Award Amount:** $75,000.00

**Abstract:** As magnetic thin-film systems became part of complex industrial applications, their composition increasingly became more complicated. A means is needed to efficiently develop and systematically characterized magnetic, electronic, and mechanical properties of advanced thin-film systems. New metrological systems are required that are capable of making on-wafer measurements on large number of sites over a large region of parameter space. Combinatorial materials techniques involve fabrication of libraries with a large number of on-wafer sites, metrologies that systematically characterize these libraries are needed. This project proposes to solve an important materials characterization problem of combinatorial film libraries. The completion of this project will result in a multi-sensor magnetic properties measurement capability and paradigm for rapidly characterizing combinatorial magnetic thin-film libraries deposited on wafers. A novel scanning system will be developed and integrated with multiple sensor types (MOKE probes and Hall microprobes). This system will obtain magnetic property data on combinatorial film libraries deposited on 37-millimeter diameter wafers. The system design is such that new sensor technologies (as they become available) can be added in order to achieve more complete magnetic properties analyses. High throughput, which is one of the system parameters, is essential to keep pace combinatorial library deposition methods.

**Commercial Applications:** The current worldwide market for magnetic films is estimated to be in excess of 30 billion dollars per year. Applications include in magnetic recording, magnetic solid-state memories, magnetic sensors, and magnetic microwave devices. The fastest growing segment is the thin film area because thin films can be fabricated using modern lithographic methods and composition modified for specific applications. The proposed scanning multi-sensor characterization system is directed at speeding the development of new thin film compositions and devices.

**FY 2002 Phase I Award**

**Topic:** 7.08 Information Technology

**Subtopic:** 7.08.03 Pervasive Computing, Accessible Computing Technology Integration and Demonstration

**Title:** A Real-time Demonstration of the Smart Flow System

**NIST OU:** 890 Information Technology Laboratory

**Firm:** Intelligent Automation, Inc.
7519 Standish Place, Suite 200
Rockville, MD 20855-2785

**Principal Investigator:** Chiman Kwan
**Phone:** (301)222-0438
**Fax:** (301) 222-0466

**Award Amount:** $75,000.00

**Abstract:** Intelligent Automation, Inc. (IAI) proposes to further the development of NIST's Smart Space technology and demonstrate that the integrated system facilitates the interaction of persons with limited abilities in a meeting room environment. Such a demonstration will serve to simulate interest in applying Smart Space technology in real world interaction. Two individuals enter the meeting room laptop computers equipped with 802.11 wireless Ethernet. As each person comes within range, connection is achieved and nodes are established. Following connection, each laptop uploads the identity of the individual. In Phase 1, the identification record will consist of standard text descriptions of an individual (gender, race, etc.) along with a voice print. Each individual will wish to exchange PowerPoint presentations and conduct a verbal dialogue with the others. The PowerPoint presentation for every individual will also be uploaded from their PCs and distributed as requested. Each individual will be tracked as he or she moves around the room. Tracking will be performed both by audible and visual clues. The microphone array will be used to localize all sound sources. If the emitted sounds can be classified using the voice print, every individual can be identified as they are tracked.

**Commercial Applications:** The Smart Space concept will have great impact in many applications such as hospitals, conference and meetings, border control, workspace, customs, airport, etc. The ability to acquire voice and facial information and track a person around a space is very important in airport or workspace security. After September 11, homeland security becomes an urgent task, which is extremely difficult as America is a free country. We anticipate the market of Smart Space in security will be billions of dollar market.

**FY 2002 Phase I Award**

**Topic:** 7.11 Manufacturing Systems Integration

**Subtopic:** 7.11.04 Next Generation Process Exchange Tools and Applications

**Title:** Advanced Tools for Process Specification Language

**NIST OU:** 820 Manufacturing Engineering Laboratory

**Firm:** Knowledge Based Systems, Inc.
1408 University Drive East
College Station, TX 77840-2335

**Principal Investigator:** Ronald Fernandes
**Phone:** (979)260-5274
**Fax:** (979) 260-1965

**Award Amount:** $74,946.00

**Abstract:** We propose to develop a robust PSL syntax based on XML and RDF that will further its role as an interlingua among various process modeling languages. In addition, we will develop the next-generation translator-generator system based on this format to automate the software development process of process-centric translation across applications and formats.

One of today's greatest challenges to successful Inter-enterprise Process Engineering implementations is the lack of technology for enabling processes to be exchanged, analyzed, modified and executed as if processes were considered as core business transaction data. This necessitates the need for (a) technology and standards for process information, and (b) software tools that can interchange, extract, merge, and transform process data.

Our proposed solution will solve these problems by extending the PSL standard and creating the PSL/XML syntax for increasing its adoption in industry. PSL/XML will be generic enough to incorporate future PSL extensions. It will also facilitate the development of the advanced toolkit that includes a PSL editor and a translator code generator. Our toolkit will be designed to be easily maintainable, scalable and extensible and it will require no additional programming for generating translators for new formats.

**Commercial Applications:** Our proposed solution will provide an innovative framework and the necessary tools for process-centric information sharing. It has tremendous commercial potential throughout public and private sectors for solving problems relating to agile manufacturing, virtual enterprises, and enterprise resource planning and supply-chain management systems.

**FY 2002 Phase I Award**

**Topic:** 7.11 Manufacturing Systems Integration

**Subtopic:** 7.11.05 Ontological Engineering Applied to Manufacturing System Integration Research

**Title:** Just in Time Ontology Mapping for Manufacturing System Integration

**NIST OU:** 820 Manufacturing Engineering Laboratory

**Firm:** Knowledge Evolution, Inc.
1215 17th Street, NW, Suite 101
Washington, DC 20036

**Principal Investigator:** Sidney Bailin
**Phone:** (202) 467-9588
**Fax:** (202) 467-9589

**Award Amount:** $74,927.00

**Abstract:** Large-scale manufacturing system interoperability requires the interchange of both process and product specifications. The heterogeneity of process representations makes this difficult. NIST's Manufacturing Systems Integration Division has developed the Process Specification Language (PSL) as a means of overcoming these problems. PSL is intended to serve as an inter-lingua, a common representation that can be used to mediate between application-specific or ontologies. A fundamental part of the PSL vision is a collection of translators between PSL and these other ontologies. The challenge is to develop such translators in a manner that is both cost-effective and adequate to the needs of client applications. Our intention is to apply just-in-time (JIT) techniques to this challenge. JIT ontology mapping is a dynamic approach in which only those parts of an ontology that are needed in a given application context are translated. The research conjecture is that JIT can greatly facilitate the implementation, deployment, and maintenance of PSL extensions and translators.

**Commercial Applications:** There is both a great need and a great potential for just-in-time ontology mapping in the e-business world. The need arises from the rapid pace at which agent technology is taking root in e-business, especially automated bidding systems. Such agents will have to engage in continual monitoring and assessment, maintaining a current view of other agents present on the web, identifying those that represent potential partners, providers, or customers, and a persistent context for ongoing communication with agents already contacted. Ontology mapping arises in this setting because every business is based on an underlying ontology. Proper operation of the interface between providers and consumers requires that the ontologies of the respective organizations be consistent. JIT techniques will lead to more efficient ontology mapping and therefore better performing e-business agents.

