



# TechUpdate

A Quarterly Newsletter for MDA Technology Transfer



▲ An MDA-funded inflatable antenna enabled emergency satellite communications for displaced Mississippians in the wake of Hurricane Katrina.

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## Coping with Katrina

Hurricane survivors communicate via portable satellite antenna funded by MDA SBIR program.

by Patrick Hartary/phartary@nttc.edu

Victims of Hurricane Katrina have suffered unimaginable loss. In addition to the physical destruction of homes and property, the emotional toll will certainly be high. But one man and his MDA-funded technology helped hundreds of evacuees find peace of mind in the aftermath. His comfort tools: an inflatable satellite antenna shaped like a giant beach ball and an Internet connection.

Paul Gierow spent one week with those made homeless by the devastating winds and ensuing floodwaters—men, women, children, families, and law enforcement—at an elementary-school-turned-shelter in Woolmarket, MS. There, he and his brother-in-law deployed an innovative satellite

communications antenna that inflates like a balloon.

Equipped with two computers, a small 1,000-watt portable generator, and access to a satellite, Gierow was able to deploy the antenna and establish a remote Internet connection—a priceless asset in a region whose telephone and electrical services were obliterated by Katrina. Dave Beering, a member of the technology development team at IGI, LLC, coordinated the satellite access with G2 Satellite Solutions. SRS Technologies, also a team member, provided antenna support.

Gierow's goal was simple: help people any way he could. So one by one, he did.

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# Making Friends

by Patrick Hartary/phartary@nttc.edu

David Dalman couldn't be happier. The manager of development at Oxazogen says he's made a lot of new friends in recent weeks.

Companies and universities are contacting Oxazogen to inquire about its MDA-funded dielectric film for multilayer circuit and printed wiring boards. Using these new contacts, the company is establishing business relationships that quite possibly could generate a significant amount of commercial revenue in the near future.

Making new friends in the business world can be tough, especially for small companies with MDA SBIR contracts like Oxazogen. The *MDA TechUpdate* newsletter helps these companies by writing and publishing articles about their MDA-funded technologies. It's great exposure for businesses whose marketing budgets and staffs are limited.

Often, our newsletter articles generate new business contacts and product sample requests for featured companies. Dalman's case is typical.

The *MDA TechUpdate* featured Oxazogen's dielectric film technology in its Summer 2005 issue. (You can read the article at <http://www.mdatechnology.net/update>. Look under the dropdown box for Summer 2005, and then click on the article "New Dielectric Film Permits Denser Circuits.")

According to Dalman, the company received four inquiries—three from commercial companies and one from

a university—that can be attributed to the article. Dalman also says that he's getting phone calls based on a research paper he recently presented at an industry conference. Oxazogen will be sending out film samples for evaluation purposes.

The summer and spring issues have produced other "successful" inquiries for featured companies, but they can't be talked about just yet. I'm hopeful that within the next few issues you'll be hearing about more companies making friends and business deals as a result of *MDA TechUpdate* articles.

### Calling All Media

The *MDA TechUpdate* Media Tip Sheet provides a wide variety of story ideas that are ideal for print and broadcast media. It is produced quarterly by the MDA Technology Applications program, and delivered via e-mail three to five weeks before each issue of the *MDA TechUpdate* newsletter is mailed to subscribers.

If you are a member of the media and are interested in news about MDA-funded companies and technologies, you are eligible to sign up for the *MDA TechUpdate* Media Tip Sheet. Simply send an e-mail to [techapps@nttc.edu](mailto:techapps@nttc.edu) indicating your interest in the Media Tip Sheet. We'll be happy to add you to the distribution list. 



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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.

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## Thanks for the Tanks



Composite Technology Development (CTD; Lafayette, CO) says its MDA-funded propellant storage tank may fly in space a lot sooner than expected. The technology is a key component in the thruster system for a pair of nanosatellites—to be launched into space in 2006—designed by students at the University of Texas and sponsored by the U.S. Air Force Research Laboratory.

Earlier this year, the project's original aluminum tanks had failed acceptance testing with only six weeks to go before final spacecraft integration. Lightweight pressure vessels were needed—fast! CTD quickly began to work on a composite, linerless solution. Less than two months later, the company had created a new storage tank design, reconfigured tooling, and manufactured tanks that were tested to meet all requirements.

“Because our composite technology is much simpler and less expensive than metal, it allowed us to complete a fast turnaround on this project,” said Mike Tupper, CTD's vice president. “Much to the delight of the nanosatellite integrators, CTD supplied a pair of operational tanks and a pair of spares within the required time frame.”

Lightweight tanks allow increased fuel storage volume and/or reduced total system mass and volume. CTD says its composite technology doesn't require a polymer or metallic liner and therefore is 50-percent lighter than metal tanks and 15-percent lighter than metal-lined, composite-overwrapped tanks. “When launched, our technology will likely be the first-ever linerless composite tank used in space,” said Tupper.

Lightweight propellant storage tanks could provide much needed weight savings on MDA programs such as the Airborne Laser, Kinetic Energy Interceptor, High Altitude Airship, and others.

CTD seeks inquiries from organizations desiring the lightest possible tanks for their spacecraft. Contact Mike Tupper at (303) 644-0394, ext 111, or look at Kiboko™ Pressure Vessels and Cryogenic tanks at [www.ctd-materials.com](http://www.ctd-materials.com).

## Just Acquired

Lockheed Martin Corporation recently acquired Coherent Technologies (CTI; Louisville, CO), a supplier of high-performance, laser-based remote sensing systems. The newly acquired company will be named Lockheed Martin Coherent Technologies and will be managed by Lockheed Martin Space Systems.

CTI developed the WindTracer® pulsed Doppler lidar system to enhance air traffic safety. A WindTracer system is currently deployed at the Hong Kong International Airport to detect and monitor aircraft wake vortices, enabling more efficient air traffic

control. In a joint evaluation program with the Federal Aviation Administration, another system was recently installed at McCarran International Airport in Las Vegas.

The MDA SBIR program funded CTI to develop long-range laser radar systems to reduce the total number of sensor monitoring and missile interceptor platforms.



