Los Alamos National Laboratory

THE ACTINIDE RESEARCH

Nuclear Materials Research and Technology

QUARTERLY

a U.S. Department of Energy Laboratory

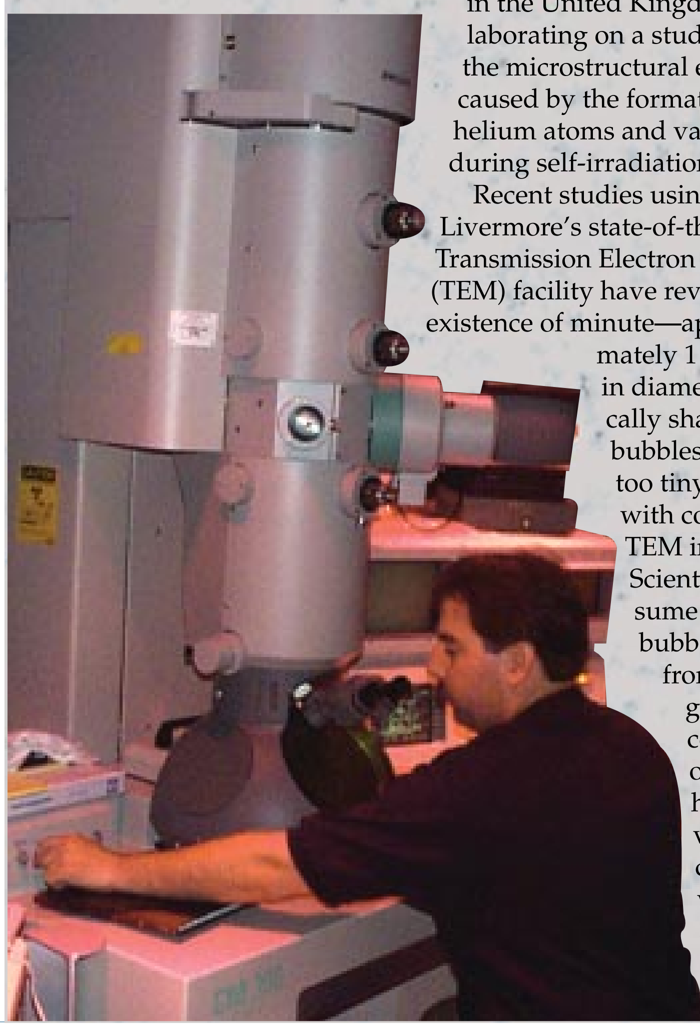
Researchers Use Transmission Electron Microscopy to Observe Helium Bubbles in Plutonium

Los Alamos, Livermore, and Aldermaston Collaborate on Plutonium-Aging Study

The ability to directly image self-irradiation damage accumulation in plutonium is critical to understanding aging. Scientists know that helium is building up in plutonium metal during self-irradiation. What they don't know is what is happening to that helium over time, and how it ultimately affects the behavior of plutonium over long periods.

Researchers from Los Alamos and Lawrence Livermore national laboratories and the Atomic Weapons Establishment at Aldermaston in the United Kingdom are collaborating on a study to observe the microstructural effects caused by the formation of helium atoms and vacancies during self-irradiation.

Recent studies using Livermore's state-of-the-art Transmission Electron Microscopy (TEM) facility have revealed the existence of minute—approximately 1 nanometer in diameter—spherically shaped bubbles, which are too tiny to be seen with conventional TEM instruments. Scientists presume the tiny bubbles formed from the migration and coalescence of many helium-filled vacancy clusters, which occur as plutonium ages.



Mark Wall of Lawrence Livermore National Laboratory uses Livermore's powerful transmission electron microscope to image a sample. Los Alamos researchers are collaborating with Livermore and the Atomic Weapons Establishment at Aldermaston, United Kingdom, to study the microstructural effects of the buildup of helium in aging plutonium. Recent research has revealed the existence of minute bubbles too tiny to be seen with conventional TEM instruments.

Photo courtesy of Lawrence Livermore National Laboratory

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In This Issue

Helium Bubbles

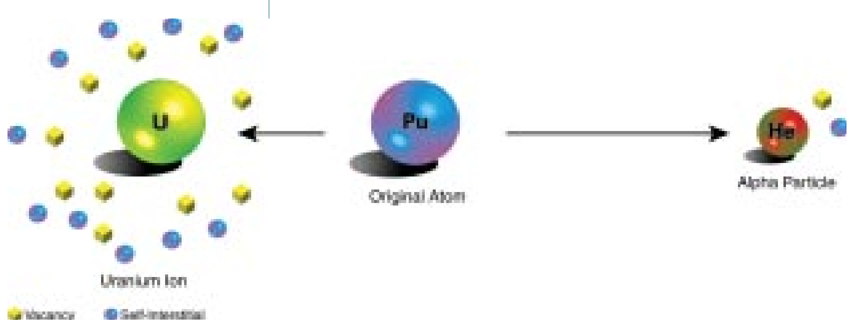
Contributors to this article are: **Thomas Zocco** (NMT-6); **Mark Wall, Adam Schwartz** and **Bill Wolfer** (Lawrence Livermore National Laboratory); and **Paul Roussel** (Atomic Weapons Establishment, Aldermaston, United Kingdom).
Also contributing to this project are: **Mary Esther Lucero** and **Michael Ramos** (NMT-16).

