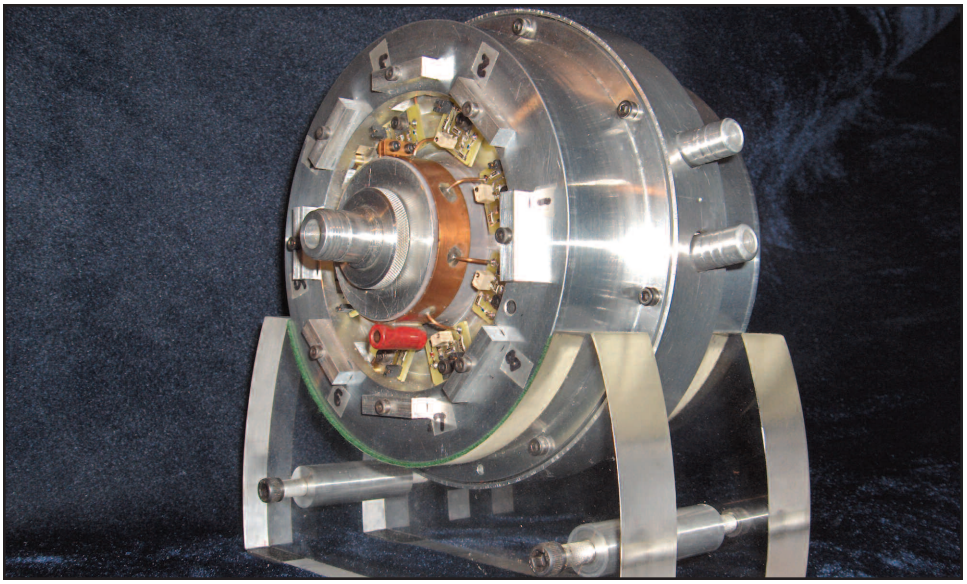
Spring 2007

Missile Defense Agency

TechUpdate

A Quarterly Newsletter for MDA Technology Transfer

INSIDE



▲ Aria's microwave amplifier could offer satellite and cell-phone providers a long-lasting, reliable alternative to commercially available solid-state technologies. The amplifier generates high levels of power through a synchronous reaction of large numbers of RF semiconductor transistors within the device.

A Slam-dunk Amplifier

Small, simple device could provide cost-effective way to boost power, reliability.

by Joe Singleton/jsingleton@nttc.edu

When you watch a basketball game on TV or call a friend on your cell phone, amplifiers make the signal stronger or the voice clearer. Now, using a hybrid, high-powered microwave amplifier from MDA-funded Aria Microwave Systems (Teaneck, NJ), such signals could be made even stronger, while offering potential savings to satellite and cell-phone system providers. Aria's amplifier will also offer a high-power solid-state solution for high-frequency needs in military, radar, industrial, scientific, and medical applications.

Funded by an SBIR Phase II award from BMDO, an MDA predecessor, Aria's Active Radio Frequency Cavity Amplifier (ARFCA™) provides a unique way of creating a high-power RF amplifier using standard off-the-shelf RF power transistors that are highly reliable and longer-lasting than microwave tubes. By combining the transistors in this way, the ARFCA makes high-power applications like communications far more affordable than current state-of-the-art solid-state device-based amplifiers. Using many commercially available amplifier components will allow Aria to manufacture ARFCAs inexpensively and priced to compete with vacuum tube technology minus the short lifespan, and while operating without dangerous high voltages. As a

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It Ain't Over Till It's Over

You never know who will seek your technology—and when they will seek it.

by L. Scott Tillett/stillett@nttc.edu

The MDA Technology Applications program rarely gets irate phone calls. We write about MDA-funded businesses in an effort to spread the word about their MDA-funded innovations—and help them commercialize those technologies. They welcome the free publicity that we give them. And we hope that readers appreciate the free and timely information we provide on emerging technologies. So there's no room for complaints, right? … Wrong. We got quite an irate phone call a few months ago. And it was wonderful.

A woman called to say that, for many months, she had been getting an exorbitant amount of commercial inquiries via phone from readers who had learned about a technology featured several years ago on our Web site, www.mdatechnology.net. It seems that many readers of the online article were eager to learn more about the technology, so they picked up the phone and called the company contact number listed on the article. The only problem was that the phone number no longer belonged to the MDA-funded company featured in the article. Instead, it now belonged to this woman.

It had been a while since we checked in with that company—one of several hundred featured on our Web site—so we had not known that the contact information needed updating. And boy did it ever need updating. Our irate caller had endured months of misdirected calls before she finally figured out that the article on the TA program Web site was the wellspring of all the calls. She said she would have phoned us sooner, but she did not realize that people were getting the phone number from www.mdatechnology.net.

And that's perhaps the big lesson here: People are reading MDA's Technology Applications' Web site, and they are taking action. They are picking up the phone and making calls to find out more about MDA-funded technologies—seeking information directly from those that developed the technology—not from the TA program, not from MDA, but from the companies commercializing the technology. And that's good news.