## A Look Back

For more than a decade, the MDA Technology Applications program has documented the many commercial and military “spinoff” applications of ballistic missile defense (BMD) technology. This year, in a soon-to-be published report, it takes a look back at the history of BMD and some of its top technology spinoffs.

*Defining Moments: Selected Highlights from 25 Years of Missile Defense*

*Technology Development & Transfer* begins with some of the key events in 1980 that herald the start of the Cold War. It then proceeds to a second historical period—from 1990 to 1998—that brought about significant changes to the BMD mission and strategy. In a third period, which lasted from 1998 through 2005, it highlights recent events that have led to BMD's current era.

Throughout the publication, top spinoffs from MDA-funded technology development projects during the past 25 years are featured. These spinoffs cover a wide range of technology areas—for example, aerospace and automobiles, electronics and energy, materials and manufacturing, and power and propulsion.

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# Reel to Reel

New tool could make superconducting tape more than a kilometer long.

by Scott Tillett/stillett@nttc.edu

A new reel-to-reel tool inspired by the movie projector could hold the key to constructing more-efficient power lines, high-power generators, and motors—as well as more-affordable infrastructure for magnetic-levitation trains.

The tool, being developed by Structured Materials Industries, Inc. (SMI; Piscataway, NJ), can deposit thin-film coatings onto kilometer-scale lengths of flexible metal tapes. Company researchers expect the tool eventually will be used to produce high-critical-temperature superconducting tape more than a kilometer long.

Superconductors are materials that, at extremely low temperatures, lose their resistance to electrical flow. With zero resistivity, an electrical current can travel through the material very efficiently, with no loss of energy as heat. A superconductor made into the form of a long and flexible tape promises far greater efficiency than traditional copper wires.

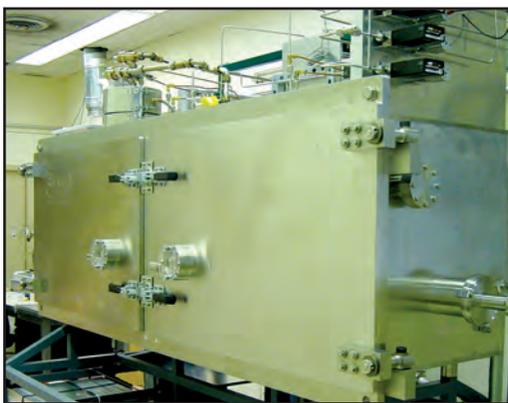
However, making the superconductors long enough to be useful—and affordable—has proven a challenge. SMI's reel-to-reel tool, however, could provide a solution to the length problem, and also draw interest for commercial uses. In addition to power companies, makers of magnetic resonance imaging (MRI) systems, magnetic-levitation trains, inductors, transformers, generators, and large motors might take notice of the tool.

## LIKE A MOVIE PROJECTOR

SMI's technology is based on superconducting yttrium-barium-copper-oxide ( $\text{YBa}_2\text{Cu}_3\text{O}_x$ , or YBCO) thin films, deposited by metal-organic chemical-vapor deposition (MOCVD) onto buffer-coated metal tapes. SMI is developing the deposition hardware, and numerous companies and research laboratories around the world are developing the superconducting tapes.

Parts of the tape-transport system for the tool itself resemble a movie projector. "In fact, we designed our reels based on those old movie-projector reels," said SMI researcher Dr. Nick Sbrockey. "We actually bought some of those, which are made out of plastic. . . . But then we remade them out of stainless steel." With SMI's tool, stock tape material is fed from one reel and then through an area in the device where MOCVD occurs.

The tape travels across a long heater table, called a susceptor, where the temperature is raised to a preset value up to  $1,000^\circ\text{C}$  for MOCVD processing before the tape is wound onto the take-up reel.



▲ SMI's technology deposits superconducting material onto long lengths of flat tape, which can be made into cables or wires to carry vast amounts of electrical current with no resistive losses.

MDA's SBIR program funded the tool to produce high-efficiency power-transmission equipment for the Ballistic Missile Defense System. A YBCO-coated conductor is a critical component for improving several defense applications that require high electrical power. These systems include directed-energy weapons and high-power radar systems.

Commercially, superconducting tapes could be used in areas with a high concentration of power lines, most likely near substations. Coolants such as liquid nitrogen would be necessary to cool the tape to below the superconducting transition temperature. But SMI

researchers said that the cooling costs would be more than offset by savings from improved efficiency since the superconducting power lines would lose no energy as heat.

## SUPER REPLACEMENT

In MRI machines, superconducting tape cooled with liquid nitrogen could replace current superconductors cooled with costlier liquid helium. In inductors and transformers—both of which typically include iron cores—using zero-resistance superconducting tape could allow for more windings, eliminating the iron core and reducing overall weight. Eliminating the iron core also should eliminate the hum of the transformer, important in applications that require quiet power. Longer and less expensive superconducting tapes could also appeal to makers of magnetic-levitation trains and tracks, according to SMI researchers.

Compared with pulsed laser deposition (PLD), a competing method of tape production, SMI's tool is faster. The PLD method of creating lengthy tapes of superconducting material is considered a "point-source" method, and it can deposit only on a small area of tape at a time. SMI's reel-to-reel MOCVD approach can deposit onto a much greater area of tape simultaneously, leading to substantially higher throughput in terms of meters of tape per hour.

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# Wafers, Get Your GaN Wafers!

Mass-produced gallium-nitride wafers can save LED and laser makers both time and money.

by Michael Felton/mfelton@nttc.edu

Technologies and Devices International, Inc. (TDI; Silver Spring, MD), is selling mass-produced gallium-nitride (GaN)-on-sapphire or silicon-carbide (SiC) wafers to more than 100 customers including universities, government labs, and companies around the world. Mass production will save customers time and money and may enable new products, such as blue-violet laser diodes for next-generation DVD players, to reach the market.

The problem with mass production of GaN is that it is grown, layer by layer, on top of wafers of sapphire or SiC because it can't easily be made in large boules and sliced into wafers like silicon. But TDI has developed a reactor that can quickly produce dozens of high-quality GaN-on-sapphire or SiC wafers in each batch.