**FY 2002 Phase I Award**

**Topic:** 7.07 Healthcare and Medical Physics

**Subtopic:** 7.07.01 Miniaturized Detectors for Brachytherapy Dosimetry

**Title:** A High-Spatial Resolution, High-Sensitivity, Rapid OSL Dosimetry System For Brachytherapy

**NIST OU:** 840 Physics Laboratory

**Firm:** Landauer, Inc.
2 Science Road
Glenwood,IL 60425-1586

**Principal Investigator:** Mark Akselrod
**Phone:** (405) 377-5161
**Fax:** (405) 743-2966

**Award Amount:** $75,000.00

**Abstract:** This project seeks proof-of-concept and prototype demonstration of a high-spatial resolution, high-sensitivity, rapid in-vitro dosimeter system for calibration and dose measurements of brachytherapy radiation sources. The present innovation utilizes the high sensitivity of Pulsed Optically Stimulated Luminescence (POSL) from Al2O3:C proprietary luminescence materials, coupled to a fiber optic delivery system. We expect measurable signals of 1 mGy in passive mode and 1 mGy/s in active mode from small (< 0.5 mm in all three dimensions) detectors with high signal-to-noise. Readout is predicted to be rapid, enabling scanning of measurements from multiple locations surrounding the source. We also test the feasibility of energy independence through calibration of several detectors of different sizes, and extrapolation to a detector size of zero. The technical implications of the innovation are the development of a system that not only solves a problem of brachytherapy source calibration, but the innovation is also designed to be used in vivo during patient treatment, thereby ensuring the same calibration device for in-vitro and in-vivo measurements. The device is free from magnetic or electrical interference and can also be used with teletherapy sources. Commercial applications of the device will be found in all radio-oncology treatment and source calibration facilities.

**Commercial Applications**: The instrument and analytical techniques anticipated by the research will allow improved quality assurance testing of brachytherapy sources, provide grater dosimetric information for improved cancer treatment planning, and enable in vivo dosimetry to verify actual delivered radiation doses from radiotherapy treatment.

**FY 2002 Phase I Award**

**Topic:** 7.09 Intelligent Control

**Subtopic:** 7.09.3 On-line, Non-destructive Measurement of Mechanical Properties of Metals and Alloys

**Title:** Magnetic Methods for On-Line Non-Destructive Mechanical property Measurement

**NIST OU:** 850 Materials Science and Engineering Laboratory

**Firm:** Magnetronix Inc.
7404 Cliffbourne Ct.
Derwood, MD 20855

**Principal Investigator:** George E. Hicho
**Phone:** (301) 963-1836

**Award Amount:** $74,999.00

**Abstract:** A pressing challenge in automotive, aerospace, and other manufacturing industry is the ability to measure the mechanical properties of formed metal and alloy components on a part-by-part basis. We propose to develop a non-destructive testing system suitable for rapid on-line measurement of critical mechanical properties of steel parts as they are being produced. Our approach is based on measurement of the Barkhausen effect and hysteresis loops. The feasibility studies will focus on (1) development of material standards, (2) development of flexible and miniaturized production-compatible probes, and (3) development of novel interpretation algorithms.The materials standards will enable the NDT system to have self-calibration and auto-testing features to assure consistent and reproducible results in a production environment.The algorithms will incorporate calibration results, as well as a broad range of characteristics derived from the Barkhausen spectra and hysteresis data, in order to provide unambiguous, rapid, and robust determination of the mechanical properties of products fabricated from steel.

**Commercial Applications:** The non-destructive characterization tools developed by this project will have broad implications. Benefits include increased efficiency and reduced pressures on energy, environment, and natural resources, accompanied by enormous cost savings and societal benefits. Another benefit lies in improved design by eliminating the uncertainty associated with the mechanical properties of formed parts. This is because design optimization is currently based on mechanical properties of sheet metal such as steel that go into the die rather than the mechanical properties of formed parts that come out of the die. Initial commercialization will be directed at vehicle manufacture with natural extensions to many other industries.

**FY 2002 Phase I Award**

**Topic:** 7.12 Microelectronics Manufacturing

**Subtopic:** 7.12.3 Improved Magneto-Optical Indicator Films

**Title:** Improved Magneto-Optical Indicator Films By Combustion Chemical Vapor Deposition

**NIST OU:** 850 Materials Science and Engineering Laboratory

**Firm:** MicroCoating Technologies
5315 Peachtree Industrial Blvd.
Atlanta, GA 30341-2107

**Principal Investigator:** Yongdond Jiang
**Phone:** (678) 287-2477
**Fax:** (678) 287-3999

**Award Amount**: $75,000.00

**Abstract:** In response to the need for improved magneto-optical indicator films for real-time characterization of magnetic domain structures, MicroCoating Technologies (MCT) proposes to enable the fabrication of epitaxial, high performance YIG magneto-optical thin films by combustion chemical vapor deposition (CCVD) process at low cost. With the rapid pace of optical telecommunications and optical information process and storage, there is an increasing need for magnetic films, and magnetic film based devices and systems. Therefore, a reliable and simple imaging technique for real-time characterization of magnetic domain structures is becoming more and more important. Rapid response to customer requirements and further cost reductions are essential to respond to the future marketplace. CCVD technique offers an attractive alternative to enable synthesis of these magneto-optical thin film materials for real-time imaging applications. The success in this proposed project will enable the U.S. to maintain leadership in the global competition in this area. The end of Phase 1 objectives are a film thickness of larger than 1 mm, a surface roughness of less than 5 nm, and a Faraday rotation of larger than 100,000o/cm.

**Commercial Applications:** Ferromagnetic materials have a wide range of applications in sensors, optical modulators, and information storage. There is a need for real time characterization of their magnetic domain structures. Magneto-optical indicator film imaging technique is expected to become a standard nondestructive quality control imaging technique for the next generation of magnetic materials for these applications. Successful development of films proposed in this Phase 1 and a follow-on Phase 2 effort will result in meeting the market need. Industrial partner has been identified and recruited for this effort. If MicroCoating Technologies triumphs in its product plan, both military and commercial segments would benefit immensely with the availability of a commercially viable production technique.