We quickly remedied the situation with the incorrect online contact information so that our irate caller would cease getting calls. So for us here at MDA's Technology Applications program the lesson was: Police our article contact information a little more diligently.

For the companies we write about—those companies funded by MDA—their lesson is a pleasant one: You never know who will seek your technology—and when they will seek it. So be prepared. Make sure that your contact information—wherever it may be listed—is accurate and up to date. Take heart in knowing that even years after you've done your initial MDA-funded work, would-be customers could come knocking on your door—as their needs catch up with what you have invented. So if your contact information changes, contact us and let us know. You might be missing out on opportunities.

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The MDA Technology Applications program sponsors publication of the *MDA TechUpdate* to encourage the transfer of missile defense technology to American businesses and other government agencies.

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The *MDA TechUpdate* is written and produced for MDA by the National Technology Transfer Center-Washington Operations. This project is sponsored by MDA. The content does not necessarily reflect the position or policy of the Government; no official endorsement should be inferred.

Approved for Public Release
07-MDA-2425 (12 APR 07)

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A New Way to Envision Costs

Modeling software lets users get a better handle on the bottom line.

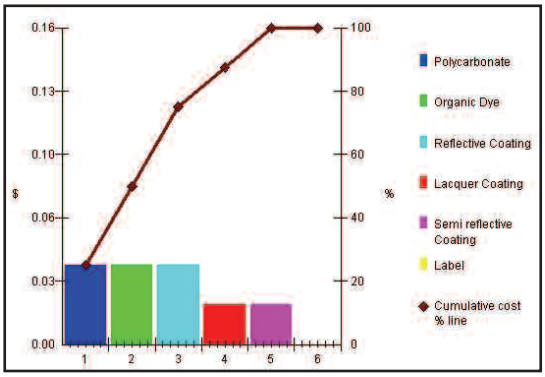
by L. Scott Tillett/stillett@nttc.edu

An MDA-funded company has developed software that offers enhanced security and functionality for people whose jobs involve making decisions that affect the cost of capital equipment, manufacturing processes, or products.

The company, CostVision (Boulder, CO), has created a software tool that employs Web-based security standards to allow users who work with cost-related data to access and share information without exposing sensitive or proprietary information. For example, a supplier working with a client to create a cost model for a new manufacturing process can use the Web-based software to share data without revealing proprietary details such as cost structure or other sensitive, internal operational factors that influence cost. "They are not giving away that data," said Charles Stirk, president of the company. "People only access the data and use it based on privileges the owner of the data gives them."

The software, called Cost2Target℠, offers a replacement to existing methods of sharing and managing data for cost modeling. MDA originally funded the software through a Phase II SBIR project that sought cost-modeling software as a tool to avoid cost overruns and shorten system development time. Traditionally, the cost-modeling process has relied heavily on spreadsheets and other scattered computer applications for modeling various aspects of cost. But users can integrate CostVision with their disparate applications—including computer-aided design (CAD) programs and enterprise resource planning (ERP) systems. "We integrate to all their normal engineering tools so that they don't have to spend their time typing in data," Stirk said.

A mix of proprietary and open software standards enables that integration. Users can employ a special client application to integrate CostVision with their existing internal systems—in a Web-services-type approach that allows machine-to-machine interoperability. Additionally, the company has turned to integration standards for product data-management systems or product life-cycle management systems. CostVision has relied heavily on data-format standards known as the Standards for the Exchange of Product (STEP) Model Data guided by the International Organization for Standardization (ISO).



▲ Graphic displays in CostVision's software enable users to visualize the cost impact from changes in product material type, features, or other specifications.

CostVision is written in Java and uses a typical SQL database. Stirk said new Web technologies and data-integration standards that have emerged only in the past few years have made the CostVision product possible.

From the desktop user's perspective, a Web-browser interface for CostVision should make the product appealing and accessible to an array of workers. "It's role-based and collaborative so that regular engineers, program managers, and people already working together in integrated product teams can use the software," Stirk said.

The product includes encryption, security, and controls that allow users to assign roles and rights to many layers and types of cost-related data running throughout a supply chain. For example, a user of the CostVision application may not see a supplier's cost-structure detail when changing an aspect of a product's design—such as CAD model features, product dimensions, specifications, or material types—but the user still could see the final cost impact of that design change. And meanwhile, on the other end of the supply chain, that same user's customers could be granted rights to see the cost impact of program changes—such as changes in delivery schedules, product configurations, or requirements.

Ultimately, users of CostVision should realize a cost reduction, according to Stirk, who said in one case users reduced costs by 66 percent by employing CostVision's integrated cost-modeling application. He said the amount of cost reduction would vary depending on the complexity of the product being designed and where the product is in its design life cycle. "If you are in concept phase, for example, you have more design freedom—or variables to play with—and you can get a larger cost reduction," Stirk said.

CostVision will market its software to companies with large capital investments, narrow margins, and complexity in products, processes or supply chains. Makers of industrial equipment, automotive components, and commercial aerospace products could find CostVision to be a very useful tool.