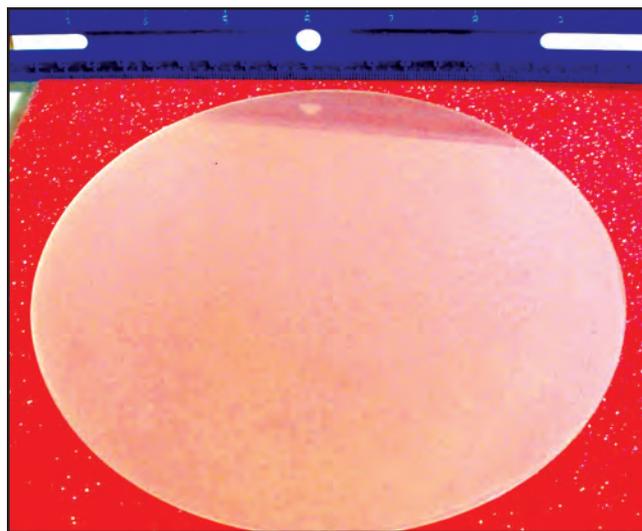
MDA's SBIR program funded TDI to improve a process called hydride vapor-phase epitaxy (HVPE) to reduce the costs of GaN components used for advanced radar and power systems. Through extensive modeling and testing, TDI developed a HVPE reactor that can produce more than a dozen high-quality, 2-inch-diameter wafers at the same time. TDI has also created the world's first 6-inch GaN-on-sapphire wafer.

## STRAIGHTFORWARD CHEMISTRY

The HVPE process is straightforward chemistry. Hydrochloric acid gas is passed over a bowl of molten gallium, which reacts with the gas, forming gallium-chloride gas. The gallium chloride flows into a chamber, where it meets the sapphire substrates and ammonia gas. The ammonia reacts with the gallium chloride, forming the GaN, which condenses on the substrate. TDI uses the same basic process also to produce and sell aluminum nitride on sapphire or silicon carbide and aluminum gallium nitride on sapphire or silicon carbide. Aluminum nitrides allow the manufacture of ultraviolet light-emitting diodes (LEDs).

**HVPE deposits semiconductor material up to 100 times faster than MOCVD.**

"[HVPE] is cheaper, faster, and simpler because the reactor does not require a vacuum, like metal-organic chemical-vapor deposition [MOCVD] does," said Vladimir Dmitriev, TDI's founder and president. Existing MOCVD processes use expensive and dangerous chemicals and precursors, and it deposits only between 1 and 2 microns of wide-bandgap semiconductor per hour. According to Dmitriev, TDI's HVPE process uses



▲ Researchers at TDI have created the world's first 6-inch GaN-on-sapphire epitaxial wafer. They have also developed a process to mass-produce smaller wafers.

inexpensive chemicals and deposits the semiconductor material up to 100 times as fast as MOCVD.

TDI's focus is on selling the wafers to electronics companies to make them into finished components. "The price for large volumes of GaN-on-sapphire is now below \$100 per 2-inch wafer, and it was over \$1,000 when we started," Dmitriev said. He sees the market demand for these wafers split as follows: 70 percent is coming from optoelectronics makers (for blue and ultraviolet LEDs and lasers) and 30 percent is from makers of high-power and high-frequency electronics. Both markets are growing and, although there are few commercial products available now in the high-power, high-frequency markets, TDI is reaching out to those developers and wants to be their future supplier.

The demand for blue LEDs and lasers for everything from home and office lighting to next-generation DVDs is growing significantly each year. TDI could be laying the foundation for a bright future. 

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# Paint Alternative is Eco-Friendly

Peel-and-stick plastic film protects against corrosion, offers environmentally safe paint replacement.

by Patrick Hartary/phartary@nttc.edu

Paint is a toxic brew of chemicals that can cause harm to humans, animals, and the environment. Changes in government and environmental regulations—in both the United States and around the world—are forcing industry and the military to seek more eco-friendly paint alternatives.

Integument Technologies, Inc. (Tonawanda, NY), has developed an eco-friendly paint replacement: a peel-and-stick plastic film that strongly resembles wallpaper. The new material is thin, flexible, and easy to apply. With a pressure-sensitive adhesive on one side, it can bond to the surface of nearly any metal or composite. Unlike wallpaper, which has just an aesthetic purpose, Integument's technology also provides corrosion protection and can be engineered to provide other "functional" benefits.

"Compared with paint, our plastic film is far more environmentally friendly" said Terry Vargo, Integument's co-founder and current president. "It doesn't contain any of the solvents, toxic metals, or volatile organic compounds that paint does. Its application is even easy on the Earth. That's another big benefit."

## HOW TO RUIN TEFLON

Integument bases its material on a family of plastics called fluoropolymers, which are well known for their nonstick surfaces (like Teflon®). These materials are also highly regarded for their resistance to a wide variety of chemicals and high temperatures (up to 475°F) as well as their ability to prevent filth and grime from building up, reducing the need for cleaning and maintenance. In addition, Integument has developed novel technology for dyeing and pigmenting fluoropolymers



▲ A field technician applies Integument's FluoroGrip technology to an outdoor storage tank. The thin-film material protects metal from rust and corrosion.

that can facilitate selective incorporation of multicolored 3-D patterns or designs.

As a research associate in the late 1980s, Vargo was working at the State University of New York at Buffalo when he developed technology that effectively modified the surface of fluoropolymers in a unique way. "We basically came up with a technique to change the nonreactive aspects of Teflon surfaces by creating permanent reactive chemical functionality on selected regions or sides of Teflon-based films," Vargo said. "At that point in time, there was no method for controllably and permanently reacting materials to fluoropolymers, and our research overcame that technological hurdle." Vargo then demonstrated the ability to permanently bond a variety of materials to fluoropolymer surfaces, including a wide range of pressure-sensitive, "peel-and-stick" adhesives.

The final product is an appliqué that offers mechanical,

thermal-, and chemical/environmental-resistance properties that are superior to those of paints currently used in industry and the military. Additionally, multilayered systems can be created, and various coatings and materials can be added to supply other functional characteristics such as visual camouflage, antifouling resistance, static dissipation, and wear and erosion protection.