**FY 2002 Phase I Award**

**Topic:** 7.13 Microelectronics Manufacturing Infrastructure

**Subtopic:** 7.13.01 Polymer Coatings by Inkjet Methodoloy

**Title:** Polymeric Coating by Ink-Jet Printing

**NIST OU:** 850 Materials Science and Engineering Laboratory

**Firm:** MicroFab Technologies, Inc.
1104 Summit Ave., Suite 110
Plano, TX 75074

**Principal Investigator:** Bogdan Antohe
**Phone:** (972) 578-8076
**Fax:** (972) 423-2438

**Award Amount:** $74,900.00

**Abstract:** The ability to pattern multilayered polymers on a micro-level is valuable to a large number of applications in microelectronic manufacturing. Applications range from printing dielectric coatings and polymer resistors to printing active devices such as polymer LEDs and polymer transistors. The advantages of ink jet printing are: (1) one station can print multi-fluids, (2) non-flat substrates could be used (non-contact printing process), (3) it is a data-driven process so no hard tooling is required since meaning shorter change-out times, (4) it is an additive process so it generates very little waste, and (5) one piece of equipment can replace multiple manufacturing stations. The objectives of Phase 1 are to demonstrate patterning several polymers that are of interest to NIST and to create guidelines for developing polymer printing applications. Phase 1 will identify the key technical issues that need to be addressed in order to create a robust manufacturing process. MicroFab will leverage its experience in printing system development and polymer printing experience to accomplish these objectives. Completion of a development program to print polymeric coatings in multilayer patterns on a variety of substrates will bring through the emerging technology productive benefits to the factory floor.

**Commercial Applications:** Potential commercial applications of the proposed research are as follows:

*Near Term Hardware Sales*
Both the polymer printing research system and the printhead subsystems can be commercialized rapidly after completion of their development. MicroFab current markets and sells products in these categories, so no change in business model is required for MicroFab to commercialize this hardware. The new capabilities embodied in the hardware will be marketed to our current customer base, including DuPont, Uniax, Honeywell, Nortel, Vantico, Siemens, and Rockwell and to other companies active in polymer printing research, including Motorola, Dow, IBM and Xerox. The most likely use by NIST and other government agencies (e.g., DOD) of the technology developed in this research project would be in the form of a research system or subsystems purchased from MicroFab.

*Fluid Formulations*
Polymer fluid formulations to be suitable for ink-jet printing and for creating polymer structures with both desired geometry and properties are of considerable value. This value is usually protected via either patenting the formulation or keeping it trade secret. We expect to create a number of valuable polymer fluid formulations during and after this research project. Marketing (licensing) of these formulations is very difficult while trying to protect them at the same time, but we plan to pursue this vigorously. Again, the commercial potential of formulations created by customers of MicroFab's printing equipment will be much greater than that of MicroFab's efforts alone.

*Polymer Structures*
The polymer printing systems and fluid formulations developed in this research will likely lead to novel printed polymer structures that are patentable. As with fluid formulation, the principle commercial opportunity for MicroFab would be in licensing these structures. We expect customers of MicroFab's equipment to be very active in this area.

*Manufacturing Tools*
The polymer printing research system will be used as a basis for developing high volume manufacturing equipment. MicroFab has previously partnered with equipment manufacturers (Speedline and Universal Instruments) to develop equipment that incorporates MicroFab's ink-jet tools (SolderJet™). We will employ the same business model for polymer printing equipment, and have already begun negotiations with a equipment company.

**FY 2002 Phase I Award**

**Topic:** 7.06 E-Commerce and Security: Infrastructures, Tools, etc.

**Subtopic:** 7.06.01 Technologies for Designing Web Sites in the Global Market

**Title:** Usability centric Localization Methodology and Tools for Global Websites

**NIST OU:** 890 Information Technology Laboratory

**Firm:** Mindlore, Inc.
114 Bonita Street
Sausalito, CA 94965-1951

**Principal Investigator:** Wanda Smith
**Phone:** (707) 869-1940
**Fax:** (415) 339-0595

**Award Amount:** $74,900.00

**Abstract:** In order to compete in international markets, US companies need eCommerce applications and Web sites that can attract and retain customers from a diverse range of cultural and linguistic backgrounds. Through many years of work in academia and eCommerce industry, our team has developed a usability centric localization process that can meet this need. In this project, we propose to document and validate this process, and design a supporting set of tools to help Web designers and developers build global Web sites, following our localization process. In particular, we propose to build a design critiquing tool that will give localization specific feedback to designers, and an online repository of eCommerce design components that contains both localized designs, and designs with more global appeal. The contents of the repository will be managed through a rigorous online usability process.

**Commercial Applications:** Our localization methodology and supporting tools will have direct commercial impact on international website design, as well user interface design for international software products, enabling US companies to be more competitive in the global marketplace.

**FY 2002 Phase I Award**

**Topic:** 7.01 Advanced Biological and Chemical Sensing Technologies

**Subtopic:** 7.01.01 Advanced Microplatforms for Chemical and Biochemical Sensing

**Title:** Robust Nanopopous Ceramic Microsensor Platform

**NIST OU:** 830 Chemical Sciences and Technology Laboratory

**Firm:** Nanomaterials Research, LLC
2021 Miller Drive
Longmont, CO 80501

**Principal Investigator:** Dmitri Routkevitch
**Phone:** (720) 652-4001 x102
**Fax:** (720) 652-4004

**Award Amount:** $75,000.00

**Abstract:** This proposal seeks NIST support for the development of a robust gas microsensor platform from nanoporous alumina ceramic. Conventional microsensors have limited application in harsh conditions, such as in the exhaust streams, due to their low stability at temperatures above 500°C. Furthermore, this also limits implementation of sensors that require high temperature for their operation. We propose a concept that has a potential to overcome these limitations and provide a microplatform for sensing in harsh conditions. Our innovation combines nano- and microfabrication with self-organized nanostructured ceramic to create low power, high surface area, fast response, robust microsensors. Using this approach, we have already demonstrated several types of microsensors. This Phase 1 project now targets comprehensive development of this ceramic microplatform in support of chemically and mechanically robust microsensors for applications that demand reliability in extended operation and could be heated in excess of 800°C.

**Commercial Applications:** Miniature gas sensors are needed for reliable real-time point-source measurements of multiple chemical species in a variety of applications, such as emission monitoring, process control, industrial and consumer health and safety, air quality monitoring, healthcare and anti-terrorist activities.

**FY 2002 Phase I Award**

**Topic:** 7.14 Optics and Optical Technology

**Subtopic:** 7.14.03 Sensitive, Linear, and Spatially Uniform Midinfrared Detectors

**Title:** Sensitive, Linear and Spatially Uniform Midinfrared Detector

**NIST OU:** 840 Physicis Laboratory

**Firm:** New Jersey Microsystems Inc.
240 Martin Luther King Blvd.
Newark, NJ 07102-2100

**Principal Investigator:** Donald E. Booth
**Phone:** (973) 297-1450 x15
**Fax:** (973) 297-1125

**Award Amount:** $74,995.47

**Abstract:** We propose an uncooled infrared detector for the 8 to 12 micron wavelength range utilizing an integrated image converter with a thermal sensitivity as small as 2 millidegK based on modeling by independent research groups. Highly stable thin films coupled to a silicon readout additionally provide the desired spatial uniformity, linearity, dynamic range, and reduced cost for the detector representing an improvement in all areas over the commercial HgCdTe-based systems presently available. During Phase 1 a prototype detector will be delivered to NIST for proof-of-concept evaluations.