Figures: L. Kim Nguyen Gunderson (IM-1)

The existence of bubbles in plutonium has been seen before in heated samples. The fact that researchers saw bubbles in materials under approximately room-temperature storage conditions is somewhat surprising, according to Los Alamos researcher Tom Zocco of Manufacturing Systems (NMT-6).

"It implies that helium and helium vacancy clusters are mobile at room temperature and can cluster, forming the bubbles," said Zocco. "The formation of bubbles can have a variety of effects on the mechanical and physical properties of plutonium metals and alloys, which can possibly affect the long-term aging of our stockpile."

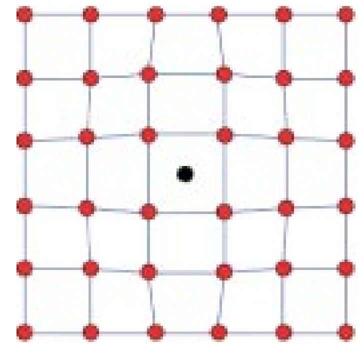
Zocco was one of the first researchers to successfully use TEM for the microstructural analysis of plutonium metal and alloys. As part of this collaboration, he has developed a sample matrix and supplied prepared and aged plutonium materials for examination.



This schematic illustrates the radioactive decay process of a plutonium-239 atom. The alpha particle releases and the uranium-235 atom recoils.

Livermore is finishing the sample preparation, performing the TEM operations, and providing image simulations. Researchers from Aldermaston also are providing material and expertise.

Radioactive materials are made up of atoms that are inherently unstable and decay over varying periods of time to form more stable atomic elements. For example, the unstable plutonium-239 isotope decays by the process of alpha emission. When the alpha particle is emitted, the loss of protons and neutrons from the plutonium-239 atom transmutes it to a uranium-235 ion. This uranium ion rapidly recoils during the alpha release, as in Newton's third law: For every action there is an equal and opposite reaction. This movement may cause significant damage to the surrounding atomic arrangement.



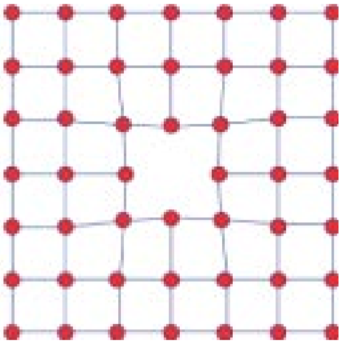
This two-dimensional representation shows the crystalline lattice and two types of damage caused by the radioactive decay process. Each red dot represents an atom. In the figure on the left, an interstitial atom (the black dot) is displaced and squeezed between other atoms. In the figure on the right, a vacancy is created by the alpha release and uranium-235 recoil.

Imagine a three-dimensional, periodic atomic arrangement—a lattice—of plutonium atoms in a crystalline structure. When any atom radioactively decays, the resulting uranium atom and helium nucleus fly apart, hitting other atoms as they travel through the lattice. Both the uranium and helium atoms generate substantial damage within the atomic arrangement of the crystalline structure, which results in defects or discontinuities in this normally periodic arrangement. The defects are primarily of two forms: vacancies or missing atoms in the lattice, or interstitial atoms, which are atoms squeezed between other regularly spaced atoms.

The amount of damage produced is directly related to the mass and energy of each moving particle. The uranium atom is large and does not travel far and deposits its kinetic energy over a short distance. This causes significant damage to the lattice and creates thousands of displaced plutonium atoms.

The alpha particle (or helium ion), on the other hand, is very energetic and travels farther through the lattice. But because the alpha particle is relatively small, it creates a lower number of lattice defects and less overall damage.

Because of the high local stresses created from squeezing the atoms into abnormal positions, most of them quickly return to the vacancies created when they were



displaced from their original positions in the lattice. This "self-healing" process returns most of the atoms to their original, uniformly spaced positions.

However, the defects that do not self-heal ultimately result in the buildup of excess damage in the material. It is this lattice damage and its long-term accumulation that is of interest to researchers investigating the aging or self-irradiation damage phenomena in radioactive materials. (For more details on the aging effects in plutonium, see The Actinide Research Quarterly, 4th Quarter 1999.)

After the alpha particle comes to rest in the lattice, it rapidly attracts free electrons from its surroundings to become a helium atom. This process occurs at a pace that creates approximately 29 helium atoms per year for every 1 million atoms of plutonium. This may not seem like a significant amount, but over a period of years the accumulation of helium becomes substantial and potentially can bring about significant changes in macroscopic physical properties.

The remaining defects (vacancies and interstitials) that survive the self-healing process coexist with the helium atoms, forming complex interactive relationships. Helium atoms may readily combine with nearby vacancies to form helium-filled vacancies, which diffuse randomly until they meet and bind with other similar species, creating a bubble nucleus. The bubble nucleus grows as it captures additional helium-filled vacancies moving through the lattice.