The company continues to develop its marketing plans for the software—and to refine the product. In addition to the

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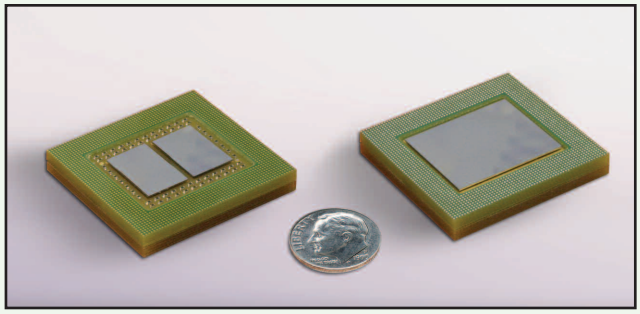
Packing More Punch into Processing

New approach addresses the growing market for shrinking electronics.

by Joan Zimmermann/jzimmermann@nttc.edu

As iPods shrink to iPod nanos, and cell phones approach the size and thickness of credit cards, to be smaller and more compact is ever more beautiful in the eyes of Generation X and beyond. Thanks to some funding from MDA and its own established track record in integrated-circuit packaging, Tessera Technologies, Inc. (San Jose, CA), has created a miniaturized image-processing module suited to the increasingly Lilliputian dimensions of popular electronic devices.



▲ Tessera creates compact, high-performance electronic products at lower cost through its innovative packaging technology. Users can stack multiple chips within the footprint of a single package.

During the course of an MDA Phase II SBIR contract to improve image-processing quality in missile interceptors, Tessera developed packaging that married field-programmable gate arrays (FPGAs) with static random access memory (SRAM). The three-dimensional packaging used with a novel module architecture enabled a quadrupling of signal processing elements in the same circuit-board area space, allowing image processing to be distributed massively. The technology application was originally developed for infrared images in missile-interception scenarios, but the FPGA/SRAM module can be adapted for visible light processing and signal processing in general. This combination of device and wavelength range makes the technology suitable for a wide range of products.

The most obvious and timely application for Tessera's modular approach is in image processing for cell-phone cameras and digital cameras. The trend of shrinking phones and cameras seems to be undiminished as the 21st Century moves forward, with the circuitry footprint determining whether we will one day be toting thumb-size phones and thimble cameras. Tessera's FPGA/SRAM combination can offer higher resolution and better reliability to image processing.

In addition, packing more components into a single footprint is another emerging avenue in personal electronics. With iPhone mania in full swing, the drive for multitasking electronics will continue to bring with it a growing demand for rapid switching technology in competing products. Switching rapidly between music, streaming video, cell-phone signal, e-mail messaging, and Internet browser requires agility and speed, as well as reliability in small packages.

As cell-phone systems have switched from analog to digital, signal processing speed has become a key aspect of how reliable the network can be. More calls are carried in the same channel space, thus more processing power is required for encoding and decoding while sending data from the cell phone to the tower and back again. In this application, Tessera's compactly designed modules offer such features as decreased signal latency and better signal integrity, without adding bulk to the device.

Another area for Tessera's modular approach is software-defined radio (SDR). Tessera is working on a lead project for Joint Tactical Radio System (JTRS), a military program conducted by the United States and its allies, which aims to provide a common platform for flexible radio communications between ground vehicles, aircraft, and fixed or mobile base stations. SDR also enables "cognitive" switching, in which the software monitors and quickly determines which radio frequency is available for use, reducing interference and smoothing communications. As the commercial airwaves evolve toward broader adaptation of hybrid digital services and other technology advances, the developers of the SDR concept expect it to become the leading technology in radio communications.

Tessera licenses its technology and also offers engineering, assembly, and infrastructure services. The company is actively engaged in adapting its technology to image processing for cell-phone cameras and digital cameras, and in finding new markets for its compact modules.

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Crystal-clear Imaging

Wideband radar-signal processor could enhance security, surveillance.

by Joe Singleton/jsingleton@nttc.edu

A new MDA-funded radar-signal-processing system could give radar operators, intelligence officials, and port security officers the new powerful imaging tools that they are seeking.

S2 Corporation (Bozeman, MT) is using patented optical memory materials to develop a signal processor that can identify targets more readily using instantaneous wideband waveforms, resist signal jamming, and operate over a broad dynamic range. This processor can potentially handle bandwidths of tens of gigahertz. It is also designed to deliver extremely precise results in applications that involve ranging or Doppler radar.

S2 has developed a hardware prototype for the radar signal processor, which company researchers call the S2RSP. S2 officials expect the prototype to be tested in house, at the Massachusetts Institute of Technology's Lincoln Laboratories, and by the contract's administrator, the U.S. Army Space and Missile Defense Command, by the end of this year. S2 also expects this technology to receive Technical Readiness Level 5 certification during the same period. Following tests, the company plans to design an application-specific production model before the contract expires, anticipated in 2009.

The company's recent work on the device has been funded by a multimillion-dollar MDA SBIR Phase III contract. MDA also funded development of the original optical memory materials on which the company relies. Those materials were developed by Scientific Materials Corporation (SMC; Bozeman, MT) under an SBIR Phase II contract.

