Industry warms up to promises of Cold Spray™

Sandia helps eight-member consortium of US manufacturers explore frontiers of splat science

By John German

Sandia is studying the science of splat. Working with a consortium of eight US companies that includes automakers and aircraft engine manufacturers, researchers at Sandia’s Thermal Spray Research Laboratory are using experimental and computer-modeling capabilities to improve the world’s fundamental scientific understanding of an emerging manufacturing technique called Cold Spray™ (Lab News, Jan. 26, 2001).

Cold Spray involves injecting microscopic powdered particles of metal or other solids into a supersonic jet of rapidly expanding gas and shooting them at a target surface. When these 10- to 50-micron-wide particles hit the substrate, they splat so hard they stick — like a bug to a windshield.

Building a reputation

Consortium members want to use new Cold Spray processes refined at Sandia to create wear-resistant coatings on car- or aircraft-engine components, for instance, or to deposit layers of reactive metals such as aluminum or copper onto substrates for use as heat-tolerant circuits.

The Sandians ultimately want to employ successfully commercialized Cold Spray processes, which originated, ironically, at a Soviet-era research lab in Siberia, to improve US nuclear weapons components. (See “The Promise of Cold Spray” on page 3.)

Sandia News

Vol. 53, No. 8
April 20, 2001

Happy birthday! MTI satellite is one year old

The Multispectral Thermal Imager (MTI) satellite, developed by a Sandia-led team, was launched last March. To celebrate the anniversary, the Lab News is pleased to publish three of the satellite’s most memorable images — in color. See them on pages 6-7.

Extreme excitement: Celebration marks EUVL microchip milestone

California site hosts industry-labs-government dignitaries and media; event marks ‘huge step’ toward next-generation microchips

By Nancy Garcia

“It seems that EUV is winning out,” Craig Barrett, president and CEO of Intel Corp., observed at a big celebration event at Sandia’s California site last week.

EUV, extreme ultraviolet lithography, is being developed through an industry-funded consortium by Sandia, Lawrence Livermore, and Lawrence Berkeley national laboratories as a way to create ever-finer features on microchips. (See April 6 Lab News for a four-page retrospective on the entire research project and partnership.)

When it was first made feasible in the 1990s, Barrett said at the April 11 event held in the Combustion Research Facility auditorium, EUV lithography “was perhaps one of the dark horses” among competing potential approaches under consideration for next-generation chip-making lithography.

Now, he said, “it has become more the leading horse in the race.”

A new approach is needed because the current chip-printing technique, traditional optical lithography, is hitting a physical limit around 2005 and won’t be able to continue increasing functionality by doubling the number of transistors that can be etched on a slice of silicon every 18 months or so — a pace the semiconductor industry has enjoyed since the 1960s.

In the last four years, an industry consor-
tium... (Continued on page 3)
Nevada Test Site
Amarillo, Texas
Nancy Garcia
Chris Burroughs, (844-5199), Neal Singer (845-7078), Larry Perrine (columnist, 925/294-2447), Iris Aboytes (Milepost photos, 844-2282), Published on alternate Fridays by Media Relations and Lab News fax ................................................ 505/844-0645

Ken Frazier
and a prime contractor to the US Department of Energy.
by Sandia Corporation, a subsidiary of Lockheed Martin Corporation
Sandia National Laboratories
Randy Montoya,
Carlsbad, New Mexico

Any other husband/wife team here ever accumulated more total service? 39-plus years, and his wife Mary (retired April 6) had 37-plus. (It totals more than 77 when their extra months are added in.) Anyone know whether any other husband/wife team here ever accumulated more total service?

Big dealing at the CU — Someone does a good job training Sandia Lab Federal Credit Union employees to stay friendly even under trying circumstances, as much as when typical Sandians count their change twice — carefully. When I visit the CU, I sometimes assume the role of “Mr. Trying Circumstances” just to spice up the employees’ day, but I may have overdone it recently. When I asked to cash a $50 check at the CU a month or so ago, a pleasant young teller asked how I wanted the money. I said, “Three twenties and a ten and said, “OK, I’ll be serious now. Just give me a twenty, three tens, and two fives and I’ll get out of your hair.” She’d had enough, handing me two tens and a ten and said, “That’s the best deal you’re getting here today!” I’ve been back several times since, but haven’t seen her again. I may have guided her into a new career.

A “shining light” for pensioners — Speaking of money, if you read our April 6 pension story, you know Sandia management will soon have a new pension plan improvement proposal ready to discuss with Lockheed Martin and DOE. We hear from quite a few Sandians who are quickly tiring of pension improvement talk and eager for some action. We promise to keep you posted about any new developments. In the meantime, keep in mind that K-Mart has reinstated its blue-light specials, that day-old bread stores have some fine deals if you get there early, and that if you look hard enough, you can find some “spiffy duds” at your local Goodwill store.

— Larry Perrine (845-8511, MS 0165, lgperrin@sandia.gov)

Sandia to host 11th International Arms Control Conference

Some 300 government officials and foreign affairs experts represent NATO, NATO, and more than 40 countries will gather in Albuquerque this weekend, April 20-22, to discuss the threat of chemical, biological, and nuclear weapons and to work to control them.

The 11th Annual International Arms Control Conference, hosted by National Security Programs Div. 5000, will feature panel discussions on:
• New Paradigms in Arms Control: Offense versus Defense
• US-Russia Cooperative Efforts in Threat Reduction: Lessons Learned and Future Concerns
• The Century of Biology: Implications for Global Security and Arms Control
• Getting the Democratic People’s Republic of Korea Out of the Proliferation Game
• Homeland Defense: Is It Real?