Larger voids or bubbles, and/or those having associated strain fields, are readily observable in conventional TEM. However, the imaging and observation of very small voids (less than 2 nanometers in diameter) or small bubbles that are in equilibrium (no strain) with the surrounding lattice are difficult and require the use of a TEM with a highly coherent source of electrons and relatively high resolving ability.

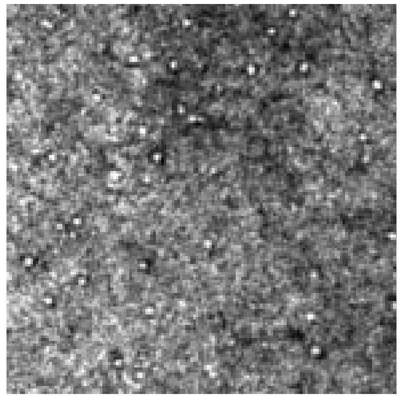
The technique for imaging these small voids is called the defocus or "Fresnel fringe" imaging technique. Depending on the amount and direction of defocus, the small voids or bubbles will visually appear as small white or black spots with surrounding black or white fringes, respectively. The diameter of these circular fringes will vary with defocus, and is not easily related to the true diameter of the voids or bubbles.

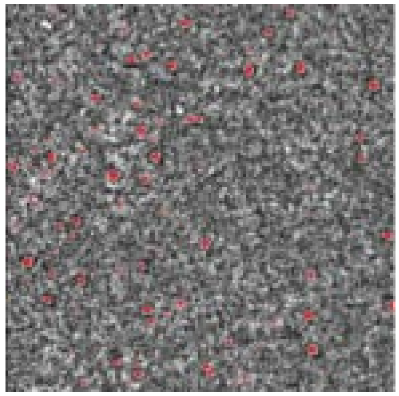
For example, when measuring small (less than 1 nanometer) voids or bubbles, the diameter of the central bright or dark spots may be in error as much as 50 percent from the true diameter. Therefore, it is necessary to perform image simulations to correctly interpret the actual size.

After the under- or over-focused images are collected, they can be processed and analyzed. Through careful control of the processing parameters, image-processing software quickly identifies and measures the bubbles in a variety of ways, such as bubble density, mean diameter, area, aspect ratio, and roundness. By measuring or estimating the thickness of the TEM specimen and counting the number of bubbles in each image, researchers can calculate the true bubble density.

Through the use of complex image simulation techniques, Livermore researchers are determining how Fresnel contrast images of bubbles appear and change as a function of defocus and bubble position in the TEM sample. This may require correction factors for bubble size, to account for distortions produced from the many imaging effects.

The researchers also are modeling helium bubble nucleation and growth. By coupling experiments and modeling, they hope to develop a good correlation between bubble formation and age. ■





At the top is a raw (as-captured) digital Transmission Electron Microscopy (TEM) image. The image on the bottom has been processed and shows identified and measured bubbles. The existence of bubbles in plutonium has been seen before in heated samples. The fact that bubbles were seen in materials under approximately room-temperature storage conditions is somewhat surprising, according to researchers.

SHOCK-WAVE RESEARCH

Shock-Wave Research on Plutonium Yields New Information Concerning Dynamic Material Properties

Los Alamos Researchers Obtain the First Dynamic Data on a Particular Plutonium Alloy

Contributors to this article are: **Robert Hixson** and **John Vorthman** (DX-1), and **Benjamin Lopez** (NMT-16).

In a nuclear weapon, many materials are subjected to impulsive loading—high-intensity, short-duration forces—caused by detonating high explosives. To understand how materials respond to such conditions, scientists must study the dynamic properties of plutonium metal and other materials over a wide variety of pressures and time scales.

Scientists can duplicate these extreme conditions of elevated temperature and pressure by creating shock waves and allowing them to propagate through materials. The size, speed, and shape of the shock wave is determined by the dynamic material behavior of the sample being studied, so careful measurements of the shock wave can be used to determine material properties.

Researchers are using the gas gun contained in this glove box in PF-4 to duplicate the extreme conditions of elevated temperature and pressure created by the high explosives in a nuclear weapon. Research on a delta phase plutonium alloy has resulted in the first dynamic data for the alloy. The gun can launch projectiles at speeds ranging from about 200 miles per hour to more than 4,000 miles per hour.

Photo by Paul Moniz

Nuclear Materials Science (NMT-16) operates a Kolsky-bar apparatus to gather dynamic data on plutonium at low pressures and a relatively long time scale, and a gas gun to gather dynamic data at much higher pressures and shorter time scales. One of the simplest, most-controlled, and most-accurate tools used to create shock waves is a smoothbore gun. Researchers in Detonation Science and Technology (DX-1) and NMT-16 are conducting experiments on such a gun—the 40mm Launcher, so named because of its bore size.

The work so far has focused on a particular delta phase plutonium alloy. Researchers have obtained a considerable amount of shock Hugoniot data that will allow the moderate- to low-pressure equation-of-state to be defined. In addition, new data on the phase diagram for delta plutonium have been obtained, including the location of solid-solid phase changes and dynamic melting. Information concerning the rate, or kinetics, of these transitions also has been obtained.