**Commercial Applications:** We propose an infrared detector for use in the NIST Infrared Detector Comparator Facility that can ultimately qualify as a secondary calibration standard, traceable to NIST primary standards. NJM is using a technology that is scalable from the single pixel detector for the NIST application up to very high-resolution imagers. The NJM detector senses temperature and is sensitive in the infrared range 8 to 12 microns wavelength. The technology that NJM is developing for the larger infrared imaging market will support the single pixel detector application for infrared spectral radiometry funded by this SBIR project at NIST. The commercialization plan is to sell and support a secondary calibration standard traceable to the NIST standards. NJM plans to become an OEM supplier of the detector to infrared laboratories and production facilities worldwide.

**FY 2002 Phase I Award**

**Topic:** 7.05 Condition-Based Maintenance

**Subtopic:** 7.05.04 Tools for IEEE 1451-based Smart Sensor Networks

**Title:** Java Framework for IEEE 1451-based Smart Sensor Networks

**NIST OU:** 820 Manufacturing Engineering Laboratory

**Firm:** NewMonics, Inc.
877 S. Alvernon Way, Suite 100
Tucson, AZ 85711-5352

**Principal Investigator:** James Lathrop
**Phone:** (515) 296-8313
**Fax:** (515) 296-4595

**Award Amount:** $74,815.00

**Abstract:** Today's vehicles are inundated with sensors and actuators that broadcast critical data over control networks. The extensiveness of these networks is likely to increase over the next few years. The promise of a plug-and-play world where system designers can buy off-the-shelf products to build complex distributed systems on vehicles is enticing. To reach this promise, software tools that support distributed systems are needed. To be effective, these tools need to work with networks commonly found on vehicles, such as the Controller Area Network (CAN). There is a recognized need within the CAN community for a middleware solution that will support the communication of distributed embedded devices. This proposal describes a framework based on IEEE 1451 which will provide the logistical communication services necessary for a distributed system. The object-oriented flavor of the IEEE 1451 standard makes Java a natural fit for implementing the standard. Phase 1 of the project will include a needs analysis for a plug-and-play framework within telematics. This will be followed by an architecture design for this framework. Phase 2 will result in the development of a prototype of the proposed framework.

**Commercial Applications:** Anticipated benefits to the telematics community include improved development tools for the CAN network. This is facilitated by a framework that supports distributed smart sensors. This framework will abstract system details from developers; therefore, we anticipate it will reduce the calendar time and costs needed to develop applications using distributed smart sensors on the CAN network. This framework would be useful commercially in other markets where the CAN network is utilized, including factory automation and medical communities. Additionally, the framework can be easily modified to other networks, thereby making the framework useful to other markets that need to build distributed smart networks.

**FY 2002 Phase I Award**

**Topic:** 7.05 Condition-Based Maintenance

**Subtopic:** 7.05.01 Ambient-powered Wireless Network Smart Sensors for Intelligent Manufacturing

**Title:** Condition-Based Maintenance

**NIST OU:** 820 Manufacturing Engineering Laboratory

**Firm:** Oceana Sensor Technologies, Inc.
1632 Corporate Landing Parkway
Virginia Beach, VA 23454-5617

**Principal Investigator:** Jens Hult
**Phone:** (757) 426-3678
**Fax:** (757) 426-3633

**Award Amount:** $75,000.00

**Abstract:** Sensors powered from environmental energy sources and capable of communication over wireless links will be a tremendous boon to manufacturing systems monitoring and condition based maintenance programs. It is usually inconvenient and often cost-prohibitive or physically impossible to run signal and power cables to sensors used to monitor complex machines and industrial systems. The ability to extract energy from the machine environment to power intelligent sensors employing wireless data communication clearly would be a very desirable development. Solid-state thermoelectric heat pumps are readily available commercially; however these units typically are optimized for refrigeration applications and operate at low voltage and high power levels. Recent advances in thermoelectric (TE) module fabrication technology has led to the development of miniature TE modules that may operate at modest temperature gradients (10° - 20° C) to generate voltage and current levels suitable for powering semiconductor electronic circuits. There also is rapid progress in the development of compact wireless intelligent sensors that employ the Bluetooth™ RF communication specification and are compliant with the IEEE P1451 family of smart transducer network standards. The goal of the proposed program is to integrate these emerging technologies to create autonomous "plug and play" sensors for use in manufacturing environments.

**Commercial Applications:** Sensor autonomy is critical to the further development of machine health monitoring instruments. Wireless communications technology exists that has the capability to transmit output data; however, power must be supplied by cable and, if it is even feasible to run cables, their cost is typically several times the cost of the sensors themselves. Thermal energy harvesting to power autonomous sensing devices will have a significant beneficial impact on the costs and manner in which sensors are deployed in manufacturing systems and condition based maintenance applications. Cable-free sensors will enable improved spatial distribution of sensors, ease of installation, higher reliability, and new methods of installation. Furthermore, sensor interoperability, universal network access, application information sharing and, thus commercial potential will be enabled by the adoption of the IEEE1451 family of sensor network information model standards

**FY 2002 Phase I Award**

**Topic:** 7.17 X-Ray System Technologies

**Subtopic:** 7.17.01 Develop Advanced X-ray Deffraction (XRD) Detection System

**Title:** Advanced Detectors For X-Ray Diffraction (XRD) System

**NIST OU:** 830 Chemical Science and Technology Laboratory

**Firm:** Photon Imaging Inc.
19355 Business Center Drive, Suite 8
Northridge, CA 91324

**Principal Investigator:** Jan S. Iwanczyk
**Phone:** (818) 709-2468
**Fax:** (818) 709-2468

**Award Amount:** $75,000.00

**Abstract:** The goal of the proposed work is to develop a novel, large-area, high energy-resolution analytical x-ray detection system for x-ray powder diffraction applications, capable of operating at count rates >1MHz. The proposed system is based on silicon drift detectors (SDD) specifically designed for installation on a Bragg-Brentano diffractometer, which will provide orders of magnitude advancement in performance compared to current energy dispersive semiconductor x-ray detectors, and greater than a factor of two improvement in efficiency compared with the current graphite monochromator combined with proportional counter systems. In Phase 1, the detector package (based on our current 50 mm2 SDD) and preamplifier will be developed and optimized for the high-count rate operation. Low noise amplification electronics, detector bias voltages, Peltier cooling and a miniaturized hermetic capsule will be developed. In Phase 2, we will finalize the development of the detector with an optimized device with the required dimensions of ~ 5 mm x 20 mm, detector package and supporting electronics and software. The detector system will be tested at Photon Imaging as well as at NIST. We will measure the performance of the system as a function of the input count rate and compare the detection efficiency with that of the conventional graphite monochromator with proportional counter system.

**Commercial Applications:** The proposed new detectors will lead to significant performance improvements and lower cost systems, compared to diffraction detectors on the market currently. Eliminating the need for liquid nitrogen, combined with the relatively low cost of silicon planar processing, will allow construction of affordable, light weight, low power consumption x-ray analytical systems. These new devices will replace many existing detectors, such as proportional and scintillation counters, as well as cryogenic Si(Li) and high purity germanium, used in many commercial (e.g. x-ray diffraction, microanalysis, x-ray fluorescence, medical imaging) and scientific (nuclear, high energy physics, synchrotron radiation experiments) applications. Other new applications are possible for use in hand-held, portable field instrumentation.