With a team of investors, Vargo helped co-found a start-up called Integrated Technologies, the precursor to Integument, to further develop the technology and explore potential applications. In 1997, the company changed its name to Integument and began conducting demonstrations of its FluoroGrip® technology. This activity subsequently led to Integument's winning of the highly prestigious 2001

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Vaalar Award for breakthrough technology for advanced control of corrosion in the chemical processing industry. In 2002, the company teamed with DACCO SCI on an MDA SBIR Phase I project to explore the possibility of integrating DACCO's corrosion sensor within Integument's material. The idea was to demonstrate a corrosion-monitoring sensor for MDA structures located in warm, humid, and salty environments like the South Pacific.

With the success of the Phase I project, the team was invited to submit a Phase II proposal, which it won. It was during this research phase that Integument discovered that the material's emissivity and reflectivity could be engineered. For example, the material could be made such that thermal energy would reflect off it, lowering the temperature of the object to which it was bonded. At an MDA facility on the Hawaiian island of Kauai, Integument applied its material to several base trucks. "The difference in surface temperature was like night and day," Vargo said. "Without FluoroGrip, nobody could touch the roofs of the vehicles exposed to sunlight for long periods. With our material, you could sit on the roof."

#### CORROSION IS COSTLY

Integument's technology has exciting possibilities, particularly in the area of corrosion protection. According to the Federal Highway Administration, corrosion-related costs in the United States are approximately \$276 billion per year, which is 3.1 percent of the 1998 U.S. gross domestic product. The top three economic sectors most impacted by corrosion problems are defense, motor vehicles, and drinking water and sewer systems.

Fluorogrip can be applied over or in lieu of traditional military standard paints in areas where paint/corrosion protection may be required. For example, Integument has ongoing projects to develop and demonstrate various FluoroGrip materials for applications on the U.S. Navy V-22 Osprey and F-35 Joint Strike Fighter aircraft, U.S. Navy land vehicles, and MDA and U.S. Air Force structures and equipment.

Besides superior corrosion protection for structures and equipment, another example of the appliqué benefit relates to potential weight savings on military aircraft. For example, with each coat of exterior paint, military aircraft gain a small amount of weight that can affect flight performance. Removing layers of paint is expensive. Aircraft must be moved to a special facility and sandblasted, creating the need for hazardous-material containment. Integument's material could save substantial maintenance costs by reducing paint-

**Corrosion-related costs in the United States are approximately \$276 billion per year.**



▲ After a few hours under the sun, the roofs of military trucks at a Hawaii-based MDA facility get extremely hot. Integument applied its FluoroGrip technology to the roofs of several trucks and measured a significant reduction in surface temperature.

ing requirements, repair time compared to touch-up painting, and environmental-containment costs. The technology could be similarly applied to military structures and vehicles like trucks.

Additionally, FluoroGrip can be used as a preventative maintenance paint-repair patch. The inner hulls of double-hulled oil tankers are prime targets of corrosion. Integument's material has been used to spot-patch these hulls, preserving them from further corrosion. It can be applied without the need for dry docking, saving more costs. Likewise, the ballast tanks of submarines have been protected from corrosion using this technology.

There are dozens of other potential uses. Integument is working with a Danish company to protect windmills from lightning strikes. The technology may also be suitable to protect graffiti-prone bridges and buildings. Because it is made with a nonstick fluoropolymer, surface modification can be applied to only one side of the appliqué so that surface foulants (e.g., graffiti and dirt) can be easily washed off.

Additionally, it may be applied to boats and recreational watercraft. By extruding the material onto a textured roller, Integument can print a textured pattern on the surface of the material. This creates a "sharkskin effect" with boundary-layer effects that reduce drag. Integument reports that an independent test of the material on a personal watercraft increased top speed by 5 to 10 percent.

Integument has a solid intellectual property position and is looking for potential military and industrial applications to establish new markets. The company is available for demonstrations of its technology.

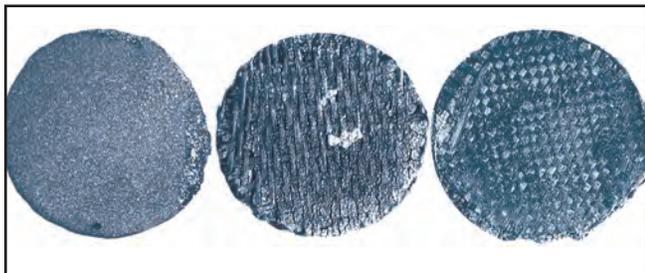
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# Light Heavyweight

Carbon composite offers strength, cost, and weight advantages for structural applications.

by Scott Tillett/stillett@nttc.edu



▲ In a one-step process, Wright Materials heats a carbon mixture under high pressure to produce low-cost carbon composite material. Affordable and lightweight, the material is ideal for a variety of structural aerospace applications.

A pressure-cooker-like approach to making carbon composites could bring strong and affordable material to market for aircraft structure, automobile brakes, and a host of other applications.

The technique, which heats a carbon mixture under high pressure in a one-step process to produce a lightweight composite foam, was developed by Wright Materials Research Co. (Beavercreek, OH). The resulting foam is actually called a carbon-carbon composite, since the company uses carbon fibers in a carbon matrix to create the foam. MDA's predecessor, BMDO, funded Wright Materials through an SBIR Phase II contract to develop a process for producing a low-cost carbon composite that could be used in space-based applications.

Carbon composites have been envisioned as an affordable and lightweight alternative for conventional structural materials used in everything from frameworks for aircraft wings and space vehicles to heat exchangers and rocket nozzles. Using lighter materials could save a lot of money, considering that launches into space cost thousands of dollars per pound. And lighter structures and wings should improve fuel efficiency for aircraft. The material also could replace composites in automobile brakes, battery electrodes, and many other applications, resulting in lighter, higher-performance components at a lower cost.

## SUPERNATURAL ADVANTAGES

While all carbon composites are naturally lightweight, Wright Materials' composite boasts the additional advantages of strength, safety, and time and cost savings. In terms of strength, competing carbon composites can withstand about 2 percent of strain before breaking. But Dr. Seng Tan,

president of Wright Materials, said that his company's composite could withstand between 60- and 80-percent compression strain.