Probably the largest amount of research has focused on the dynamic strength of delta plutonium in tension: spall. Careful research has been done on the effect of impurities and peak stress on tensile strength. The research has resulted in the first dynamic data ever obtained on this plutonium alloy. The data are of very high quality, according to the researchers, and currently is being used by theorists to develop new physics models for the dynamic response of this alloy.

The Launcher, housed in Building PF-4 at TA-55, can be used with either a gas breech or a propellant breech to provide the projectile acceleration. It can launch projectiles at speeds ranging from about 0.1 kilometer per second to almost 2 kilometers per second, or from 200 miles per hour to more than 4,000 miles per hour.

The gun works by firing a projectile at a small plutonium sample, or target. When the projectile impacts the sample, shock waves are generated in both the projectile and the sample. In the target, material ahead of the shock wave is stationary until the shock wave passes; after the shock wave passes, the material is moving. A shock wave also moves back into the projectile, slowing down the projectile's initial velocity. High pressures are generated in the region between these two shock waves.

Higher projectile velocities lead to higher pressures and faster shock velocities. Shock waves may be viewed as wave disturbances that abruptly change the pressure, temperature, density, and internal energy of a substance from an initial value to a final state.

The final state generated is at a higher pressure, temperature, internal energy, and density than the initial unshocked material. In other words, a shock wave compresses a material.

Because NMT-16's gas gun is used to study plutonium, it is contained in a glove box. This greatly increases operational difficulties compared with guns used outside of TA-55, and special techniques had to be developed to perform well-controlled experiments.

The Launcher's projectile is a cylinder of plastic or metal. High-pressure gas in the breech is used to push the projectile down the barrel. The material inserted into the nose of the projectile, called the impactor, varies depending on the data researchers are trying to collect. Some materials are stiffer than others, and so produce higher pressures in the target for a given projectile velocity.

Two electrical pins, one placed on each side of the target, record the exact time of impact. Another diagnostic tool, a velocity interferometer, or VISAR, measures the velocity history of the back of the target. This surface moves when a shock wave emerges from the sample. The velocity interferometer senses the motion and sends back information about wave(s) generated by impact.

Other pin arrival times are used to measure the angle at which the impactor hits the target plate; also known as impact tilt. This is important for researchers to know because large amounts of tilt can cause data quality to suffer. In addition, by combining impact time with the time-resolved velocity information, researchers can determine the velocity of the wave(s) moving through the target material.

VISAR data also may be used to obtain the size and shape of the wave(s) moving through the target, as well as the speed of the material just behind the shock wave—called the particle velocity. In general, faster projectiles generate higher pressures, higher shock velocities, and higher particle velocities.

A graph of shock velocity vs. particle velocity defines a curve called the shock "Hugoniot" of a material. The Hugoniot describes the locus of end states that may be achieved in a material through shock-wave compression and is different for different materials. The most basic understanding of how a material responds to shock compression is contained in the shock Hugoniot.

Data obtained from these kinds of experiments provide a wealth of additional information. Materials with limited strength typically have two distinct waves created in an experiment. The first wave propagates at the longitudinal wave speed and takes the material to the point where it plastically yields. A second wave, which moves more slowly than the first and in which plastic deformation occurs, follows the first wave. The velocity interferometer will clearly show this kind of wave structure.

Shock-wave experiments can produce information on how a material changes phase under increased pressure and temperature. This process must be well understood for scientists to develop physics models that correctly

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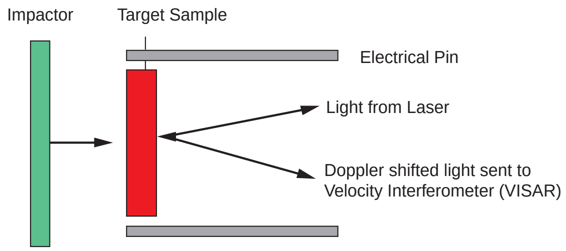
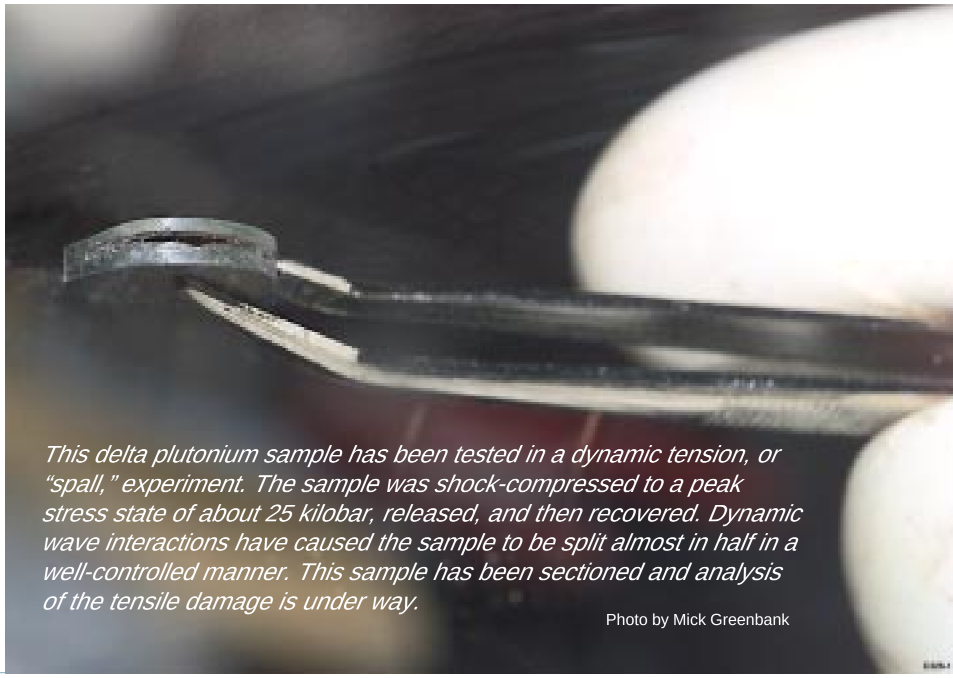