**FY 2002 Phase I Award**

**Topic:** 7.10 Manufacturing (Microfabrication and Micromachining)

**Subtopic:** 7.10.02 Silicon Cross Capacitor for Gas Analysis

**Title:** A Micro-Electroformed Cross Capacitor (MECC)

**NIST OU:** 830 Chemical Science and Technology Laboratory

**Firm:** Research Support Instruments, Inc.
4325B Forbes Blvd.
Lanham, MD 20706-4854

**Principal Investigator:** Jon R. Fox
**Phone:** (609) 580-0080
**Fax:** (609) 580-0083

**Award Amount:** $74,852.00

**Abstract:** Utilizing new hard, etch resistant photoresists derived from epoxy formulations such as SU-8 to serve as the mold for electroless metaldeposition for MEMS electroforming techniques, a fully micro-miniaturized cross capacitor can be realized. A Micro-Electroformed Cross Capacitor (MECC) is built by electroforming high aspect metals atop the substrate. A Phase 1 effort would model MECC performance, develop the process steps for fabrication, and finally demonstrate the ability to fabricate a micro-miniaturized cross capacitor.

**Commercial Applications:** NIST has an interest in producing micro-machined cross capacitors for
metrologic studies of the dielectric constant of gases, and as a possible measure of pressure. Industrial uses of a micro-machined cross capacitor would be similar.

The cross capacitor is a capable tool for the measure of the dielectric constant of gases and as an ancillary may be used as a pressure measure for systems where epsilon (p,T) is well understood. Such capabilities would be desirable for a wide range of customers who have demanding process gas monitoring requirements, including the gas pipeline industry, the semiconductor industry, the chemical manufacturing industry, and the medical systems industry.

**FY 2002 Phase I Award**

**Topic:** 7.12 Microelectronics Manufacturing

**Subtopic:** 7.12.01 High-Temperature Emissometer for Semiconductor Materials

**Title:** High Temperature Emissometer for Semiconductor Materials

**NIST OU**: 840 Physcis Laboratory

**Firm:** S C Solutions, Inc.
1261 Oakmead Pkwy
Sunnyvale, CA 94085-4040

**Principal Investigator:** J. L. Ebert
**Phone:** (408) 617-4526
**Fax:** (408) 617-4521

**Award Amount:** $75,000.00

**Abstract:** This Small Business Innovation Research Phase I project involves the design of a test facility for a new method to accurately measure the near-normal spectral emissivity of semiconductor wafers at near-infrared wavelengths. The accurate emissivity characterization of wafers by the proposed test equipment will provide a measurement standard needed for improved thermal processing of wafers, such as in Rapid Thermal Processing (RTP), particularly for model-based temperature control and sensing. SC Solutions, an industry leader in delivering RTP temperature control solutions, recognizes accurate temperature measurement as the single biggest impediment to more precise control of wafer temperature necessary to meet the increasingly stringent specifications of the semiconductor processing industry. The novelty of the proposed design is in the use of both direct and indirect methods, including transmittance measurements, to determine wafer emissivity over a temperature range of 300K-1400 K. The measurements will be made on both surfaces of the wafer in air or in an inert environment using a hot-wall, pancake chamber that ensures excellent temperature uniformity. Apart from the detailed design, the Phase 1 work will include developing a dynamic thermal model of the furnace and an estimate of the error. In Phase 2, the test facility will be constructed and tested, and delivered to NIST.

**Commercial Applications:** SC Solutions proposes to develop a new high-temperature emissometer to measure the near-normal emissivity of semiconductor materials. The measurement of emissivity is the key to determination of wafer temperatures during thermal processing of semiconductors and other advanced materials. The final result of this focused effort will be a fully instrumented emissometer with accompanying control computer and software that can be marketed to all thermal equipment manufacturers, as well as to semiconductor manufacturers. The proposed standard has the potential to significantly improve temperature measurement accuracy, resulting in substantially improved controller performance and process repeatability for RTP and other thermal processing systems. Consequently, the commercial application of the proposed product is significant.

**FY 2002 Phase I Award**

**Topic:** 7.16 Technologies to Enhance Fire Safety

**Subtopic:** 7.16.02 Fast-Response Oxygen Sensor for Fire Environments

**Title:** Oxygen Sensor in Fires

**NIST OU:** 860 Building and Fire Research Laboratory

**Firm:** Southwest Sciences, Inc.
1570 Pacheco Street, E-11
Santa Fe, NM 87505-3993

**Principal Investigator:** Shin-Juh Chen
**Phone:** (505) 984-1322
**Fax:** (505) 988-9230

**Award Amount:** $75,000.00

**Abstract:** The ability to perform in-situ measurements of oxygen concentration in fire environments at a fast rate (better than 1 sec ) is not fulfilled by available sensor systems in the marketplace. Current systems involve extraction of gas samples with the required removal of water, particulate, and interfering chemical species, which can take several seconds to complete, prior to passing the samples to a gas analyzer. To capture the flow dynamics and chemical processes in fires, oxygen concentration measurements with better temporal and spatial resolution are needed. Better understanding of fire phenomena are crucial to fire safety and abatement of fires.

Southwest Sciences proposes to develop a diode laser-based sensor for the in-situ measurement of oxygen concentrations in fires. Using a newly developed vertical cavity surface-emitting laser (VCSEL) as the light source for optical absorption sensing has several advantages over other techniques such as electrochemical cells, solid-state and dye-based sensors. Phase 1 will establish the requirements for a measurement probe that is hardened for fires and evaluate the performance of the sensor design in a fire.

**Commercial Applications:** The proposed oxygen sensing system will be an essential tool for researchers to monitor oxygen concentrations in fire tests with temporal and spatial resolution. These tests will improve the understanding of fire phenomena, validate and improve the modeling capabilities of fire simulation codes. Commercial partners will be sought towards the end of Phase 1 to commercialize this technology. Possible applications of this technology include monitoring oxygen consumption in industrial furnaces or incinerators to determine the combustion efficiency, or monitoring building fires to assess the efficacy of fire suppressants.

**FY 2002 Phase I Award**

**Topic:** 7.12 Microelectronics Manufacturing

**Subtopic:** 7.12.05 Semiconductor Diode Lasers for Water Spectroscopy

**Title:** Compact, Turnable Diode Laser for Water-Vapor Spectroscopy

**NIST OU:** 810 Electronics and Electrical Engineering Laboratory

**Firm:** Vescent Photonics
P.O. Box 315
Lyons, CO 80540

**Principal Investigator:** Mike Anderson
**Phone:** (303) 823-9229

**Award Amount:** $75,000.00

**Abstract:** Stable tunable diode lasers suitable for industrial environments are cost prohibitive. Lower-cost systems suffer from unstable wavelength behavior and mode hopping requiring operation by highly-trained personnel. The development of low cost, compact and robust tunable diode lasers is required for the transition of diode-laser spectroscopy from the laboratory to the marketplace. We will develop a compact, external-cavity stabilization system which will employ independent control over the cavity optical path length and a wavelength-selective element. The system will quasi-continuously tune over the entire laser diode gain profile in 10 nm-20 nm continuous tuning intervals. The final package for a Phase 2 prototype could be the size of a deck of cards. In Phase 1 we will assemble a demonstration system on an optical breadboard. In Phase 2 a fully integrated device will be developed with a tuning range centered at 1380 nm for water-vapor spectroscopy.