FLIR Systems acquired SMC in November 2005, with S2 spinning out of SMC as a separate company. FLIR Systems continues to provide high-quality optical-memory materials to S2 Corporation. Some of the prior technology was patented by researchers at Montana State University. S2 Corporation maintains exclusive licenses to these patents and also claims several trade secrets under SBIR data rights.

At the heart of the S2RSP is a specially grown and cryocooled crystal—into which are written holographic representations of modulated analog radar signals. These spatial-spectral, or S2, crystals have been proposed for possible use in radar applications since the beginning of the decade, when SMC's Phase II contract was in play.

The S2RSP is designed to operate as a highly efficient and flexible radar system component that enhances performance by allowing the radar to transmit and receive complex, instantaneous wideband waveforms. Instead of down-converting radio-frequency signals as in conventional radar processors, the S2RSP modulates a laser with these signals. The laser-modulated signals are "written" holographically into an S2 crystal. The information stored in the crystal is then read out and reprocessed digitally, leading to range and Doppler graphics.

S2's processor provides many distinct advantages over legacy systems. The system allows for analog processing as well as wide and sustaining bandwidth capabilities up to 20 gigahertz with long time apertures. Such capabilities can provide an order-of-magnitude improvement in the bandwidth and aperture allowed by conventional systems. Analog radar-signal processing allows the user to avoid being confined to one waveform class. S2 has successfully demonstrated its technology with various waveform patterns—including random noise.

The S2RSP also has the advantage of being easy to integrate into existing radar systems. It is a technology that could either replace a receiver or operate side by side with existing units. "The modification really is as simple as taking the raw signals at the antenna and piping them over to the [S2RSP]," said S2 President Dr. Kris Merkel. For missile defense, one of the S2RSP's strategic advantages over legacy processors is the ability to provide a surveillance mode simultaneous with a fire-control mode. Two warheads could be separated by kilometers, both perhaps several thousand kilometers from the imaging radar, but each would be visible to the S2RSP simultaneously. With its Phase III contract, S2 hopes to provide the U.S. military with equipment that offers a large surveillance zone and constant wideband reception.

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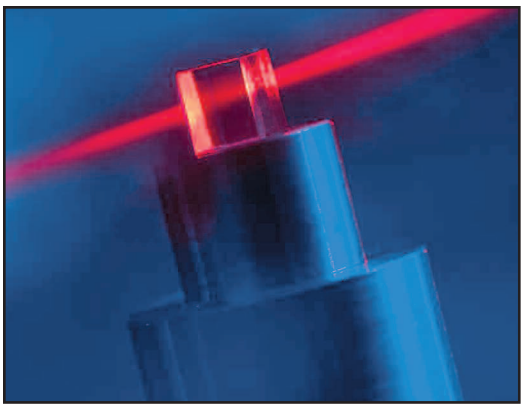

▲ S2's device digitally reprocesses laser-modulated radar signals stored in patented optical materials. The technology could give users constant wideband reception with extremely precise results over a large surveillance area.

Optically Detecting Fuel Leaks

Innovative use of fiber optics provides early warning of chemical hazards.

by Alan Sherwin/asherwin@nttc.edu

A new sensor system that uses light and fiber-optics technology to detect rocket-fuel leaks could help avoid waste, improve reliability, and protect personnel. Future iterations of the system could monitor other types of industrial chemical leaks, aid environmental monitoring, and support homeland security.

The technology, developed by InnoSense, LLC (Torrance, CA), emerged with funding help from MDA, which awarded the company SBIR Phase I and II contracts to develop a hydrazine leak detector for the sea-based Kinetic Energy Interceptor (KEI) program. In missile defense applications, detecting leakage of hydrazine-based fuel is critical for several reasons. The fire risk of leaked fuel is obvious, but more likely than a fire or explosion is the slow depletion of fuel over time, which degrades performance and reliability of the missile system. Finally, hydrazine vapor is extremely toxic when inhaled or brought into contact with the skin. Leaks are of particular concern aboard ships at sea, where the only escape route is over the side.

MDA funded InnoSense to develop a new type of leak detector for hydrazine-based hypergolic rocket fuel. Existing hydrazine detectors have various drawbacks. Some require maintenance, such as battery replacement; some can't withstand the harsh environments where the missile systems are deployed; some are not sufficiently sensitive. InnoSense addresses all of these concerns with its innovative fiber-optics-based sensor.

▲ InnoSense's all-optical leak detector can be calibrated to detect leaks in the parts-per-million or parts-per-billion range.

Because the sensor is all-optical, there are no batteries to replace over its 10-year expected lifetime, a significant advantage over competing battery-operated sensors. The sensor can be calibrated to detect leaks in the parts-per-billion or parts-per-million range. In addition to its capability of sensing a static level of fuel molecules in the environment, it can also be configured to sense the rate of accumulation over time. The InnoSense device has met MDA's temperature-range requirements (-46°C to 71°C), a significant technical achievement for InnoSense, and a challenge that has defeated some of the competing technologies, according to InnoSense President Kisholoy Goswami. The sensing unit is also small and lightweight, so users can easily deploy as many units as required.