As for time and cost, Wright Materials' one-step process reduces post-processing time by an order of magnitude when compared with processing of similar carbon composites. Post-processing usually requires lengthy stages of heating and then slowly cooling materials. Reducing the post-processing time to as little as one-tenth the time for conventional carbon composites should bring down costs respectively, too. Tan said the cost savings would come from using less energy and labor in post-processing.

The composite that Wright Materials can create also has a coefficient of thermal expansion (CTE) near zero. The low CTE means that it will shrink or expand very little with extreme changes in temperature, making it an appropriate and safe replacement for materials such as toxic beryllium, which is used in space applications.

Wright Materials can produce blocks of its composite measuring 12 inches by 24 inches. Within a year, pending installation of new equipment, the company should be able to make blocks measuring 3 feet by 6 feet, with thickness varying to meet customer needs. Tan said the company could make the blocks several feet thick. Customers can machine blocks of the composite to fit their individual applications—be they aircraft structure, rocket components, or other devices.

Wright Materials has a patent on its process and material. The company continues to look for ways to develop sales, marketing, and distribution channels, and it remains open to the idea of bringing on investors and undertaking new partnerships.

**Wright Materials' composite withstands up to 80-percent compression strain.**

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# Fine Tuning

Next-generation tunable optical filters are being developed using liquid crystal Fabry-Pérot technology.

by Michael Felton/mfelton@nttc.edu

Scientific Solutions Inc., (SSI, North Chelmsford, MA), has combined liquid crystal technology with Fabry-Pérot interferometry to create a tunable optical filter with no moving parts. The new device is currently being examined for use in satellite telescopes, chemical analyzers, semiconductor quality-control sensors, and even as a drop/add device in fiber-optic communications.

Conventional Fabry-Pérot interferometers rely on a change in pressure of a gas within the resonant cavity or a change in distance between two mirrors forming the cavity to change the wavelength passing through the device. Such systems are bulky and require extensive calibration and adjustment. While working with Fabry-Pérot interferometers as a graduate student, SSI founder and president John Noto came across a new method for tuning these devices: using liquid crystals.

“Liquid crystals are like the goop at the bottom of your soap dish in your shower, and that is half our product,” Noto said. The other half of SSI’s liquid-crystal Fabry-Pérot (LCFP) technology is extremely-high-precision optics, and combining the two proved challenging. “We have had to come up with various coating recipes and ways to deposit the coating, and we have had to develop an alignment layer so we don’t just smear the liquid crystal on there like cream cheese on a bagel.”

## FASTER, BIGGER, BRIGHTER

LCFP filters offer several advantages. Because there are no mechanical parts, they can switch from one wavelength to the next faster than other Fabry-Pérot devices—as fast as 3 milliseconds—and use far less power. The lack of mechanical parts allows instruments based on LCFP technology to be portable and even used in space.

SSI is currently working with Utah State University to build an LCFP atmospheric oxygen sensor for a Brazilian satellite. In a U.S. Air Force project, SSI combined 12 independent LCFP filters to create a giant filter. “You can tune each individual filter to the same wavelength or to different wavelengths for hyperspectral imaging,” said Michael Dorin, an applications engineer and director of sales and marketing at SSI. “Thanks to the wavelength precision and repeatability of LCFP technology, you can arrange multiple filters in an array and have them act as one filter.” The benefits of precise tuning don’t end there, as this particular instrument has the ability to detect the Doppler shift of rocket plumes and yet ignore clouds and weather.

On the ground, LCFP filters have new applications as well. SSI has two customers that are exploring applications in chemical instrumentation to create hyperspectral images and in semiconductor quality control to detect defects in LEDs and laser diodes. These applications use the LCFP technology’s ability to see parts of the spectrum that are unseen by us to detect chemical compounds and to identify defective components.

## HIGH LUMINOSITY

SSI’s LCFP devices are also more efficient at filtering light than other types of filters, a property called luminosity. “Fabry-Pérot technology offers the highest luminosity for a given spectral resolution of any tunable technology that we know of,” Noto said. “Compared to a diffraction-grating-based system, it’s 100 times more luminous.” What this means is that, in LCFP filters, even the unwanted light is reflected rather than absorbed or scattered.

This property is exploited in SSI’s MDA-funded STTR project to develop a drop/add switch. “A drop/add is a type of optical communications switch that allows you to add or subtract a wavelength from a multichannel fiber,” Noto said. “If you have multiple wavelengths going through a fiber, you could use one of these LCFP filters to selectively

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▲ Compared to other Fabry-Pérot interferometers, SSI’s liquid crystal device can switch faster and use far less power.

# A Compelling Propellant

Making zirconium safer provides alternative to aluminum.

by Scott Tillett/stillett@nttc.edu

Zirconium could offer a higher-performance alternative to aluminum powders in propellants. But the highly energetic material is extremely combustible. Just by walking around on a dry day, you can build up enough static electricity to make a pile of zirconium powder explode.

Mach I, Inc. (King of Prussia, PA), has developed a way to make zirconium powder as safe and manageable as aluminum powder. MDA funded the company through an SBIR Phase II contract to develop propellants with high density impulse for potential use in the Ballistic Missile Defense System. These propellants would produce a high degree of impulse, or thrust, per unit of volume.



▲ Mach I is making zirconium powder safer and more manageable. In the image above, researchers test a new batch of propellant.

## HIGHER DENSITY

Zirconium could provide up to a 20-percent higher density impulse than other metals such as aluminum. Having a propellant with a higher density impulse should allow planners of space or military missions to achieve higher payload and/or range capability for a rocket or missile.

To make zirconium powder safe, Mach I addressed the material's electrostatic discharge (ESD) sensitivity. Raw zirconium has an ESD of 0.5 millijoules, meaning it could be set off easily by normal static electricity. (A person can quickly generate 20 millijoules of static electricity during a casual stroll.) Mach I's process, however, takes the ESD of zirconium up to a much safer level—about 200 millijoules, the same as the ESD of aluminum.