Keynote addresses will be given by Gen. Charles Boyd (ret.), Executive Director, U.S. Commission on National Security/21st Century; and Amb. Wolfgang Hoffmann, Executive Secretary, Comprehensive Test Ban Treaty Organization.

Labs President Paul Robinson and VP-5000 Roger Hagedonrger also will speak.

“The conference brings together key leaders and policymakers in the arms control and nonproliferation communities to discuss issues that are of concern to nations around the world,” says conference chair Jim Brown (5325). “Previous conference have allowed for a constructive exchange of ideas and have resulted in valuable relationships among some of the world’s top arms control and nonproliferation experts.”

Occupational health concerns? Review document on web site

Labs employees, a written occupational health program is available for your review. The need for a review by affected personnel is a regulatory requirement published by the Occupational Health and Safety Administration. The Sandia/New Mexico Confined Space Program document may be accessed at: http://www-im.sandia.gov/corporate/eh-manuals/confined_space/index.htm.

Instructions for submitting review comments are given on the web site. All comments must be received by Friday, April 27.

Sandians to participate in four-part radio series focusing on the nation’s energy crisis

Two dollars a gallon for gas, soaring home heating bills, rolling blackouts in California — what’s next? Does anybody know where we’re going in our energy future? What’s on the horizon — Wind? Solar? Clean coal? Nuclear? These and many other questions about the energy crisis we’re facing will be explored in a four-part, locally produced radio series titled Running on Empty. The series will air on four consecutive Wednesdays, starting May 2, on Albuquerque KUNM, public radio 89.9 FM, at 8:30 a.m. following NPR’s Morning Edition.

Sandia Directors Margie Tatro (6200) and Amb. Wolfgang Hoffmann, Executive Secretary, Comprehensive Test Ban Treaty Organization.

Ken Frazier
Bill Murphy, Writer .......................... 505/844-6210
Chris Burroughs, Writer .......................... 505/844-0948
Randy Montoya, Photographer .......................... 505/844-5605
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Meetings scheduled May 1-3 to discuss health care plans, cost potentials, changes

Human Resources Div. 3000 VP Don Blanton, Benefits and Health Services Center 3300 VP-5000 Dr. Larry Cleaver and Benefits Dept. 3341 Manager Becky Satter will discuss health care plan costs projections and plan design strategies at a series of employee meetings in California and New Mexico.

While any changes to Sandia’s health care plans and options available to employees will not occur before next January, the Benefits management team will continue the series of meetings as a way to brief employees on the current status of its negotiations.

Here are the times, dates and locations for the meetings:

• Tuesday, May 1, 1-2 p.m., Bldg. 904 Auditorium for California Site employees
• Tuesday, May 1, 2:30-4 p.m., Bldg. 904 Auditorium for California Site employees
• Wednesday, May 2, 1:30-3:30 p.m., Steve Schiff Auditorium for New Mexico managers
• Thursday, May 3, 1:30-2:30 p.m., and 3-4:30 p.m., Steve Schiff Auditorium for New Mexico employees.

Congratulations

To Susan Boggs and Russ Jarek (1812), a son, Christopher, March 3.
Huge step, leading choice

Sunlin Chou, an Intel senior vice president and manager of technology and manufacturing — who heads the international consortium of the EUV Limited Liability Company — called EUV lithography a promising “huge step” that won’t require the ordinary, slow, and expensive development of new materials for each successive generation of microchip manufacture.

Instead, he said, EUV would allow “many, many” generations of microchip manufacture. He considers it the leading choice for use in the second half of this decade and beyond, saying it will meet industry needs for more than a decade. In a process similar to photo-

eicizing the impending partnership, the US companies believed they could move ahead faster if they had access to Japanese optics technology, but the Japanese refused to put a stop to the idea of EUV lithography. For their part, the US companies believed they — as it should be — would use the new technology to go on to beat each other over the head in the marketplace — which is as it should be.

Representatives of semiconductor equipment manufacturers attended. They will use the tool assembled at Sandia to craft their commercial products for industry. “We look forward to getting one of these machines on the production floor in a couple of years,” Barrett said.

The initial prototype, called the EUV Test Stand, is not just a gleaming and complicated research tool occupying a 10x10-foot floor space, Chou said. It also represents “a history-making achievement.”

Representing the three Department of Energy labs, which joined efforts in the partnership in a Virtual National Laboratory, John Gordon, Director of the Nuclear Security Administration, said the tool’s ability to print features that may one day manufacture smaller, smarter, and leaner products for industry.

At $250 million from 1997-2002, this largest industry-funded CRADA ever undertaken by the DOE, he said, “really is a partnership that works in every direction.”

“People four years ago said you can’t do this,” Mm said, “and by God, we’ve done it.” Chou pointed out that members of his company have worked on smaller collaborations with the DOE labs for many, many years, and were always impressed. “It sometimes seemed literally magical — things that it seemed couldn’t be done were done.”

In a letter as the only member of Congress with two national labs in his district, Ellen Tauscher (D-Calif.), savored her role “representing the smartest people in the world.”

“We like people who are smart,” she said, “and we believe in the state of the art.” She praised the relatively new National Nuclear Security Administration for helping remove Defense Program laboratories “from the bureaucratic kudzu,” saying she was proud to show the business community that government can be “smaller, smarter, and leaner — but not meaner.”