This simple diagram of a target assembly shows the electrical pins, one on each side of the target, from which researchers obtain the time at which impact occurred. The velocity interferometer (VISAR) detects the velocity history of the back of the target. This surface moves when a shock wave emerges from the sample, and the velocity interferometer senses this motion and sends back information about wave(s) generated by the impact.



This delta plutonium sample has been tested in a dynamic tension, or "spall," experiment. The sample was shock-compressed to a peak stress state of about 25 kilobar, released, and then recovered. Dynamic wave interactions have caused the sample to be split almost in half in a well-controlled manner. This sample has been sectioned and analysis of the tensile damage is under way.

Photo by Mick Greenbank

Editorial

A Personal Perspective on Issues in Science and Technology in NMT Division

This article was contributed by **Kyu C. Kim**, chief scientist of NMT Division.

The opinions in this editorial are the author's. They do not necessarily represent the opinions of Los Alamos National Laboratory, the University of California, the Department of Energy, or the U.S. government.

Since it was first organized in 1989, the scope and mission of the Nuclear Materials Technology (NMT) Division have expanded significantly. The division has grown in size—the regular employee population of about 700 represents close to 10 percent of the Laboratory population—and its annual budget represents a significantly greater part of the Lab's budget. NMT Division also operates two of the Laboratory's major facilities: the Chemistry and Metallurgy Research (CMR) Building and the TA-55 Plutonium Facility.

You'd think that a division like NMT, whose "job" is to conduct scientific and technical research and experimentation, would be expert in promoting science and technology. But are we doing the best we can in these areas? Or are there significant obstacles to our doing good science? Perhaps the most useful suggestions I can make are those that can help diagnose the nature of the problems, if any, that may lie in the way of promoting science and technology.

Just like medical students following a training program in which they may use a decision-making tree to correctly diagnose a patient's illness based on the symptoms, patients' descriptions, and laboratory test results, my goal is to take a closer look at some of the issues raised by many in relation to NMT's science and technology. My analysis will be based mainly on symptoms and descriptions rather than on hard data and test results. From this analysis, we may be able to come up with ways to enhance the division's science and technology.

For those of you who may want a more complete picture of NMT's science and technology, read NMT Division's Organizational Self-Assessment, which is published annually in preparation for the annual Science and Technology Assessment (also known as the Division Review). You can get a copy from the division office.

Many common beliefs develop over time in an organization like ours. When enough people share these beliefs long enough, they become part of the organizational culture. Some beliefs contribute to the organization's strength, while others do not. Interestingly enough, one can frequently find almost as many proponents as opponents for these beliefs. The first step in addressing the science and technology issue is to understand the nature of these beliefs and to dispel aspects of the undesirable beliefs.

Belief No. 1: ***"Because we are working on project deliverables, we do not have the time to do science and technology."***

I think this belief is shared largely among the people who are engaged in programmatic tasks such as manufacturing weapon components and plutonium heat sources for space missions and processing nuclear materials. The term "science and technology" should not be so alien a concept because these people are actually the practitioners of science and technology in their particular fields of expertise. And yet it's a contrarian view of what they do every day.

Belief No. 2: ***"Facility and infrastructure operation are in competition or in conflict with science and technology activities."***

This is a unique problem, or a blessing, depending on your view of the organization. NMT runs two major nuclear facilities and also is the major user of the facilities. No separate funds exist for the facility operation and the programmatic work; therefore the word "competition" creeps in here. In a nuclear facility like ours, facility operation and programmatic work go hand in hand. The debate is similar to "Which came first: the chicken or the egg?" We must recognize that both operational elements are indivisible parts of the same organization.

Belief No. 3: ***"NMT Division's mission is geared toward production, so it has no future in science and technology."***

This statement resonates with the first one, and it couldn't be further from the truth. The existence of our nuclear facilities as national assets and the continuing maintenance of the knowledge base founded on sound science and technology serve as the cornerstone for the national security. NMT members possess unique skills that must be maintained and nurtured.

While the weapons component production programs may end some day, maintaining the knowledge and capability to produce the components will always be a mission of this Laboratory and this division. Manufacturing plutonium pits is clearly an important component of NMT's long-term goal and mission, but the scope of our work in general is significantly broader than the manufacturing program.