The company's process involves mixing zirconium powder and aluminum powder in a steel grinding medium. The mixture is put into a furnace and heated above the melting point of aluminum (about 650°C). The process melts the aluminum, which then coats the zirconium particles. The aluminum actually reacts with the zirconium particles to create zirconium-aluminum intermetallics with aluminum surfaces. So the surface of a treated particle resembles an aluminum particle. Beyond the particle surface lies a region of aluminum-rich zirconium-aluminum intermetallic compound, followed by a relatively aluminum-poor region, and then finally an almost completely zirconium metal core.

## BEYOND PROPELLANTS

Mach I researchers envision the propellant and its future iterations as appropriate for a variety of applications that require energetic materials. For example, beyond propellants for rockets, missiles, and other military hardware, safer zirconium-based propellants could find their way into deployment mechanisms for automobile airbags. The company still faces a challenge in achieving the appropriate ESD sensitivity and particle size for zirconium that would be used in the airbags, however.

Other challenges include addressing cost-related issues. Zirconium costs about \$100 per pound, while aluminum costs only about \$2 per pound. So the company continues to seek applications in which the benefits of its material would outweigh the associated costs. Smaller, tactical, specialized applications are likely where the material's future lies. A company researcher said the material would not be appropriate for large applications such as Space Shuttle launches, in which well more than half of the launch weight is propellant.

Mach I has the capacity to make 1,000 pounds of material annually, which would be enough for a rocket engine manufacturer, for example, to use in initial testing. Beyond that amount, the company would call on its partner, ZR Energy, to help produce greater quantities. 

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# Software Making Software

Autocoding software reduces cost of creating programs for multiprocessor computers.

by Michael Felton/mfelton@nttc.edu

Management Communications and Control, Inc. (MCCI; Arlington, VA), has developed software that automates the tasks of writing and debugging code for multiple-processor computers. The software, called the Autocoding Toolset®, can significantly reduce programming costs, time, and errors. In an MIT Lincoln Laboratory test, it cut costs by 86 percent and reduced the development schedule by 71 percent. Researchers at Johns Hopkins used the software to create more than a million lines of code—with only one error.

Through an MDA Phase I SBIR project, MCCI showed that its Autocoding Toolset could produce an order of magnitude gain in the rate of source code production. But perhaps even more impressive, is that zero errors were found in the final code for the project, especially considering that multiple-processor computers are notoriously difficult to program without trial and error. Multiple-processor computers are often used to quickly analyze large data sets, such as radar signals. “The programs have to work as fast as the data is coming in,” said Christopher Robbins, MCCI’s president, “You can’t lose data, and you can’t stop.”

## HELPING GOOGLE

In the commercial world, MCCI’s software might help companies such as Google or Yahoo develop their programs. In addition, it is being used to develop programs to run on a U.S. Army 2,000-processor supercomputer to simulate heat flow. Other supercomputer applications—from simulating oil and gas reservoirs using geologic data to modeling the interaction between atoms in drug molecules—are possible. Even medical imaging, machine vision, bioinformatics, and financial data modeling programs could be produced using MCCI’s software.

At the heart of MCCI’s software is a concept called a data-flow graph, which allows software designers to tell the computer which operations should happen in which order. The graphing system works much like an electronic circuit, but instead of resistors or capacitors, each object is a mathematical operation. Like a circuit, the output of one object is the input for the next object and, similarly, data flows from object to



Courtesy of stock.xchng

▲ MCCI’s software automates the writing and debugging of code for multiprocessor computers. Using it, programmers may increase source code production by an order of magnitude.

object like electrons. The advantage of the data-flow graph is that a series of mathematical operations can be compressed into partitions that can be executed very efficiently. MCCI’s software then converts these partitions into code for threads. Connections between each thread and instructions on how the threads should be run are also coded by MCCI’s software.

## SUITE TOOLS

The truly innovative part of the Autocoding Toolset is the included tools to help test and troubleshoot the data-flow graph and resulting program. The first tool lets developers test a prototype on their own workstation before generating the final code for a multiprocessor computer. “It won’t be as fast as the ultimate system, but you can analyze a big data set and tell if your system is performing as you expected,” Robbins said.

If the program doesn’t operate as intended, a second tool can run each thread and look inside the thread as it runs. Once the designer sees where the problem might be occurring, MCCI’s debugging and editing tools can help. “The debugging tool works a lot like an oscilloscope in electronics,” Robbins said. “You can view the mathematical operations easily to make sure they are correct. The editing tool makes it easier to change these operations by converting mathematical functions written in almost any language, including those created with the widely used MATLAB® mathematics software, into data-flow graph objects.

The Autocoding Toolset includes several tools that enable designers to get the most bang out of whatever architecture the program will run on. Designers can use one tool to create a virtual version of the hardware architecture, and then MCCI’s software calculates the time each part of the final program will take to execute. Another tool provides a “play-by-play,” displaying where

**MCCI’s software could help Google and Yahoo to reduce programming cost, time, and errors.**

continued on page 14

Through his satellite link, Gierow helped the now-homeless evacuees—many with little or no money—access the Federal Emergency Management Agency (FEMA) Web site and submit assistance request forms. He also e-mailed video clips and notes from the hurricane survivors to their friends and family. In all, he touched the lives of more than 250 families, providing great comfort at a time of great loss.

It's an uplifting anecdote in the history of the most destructive hurricane ever to hit the United States. But the story hasn't ended yet. In addition to its missile defense applications, the technology has significant potential for use in emergency communications and military operations. To pursue these markets, Gierow started a company that could begin producing units by as early as 2006.

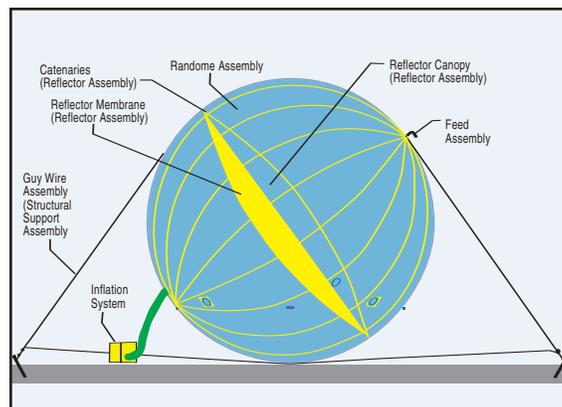
#### GIANT BEACH BALL

Having spent decades designing inflatable space structures for a military contractor, Gierow has a knack for blowing up things. When the Department of Defense asked him to consider developing an inflatable antenna for terrestrial radar, he initially balked. "Do you want to see it blow down the street?" he replied.