**Commercial Applications:** Water is an important contaminant requiring control in semiconductor processing and robust water-vapor spectrometers are needed. Other applications include combustion control, explosives detection, medical diagnostics in exhaled human breath, and environmental monitoring.

**FY 2002 Phase I Award**

**Topic:** 7.04 Chiral Chemistry

**Subtopic:** 7.04.01 Chiral Surface Diagnostic Instrumention

**Title:** Surface Selective Chiral Detector

**NIST OU:** 840 Physcis Laboratory

**Firm:** Vescent Photonics, Inc.
737 4th Street
Lyons, CO 80540

**Principal Investigator:** Scott R. Davis
**Phone:** (303) 823-9229
**Award Amount:** $75,000.00

**Abstract:** A novel approach to the problem of surface-selective chiral detection is presented. In a small and potentially inexpensive optical package, chiral molecules adsorbed to the surface of a guided wave optic are probed via the evanescent field of the guided radiation. Single-mode guided-wave optics are exploited to increases the analyte-probe interaction region compared to traditional methods such as attenuated total-reflectance spectroscopy. Techniques for both circular-dichroism and optical-rotary-dispersion measurements will be studied and compared. In Phase 1 surface selectivity will be demonstrated in an optical-breadboard experiment. In Phase 2 a prototype of a surface-selective chiral spectrometer will be developed. This device promises to be useful in the characterization and understanding of the increasingly important field of chiral stationary phases as it relates to HPLC and enantio-specific synthesis.

**Commercial Applications:** The fields of enantio-specific synthesis and enantiomeric separations are crucial in several large industries such as pharmaceuticals, pesticides, food chemistry, and biomedical. The detailed chiro-surface chemistry and physics that enables such synthesis and separations is poorly understood. The proposed technology could be the basis of a research spectrometer that directly and selectively probes surface adsorbed chiral molecules. Reduction in size through optical integration could enable sensors for monitoring of enantiomeric excess on pharmaceutical production lines.

**FY 2002 Phase I Award**

**Topic:** 7.08 Information Technology

**Subtopic:** 7.08.02 Mobile Workforce Privacy

**Title:** Mobile User Privacy

**NIST OU**: 890 Information Technology Laboratory

**Firm:** VKD Shoppe, Inc.
56 Beaver Street, Suite 305
New York, NY 10004

**Principal Investigator:** Yiannis Tsiounis
**Phone:** (917) 660-3913
**Fax:** (347) 710-4580

**Award Amount:** $74,800.00

**Abstract:** As the deployment of mobile devices becomes ubiquitous and special interest groups and governments create laws to require the tracking of mobile users, user privacy is under serious threat. Being able to identify and locate an individual also creates a potential liability for service providers. Today the only private wireless communication system is the pre-paid cell phone. However, a pre-paid system is not ideal, as subscription-based services are more popular with both consumers and service providers, while users cannot be identified in emergencies as is required by the FCC's E911 Phase 2 bill.

We aim to create a system that can be used by service providers, or by third parties, to (a) guarantee user privacy without restricting the billing options; and (b) allow identification of users when required by law or requested by the customer.

Currently the user's identity is disclosed when accepting payments or authorizing access. We therefore aim to construct an anonymous electronic payment system that (a) can be used to hide the user's identity during payment or login, (b) can be integrated into typically low-powered and size-constrained mobile devices, (c) can trace users when required by law, and (d) can be adapted to existing providers' infrastructure.

**Commercial Applications:** Upon successful completion of the research we anticipate the following results:

· A very efficient, easy to implement and secure under clear assumptions Rabin signature-based anonymous on-line e-cash system and the methodology for such a system to support privacy in a mobile setting.

· A very efficient, easy to implement and secure under clear assumptions traceable anonymous on-line e-cash system and the methodology for such a system to support privacy and trustee-based revocation of privacy in a mobile setting.

**FY 2002 Phase I Award**

**Topic:** 7.11 Manufacturing Systems Integration

**Subtopic:** 7.11.03 Manufacturing Data Exchange Standards Interoperability Testing Tools

**Title:** Manufacturing Data Exchange Standards Interoperability Testing and Optimization Tool

**NIST OU:** 820 Manufacturing Engineering Laboratory

**Firm:** VulcanCraft
201 Stable Road
Carrboro, NC 27510-4144

**Principal Investigator:** Donald M. Esterling
**Phone:** (919) 942-2757
**Fax:** (919) 942-2757

**Award Amount:** $74,921.00

**Abstract:** The International Standard for the Exchange of Product Model Data (STEP) offers a platform for a seamless flow of information from product design though product planning and product manufacture. However, the current information flow is strongly biased in the direction of design to planning to manufacture. A closed loop feedback system is desirable to achieve optimum design through manufacturing conditions. The same feedback system would be a powerful testing tool to ensure that the model and data exchange between different Standards and their implementations are correct. The part representation in each of the three major domains (design, planning and part manufacture) will be placed within two common model formats: a populated B-Rep model that contains pointers from low level B-Rep entities to high level STEP features and which would have particular advantages for 2.5D parts and a volumetric model which is particularly facile in testing surface information and errors, making it highly suitable for free form parts. Representing the part in a common language across different domains will assist in comparing the resulting part models for each domain and in providing the closed loop/up-stream feedback that is a requirement for a fully optimized design to manufacturing system.

**Commercial Applications:** There is a large, international contingent of companies and government organizations that are rapidly moving to an integrated design to manufactured environment as mediated by the STEP standards. But currently there are no tools to ensure that various implementations of the Standards properly handle the exchange of information between domains. Further, the entire process is currently open loop, lacking the feedback necessary for optimization. The latter (optimized processes) is an industry requirement. Industry may be expected to enthusiastically support this solution to an acute and important need.