As painfully demonstrated in recent disastrous events worldwide, Los Alamos National Laboratory and NMT Division must be at the forefront of science and technology to meet the present and future challenges in everything nuclear — including nuclear weapons.

Belief No. 4: ***"We are making sufficient progress and our mission is so compelling that the business-as-usual approach will ensure our survival and future prosperity."***

Programmatic dollars have been easier to obtain than scarce research dollars, but complacency is the antithesis to scientific prosperity. We should never forget that the nation relies on Los Alamos because of the scientific foundation laid by the scientists and technologists who worked here in the past.

We are the direct beneficiaries of the previous generation's great scientific minds, and our generation should in turn pass on something to future generations. Science and technology never stand still. One either advances or risks being surprised by new discoveries by friends and adversaries alike.

Belief No. 5: ***"Division leaders and managers know best and understand all the issues; therefore, they are likely to make the best decisions for the division's employees, the division, and the Laboratory."***

Science and technology is not a spectator sport; we all should be engaged in it, but we should make sure that people are spending their time doing what they do best. The division's main task is to conduct its science and technology work. Managers are here to ensure that we have skilled people to conduct the tasks, resources are properly allocated, work gets done on schedule and budget, we meet all regulatory requirements, we interact with our sponsors and customers, etc. The scientists and technologists should not have to spend their time doing these things; they are here to do the actual science. We need to clearly separate the responsibilities of the scientific staff and the management staff, yet create an atmosphere where the two halves can communicate and work in tandem to achieve the whole.

While it's easy to list the problems, it's harder to come up with solutions. The question remains: ***How do we enhance the division's science and technology?***

I think the answer is threefold: a skilled workforce, enhanced productivity, and strong leadership.

A scientific organization is only as good as its people. Without knowledgeable and skilled people, there can be no productivity or excellence. Division leadership and management can, and should, employ effective recruiting and hiring plans to ensure that there are people in all work areas with the proper skills and talents.

NMT's core technical capabilities include plutonium metallurgy, actinide process chemistry, actinide ceramics, manufacturing nuclear parts, and nuclear facility operation. Our efforts should be directed toward enhancing these core capabilities for present as well as future missions. Not all of our projects or tasks have the same priority. The leadership and management must set the priority and allocate the resources accordingly.

The recent realignment of the Laboratory program offices into line organizations should help all technical divisions run more effectively. Under the realignment, our division office will have greater responsibility in making sure that the right amount of resources is

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allocated to various tasks and that our goals and deliverables are met. Also, our division office will have to see that NMT maintains and fosters the right mix of capabilities for our present and future missions.

Next to the work itself, the most important part of our business is documenting the work. NMT Division's productivity as measured in terms of published reports and scientific articles lags behind other technical divisions.

One of the problems we have identified is that our people are not documenting what they do in their technical work. By documenting, I mean recording the experimental steps, the processes followed, the observations made, the data obtained, etc. From this documentation, researchers can write reports, publish technical papers, or present the findings at scientific meetings.

Experimental results should be recorded so that other researchers can repoduce the same results. Without documenting the scientific work or theory in laboratory notebooks, anything a researcher might write could be considered fiction. You have no proof.

Documentation can be done in a variety of ways. Reports are the most common in technical work. Just as any engineered product comes with a manual, all of our work and products should be accompanied by reports. When the products, inventions, or results of a researcher's investigation are deemed sufficiently original, innovative, and new, the results should be published in scientific journals for public dissemination. Some may even be patented.

In NMT, we have voluminous documentation of how we do certain tasks, but not everyone keep records of what they actually do, and not enough documents are produced to keep track of what's been accomplished. In recording one's own work, it is important to record both successes and failures, because failure, as well as success, adds to the scientific knowledge base.

In addition to NMT's continued scientific productivity and meeting its programmatic goals, the division has had a number of scientific and technological initiatives with Laboratory-wide implications and visibility. These include the establishment of the Glenn T. Seaborg Institute for Transactinium Science; hosting two international Plutonium Futures–The Science conferences; publication for the past seven years of The Actinide Research Quarterly; and the annual Science and Technology Assessment. All of these endeavors have been highly successful, and NMT Division members collectively should be proud of these accomplishments.

Some of our scientists and technologists are engaged in nonscientific work for some portion of their time. None of us spends all of our time doing science and technology; we all have a variety of other responsibilities and tasks. And some of us may not feel so compelled to do original scientific work outside our programmatic tasks. Whether one does scientific work or programmatic work, the burden is on us to convince our sponsors of the importance and relevance of our work to the sponsors', and in our case, national need. It would be foolhardy to expect that all of our scientific ideas will be considered worth pursuing.

In summary, we have been doing many things very well and some others not too well. It is time to review all of our activities in light of our present objective of enhancing NMT Division's science and technology. While we are asking our members to excel in their work and make changes as necessary, the leadership and management also should lead and show a willingness to change their mode of operation when necessary. We need to become expert at "self-critiquing" to keep up with the changing times.

The work of science and technology is based on creativity and imagination, and the people in NMT Division excel at both. In light of our present objective of enhancing the division's science and technology, let's take the time to review all of our activities.