Tauscher closed by predicting the partnership will create quality jobs, urging her listeners, “Let’s get back to work.”
White paper

(Continued from page 1)

There are thousands of people for the past few years that we really needed to start thinking much more broadly than just US-Russia deterrence and that policy. Now, the strategic review, which I led, started at the start of each new administration, seemed to be the best opportunity to influence thinking and get people thinking in new ways.

Paul noted that while he has served for eight years as chair of the US Strategic Command Strategic Advisory Group policy subcommittee, and has learned much from his STRATCOM experience, the thoughts in the white paper are his own.

I don’t claim that this is a consensus opinion of anybody. . . . It really is my own food for thought that I’m contributing to help the discussion along.

Paul recognizes that there will be skeptics who consider his involvement in the discussion as motivated by a desire to stimulate jobs at the national labs. One local newspaper account, for example, characterized Paul’s public advocacy of his policy views as “seeking ways for the nation’s nuclear weapons complex to remain relevant in the post-Cold War world.”

“What was most wrong with that characterization,” Paul says, “is that there is not a first- or even second-order connection between the numbers of weapons in the stockpile and the amount of design work which Sandia does. [It] (the motivation for writing the white paper) really was, the world has changed enough that we were running out of policy. That, and the fact that I’ve been exposed to this [the policy debate over America’s nuclear weapons posture] for so many years decided I ought to sit my hand at trying to make some contributions. What value these ideas will have in the nuclear posture review, I don’t know. This is input in that process and it comes from the unique background I’ve had.”

Paul is convinced that the nation’s deterrent policy for the 21st century needs to incorporate non-nuclear weapons (available in the military that have advocated) solely on advanced conventional arms. He comes to this perspective not from his role as a laboratory director but from personal experience (his tenure during his tenure as an arms control negotiator in Geneva).

Monuments to failed deterrence

“I’ve never believed that we could rely on conventional weapons alone for deterrence. When I’d get a change to take a ride through Europe, which was beaten twice last century, I used to point out to people that in every little town, there’d be a monument to the folly of conventional deterrence — with lots of names on it, just like the Vietnam Wall. And so I found myself when I set out to write this paper saying, I need to make some of those thoughts known — that nuclear weapons serve in deterring these threats from ever starting, can prevent conflicts from ever starting, can prevent wars, and which, I’ve been exposed to in the Cold War, are the most potent tool for deterrence the world has yet found. Or, as Paul wrote in his paper, citing Margaret Thatcher’s quotation of a warning from Winston Churchill: “Be careful above all things not to let go of the atomic weapon until you are sure, and more sure than that, other means of preserving the peace are in your hands.”

Pursuing a New Nuclear Weapons Policy for the 21st Century: Extracts from Paul Robinson’s white paper

Note: The following excerpts are taken from Sandia Labs President C. Paul Robinson’s white paper. These selected excerpts do not intend to provide a complete synopsis of Paul’s views, but rather a flavor of his language and his thinking on the issues addressed. To understand and appreciate the arguments Paul is putting forth, one should download the white paper from Sandia’s web site — http://www.sandia.gov/media/whitewpaper/2001-04-Robinson.htm.

It is abundantly clear (to me) that formulating a new nuclear weapons policy for the start of the 21st century is difficult and controversial. While the often over-simplified picture of deterrence during the Cold War — two behemoths facing each other down — has thankfully retreated into history, there are nevertheless huge arsenals of nuclear weapons and delivery systems, all in quite usable condition. There were three problems that could be brought back quickly to their Cold War postures. Additionally, throughout the Cold War and ever since, there has been a steady proliferation of nuclear weapons and other weapons of mass destruction by other nations around the globe. The vast majority of these newly armed states are not US allies, and some are already exhibiting hostile behavior, while others have the potential to become aggressors toward the US, our allies, and our international interests.

It seems inescapable that the US must carefully think through how we should be preparing to deal with new threats from other corners of the world, including the role that nuclear weapons might serve in deterring these threats from ever reaching actual aggression.

I personally see the abolition of nuclear weapons as an impractical dream in any foreseeable future. I came to this view from several directions. The first is the impossibility of ever “uninventing” or erasing from the human mind the knowledge of how to build such weapons. While the sudden appearance of a few tens of nuclear weapons causes only a small stir in a world where several thousands of such weapons already exist, their appearance in a world without nuclear weapons would produce huge effects. (The impact of the first two weapons in ending World War II should be a sufficient example.)

It seemed to me that it was time for someone to step forward and articulate the other side of these issues for the public. First, that nuclear weapons remain of vital importance to the security of the US and our allies and friends (today and for the near future); and second, that nuclear weapons will likely have an enduring role in preserving the peace and preventing world wars for the foreseeable future. These are my purposes in writing this paper.

* * *

Let me first stress that nuclear arms must never be thought of as war fighting tools. Rather we should rely on the catastrophic nature of nuclear weapons to achieve war prevention, to prevent a conflict from escalating . . . or to help achieve war termination when it cannot be achieved by other means, e.g., if the enemy has already escalated the conflict through the use of weapons of mass destruction. Conventional arms remain important to serve in deterring the nation, needs to be reconfigured to address new threats.

Capability One and Capability Two

That configuration, he writes, should have two components: Capability One and Capability Two. Capability One represents what Paul calls “central deterrence”: an on-going ability to maintain a viable deterrent to Russia’s still very substantial nuclear arsenal. (Other nations may someday pose a risk of the same scale as Russia; today only Russia has the capability to utterly destroy American society.) Capability two, Paul writes, should be thought of as “human force,” a force scaled and deployed to deter threats from rogue states and sub-national movements.