**FY 2002 Phase I Award**

**Topic:** 7.16 Technologies to Enhance Fire Safety

**Subtopic:** 7.16.01 Advanced Building Sensors and Information Systems

**Title:** Advanced Building Sensors and Information Systems

**NIST OU:** 860 Building and Fire Research Laboratory

**Firm:** Williams-Pyro, Inc.
2721 White Settlement Road
Fort Worth, TX 76107

**Principal Investigator:** Matthew B. Scarpino
**Phone:** (817) 335-1147 x117
**Fax:** (817) 332-7341

**Award Amount**: $75,000.00

**Abstract:** The objective of this proposal is to develop an advanced technology system that can detect the location and size of fires and activate a fast response system. The proposed innovation will detect the incipient stage of a fire using smart sensors with data fusion and Artificial Neural Networks to reason and minimize the false alarm rate. In addition, the proposed system will provide standardized display schemes that will allow firefighters to easily access information about the fire. The system will initially provide information about the size and growth of the fire, which will allow firefighters to determine adequate resources to dispatch: how many fire trucks to send, how many firefighters are required. When firefighters arrive at the scene, the system can provide information including the location of the fire within the building, location of any occupants, routes to the fire within the building, a safe location to stage firefighting activities, and growth of the fire (including temperature/CO/02 conditions related to OSHA requirements). As the fire is fought, our proposed system will continue to indicate the location of both the fire and smoke/gases, which are conditions relative to the OSHA 2 and 2 regulation.

**Commercial Applications:** Potential commercial applications of the research include buildings, especially large buildings with stairs and elevators. These buildings can be office buildings or used for other purposes. As the commercialization process progresses, WPI's marketing department will investigate alternative product applications. For example, the U.S. Air Force has expressed interest in a fire detection system for use in aircraft hangars. A variation of this proposed building control system may have application for the government in military aircraft hangars. Another possible application of this system is fire detection in private homes.

**FY 2002 Phase I Award**

**Topic:** 7.17 X-Ray System Technologies

**Subtopic:** 7.17.02 High Speed Pulse Processing for the Silicon DriftDetector X-ray Spectrometer

**Title:** Digital Electronics for Silicon Drift Detectors

**NIST OU:** 830 Chemical Science and Technology Laboratory

**Firm:** X-ray Instrumentation Associates
8450 Central Avenue
Newark, CA 94560-3430

**Principal Investigator:** Peter Grudberg
**Phone:** (510) 494-9020
**Fax:** (510) 494-9040

**Award Amount:** $75,000.00

**Abstract:** Silicon drift detectors (SDDs), a new class of energy dispersive detector that operates at near-room temperature, have just started to become commercially available. SDDs achieve energy resolutions comparable to the best Si(Li) detectors but at much shorter peaking times. The use of these detectors has resulted in photon throughput rates exceeding 1 MHz, exceeding the capabilities of existing pulse processor electronics to produce a clean spectrum. We have existing technology that can handle the raw count rates, but not with the desired spectral quality. We propose to develop the processing algorithms necessary to produce a clean spectrum under extremely high count rate conditions. In addition, since one of the main target applications for this technology is high speed x-ray full spectrum mapping, we will develop algorithms to properly handle the assignment of x-rays to pixels as well as to apply individual deadtime corrections to each pixel. Finally, we propose to develop the high speed communications interface necessary to transfer the large volume of mapping data to the host computer for display and storage on disk.

**Commercial Applications:** The primary commercial application of this research is for high speed x-ray spectroscopy using silicon drift detectors. These detectors offer excellent performance at much higher data rates than the exisiting state of the art, and promise to revolutionize the EDS industry. Other potential commercial applications include synchrotron research and a wide range of industrial applications that can benefit from the shorter process times offered by the higher data throughput. XIA's digital spectrometer is uniquely situated to capitalize on this opportunity.

**FY 2002 Phase I Award**

**Topic:** 7.16 Technologies to Enhance Fire Safety

**Subtopic**: 7.16.04 High Temperature Smoke Obscuration Measurements

**Title:** Advanced Technology Smoke Measurement

**NIST OU:** 860 Building and Fire Research Laboratory

**Firm:** Zerad, Inc.
425 E. Greenway Drive
Tempe, AZ 85282-6938

**Principal Investigator:** Richard E. Zimmermann
**Phone:** (480) 456-1010
**Fax:** (480) 456-1010

**Award Amount**: $74,617.00

**Abstract:** Smoke obscuration must be measured simultaneously at multiple locations to support building fire research. Currently used equipment experiences drift with both time and temperature. Ambient and forward scattered light also introduces error. The R & D will apply current photonics, materials, and data processing technology to reduce errors to acceptable levels.

**Commercial Applications:** Better smoke obscuration measurement equipment will save lives by establishing more viable egress paths in building fires and by supporting more precise evaluation of smoke detectors. The technology can also be applied to new products for assuring mine safety, early detection of aircraft fires, and monitoring air quality in metropolitan areas.

**FY 2002 Phase II Award**

**Topic:** 7.11 General

**Subtopic:** 7.11.03 Advanced Time-Resolved Planar Velocity Diagnostics for Spray Flames

**Title:** High Frequency, Time-Resolved Digital Particle Image Velocimetry System for Polydispersed Multi-Phase Flows

**NIST OU:** 830 Chemical Science and Technology Laboratory

**Firm:** Areoprobe, Corporation
2000 Craft Drive, Suite 1104
Blacksburg, VA 24060

**Principal Investigator:** Pavlos P. Vlachos
**Phone:** (540) 951-3858
**Fax:** (540) 951-8618

**Award Amount:** $299,598.00

**Abstract:** We propose to capitalize on the success of the Phase-I effort and develop a unique next generation three-dimensional DPIV system with the capability to resolve quantitatively with sub-pixel accuracy, both velocity and size of poly-dispersed multi- phase flows. This system is going to be unique compared with existing commercial systems in several aspects. Specifically, there is no commercially available PDIV system that: 1) delivers KHz time-resolution measurements 2) integrates a dynamically adaptive methodology with particle-tracking schemes, resolving the global three-dimensional velocities in a multi-phase flow with high accuracy (sub-pixel) and enhanced spatial resolution 3) resolves the size and shape of a dispersed phase simultaneously with the velocity measurements. The proposed system will deliver all of the above becoming an equivalent of a combined DPIV, LDA and PDA in one competitively priced package with the flexibility to address different fluid mechanics problems.

The success of Phase-I, the unique features of the proposed system, the innovative task identified for Phase-II, the assembly of an experience team to carry out the effort, combined with the fact that the most prominent fluid diagnostics company worldwide will be marketing the system almost guarantees the success of the proposed project.

**Commercial Applications:** No commercial DPIV system today, can perform with 10KHz frequency and the ability to resolve shape and size in multi-phase flows. Upon successful completion of the proposed work, a unique tool for basic fluid mechanics research and industrial applications related to fluid mechanics will be delivered. Currently the conventional DPIV, LDA and PDA systems market represents an approximate sales volume of $40M worldwide. The proposed system will penetrate this market by commercializing the product through Dantec Dynamics who commands approximately 60% of this market. It is expected that within 5 years from the first sale, the overall market share could be in the order of 10 to 20%.