To fabricate the sensor, InnoSense starts with a standard communications fiber. The outer layer, or cladding, is removed and replaced with a coating developed at InnoSense's lab. The optical properties of the coating are affected by exposure to hydrazine, resulting in detectable changes in light transmitted through the fiber. In a typical application, transmit/receive fibers from an array of sensors are attached to a central electronics/display module.

Apart from rocket fuel, hydrazine is found in a wide variety of civilian applications, including manufacturing printed circuit boards, treating industrial boilers to inhibit corrosion, curing rubber, fabricating textile dyes, and processing pharmaceuticals. Suppliers, transporters, and end users of hydrazine could all benefit from a sensitive, maintenance-free leak detector. And, just as InnoSense was able to create a hydrazine-sensitive coating, additional R&D could turn up coatings to detect the presence of chlorine or other dangerous chemicals. A handheld unit could quickly assess conditions in the field without the need to bring samples back to a lab for analysis.

Dr. Goswami says his next hurdle is to complete a round of harsh field testing and to perform tests that will simulate a full 10 years of use. After that, he hopes to link up with a manufacturing partner when the devices are ready for production. InnoSense seeks funding partners to commercialize its technologies for the defense and aerospace markets.

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Data-driven System Makes Prediction Look Simple

An integrated statistics-based monitoring system predicts failures before they happen.

by Joan Zimmermann/jzimmermann@nttc.edu

Spend a couple of minutes tossing dice and observing the combinations, and you'll soon find yourself bored silly and searching for the remote. Spend an entire day tossing the dice and tabulating the results, however, and you just might start to see an interesting pattern emerge. That is roughly what statistical theory is based upon, only with high-performance computers tossing the dice and freeing up your time for higher pursuits.

▲ The GasTutamen spectroscopy system monitors the air for the presence of methane, under a variety of weather conditions. Migma's algorithms make it possible to dramatically reduce system costs associated with expensive and complex platforms.

Migma Systems, Inc. (Walpole, MA), has applied statistical algorithms to observe and monitor automated processes, using accumulated data from disparate sensors to formulate predictions about a system's behavior. Under Phase I and II SBIRs from MDA, in advanced signal processing and in the Airborne Laser (ABL) program, Migma devised a system to predict failures in the ABL composite vessel and developed a Computerized Maintenance Management System (CMMS) that could be applied to virtually any type of industrial process. The online, real-time monitoring system learns the characteristics of the process and detects equipment faults as they occur, while identifying the faulty components. Early detection of equipment failure can help manufacturers avoid costly shutdowns that can occur as multiple glitches build up at multiple points in a process.

Migma offers two systems, EquipTutamen™ and GasTutamen™, both of which operate on similar principles, but with slightly different spins. EquipTutamen is designed to monitor industrial equipment, using either the physical plant's own sensors or Migma's installed wireless sensors. The sensors report continuously to a powered wireless receiver and an industrial-grade computer, which in turn provides a graphical interface that is compatible with commonly used operating systems. The monitoring system can keep track of more than 100 sensors at the same time and provides data such as a performance degradation index, informing the operator of equipment health and estimated times to failure for faulty components. Migma's system can provide remote monitoring through both secured wired and wireless networks, allowing plant managers some off-site flexibility. The relatively low cost per monitoring node rounds out the suite of features.

GasTutamen was created with the nation's 2 million miles of natural gas pipeline in mind, vulnerable to breaches and corrosion, and posing dangers to utility workers and citizens in surrounding communities. Natural gas, which is colorless and odorless, can be observed through active means such as by laser illumination or through passive detection. Active detection techniques are reliable but expensive, while passive techniques are lesser on both counts. Migma's approach to gas detection takes advantage of natural sunlight and the absorption spectra of methane, as well as pattern-recognition techniques to enhance the probability of methane detection and reduce the incidence of false alarms. GasTutamen offers the reliability of expensive laser systems without the laser, and it functions regardless of weather conditions.

Migma's technology has many applications beyond industrial systems, including assessing baggage/passenger risk combinations in airport security. The company is actively seeking investors and venture capital and is also interested in identifying customers willing to beta-test its prognostic tools.

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Velvet May Become New King of Laser Absorption

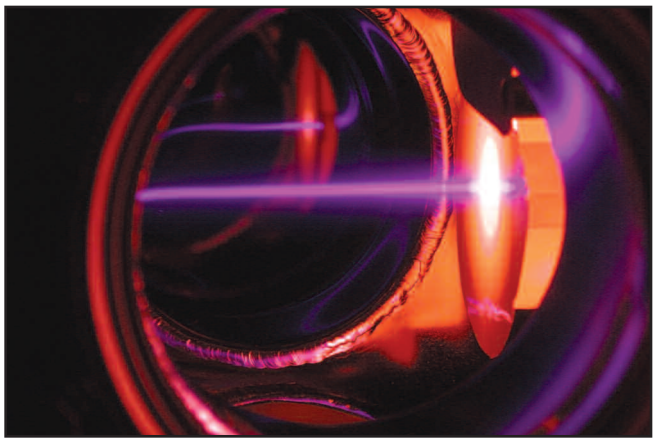
Carbon-based fabric suppresses stray energy emissions.

by Joe Singleton/jsingleton@nttc.edu

Black velvet is no longer just a fabric for your painting of Elvis. Modern applications such as laser surgery might soon use black velvet to absorb radiation.