In an interview, Paul told the Lab News the timing was right for him to offer public comments on the issue. He said a new century, a new administration, and new, more complex threats to the nation’s security demand a new round of hard thinking about nuclear weapons. “What you’re seeing in this paper,” Paul says, “is my attempt to put down on paper some suggestions for the upcoming national security review.”

Need for new policy obvious to many

I would say it has been fairly obvious to a number of people for the past few years that we really needed to start thinking much more broadly than just US-Russia deterrence and that policy. Now, the strategic review, which I led, started at the start of each new administration, seemed to be the best opportunity to influence thinking and get people thinking in new ways.

Paul noted that while he has served for eight years as chair of the US Strategic Command Strategic Advisory Group policy subcommittee, and has learned much from his STRATCOM experience, the thoughts in the white paper are his own.

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It seems inescapable that the US must carefully think through how we should be preparing to deal with new threats from other corners of the world, including the role that nuclear weapons might serve in deterring these threats from ever reaching actual aggressions.

I personally see the abolition of nuclear weapons as an impractical dream in any foreseeable future. I came to this view from several directions. The first is the impossibility of ever “uninventing” or erasing from the human mind the knowledge of how to build such weapons. While the sudden appearance of a few tens of nuclear weapons causes only a small stir in a world where several thousands of such weapons already exist, their appearance in a world without nuclear weapons would produce huge effects. (The impact of the first two weapons in ending World War II should be a sufficient example.)

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* * *

Let me then state my most important conclusion directly: I believe nuclear weapons must have an enduring place in the international scene for the foreseeable future. I believe that the world, in fact, would become more dangerous, not less dangerous, were U.S. nuclear weapons non-existent. The most important role for our nuclear weapons is to...
Intelligent nanorafture report on their environment
Sandia-UNM group's conjugated polymers easily implanted in rigid structure

By Neal Singer

Intelligent nanoraftures that report on their environment by changing color from blue to fluore-
scent green, white, or yellow in response to chemical, electrical, or thermal stress have been created by researchers at Sandia and the University of New Mexico.

Most immediately, the durable, self-assem-
ing nanoraftures may lower costs by reducing the need for manufactured devices like stress detec-
tors, chemical analyzers, and thermometers.

“Two main challenges in developing nanoraftures that respond to changing environ-
mental conditions are finding a trigger and understanding how to distribute the materials through the structure,” says Alan MacDiarmid, professor Jeff Brinker (1841).

In September Sandia releases latest version of ALEGRA this month
Robust housing for fragile molecules
Sandia-UNM group

The elegantly simple method is published this

April in Nature.

Robust housing for fragile molecules
Perhaps more important, the method is a
generic, efficient solution to a problem that has
plagued modern materials science: how to effi-
ciently distribute conjugated polymers — inexpen-
sive organic molecules that carry electric current — within a hard, protective structure.

In a series of papers the new Sandia-UNM method
evenly pre-distributes materials for polymers
within a silica matrix through self-assembly. Poly-
merization reaction involves a detergent/silica
nanocomposites that are mechanically robust and
topically transparent and that produce telltale
changes of color under changing environmental
conditions.

Discovery of conjugated polymers themselves is considered important enough that the Nobel Prize will be awarded for the first time this

month. The culmination of this effort is the recent
build future z-pinch machines.

Sandia researchers initially developed ALEGRA
in 1993, as a shock wave physics code used to
model high-speed impact and penetration
phenomena involving a variety of materials. As
computer hardware evolved, the code was
rewritten to accommodate the newly developing
dynamically parallel computational engines, like Sandia's Teraflop computer, ASCI Red.

In 1995 ALEGRA was expanded to model
electromechanical properties — piezoelectric materials — giving researchers a new tool to simulate the shock-activated power supply in the neu-
tron generator, for example.

Three years later ALEGRA integrated another advanced physics model with the
capability to model magnetohydro-
dynamic (MHD) phenomena — the interac-
tion between magnetic fields and electric-
ity conducting materials.

For researchers working with the Z
accelerator, this aspect opens new hori-
zons. ALEGRA provides the ability to
understand the complexity of the for-
mation and compression of hot plasma
to generate the extreme X-ray environ-
ment needed to simulate a nuclear explosion.

"ALEGRA is critical to the future success of the high-energy-density physics research per-
formed in the Pulsed Power Center," says Tom Mehlhorn, Manager of Target and Z-Pinch
Theory Dept. 1674. "It is already being used to understand and design experiments on the Z
accelerator in order to anticipate future capabilities, it will provide
simulations that will lay the foundation for an upgrade to Z machine and to design and build future pinch systems.

On the other hand, the elegant simplicity of the ALEGRA framework makes it ideal for
massively parallel computational environments, like Sandia's Teraflop computer, ASCI Red.

The Laboratory-Directed Research and Develop-
ment (LDRD) program, DOE's Office of Science, the US Air Force Office of Scientific Research, and NASA co-funded this work.

The achievement is the Sandia-UNM group’s
latest in making use of self-assembling two-sided molecules. The earliest, simplest version of the method was first reported in Nature in September 1997. In that paper the group described how detergent molecules, alcohol, silica, and water could be used to self-assemble a thin film with precisely defined pores for membranes, sensors, and low-k dielectrics.