**FY 2002 Phase II Award**

**Topic:** 7.11 General

**Subtopic:** 7.11.14 High Efficiency Wavelength Dispersive X-ray Fluorescence Detectors

**Title:** Wavelength Dispersive Fluorescence Detectors in Soft X-ray Region

**NIST OU:** 850 Materials Science and Engineering Laboratory

**Firm:** HD Technologies, Inc.
7900 South Cass Ave., Suite 255
Darien, IL 60561

**Principal Investigator:** Ke Zhang
**Phone:** (630) 241-9737
**Fax:** (630) 241-9863

**Award Amount:** $299,767.00

**Abstract:** A wavelength dispersive x-ray fluorescence detector working in soft x-ray region has been proposed based on the diffraction principles. The detector uses graded multilayers as analyzers and large area detectors for data collection to achieve good energy resolution and to avoid count rate problems encountered by solid state detectors. Furthermore, the detector will be tunable in a wide energy region and easy to operate. Testing results obtained in Phase 1 indicate that the detector will have a throughput between 20 to 30%, and a bandwidth of 3-4%. In the Phase 2 project, we will design and fabricate the multilayer array analyzer/detectors with large solid angle, which will be optimized in two energy regions: 500 to 1000 eV, and 1000 eV to 2000 eV. The detectors will be evaluated for their performance, and will be marketed as a generally used soft x-ray fluorescence detector for x-ray spectroscopy, fluorescence analysis, and imaging experiments.

**Commercial Applications:** The proposed detector will be marketed as a generally used soft x-ray fluorescence detector for various experimental techniques, which can be tailored to satisfy various applications. With superb energy resolution, reasonable solid angle, and very large count rate limitations, it will have a very promising market potential, especially a much better performance to price ratio compared to the solid state detector available. The product may lead to new market opportunities in high sensitive and more rapid data collection.

**FY 2002 Phase II Award**

**Topic:** 7.05 Information Infrastructure Security (Electronic Commerce)

**Subtopic:** 7.05.05 Mobile Code Policy Toolkit

**Title:** Inlined Reference Monitors for Java Bytecode

**NIST OU:** 890 Information Technology Laboratory

**Firm:** GrammaTech, Inc.
317 N. Aurora Street
Ithaca, NY 14850

**Principal Investigator:** Dr. Paul Anderson
**Phone:** (607) 273-7340
**Fax:** (607) 273-8753

**Award Amount:** $299,995.00

**Abstract:** Current state-of-the-art technology for specifying and enforcing security policies for software is generally too inflexible, coarse-grained, and difficult to use. In systems that make use of mobile code, such as Java applets, the situation is yet more difficult. A more flexible and powerful approach is needed that will allow a wider range of security policies to be set by various policy-setting authorities for different applications. At the same time, there must be check-box simplicity. We propose to commercialize mechanisms for specifying and enforcing security policies for mobile code that work by inserting fragments of code into programs in order to monitor their state and prevent them from violating security policies. The proposed system will allow arbitrary policies to be specified independently by different policy-setting authorities. We will apply this approach, named Inlined Reference Monitors (IRMs), to Java bytecode using a technique called aspect-oriented programming. We will leverage existing static-analysis technologies in the implementation of a security policy toolkit.

**Commercial Applications:** The software proposed has applications in computer security policy specification and enforcement. In addition, it has applications in general Java development and maintenance.

**FY 2002 Phase II Award**

**Topic:** 7.09 Microelectronics Manufacturing Infrastructure

**Subtopic:** 7.09.05 Cryogenic Packaging for Programmable Voltage Standards

**Title:** A Closed Cycle Refrigerator-based, Programmable Voltage Standard System

**NIST OU:** 810 Manuacturing Engineering Laboratory

**Firm:** HYPRESS, Inc.
175 Clearbrook Road
Elmsford, NY 10523-1109

**Principal Investigator:** Masoud Padparvar
**Phone:** (914) 592-1190 x7827
**Fax:** (914) 347-2239

**Award Amount:** $299,378.00

**Abstract:** Researchers at the NIST have demonstrated a programmable Voltage Standard (VS) chip based on SNS (superconductor-normal-superconductor) tunnel junction technology. Excellent programmable voltage standards were demonstrated using this SNS technology in a liquid helium-based system. At HYPRES, we have developed and commercialized a Closed Cycle Refrigerator (CCR)-based DC voltage standard system using a VS chip previously developed and integrated into a liquid helium-based system at NIST. Under the Phase 1 SBIR project, we developed a high performance cryogenic package for the programmable VS chip for integration with a CCR system. This developmental work involved collaborations between NIST and HYPRES to develop the package that was integrated with a NIST-provided CCR. In the Phase 2 program, we will continue to improve the packaging technology and design and implement a flexible cable technology to interface to the chip. In addition, we will procure a CCR system and develop and demonstrate a complete CCR-based programmable VS system. This system, based on a new CCR system developed by Sumitomo, will be compact and portable. The programmable Voltage Standard system has many other applications such as D/A converters and signal synthesizers. Phase 1 established the feasibility of the concept and Phase 2 will lead to a prototype compact system.

**Commercial Applications:** The product targeted in this program will encompass voltage standard markets as well as high-resolution D/A converter markets. Dual civilian and military uses for both applications abound. Through its contact with the Army, HYPRES has discussed the merits of the proposed program and obtained support and agreement that the goals of lower cost, programmability, and flexibility to implement D/A operations are important to the applications the Army and the other services would have for this product.

**FY 2002 Phase II Award**

**Topic:** 7.04 Condition-Based Maintenance

**Subtopic:** 7.04.03 Development and Inegration of Condition-Based Maintenance Technologies

**Title:** Development of an Intelligent Condition Based Maintenance System, Phase 2

**NIST OU:** 810 Electronics and Electrical Engineering Laboratory

**Firm:** VerTech, LLC
15471 Riddle Road
Chagrin Falls, OH 44022-3943

**Principal Investigator:** William H. VerDuin
**Phone:** (440) 247-8315

**Award Amount:** $299,814.03

**Abstract:** An Intelligent Condition Based Maintenance System (ICBMS) will provide "early warning" of equipment maintenance needs. Adaptive process models will predict changes in machine health from analysis of sensor inputs and machine usage. A troubleshooting and repair knowledge base will provide advice on maintenance scheduling and procedures to support ongoing operations and training of new staff. ICBMS will minimize the cost and disruption of maintenance, repair and unscheduled downtime. Innovations include hybrid neuro-fuzzy technology to provide "virtual sensors" and adaptive models. Automatic rule acquisition technology will extract structured rules by analyzing operational decisions and problem solving approaches provided by machine operators and maintenance staff. Proposed Phase 2 work will build upon preliminary technical feasibility demonstrated in multiple applications.

**Commercial Applications:** Two application areas have been identified in Phase 1. One involves the addition of intelligence to current manufacturing supervisory control systems. The Intelligent Condition Based Maintenance system will add to current reporting and presentation capabilities the functionality to predict maintenance requirements, as enabled by adaptive machine health models, and a decision support capability enabled by an associated knowledge base to support troubleshooting and specification of repair procedures.

The second application area is in support of sophisticated rotating machinery products such as turbine engines for aircraft propulsion and power generation. In this application, our technology will sit on top of existing data logging and presentation systems and will enable the human experts currently providing interpretation of all data streams to instead focus on the more challenging situations. They will additionally be provided a model-based predictive capability.