Gierow later received DOD funding to demonstrate the antenna concept and build a prototype. But without additional research and development, the technology literally wouldn't take shape.

In 2004, Gierow incorporated GATR Technologies, Inc. (Huntsville, AL); GATR stands for ground antenna transmit/receive. Soon after, he applied for an MDA SBIR Phase I contract to develop a fully functional satellite terminal using the antenna. For MDA, the technology could be used to establish satellite communications systems in remote areas such as Alaska. "GATR's technology is definitely applicable to reach-back scenarios for quick communications," said Aaron Corder, the SBIR program monitor at MDA Ground-Based Midcourse Defense. "It provides a reduction in transportation logistics not currently present with rigid deployable antennas." For GATR, the SBIR funding would move the technology forward, perhaps far enough to interest a major customer.

What was developed looks like a giant beach ball and weighs approximately 70 pounds. Made of a proprietary synthetic material, it can fold into a special backpack or container. It is anchored to the ground using guy wires and stakes and inflated with a blower. Inside, a parabolic-shaped reflector



▲ An inside view of GATR's inflatable antenna shows the parabolic-shaped reflector membrane attached to the ball. Pressure is monitored on both sides of the reflector membrane by a sensor and a blower.

membrane is attached to the ball. Pressure is monitored and maintained on both sides of the reflector membrane by a sensor and a blower. At the top of the ball, a feed assembly allows the mounting of amplifiers and modulators.

The 1.8-meter antenna is designed for X, Ku, and other bands. A lightweight mount holds the antenna and provides automated pointing and tracking.

Compared to conventional technologies, the new antenna design provides an order of magnitude of improvement in packaging efficiency and mass at a fraction of the cost, according to

Gierow. Transmission power output is also important. In general, the larger the aperture of the antenna, the less transmission power it requires. So smaller antennas need to boost transmission power. But this can cause their transmissions to interfere with other satellites. Gierow's antenna provides the transmission power benefits of a large-aperture antenna, but with portability of a smaller antenna. Power needs are low: The antenna has been successfully operated for long periods using only a 1,000-watt off-the-shelf power generator.

Highly portable antennae for remote locations are in demand. The U.S. military needs this technology for secure communications from the battlefield. Federal, state, and local governments responding to acts of terrorism and natural disasters may look at it to establish emergency communications to coordinate relief and rescue efforts. Television broadcasters could use it for remote broadcasts because debris and damage may prevent support vehicles from traveling with reporters.

GATR has teamed with IGI and SRS Technologies to further develop and market the antenna technology for DOD and emerging commercial applications. The company will be seeking Federal Communications Commission transmit approval for a commercial product to be launched in 2006. It is now looking for potential users to evaluate prototypes.

#### COMFORT TO SURVIVORS

After Katrina, Gierow wanted to do something for the survivors. He quickly found himself at the doorstep of the local headquarters of the American Red Cross in Montgomery, AL. Although initially skeptical and concerned for his safety, the Red Cross eventually relented. Gierow was told to travel to Mississippi and set up his antenna at an elementary school in Gulfport. Along the way, he was rerouted to another elementary school in Woolmarket.

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Coping with Katrina from page 12

Gierow wasn't sure what to do once he arrived and set up his equipment at the school. Slowly, people came by his area. At first they asked questions about his gear. Then, someone asked him if he could contact one of his friends via e-mail. Using a small webcam device, Gierow created a small video of this person and his family telling their friend that they were safe. Once a satellite connection was established, he sent the video via e-mail.

Next, a woman upset by the lack of telephone service asked if Gierow could help her submit a FEMA assistance request form, which could be done only by telephone or through FEMA's Web site. Since neither was available, Gierow accessed FEMA's Web site and submitted her form. He then proceeded to submit forms for everyone else at the shelter, even the deputy sheriff stationed at the school. The deputy eventually called her fellow officers on the police radio and had them give their information to Gierow to submit online.

In another case, a woman approached Gierow and said that she had been in a retirement home and hadn't talked to her son in five years. Gierow found the son's Web site and e-mailed him. Five minutes later, he e-mailed back, saying that his sister was coming to Woolmarket to pick up his mother. Another woman had Gierow e-mail one of her friends in Iraq. Her friend contacted her shortly thereafter, saying that he had thought she hadn't survived the storm.

#### WIRELESS NETWORKING

During his stay, Gierow tinkered with his system and was eventually able to set up a wireless router. Although he had only two computers, he says he could have set up a network of 20 computers and/or Internet phones.

A CBS radio reporter found Gierow's wireless network at the school. He asked if he could conduct live radio broadcasts using the setup. The reporter conducted two live interviews



▲ While travelling to Gulfport, MS, Gierow got a firsthand look at many residential areas devastated by Hurricane Katrina.

with Gierow during Los Angeles rush hour. "I could have used this on the Michael Jackson case," the reporter told Gierow.

With his supplies running out and no more forms to submit, Gierow returned home. He was excited that the technology not only proved itself, but was instrumental in helping so many people in need. Having submitted a Phase II SBIR proposal to MDA, Gierow is hoping to get the funds he needs to further develop the technology. "Everybody was impressed with the technology," Gierow said. "It's still in development, but there's a heck of a lot of product potential here." 

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▲ Superconducting tape would be ideal in areas with a high concentration of power lines.

SMI researchers claim that their reel-to-reel production tool could be used for fabrication of other materials and devices besides superconductors. In fact, any device that currently requires a thin-film coating on a flexible substrate, such as solar cells, flexible displays, or flexible electronic components, would benefit from a reel-to-reel production capacity. The cost of producing these devices could be reduced significantly if they are fabricated uninterrupted over hundred of meters of length.

The company has delivered a kilometer-scale, reel-to-reel MOCVD system to the Air Force Research Laboratory at Wright-Patterson Air Force Base. SMI researchers said that Air Force personnel will be using the tool to develop processes to improve the performance and production efficiency of superconducting tapes greater than a kilometer in length.