Since then, this inexpensive process has been
used in increasingly complex procedures, all
reported in Nature and in Science. The process has produced a seaweed-like layering at once very
strong and nonbrittle, nanoscopic spheres that can
hold medicine, intelligent ink that assembles dur-
ing inkjet printing, and self-assembled nanoraftures with pores sizeable by light to a finenes-
s of 0.2 angstroms.

By Chris Burroughs

The latest version of ALEGRA, a computer
code used by departments Labs-wide to model
Z-machine implosions and hostile nuclear
weapons environments, was released earlier this
month.

“This release is significant because the
new version turns ALEGRA into a true code frame-
work,” says Dan Carroll (9321), ALEGRA team
leader. “It now can be much more easily used for
a wider array of applications.”

Besides departments at Sandia, some Depart-
ment of Defense customers also employ ALEGRA
to model non-nuclear weapon effects.

ALEGRA (the name stands for Arbitrary
Lagrangian Eulerian General Research Application) is one of two codes being developed by
DOE's Accelerated Strategic Computing Initiative (ASCI) program. The idea behind these frameworks is to develop certain common capabilities needed
to model Z-machine implosions and hostile
environment.

Framework are going very well,

- A still-different (detergent) molecule served as both the struc-
ture for these potentially useful but
difficult to fashion materials.

He says the ALEGRA framework includes
massively parallel computational engines, like Sandia's Teraflop computer, ASCI Red.

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electromechanical properties — piezoelectric materials — giving researchers a new tool to simulate the shock-activated power supply in the neu-
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Theory Dept. 1674. "It is already being used to understand and design experiments on the Z
accelerator in order to anticipate future capabilities, it will provide
simulations that will lay the foundation for an upgrade to Z machine and to design and build future pinch systems.

He says the ALEGRA framework includes
physics modules that allow his engineers and
researchers to simulate most of the major activi-
ties in the high-energy-density physics program — x-pinches, shock physics, radiation-hydro-
dynamics, and electron-photon transport.

Dan says the Z machine work is only half
the story of how ALEGRA is used. The other half falls in the area of modeling hostile environments — the effects of exploding nuclear
weapons on the environment.

"We are making progress much faster than we expected would be possible. Our efforts
to produce a seaweed-like layering at once very
strong and nonbrittle, nanoscopic spheres that can
hold medicine, intelligent ink that assembles dur-
ing inkjet printing, and self-assembled nanoraftures with pores sizeable by light to a finenes-
s of 0.2 angstroms.

"All of our observations can be summed up
(Continued on next page)
ALEGRA effort spread across the Labs

Among those working with the framework is Scott Wunsch (8351) from Sandia/California, who attends the ALEGRA meetings via a teleconference connection. Other code development teams working in Area 4 from Center 1600 are preparing to begin work in the ALEGRA framework. The framework development team includes: Allen Robinson, Kent Budge, Mike Wong, Rich Drake, Kevin Brown, Randy Summers, Sharon Petney, Mark Christon, Chris Garasi, Josh Robbins, Dan Carroll, Sue Carroll, Ed Boucheron (all 9231), and Tom Halli (1674). Others who have participated in developing ALEGRA or who are using the ALEGRA framework for further simulation development include: David Turner, David Seidel, Mike Pasik, Rebecca Coats, Kelley Shaw (all 1642); Kyle Cochrane, Tom Brunner (both 1674); Scott Wunsch (8351); Randy Weatherby, James Peery (both 9142); Rebecca Brannon, and Ray Bell (both 9232).
Members of the Multi-spectral Thermal Imager (MTI) satellite team in March celebrated the satellite’s first year in orbit by holding a symposium attended by 200 users of the data being gathered by MTI. The MTI satellite, developed by a Sandia-led government and industry team, was launched from Vandenberg Air Force Base, Calif., on March 12, 2000.

The satellite carries an advanced ground-imaging system that very accurately measures the “brightness” of ground features in 15 visible and infrared spectral bands.

During its three-year research mission, the MTI is collecting images of volunteer sites located throughout the US that have been instrumented to collect simultaneous “ground truth” data.

Researchers compare the satellite data with the ground truth data to develop engineering, processing, and analytic techniques that could be employed in future satellite systems to address a host of national needs, ranging from military and treaty-monitoring applications to hazardous waste site characterization and climate research.

The imaging instrument was assembled and tested at Sandia and calibrated at Los Alamos National Laboratory.

Researchers at DOE’s Sandia, Los Alamos, and Savannah River Technology Center are focusing on treaty monitoring applications, while researchers at 50 other national defense and civilian organizations involved in the project are addressing applications of interest to their respective agencies.

About the images

THE VIEW FROM UP HERE — A few of the interesting images taken by the MTI satellite include: 1) Left page, an infrared image of the Los Alamos area taken after the Cerro Grande fire. Vegetation shows up red. The large gray swath from lower left to upper right is the devastation left by the fire. The Los Alamos town site and lab are visible in the lower right. The ski hill is visible to the left. 2) Right, a view of the Albuquerque area, imaged in November 2000 while the MTI was over El Paso, Texas. The true-color image shows parts of Kirtland Air Force Base to the south and Rio Rancho and Bernalillo to the north. A portion of the Sandia Mountains is visible at upper right, and the Rio Grande flows through the valley. 3) Below, an infrared view of the San Rafael Bridge in the San Francisco Bay area.
Cold Spray

Spray™ processes: below right.

“Cold Spray has some significant advantages as a coating and fabrication tool,” says Mark Smith, Manager of Joining and Coating Dept., 183. “We think the best way to legitimize Cold Spray for use in the nuclear weapons program is to have its use proven in US industry, and to support the development of a commercial supplier base.”