Energy Science Laboratories, Inc. (ESLI; San Diego, CA), has developed a lightweight, carbon-based velvet-lined curtain that can be affixed to a surrounding metal hull, known as a beam dump, to catch and absorb stray light and radiation emitted by a high-power laser.

The concept of a velvet curtain emerged from a 2004 MDA SBIR Phase II contract to ESLI. The MDA project called on ESLI to design a lightweight beam dump for MDA's Airborne Laser program. Testing was conducted at the Lawrence Livermore National Laboratory, the Naval Research Laboratory, and various Army sites during the contract period that concluded in late 2006. The company is now continuing its quest to achieve an advanced technology readiness level by making the curtains available to the Defense Advanced Research Projects Agency.



▲ Stray radiation emitted from high-power laser beams, such as the one shown here, may be further minimized by ESLI's energy-absorbing velvet curtains. The velvet-based technology is proven to suppress energy from beams with temperatures as high as 2,000ºC.

ESLI's involvement in velvet-based technologies spans more than two decades, and the company holds four carbon-velvet-architecture patents. While the MDA-funded curtains are specifically designed to suppress unwanted emissions from high-yield airborne lasers, the carbon-based fabric can be used in other applications. One example with widespread use is lining telescope walls with black velvet, which would act as a stray-light suppressor. ESLI anticipates carbon-velvet curtains might someday be converted to suppress expended energy from smaller, less powerful lasers, like those used in laser surgery.

Conventional velvet is a tufted fabric, usually made from silk, cotton, or synthetic fibers, where the tufted threads are cut in evenly distributed, short, dense piles.

ESLI's velvet curtains have a unique carbon-based architecture. The material consists of short carbon fibers that stand vertically on a surface. Curtains are produced in sheets that are about 1/8-inch thick, each weighing only a few ounces per square yard. The sheets are custom-formed and fitted for a laser's beam dump. Testing of ESLI's velvet curtains has taken place in specially designed tanks filled with a water solution used for containing high-power laser energy.

ESLI makes two varieties of velvet—each with carbon fibers attached to a substrate. One velvet uses a carbon-fiber substrate (for high-power beams); the other uses a graphite substrate (for lower-intensity applications). ESLI applies a carbon-based adhesive to attach the fibers to the substrates. Both velvets produced by the company are processed at temperatures of 1,200ºC or greater.

ESLI velvets provide a significant advantage over other stray-light and radiation-suppression materials: They will not degrade under the light intensity and temperatures of high-powered lasers, said company President Timothy Knowles. The company successfully tested its velvet curtains against laser beams emitting 100 watts per square centimeter and operating at temperatures around 2,000ºC. This temperature equates to 10 times the heat that other light-suppressing materials can withstand.

Carbon velvet's ability to withstand high-energy and high-temperature environments is also beneficial in minimizing heat contamination within the beam dump. For instance, in most beam dumps, there is a threat that any substance—such as a single strand of fiber—can degrade and become detached because of the heat reflected and absorbed when the laser is fired. Such incidents could cause a detached particle to be heated to such intensity that, if it were to hit a large beam dump's observation window or the laser itself, significant damage could occur. ESLI's velvets are designed to minimize such costly and dangerous problems.

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Handled with Care

Advanced processes expand use of brittle material.

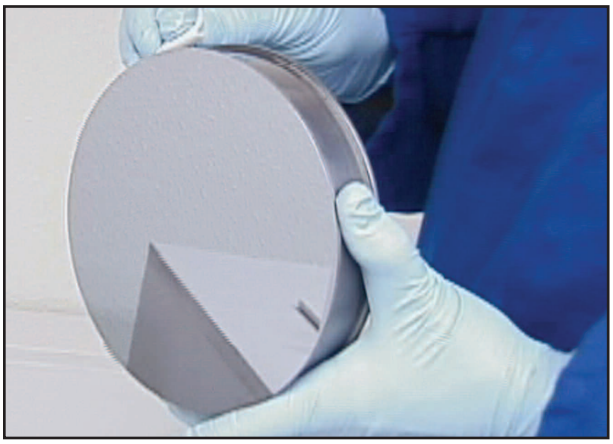
by Michele Rejonis/mrejonis@nttc.edu

The process of shaping and attaching parts to brittle materials is a delicate matter. But new methods developed by MDA-funded McCarter Machine, Inc. (Deer Park, TX), are bringing highly precise techniques and some unique shaping capabilities to the practice. In the near term, the company's work could lead to materials that replace toxic beryllium, especially in space-based applications.

