Abstracts of Awards for Fiscal Year 2007 NIST SBIR Program

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**FY 2007 Phase I Award**

**Topic:** 9.01.1-1 Advanced Biological and Chemical Sensing Technologies

**Subtopic:** 9.10.2-3 Broadly-Tunable CW Terahertz Single-Port Source

**Title:** Solid-State Broadly-Tunable Milliwatt CW ThZ source Based on Intra-Cavity Frequency conversion

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

**Firm:** Agiltron, Inc.
15 Cabot Rd.
Woburn, MA 01801-1003

**Principal Investigator:** Jack Salerno
**Phone:** 781-935-1200
**Email:** jsalerno@agiltron.com

**Award Amount:** $74977.00

**Abstract:** This proposal provides a breakthrough solution to realize a compact broadly-tunable THz local-oscillator, whose tuning range covers 0.8-1.2 THz with flat output power in excess of 200 uW. The innovation is based on high efficiency intra-cavity difference frequency generation. A dual cavity laser is designed to generate two separate frequency lasers, which share an EO crystal inside the cavity for THz generation. The THz frequency can be tuned by changing the EO crystal orientation. The output power can be controlled by an externally applied analog signal provided by the user. The power consumption is <40 W. In Phase I, the feasibility will be demonstrated in a deliverable prototype and the system design will be optimized. A fully functional THz source with unprecedented performance is anticipated in Phase II.

**Commercial Applications:** The proposed technology offers a unique solution for an innovative broadly-tunable THz source that is practical for THz imaging and spectroscopy of biological and chemical agents for healthcare applications. The technology also benefits high data rate communications, advanced electronic materials spectroscopy, medicine, biology, surveillance, remote sensing, defense, drug discovery and homeland security applications.

**FY 2007 Phase II Award**

**Topic:** 9.10 Optics and Optical Technology

**Subtopic:** 9.10.2-3 High Performance NIR Array Detectors for Advanced Sensors

**Title:** Low-Noise Detector Arrays for Raman Spectroscopy

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

**Firm:** Aerius Photonics
4160 Market St., Suite #6
Ventura, CA 93003-5622

**Principal Investigator:** Michael MacDougal
**Phone:** 805-642-4645
**Email:** macdougal@aeriusphotonics.com

**Award Amount:** $299,970.00

**Abstract:** We propose to demonstrate near infrared (NIR) sensor arrays with 10 times lower noise than arrays presently available to improve the sensitivity of current spectroscopy systems. Such an achievement would allow the measurement of new phenomena through Raman spectroscopy and other diagnostic techniques. The low noise performance is enabled by the use of low-noise Si readout integrated circuits mated to low-capacitance InGaAs detector arrays. Arrays using these two technologies have never been combined for spectroscopy applications. The new InGaAs sensor array is expected to achieve less than 20 electrons of read noise and quantum efficiency of greater than 80% at 77K. Such a sensor would directly lead to higher sensitivity than presently available at low light levels, thereby improving spectroscopic systems ability to detect signals that were previously masked. The end product will be a 27 x 1380 pixel 2D InGaAs array on an 18.5 um pitch with less than 20 electrons/pixel/frame at liquid nitrogen temperature (~77K) and a 60 Hz frame rate, delivered in a cryogenic dewar.

**Commercial Applications:** The low noise InGaAs arrays to be developed under this program will be directly applicable to markets in Raman spectroscopy, emission microscopy, and astronomy. Within Raman spectroscopy, important markets include pharmaceuticals, forensic science, and polymers, among others.