Members of the consortium — Alcoa, DaimlerChrysler, Ford Motor Co., The Jacobs Chuch Manufacturing Co., Ktech Corp., Pratt & Whitney, Praxair, and Siemens/Westinghouse — met at Sandia recently to discuss progress they’ve made toward readying the Cold Spray processes for widespread commercial use.

Cold Spray 101

Cold Spray more appropriately might be called “room-temperature spray.”

Conventional “thermal spray” processes require preheating the sprayed materials so the particles are in a semi-molten state when they reach the substrate, allowing them to splash across the surface. But as the “splats” cool, they contract slightly, creating residual (stored) stresses or flaws at the interface that can cause defects later.

Cold-sprayed materials typically remain at or near room temperature until impact, slamming into the substrate so hard travelling at 500 to 1,500 meters (1,600 to 5,000 feet) per second that a tight bond is formed without the undesirable chemistry changes and stresses associated with conventional processes.

Although the science behind this bonding process is not yet well understood, the researchers think the high-velocity impact disrupts thin metal-oxide films on the particle and substrate surfaces, pressing their atomic structures into intimate contact with one another under momentary high interfacial pressures and temperatures.

Understanding splat

Unlike thermal-sprayed materials, cold-sprayed particles experience little to no defect-causing oxidation during flight and exhibit remarkably high densities and conductivities once fabricated, the researchers have found. In addition, deposition rates comparable to traditional thermal spray processes can be achieved with Cold Spray.

“This is the logical conclusion of research thrusts in thermal spray technology during the last two decades toward faster-and-faster and cooler-and-cooler methods,” says Richard Nelser (118).

To advance the state of fundamental understanding and improve the usefulness of Cold Spray, the Sandians are combining modeling expertise in Engineering Sciences Center 9100 with experimentation in Materials and Process Science Center 1800.

The team has examined gas dynamics, aerosol physics, and plastic deformation during splat-to-substrate impact. Current efforts focus on avoiding fouling of nozzles with powder residue; experimenting with varying materials, particle sizes, and impact velocities; and characterizing splat patterns and Cold Spray-fabricated bulk materials.

The researchers also want to design better aerodynamic lenses that focus or spread out the spray pattern like a thumb held over the end of a garden hose.

A variety of metals have been deposited, including copper and aluminum, as well as several types of steel and nickel-based alloys. Even a few metal-ceramic composites have been successfully fully cold sprayed.

Revolutionary changes

The Cold Spray consortium supplies $400,000 a year for three years toward Sandia’s R&D efforts, plus in-kind contributions by each member. Sandia also is collaborating with several individual member companies on proprietary Cold Spray R&D.

Cold Spray technology came to the US in 1994, ten years after its Russian inventors first recognized its potential significance while conducting high-velocity wind tunnel tests at the Institute of Theoretical and Applied Mechanics of the Russian Academy of Sciences in Novosibirsk.

One of its discoverers, Prof. Anatolii Papyrin, who holds the US patent for Cold Spray, now works for Ktech in Albuquerque, which hopes to supply fabrication equipment to a broadened Cold Spray market.

Sandia is among just a few R&D institutions in the world successfully turning improved understanding of Cold Spray science into marketable technology, says Mark.

“We think Cold Spray provides capabilities not previously possible,” he says. “It’s a new enough technology that we don’t yet know all the possible applications, but it has the potential to make truly revolutionary changes in the way some products are manufactured.”

The promise of Cold Spray™ processes

Cold Spray™ processes show unique promise for creating wear-resistant coatings, fabricating durable small piece parts layer by layer, and joining chemically dissimilar materials with bonds that gradually transition from one material composition to another.

Coatings could be applied to materials that can’t tolerate the higher temperatures of thermal sprays, or allow large parts to be made from lighter-weight materials without a net loss of strength — on composite automobile engine blocks, for instance.

Lower-defect crystalline materials could be consolidated without heat treatment for better-performing corrosion-resistant coatings. High-density copper lines could be used as electrical leads for heat-tolerant under-hood automobile electronics. For weapons applications, Sandia might use them to create vacuum-tight seals in metals or high-quality metal-to-ceramic bonds without heat treatment, and perhaps as a low-temperature alternative to welding.

Already Cold Sprayed materials are being evaluated as wear-resistant coatings for light-weight aluminum automobile engines. Sandia has used Cold Spray processes to reclaim an expensive “out of tolerance” satellite part, which is now destined for space rather than the scrap heap, says Mark. New industry inquiries about design and manufacturing possibilities are arriving at a steady pace, he says.

“The killer application is probably the one no one has thought of yet,” he adds.

Feedback

Sandia’s 401(k) program: Is it wonderful for everybody, or a ‘cruel joke’ for some?

Q: I noted that in discussions concerning equity of retirement plans, our protagonists invariably cite the “wonderful 401(k) plan” as a primary factor in achieving equity with our sister labs. For those whose salaries here are much below our industrial contemporaries and I’ve hand-to-mouth, this 401K plan is a cruel joke. Participation is not possible.

Drop this self-serving pretense of magnanimity and do what is right. Make our retirement plan genuinely equitable.

A: Regarding the 401(k) plan, a study was conducted of the employees at Sandia who are in your same job classification. Those results showed that more than 90 percent of these workers participate in the 401(k) with a contribution of more than 8 percent of their salary, which is of course matched by the company at 66-2/3 percent of the first 6 percent. Even in a down market, the average balance of current employees in this group is greater than $100,000. The final analysis showed that within your same job classification there is high interest in participating in the 401(k) and receiving the company match as part of a long-term strategy to save for retirement.