Together, we can build upon the legacy of a scientific institution that the nation has come to rely on and respect. ■

Publications and Invited Talks

Attention, authors: Have you published a paper, book, or book chapter, or given an *invited* talk? Please send the particulars to suki@lanl.gov and we'll publish your citation in a future issue of ARQ.

Publications:

M. E. Barr, L. D. Schulte, G. D. Jarvinen, J. Espinoza, T. E. Ricketts, Y. Valdez, K. D. Abney, and R. A. Bartsch, "Americium Separations from Nitric Acid Process Effluent Streams," *J. Radioanal. Nucl. Chem.* **248** (2), 457–465 (2001).

E. Glagovski , B. Zakharkin, Y. Kolotilov, Y. Glagolenko, A. Skobtsov, S. Zygmunt , C. Mason, W. Hahn, R. Durrer, S. Thomas, B. Sicard, P. Brossard, N. Herlet, G. Fraize, and A. Villa, "Conversion of Russian Weapon-Grade Plutonium into Oxide for Mixed Oxide (MOX) Fuel Fabrication," Los Alamos National Laboratory document LA-UR-01-2668 (submitted to *Global 2001*, Paris, September 9–13, 2001).

S. Hecker and C. Mason, Eds., "Nuclear Physical Methods in Radioecological Investigations of Nuclear Test Sites," in "Proceedings of the NATO Advanced Research Workshop," Los Alamos National Laboratory document LA-UR-00-1774 (August 2000).

N. Lu and C. F. V. Mason, "Sorption-Desorption Behavior of Strontium-85 onto Montmorillonite and Silica Colloids," *Appl. Geochem.* **16** (14), 1653–1662 (2001).

T. P. Martinez and M. E. Cournoyer, "Lead Substitution and Elimination Study, Part II," in *Journal of the American Society of Mechanical Engineers* (Waste Management 2001, Tucson, Arizona).

T. P. Martinez and M. E. Cournoyer, "Lead Substitution and Elimination Study," *J. Radioanal. Nucl. Chem.* **249**, (2), 397-402 (2001).

E. W. Moody, M. E. Barr, and G. D. Jarvinen, "QSAR of Distribution Coefficients for Pu $(NO_3)_6^{2-}$ Complexes Using Molecular Mechanics," *J. Radioanal. Nucl. Chem.* **248** (2), 431–437 (2001).

R. I. Sheldon, "An Estimate of the High Temperature, Metal Rich Phase Boundary of Plutonium Sesquioxide," *J. Nucl. Mater.* **297**, 358–360 (2001).

T. N. Taylor, G. K. Lewis, D. M. Wayne, J. C. Fonseca, and P. G. Dickerson, "The Role of Impurities in Bubble Formation During Directed Light Processing of Tantalum," *Appl. Surf. Sci.* **180**, 14–16 (2001).

D. M. Wayne, W. Hang, D. K. McDaniel, R. E. Fields, E. Rios, and V. Majidi, "A Linear Time-of-Flight Mass Analyzer for Thermal Ionization Cavity Mass Spectrometry," *Spectrochim. Acta, Part B*, **56** (7), 1175–1194 (2001).

S. Zygmunt, C. Mason, and W. Hahn, "The U.S. Plutonium Materials Conversion Program in Russia," in "Proceedings of Atalante 2000" (Avignon, France, October 24–26, 2000), Los Alamos National Laboratory document LA-UR-00-3442.

Invited Talks:

M. E. Cournoyer, "Software Tools for Hazardous Material Management Excellence," Chemistry Department Seminar Series, University of Texas at El Paso, El Paso, Texas, April 23, 2001.

M. E. Cournoyer, "Software Tools for Hazardous Material Management Excellence," Environmental, Health, and Safety Division Seminar, Brookhaven National Laboratory, Brookhaven, New York, June 22, 2001.

Newsmakers

Patent Issued for Hafnium-Recovery Method

Wayne Taylor of Actinide Chemistry Research and Development (NMT-11) and David Jarminska of Isotope and Nuclear Chemistry (C-INC) have received a patent for their process to recover hafnium from irradiated tantalum. The radioisotope hafnium is formed in accelerators by irradiating tantalum targets with protons.

Taylor and Jarminska's method involves precipitation and ion-exchange methods to recover high-purity hafnium isotopes in a more environmentally friendly manner. Traditionally, recovering hafnium isotopes from irradiated tantalum involved separation techniques using organic solvents that now are considered hazardous. The solvent extraction techniques generated a mixed-waste stream containing radioactive and hazardous components that cannot easily be treated for disposal.

The recovered hafnium isotopes have several industrial applications, including use in medical diagnosis and treatment, and for nuclear physics studies. ■

NMT-15's Zygmunt Cited for Work on U.S./Russian Project

Stan Zygmunt has received a certificate of merit for his work on the U.S./Russian Federation Plutonium Conversion project.

Photo by Mick Greenbank

Stan Zygmunt has been awarded a Nuclear Materials Technology (NMT) Division certificate of merit for his work on the U.S./Russian Federation Plutonium Conversion project.