While the company completes its MDA-funded research on the tape-production tool, it is looking for other organizations that might have potential applications and interest in testing the technology.

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transmit one wavelength and reflect all the others back down the fiber, so you could remove one wavelength from the fiber.”

SSI’s drop/add switch takes the technology a step further by combining the LCFP filter with a new type of holographic lens. The holographic element converts the Fabry-Pérot interference pattern into individual points of light so that it can be more easily detected or channeled into optical fibers.

**OPPORTUNITIES**

SSI is seeing the fruits of its 10-year effort to turn LCFP technology into a revolutionary product. “The initial motivation was to sell a few of these things to my friends, but we have gotten much bigger than that, and we have a mature technology,” Noto said.

Noto calls the company a boutique manufacturer because it currently buys the optical components from another company and make the filters on a custom basis tailored to a client’s needs. However, the company’s eyes are set toward becoming an OEM supplier by producing several catalog products for instrument makers and designers to incorporate into their tools. These products would reduce costs by allowing volume purchasing of raw materials and moving fabrication of the optical parts in-house. To facilitate this expansion, the company is looking for investors.

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the thread is being processed or written to memory, etc., as well as displaying a timeline of the events occurring on each processor. “You get a really good idea of whether you are using processors efficiently and if you have bottlenecks somewhere,” Robbins said.

In addition to saving time and costs for developing software, MCCI’s technology allows programs to be easily changed or upgraded. Components can be made from an algorithm in MATLAB® and inserted into the data-flow graph, and the entire program can be re-coded by MCCI’s software. If programmers were writing the code, they would make hundreds of adjustments, line by line, to insert a new component

into the program, and then they would have to reexamine the program to make sure that multiple processors could execute the program correctly and efficiently. This is all handled automatically by the Autocoding Toolset, reducing programming time, costs, and errors.

MCCI seeks new applications and potential customers for its programming technology.

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# 5 Common Web Site Mistakes—and How to Fix Them

by Patrick Hartary/phartary@nttc.edu



Courtesy of stock.xchng

Web sites are great marketing, sales, and communication tools. Many MDA-funded companies have created sites and are using them to improve their businesses. Having visited hundreds while conducting research for *MDA TechUpdate* articles, I've found some common mistakes that could scare visitors away. Below are the top five—along with information on how to fix them.

## ■ BAD LINKS

During my browsing, I found many Web sites contained bad links, e.g., paths to files that have been moved or deleted. Frustrated by error pages, visitors will leave. Ask your webmaster to review the site logs to identify any old or broken links. The webmaster can also create a custom “404 error” page to direct visitors back to the home page or an alternative path. Once uploaded, this page will also redirect visitor mistypes.

## ■ OUTDATED MATERIAL

Many Web sites I've encountered contained outdated material. This was particularly evident on sites offering press releases. Some companies hadn't issued a press release since 2002 or 2003. Make sure to update your content regularly. Spend one or two hours a month writing a new press release or information for a news page.

## ■ NO POINT-OF-CONTACT

On a few Web sites, I couldn't find any point-of-contact information. What if I were a potential user or development partner? Not having such information on your site could result in lost business opportunities. Make sure your Web site offers a “Contact Us” page with a point of contact who can respond to interested parties. To prevent spam, don't hot-link your e-mail address.

## ■ PUBLIC E-MAIL ADDRESS

There's one sure way to look unprofessional on your Web site: use a public e-mail address. I'm talking about `yourname@aol.com` or `yourname@yahoo.com`. Setting up and using an e-mail address that contains your company domain name is easy. The tech department of the company that hosts your site can help you with this task.

## ■ NO WEB SITE

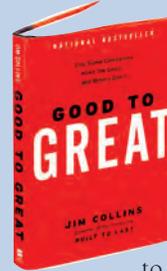
It amazes me that, in this digital age, some companies still don't have an online presence. Web sites can be developed on the cheap, either using off-the-shelf software or a hired designer. Hosting services can be obtained yearly for as little as \$100. In the long run, it may cost you more *not* to build a site.

## Easy Read with Enlightening Principles

Murray Johns of Dynamics Structures and Materials recommends *Good to Great: Why Some Companies Make the Leap... and Others Don't* by Jim Collins. “Although the data are derived from studies of

publicly traded corporations, we felt as though the lessons learned can apply in many ways to small businesses as well,” Johns said. “We asked all of our staff to listen to the abridged

version or to read the text, and as engineers, we appreciate the data-driven mindset behind the conclusions. The concepts are simple in nature, and although mastering the concepts and gaining the deep, internally-focused understanding is extremely difficult, we feel as though our company-wide discussions about these topics have helped to shape our thoughts around what is required to make the transformation (individually and collectively) from good to great.”



## Inspiring Quotes

*“The secret to my success is that I bit off more than I could chew and chewed as fast as I could.”*

Paul Hogan

*“If A is a success in life, then A equals x plus y plus z. Work is x; y is play; and z is keeping your mouth shut.”*

Albert Einstein

*“The human mind treats a new idea the way the body treats a strange protein; it rejects it.”*

Peter Medawar

After reading this newsletter, you've stored a lot of new information in your brain. Play our Tech Trivia game to test what you just learned.

1

*Tech Trivia*

During a casual stroll, a person can quickly generate about \_\_\_ millijoules of static electricity.

- A. 20
- B. 60
- C. 120
- D. 180

2

*Tech Trivia*

Fluoropolymers are highly regarded for their high temperature resistance. They can endure temperatures up to

- A. 200°F
- B. 400°F
- C. 475°F
- D. 750°F

3

*Tech Trivia*

The world's first 6-inch GaN-on-sapphire wafer was created by

- A. Integument Technologies
- B. Structured Materials Industries
- C. Technologies and Devices International
- D. Mach I

4

*Tech Trivia*

According to John Noto, founder and president of Scientific Solutions, liquid crystals are a lot like

- A. Silly putty
- B. Spaghetti sauce
- C. The juice used to baste a turkey
- D. The goop at the bottom of your soap dish

Answers: 1. A, 2. C, 3. C, 4. D

Missile Defense Agency  
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Winter 2005-2006

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