Sandia’s pension plans were never designed to fully replace pre-retirement income. The pension benefit was intended to be supplemented by Social Security and personal savings — the other legs in the three-legged stool of retirement security — to provide income in retirement. Given the extremely high levels of participation in Sandia’s savings plans over time, we believe it is appropriate to include the value of the company matching contribution when comparing Sandia’s retirement benefit to those at other national laboratories.

— Ralph Bonner (10300)
Sandia develops TIVA, a new integrated circuit failure analysis technique

By Chris Burroughs

OptoMetrix license
Sandia has granted OptoMetrix, Inc. an optical instrumentation company specializing in failure analysis techniques for integrated circuits, a license to use the Labs-developed technologies Light-Induced Voltage Alteration (LIVA) and Thermally-Induced Voltage Alteration/Seebeck Effect Imaging (TIVA/SEI).

The license allows the company, located in Seattle, to market equipment using the techniques. The equipment could then be sold to integrated circuit manufacturers for failure detection.

While a few semiconductor manufacturers have directly licensed these technologies in the past, this agreement is the first time an equipment manufacturer has licensed these technologies for sale.

Excerpts from Paul Robinson’s nuclear policy white paper

(Continued from page 4) serve as a “sobering force,” one that can cap the level of destruction of military conflicts and thus force all sides to come to their senses.

Russia is the only nation that we can conceive of with the potential to threaten the U.S. national existence. It would be exceedingly foolish to allow our deterrent forces against Russia to weaken as long as that potential remains in place. The strategy and policy for continuing to deter Russia follows closely that which we developed during the Cold War. . . . I will designate that portion of our strategic force capability that continues to be devoted to deterrence of Russia as Capability One.

I believe that nuclear weapons do have a place and purpose today in other than a Russian context. Rather than inflame debates prematurely as to who is at risk from whom’s enemies or adversaries, I would call the second force capability simply the “Non-Russian Force” or Capability Two. In my early thinking on this subject, I even referred to this second force as the “To Whom It May Concern” Force.

The whole question of “Against whom would we really contemplate the use of nuclear weapons?” is an important political and international issue. A direct response might well be “Any nation or group of nations in a position to deliver nuclear weapons.” Another way of phrasing it is that nuclear weapons are capable of being used by a variety of entities, even if not actually developed, might be tempted to deploy nuclear weapons with the capability to destroy large cities.

Faults and failures within the circuit react differently to the heat stimulation than operational components. In an unflawed device, the effects produced by the heat don’t change the circuit’s operation. However, if the power demands of the chip change due to the local heating, it is an indication of a malfunction or a mode defects if a conductor is open, while TIVA indicates a short circuit.

“TIVA is extremely sensitive and allows us to see flaws we either couldn’t detect before or could locate only with significant time and effort,” Ed says.

One of the significant aspects of TIVA is that it allows for scanning of the integrated circuit from both the front and back.

“This is important because the current state-of-the-art chips employ up to seven layers of metal interconnections, preventing direct observation of many areas from the front of the device,” Ed says. “Additionally, flip-chip or up-side-down packaging denies direct access to the front surface. TIVA gives us the ability to examine the integrated circuit from both sides.”

TIVA operates similarly to its older cousins CIVA (charge-induced voltage alteration) and LIVA (light-induced voltage alteration). CIVA was the first “induced voltage alteration” failure analysis technique developed at Sandia. LIVA uses open circuit boards with a scanning electron beam. LIVA uses neutralized detectors produced with relatively short wavelength light, instead of heat as in TIVA.

TIVA has recently been successfully applied beyond the world of integrated circuits in the diagnosis of various failures in MEMS (micro-electromechanical systems) devices.

Team effort on ‘IVA’s’
Developing the “IVA’s” has been a team effort, Ed Cole (1739) says.

The original CIVA development team included Ed, Richard Anderson, Jerry Soden, Chris Henderson (all 1739), and Bruce Dodg (no longer with Sandia).

He co-invented LIVA with Jerry Soden (1739). Others on the team included Chris Henderson, Dan Barton (all 1739), and James Rife (ret.).

Working on the TIVA effort with Ed were Palloon Tangnyonong, Dan Barton (all 1739), and David Benson (ret.).

TIVA applications to MEMS were developed by Ed and Jeremy Walraven (1739).

April 20, 2001
In contrast to what you may have been led to believe by our publishing his photo in the March 23 Lab News under "Recent Retirees," Robert "Bob" Fisher of Materials and Process Sciences Center 1800 is still very much here at Sandia, not retired at all. In fact, he tells us he's not planning on any immediate retirement or retirement date. We should have published his picture on the Milepost page rather than in the Recent Retirees section.

The problem all started when Bob came in for his 35-year Milepost photo a year after his 35th service anniversary. We got the photo marked 36 years and in the format of retiree photos, so assumed... But we're happy to now correct the record. — Editor

Cynthia Schneeberger, Manager of Supplier Relations Dept. 10205, has won two awards from the US Small Business Administration, and Corina Gallegos (10205) will receive an award from the National Association of Purchasing Management for their work with small businesses.