McCarter has developed an ability to work with single-crystal silicon at a level of quality that company officials believe is matched by no one else. The proprietary processes—particularly useful for creating large and complex shapes—include shaping, finishing, and bonding of attachments to single-crystal silicon, which encompasses the use of special metal devices for attaching various components. These approaches are unique to McCarter. One process—a patented method called SuperFinish—can fix surface cracks and get net-shaping of a silicon part to 1/1000th of an inch. This process can cut months of polishing time when compared with traditional silicon manufacturing.

Single-crystal silicon is currently used in items such as computer wafers, x-ray mirrors, solar cells for solar-powered instruments, and high-energy laser mirrors. Single-crystal silicon is a very stable but brittle material, and its application in environments where stability and precision are critical would be an important improvement over current uses of beryllium in similar applications. Single-crystal silicon has properties similar to beryllium: The material is stable when exposed to extreme temperatures, when used in space, or when exposed to radiation—holding precise optical figuring as well as strength and coating properties. As McCarter manufactures single-crystal silicon components, the company can maintain the stability of the material and is able to overcome previous limitations based upon size and complexity of final parts. These abilities should lead to future materials that can replace beryllium, which is difficult to use due to its toxicity and the special precautions needed to work with it.

The components developed via the three McCarter processes have possible uses in military, aerospace, and commercial arenas. In seeking a suitable beryllium-substitute material, MDA has considered single-crystal silicon as a possibility. The company was awarded an SBIR Phase I contract in 2005 to define and determine the feasibility of using frit bonding or solder when attaching hardware to brittle materials. With frit bonding, which uses low-melting-point glasses suitable for bonding silicon, McCarter was able to put threaded metal inserts into the silicon material to provide for hardware attachment. The company frit-bonds the outside of the metal inserts. The component is then bonded with one of the proprietary processes. Such attachments have a higher temperature tolerance while maintaining the other properties of single-crystal silicon.



▲ The silicon mirror shown in this photo was produced using one of McCarter's MDA-funded processes. The techniques also can be used to machine other delicate items such as computer wafers and solar cells.

McCarter is now working to construct a single-crystal silicon telescope for space-based applications. The company has completed the necessary R&D and has developed various prototypes using the three processes. But the products still lack flight heritage, which is necessary to raise the technical readiness level and qualify the material for space-based use. Company officials have been challenged with finding willing participants to conduct such flight tests. In addition to using the single-crystal silicon for telescopes, the material also may have uses in other satellite applications, such as highly stable support components and upgraded optics, which are especially important for longer mission life. The lithography industry also could benefit from single-crystal silicon mirrors with low distortion and long lifetimes.

From a commercial standpoint, McCarter Machine has many customers. The company is a critical supplier of parts to a prime contractor for a laser technology with an estimated need of three to five systems per year, each requiring 22 single-crystal silicon mirrors per laser gun. The company also is assisting Texas-based MEMC, a supplier of silicon boules,

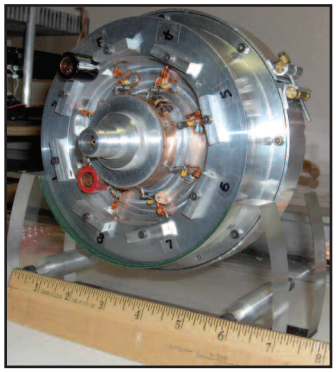
continued on page 11

A Slam-dunk Amplifier from page 1

result, applications such as UHF phased-array radars and digital TV transmissions can become more practical, said company researchers.

Because it does not require discrete circuit components, such as capacitors, inductors, and resistors in the RF circuitry, an Aria amplifier also offers greater reliability than not only vacuum-tube-based amplifiers but commercially available solid-state-based amplifiers, which generally average a six-year life cycle.

Aria envisions its patented amplifier technology being used in commercial applications such as cell-phone transmission towers, satellite television transmission systems for remote broadcast of events in high definition, and industrial processing units such as RF heaters for chemical processing. The company also is interested in using ARFCAs to enhance output power and reliability of radar as well as other military applications.



▲ At about 6 inches, Aria's amplifier may be small, but it could provide a whopping 420 watts of power (at 2.1 gigahertz) to cell-phone base stations. The technology is now being considered for use in industrial heating and lighting.

Aria designed the ARFCA to be a simple solution for power amplification—one that flies in the face of the trend to build all modern electronics on printed circuit boards. The design calls for placing a circular disc between cylindrical cavities of an amplifier, onto which are bonded a large number—eight or more—RF semiconductor transistors. When power reaches the amplifier's output cavity, the transistors begin to react in sync.

The synchronous reaction subsequently generates a high level of power output that is coupled into the device's output cavity and then piped out through standard connectors. This increase in amplitude can be used to boost reliability should it be used in telecommunications or satellite operations, or increased output, should it be used for commercial RF heating.

Several ARFCA prototypes have been successfully tested for various applications. For cell-phone infrastructure, Aria designed an amplifier to operate at 2.1 gigahertz (GHz). This increased power level meets the high peak power required of wide code division multiple access (W-CDMA) and time division multiple access (TDMA) base-station amplifiers.