Los Alamos is the lead national laboratory for Russian collaborations on technologies to convert plutonium metal extracted from disassembled nuclear weapons into an oxide form suitable for use as mixed-oxide fuel (MOX). Zygmunt is the Los Alamos project leader for the program.

Zygmunt's award was based in part on a commendation from John Baker and Sam Thomas of the Office of Fissile Materials Disposition, National Nuclear Security Administration (NNSA). In a memo to Pit Disassembly/Surveillance Technologies (NMT-15) Group Leader Tim Nelson, Thomas said Zygmunt was responsible for progress being made on the project because of his "crucial contributions and effective relationships with the Russian Federation experts.... Stan's technical expertise and his ability to manage and negotiate [have] served this program with excellent results."

Under an agreement signed with the Russian Federation in 2000, the United States and the Russian Federation each will convert 34 tons of weapons-grade plutonium into a form not easily transformed into weapons. As part of the project, NMT-15 is assisting the Russian Federation with the design, licensing, construction, and commissioning of facilities in Russia for plutonium conversion. France entered into a similar agreement with the Russian Federation in 1992, and it is hoped that the two programs one day will be merged into one. ■

Kniss Receives DOE Award

Laboratory engineer Brett Kniss has received the Department of Energy's (DOE) Distinguished Associates Award, the highest award given by the DOE to a nonfederal employee.

Kniss served as project leader and also chief engineer for the Lab Pit Production Project in Weapons Component Technology (NMT-5). He received the award for his many years of work establishing Los Alamos' capability to produce small numbers of plutonium pits, the cores of nuclear weapons.

"Brett Kniss provided the knowledge, management, and energy to bring together the technical and practical requirements to help put Los Alamos on track to produce a plutonium pit that can be certified for the stockpile," said Gen. John Gordon, chief administrator of DOE's National Nuclear Security Administration (NNSA). "Re-establishing pit production is a major mission requirement for DOE, and Brett has been instrumental in helping NNSA make significant steps in achieving that goal." ■

Brett Kniss receives congratulations on his Distinguished Associates Award from Gen. John Gordon via a video teleconference.

Photo by LeRoy N. Sanchez

Shock-Wave Research on Plutonium...

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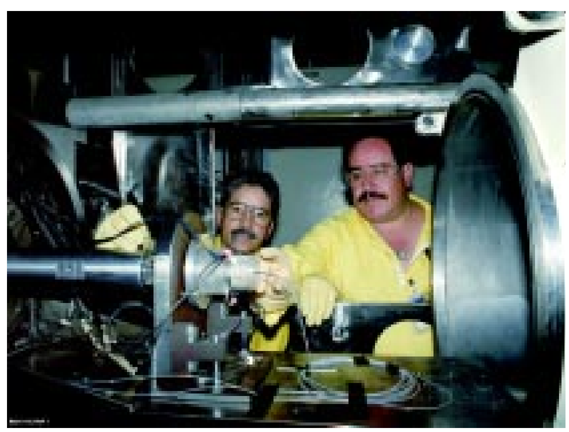
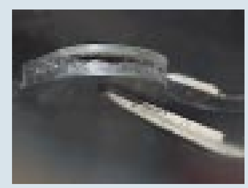
describe the dynamic response of phase changing materials. Shock-wave experiments also can be used to produce data about the dynamic strength of materials in tension. More complicated shock-wave techniques than those described above allow the tensile, or spall, strength of materials to be studied on very short time scales.

While the Launcher itself is owned and operated by NMT-16, the shock-wave experiments involve several divisions. Researchers in DX-1, with input from others in Applied Physics (X) Division, design the experiments. Members of Weapons Component Technology (NMT-5) prepare many of the samples. The data are collected and analyzed by DX-1 and sent to X and Theoretical (T) divisions for further analysis, physics model developments, and eventual inclusion in computer codes. The multidivisional research effort has resulted in a significant amount of new data on plutonium over the past few years. ■



Ben Jacquez of Structure/Property Relations (MST-8), left, and Johnny Montoya of Nuclear Materials Technology (NMT-16) make adjustments to the target of the 40mm Launcher during its shakedown period in November 1995, before the windows and gloves were installed in the glove box. Researchers performed several experiments on inert samples this way to test the system before going hot. Part of the gun barrel is shown on the left; the round aluminum plate with the plastic cylinders is the target.

Photo by Tom Baros



Circle of Life Blanket Presented to NMT Division and the Laboratory

Photo by LeRoy N. Sanchez

Stacey Talachy, Nuclear Materials Science (NMT-16), top left; NMT Division Leader **Tim George,** top right; **Vera Aguino,** Weapons Component Technology (NMT-6), lower left; and **Patrick Trujillo,** NMT chief of staff, display a blanket recently presented to the Laboratory by the American Indian Science and Engineering Society (AISES). The limited-edition "Circle of Life" commemorative Pendleton blanket was presented at the 23rd Annual AISES national conference. NMT Division and the Lab were among the sponsors of the conference, which was held in November in Albuquerque. The inscription with the blanket states: "In honor of all tribal elders, the wisdom keepers who are charged with handing down teachings and spiritual direction so the children better understand their responsibility to the universe and the Creator." ■

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