Cynthia will receive the national Small Business Administration (SBA) Frances Perkins Vanguard Award during ceremonies in May at the National SBA Small Business Week celebration in Washington, D.C. This award honors government and industry for excellence in the use of women-owned small businesses as prime contractors and subcontractors. The evaluated areas include leadership, advocacy, innovation, and implementation. Frances Perkins served as secretary of labor from 1933 to 1945 under President Franklin D. Roosevelt. The first woman to hold a cabinet-level position, Perkins was a social reformer who brought to her post a commitment to women's issues.

Cynthia was also selected as the 2001 New Mexico Minority Small Business Advocate of the Year by the SBA. She will receive the award May 1 at the New Mexico Small Business Week Celebration. Corina Gallegos, also of the Supplier Relations Department, has been selected to receive the National Association of Purchasing Management's 2001 Charles J. McDonald Minority Business Advocate Award. Corina was selected as the sole recipient of the award for her outstanding contributions to small, minority, and women-owned business. The award will be presented formally at NAPM's 86th Annual International Purchasing Conference in Orlando, Fla., April 30.

Founded in 1915, the National Association of Purchasing Management, Inc. (NAPM) is a communication link with more than 47,000 purchasing and supply management professionals. NAPM provides national and international leadership in purchasing and materials management, particularly in the areas of education, research, and standards of excellence. It is a not-for-profit association.

Perry Robertson (1751) and Edward Witzke (9336): General Purpose Programmable Accelerator Board.

Marcelino Essien, Henry Peebles, Philip Sackinger (9141), and M. Erick Schlienger (1843): Apparatus for Jet Application of Molten Metal Droplets for Manufacture of Metal Parts.

Sandia is hosting an open house in honor of retiree Lola Stude (7112) in the Thunderbird Café on Wednesday, May 2, 10-11 a.m. Friends and acquaintances are invited.
Engineer-artisan Kevin Fleming to exhibit wood art at prestigious Smithsonian Craft Show next week

By John German

Kevin Fleming, the optical engineer, seeks perfection. But imperfections are what give "Kevin Fleming's wood turner" a thrill when he's roughing out a wooden vessel in the studio behind his kitchen or selecting that extraordinary chunk of stumpy in a New Mexico forest.

"Imperfections make wood look just like people," he says. "Who wants to hang out with a perfect person?"

A few years ago Kevin (2554) got special permission to remove a felled juniper in the Cibola National Forest. The 200-year-old tree was twice struck by lightning — once in the 1930s and again more recently — according to its grain pattern.

"I won't cut down a healthy tree for woodturning," says Kevin. "Instead I use wood from dead trees or trees being removed for landscaping. To me there's a certain satisfaction in capturing the beauty in a piece of wood destined for the landfill or fireplace."

The lightning-scarred tree is now a vase on Kevin's living-room bookcase.

Next week Kevin exhibits 30 of his wood vessels at the Smithsonian Craft Show, the nation's most prestigious artisan show, in Washington, D.C., April 25-29. He joins 119 other creators in 12 categories, including nine top-notch wood artists, selected by an expert jury from thousands of applicants.

I applied for the show with the same sense of hope and pessimism that you might buy a lottery ticket with," he says. "Thousands of good artisan try year after year and never get in. I thought maybe with a computer malfunction or something I might get lucky."

To Kevin's surprise, the jury liked his work.

"The woodworks evidence a growth of ideas beyond the mere technical handling of materials," wrote one of the show's jurors about Kevin. "There is an exceptional understanding of the principles of composition, color, design, line, texture, pattern, and form... an understanding of materials and their inherent possibilities and limitations... as well as a sense of feeling and caring for how it has for the creations."

Influenced by New Mexico

Kevin's pieces take months to complete.

The process starts when he finds an interesting piece of wood. He immediately seals the cut ends with wax and encloses the wood in a plastic bag to prevent splitting from sudden dry-out in the arid New Mexico climate.

He hollows the vessel and roughs out the shape on a lathe, then lets the piece dry slowly, sometimes for months, which results in subtle shape changes. When most of the moisture is out of the wood, he turns the vessel into its finished shape and seals it with a durable finish. He accents and enhances the wood with inlays of varying wood species, stain colors, and contrasting woods with interesting grain patterns.

He's also created unique cooperative pieces with renowned New Mexico gourd artist Robert Rivera, a friend.

"I try to base my work on shapes and forms found in nature and mathematics, blended with an intuitive feel for what, I hope, looks and feels pleasing," he says. "Being born and raised in New Mexico has exposed me to Indian vessel designs and shapes that have had a definite impact on my work."

Kevin Fleming with one of his finished pieces, a vase made of alligator juniper.

Sympathy

To Ken Condreva (8416) on the death of his mother, Dolores Condreva, in Dolton, Ill., on Jan. 7, and on the death of his father, William Condreva, also in Dolton, Ill., on Feb. 6.

To Daniel A. Lucero (9117) on the death of his mother, Dolores Condreva, in Dolton, Ill., on Feb. 6.

To Kevin (2554) on the death of his father, Abel Lucero, in Albuquerque, on Feb. 13.

To Mary Condreva (72) on the death of her mother, Audrey Scheniber, in Albuquerque, on April 7.

Reader Service information

Retirees (only)
To notify the Labs of changes in address, call or write Diana Marie, Benefits Dept., 3341, at 505-845-9705, Mail Stop 1021, SNL, Albuquerque, NM 87185-1021.

Others:
To receive the Lab News or to change the address (except retirees), contact Iris Abydes, Media Relations and Communications Dept. 12640, at telephone 505-844-2282, e-mail iso@sandia.gov, or Mail Stop 0165, SNL, Albuquerque, NM 87185-0165.

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