 **FY 2007 Phase II Award**

**Topic:** 9.03 Homeland Security

**Subtopic:** 9.03.1-6 Development of a Large-Area Solar Simulator Using Light Emitting Diodes

**Title:** Holographic Light-Emitting Diode-Based Solar Simulator

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

**Firm:** Physical Optics Corp.
Applied Technologies Division
20600 Gramercy Place, Bldg. 100
Torrance, CA 90501-1821

**Principal Investigator:** Dr. Kang-Bin Chua
**Phone:** 310-320-3088
**Email:** sutama@poc.com

**Award Amount:** $299,990.00

**Abstract:** NIST is seeking a large-area solar simulator to overcome the shortcomings of current devices. Therefore, Physical Optics Corporation (POC) developed in Phase I a new Holographic Light-Emitting-Diode (LED)-Based Solar Simulator (HOLIOS) system based on: high-power LEDs with electronic drivers; holographic filters; and collimating, homogenizing, and projection optics for indoor testing of photovoltaic (PV) modules. The combination produces an irradiation spectrum precisely matched to the solar irradiation spectrum, with a uniformity or +/-2% over the entire area. In Phase I POC delivered to NIST a proof-of-concept prototype with an array of high-power LEDs and one-of-a-kind LED driver electronics to produce irradiance approaching 50% of solar in the visible spectrum, covering a 0.3 m x 0.3 m area. In Phase II POC will produce a scaled-up multiple-module prototype simulating both solar irradiance under a wide range of air mass conditions, and atmospheric absorption by water, oxygen, ozone, and carbon dioxide molecules. It will irradiate a 0.6 m x 0.6 m to 1.5 m x 1.5 m area, depending on the number of modules, at irradiance levels that can be varied from <500 to 1100 W/sq.m, while maintaining uniformity of irradiance within +/-2% over the irradiated area.

**Commercial Applications:** The proposed solar simulator not only addresses the NIST requirement for a large-area solar simulator that overcomes the shortcomings of current solar simulators, but also has significant commercial applications in agriculture for artificial greenhouses in remote locations such as the arctic and space stations and in treatment of skin disorders.

 **FY 2007 Phase II Award**

**Topic:** 9.11 X-ray System Technologies

**Subtopic**: 9.11.1-5 Imaging Variable Kinetic Energy (0.1 to 8 KeV) Electron Analyzer

**Title:** Imaging Variable Kinetic Energy Electron Analyzer

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

**Firm:** R. Browning Consultants
522 Chestnut St., #1
San Carlos, CA 94070-2146

**Principal Investigator:** Raymond Browning
**Phone:** 650-595-1528
**Email:** rb\_net@sbcglobal.net

**Award Amount:** $299,968.00

**Abstract:** The objective of this proposal is to create a prototype imaging variable kinetic energy electron analyzer in the range 0.1 to 8 keV for use with an X-ray excitation source. The imaging analyzer is to have a target imaging spatial resolution of 100 nm. The X-ray excitation source will be a synchrotron light source. The instrument can be described as an X-ray photoelectron spectroscopy (XPS) microscope XPM. The microscope will use a magnetic immersion projection lens and an electrostatic hemispherical electron analyzer. The images the microscope will produce will be multidimensional spectrographic images. A second objective of this proposal is to further develop the new class of electron microscope invented in the Phase I work program. The new class of microscope can combine high spatial resolution and time resolved imaging.

**Commercial Applications:** XPS microanalysis could prove to be a significant analysis tool in the investigation of techniques for sub-micron semiconductor device physics, materials science, fiber science, and nanoscale devices. Current XPS imaging systems are limited in spatial resolution and the images have low informational value. The microscope proposed here could have widespread acceptance as a routine tool for microanalysis. An output of the Phase I work program was a new class of electron microscope that may have immediate applications such as in semiconductor device defect analysis.

**FY 2007 Phase II Award**

**Topic:** 9.04 Information Technology

**Subtopic:** 9.04.2-4 Gigabit/second Random Number Generator

**Title:** Gigabit/second Random Number Generator Using White Noise Generated by Delayed Optical Homodyne

**NIST OU:** Physics Laboratory

**Firm:** Structured Materials Industries, Inc.
201 Circle Dr. North, Unit 102-103
Piscataway, NJ 08854

**Principal Investigator:** Bruce Willner
**Phone:** 732-302-9274
**Email:** Bwillner@structuredmaterials.com

**Award Amount:** $300,000.00

**Abstract:** SMI proposes Gigabit/second Random Number Generator using the white phase noise generated by delayed optical homodyne. In Phase I, we have successfully demonstrated and delivered to NIST a bench-top proof of concept of the proposed random noise generator operating at >10 Mega-bit/second. This bench-top demonstration unit is operating today in the NIST laboratories. The delivered system successfully passed all the NIST statistical tests that could be finished on that delivery day. We proposed to further increase the speed of the random number generator, to further extend its frequency band to cover from DC to 10 Giga bits/second, and to supply more digital output formats, for example, the SCSI connector, in addition to the existing SMA output. Phase II will see a commercial compact random noise generator targeted at 10 Giga-bits/second, for commercialization in Phase III.

**Commercial Applications:** Potential commercial applications besides scientific and engineering research, such as the NIST labs, exist in military and government data storage security, military and government communication encryption, data and communication encryption and security for the financial industry, private data security, etc.