Aria researchers say ARFCA technology could possibly enable a significant reduction of the number of base stations required to cover a certain area as compared with using high-power, state-of-the art amplifiers.

An Aria prototype for high-power industrial heating also has shown success in tests. The amplifier operates at 915 megahertz (MHz), with more than 700 watts of output power at approximately 1-decibel gain compression, which meets the requirements of most industrial applications, such as semiconductor manufacturing, plasma processing, and large-scale food processing. Higher power can be attained by using higher-power transistors.

Another variant operates at 2.45 GHz and can be used for plasma-fusion lighting. Such lighting—which requires microwave stimulation—is being used to replace conventional high-intensity lights at ballparks, arenas, and factories.

Aria is actively seeking business partners who would be interested in marketing an amplification technology that provides the simplicity of a microwave tube, yields high performance, and offers more flexibility in design than commercially available solid-state devices.

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A New Way to Envision Costs from page 3

MDA SBIR funding, an SBIR award from the National Science Foundation also has helped push the software toward commercial readiness. Stirk said he envisions CostVision selling the software in several forms: as a commercial off-the-shelf software, resold through value-added channel partners, and as a service delivered via the Web.

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Crystal-clear Imaging from page 5

S2 seeks interest from other U.S. Government agencies that use passive-receive systems for surveillance, including signal-intelligence activities. The company also envisions commercializing some of the technology used in the S2RSP for short-range imaging applications needed in homeland security operations.

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Web Site Features Wide Range of MDA-funded Innovations

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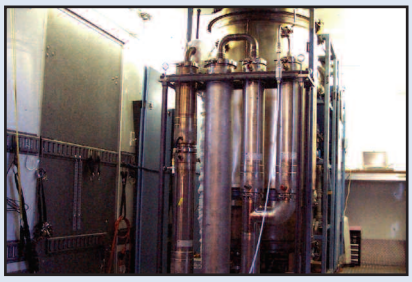
High-temperature, Solid-oxide Fuel Cell and Co-production Systems



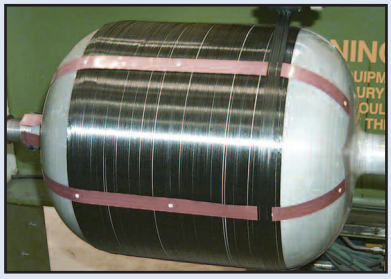
▲ ZTEK's fuel cell system.

ZTEK Corporation (Woburn, MA) has developed a stationary, high-temperature, zirconia-based, solid-oxide fuel cell (SOFC) system. ZTEK was funded by the missile defense program in 1988 to examine this technology for its use as a power system for space systems. What sets ZTEK's current fuel cell product apart from other stationary, high-temperature fuel cell systems is that ZTEK has developed a system that not only generates electricity, but can also produce hydrogen. The hydrogen co-production system is becoming part of two projects in California that will be used to refill fuel cell vehicles with hydrogen. The company has also combined an SOFC with a turbine to increase the efficiency of generating electricity.

Search code for tech profile: #688

Development of Intelligent Composites using Integrated SMART Layer Technology

Acellent Technologies, Inc. (Sunnyvale, CA), has developed sensor technology, called "SMART Layer®," that might be used in structures such as car chassis and airplane wings as a network of sensors to help owners and operators monitor structural wear and tear. BMDO, MDA's predecessor, funded Acellent to integrate the company's SMART Layer technology with composites to create "intelligent composites," which could help monitor structural health of missiles and space assets. The company continues to work on pilot projects and sees promise especially in the aircraft and auto industries.



▲ A rocket motor with SMART Layer strips.

Search code for tech profile: #675

continued on page 12

Velvet May Become New King of Laser Absorption from page 8

Following successful tests during the SBIR contract, ESLI now looks to market its velvet curtains to laser manufacturers as well as systems integrators involved in laser-intensive projects such as MDA's Airborne Laser program. Company officials remain hopeful that the readiness of the technology will result in new contracts and new business opportunities soon.

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Handled with Care from page 9

with handling a growing demand for single-crystal silicon for solar cells. McCarter is the key supplier of the silicon parts that MEMC uses in its processing to keep the single-crystal silicon pure. McCarter recently purchased a programming machine center, and the company plans to automate some of its processes in the near future.

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Web Site Features Wide Range of MDA-funded Innovations from page 11

Fiber Grating Sensor for Damage Assessment

Blue Road Research (Gresham, OR) has developed fiber-optic technology with multiple uses for detecting strain in materials, including composites. Originally developed for monitoring the strength of solid rocket motor casings, the fiber-optic systems can also be used to monitor the structure of aircraft, buildings, bridges, roadways, and hydrogen fuel tanks for future hybrid vehicles. The fiber-optic systems developed at Blue Road offer considerable advantages in sensitivity and robustness for nondestructive evaluation systems, and offer time and cost savings as well.

▲ Sensor could monitor bridges.

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