MST e NEWS

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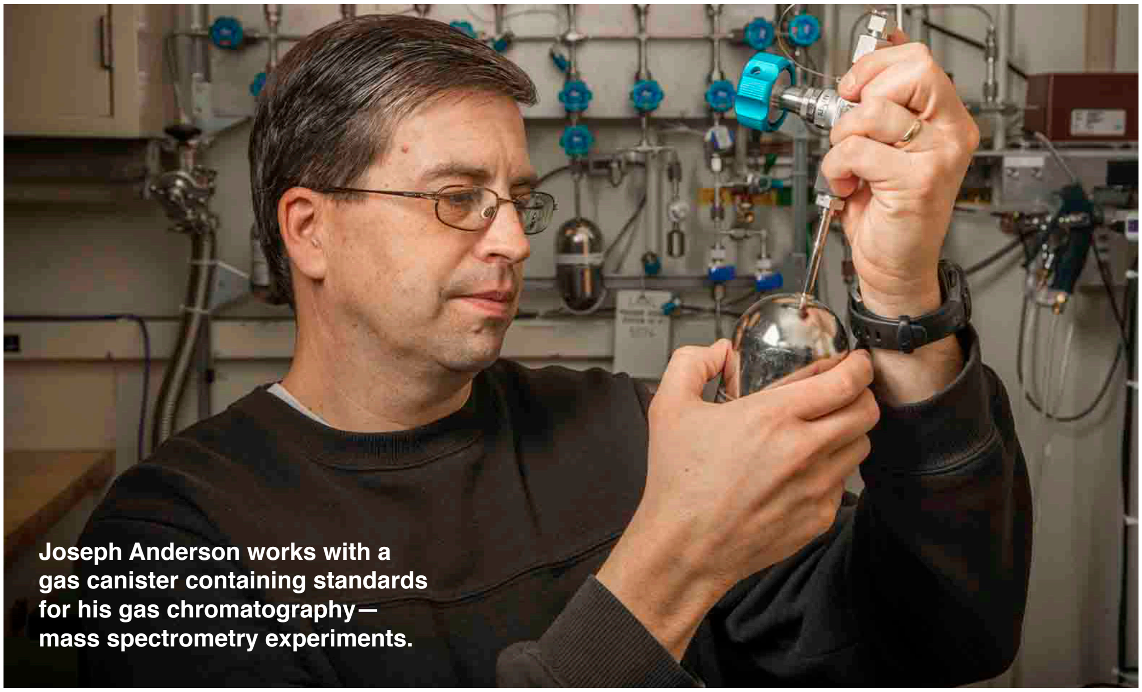
INSIDE



Joseph Anderson works with a gas canister containing standards for his gas chromatography—mass spectrometry experiments.

Joseph Anderson

Using precision science to maintain the stockpile

By Madeline Bolding, ALDPS Communications

"My family is the joy of my life," said Joseph Anderson (Nuclear Materials Science, MST-16). But the project where his chemical analysis changed the course of a major weapons maintenance decision? That was pretty cool, too.

> *"Having people whose abilities I know and trust not only helps with the workload, it allows me to specialize more than I could before. I've learned from their ideas and experience."*

The B61 Life Extension Program (LEP) had planned the weapon's next maintenance step based on conventional weapons knowledge. Wanting a science-based decision that incorporates this weapon's specifications, the program turned to Los Alamos, and knowing his meticulous process, Los Alamos turned to Anderson.

The heart of Anderson's work is understanding how gases interact with plutonium, especially at the metal's surface. He specializes in gas analysis and he studies monolayers on the plutonium surface using instruments available at the Laboratory's Plutonium Surface Science Lab.

To investigate whether the general weapons knowledge held true for this stage in the B61's life, Anderson needed new ways of sampling and testing. The ideas he developed

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Los Alamos NATIONAL LABORATORY EST. 1943

From Ellen's desk . . .

It's been six months that I have had the privilege of serving as the MST Division Leader. While I am enjoying a homecoming of sorts (I spent 16 years in MST-8 prior to joining M Division), I have been remiss in reaching out to the entire division to share some of my impressions and my thoughts about continued opportunities for us to robustly serve the Lab mission.

I have known for many years that the staff in MST are some of the hardest working and technically respected people at the Lab. In returning, that has been validated for me in a number of ways. Because of the technical expertise and partnerships that our staff have built with ALDWP, MST is well positioned to respond to challenges related to the 30 pits per year mission. MST has built an exciting programmatic portfolio in additive manufacturing, survivability, industry-led FOAs, and fossil energy—all while growing funding in long-standing programmatic areas, including the Office of Science, Nuclear Energy, and Office of Experimental Sciences. To respond to this, MST has grown to 200 staff members and is looking forward to significant capability investments in terms of equipment in the MSL, RLUOB, and TFF, in terms of characterization and mechanical testing equipment, and some modest infrastructure updates. Most recently I was briefed on statistics from the 2019 LANSCE run cycle. The materials science beam lines there supported the most proposals since becoming an NNSA user facility and did that on limited available beam time. I believe all of this success aligns the division directly with many aspects of the Lab Agenda, which I hope you check out, if you haven't already, at int.lanl.gov/strategic-planning/index.shtml.

"I have known for many years that the staff in MST are some of the hardest working and technically respected people at the Lab."

All of this success represents new challenges and, perhaps more optimistically, provides some new opportunities. MST has hired 100 staff members since I left in April 2017. This represents a huge amount of work: supporting search committees, hiring actions, mentoring new staff, and being mentored. While even contemplating the enormity of that is exhausting, your hard work is paying off. You have attracted many highly talented people to the division and as you did that, your eye on supporting an inclusive work environment at LANL has led to improved diversity within MST. This is something I am extremely proud to see. The program and commensurate staffing growth, however, has also highlighted some old and growing problems—like aging facilities with limited footprints. I strongly believe that this, too, is an opportunity for MST. In the upcoming months, Jon Bridgewater and I will be asking many of you to help your group offices as we strategically consider priorities and advocacy for small, moderate, and even large infrastructure investments that help relieve some of this pressure. And finally, your technical excellence is not only known to me, but is observed within other divisions at the Lab and, more broadly, in the academic and national laboratory communities. I believe that this means as a division we need to ensure that all staff have career development opportunities so as to enable robust careers and retain staff within MST.

So, I think the question that could come to mind as you read this note, is: "What do you plan to do about it?" My first steps have been getting reacquainted with MST—learning about the parts that I did not previously know that well and making sure that my confidence in the knowledge I have about those parts with which I was familiar is well placed. This has been fun and extremely busy for me, but many of you have been good mentors. Next, I plan to engage in some division-wide strategic planning. Many of you have been involved at the group level. I am hoping to roll up some of that to the division as well as hear from a broad range of stakeholders and internal leaders on future opportunity space and plans to enhance MST. As we do this, I ask that you support your group offices in requests for information and please offer your thoughts to our leadership team regarding where you think our focus needs to be for the next 5 and even 10 years to ensure the health and excellence of MST.

In closing, I am happy to be back in MST Division. I know I will have to work hard to keep pace with all of you, and I am looking forward to the challenge.

MST Division Leader Ellen Cerreta

Anderson cont.

were innovative and his colleagues credibly debated every aspect of his proposed methods. Anderson's plan passed muster and he started the years-long study. He patiently worked on the study, taking careful, difficult measurements, and in the end his results surprised everyone—the initially proposed plan could invalidate the LEP's purpose.

"Some lines of work, like weapons, need perfectionists like Joseph," said Anderson's colleague Joseph Hickey (Information Protection, SAFE-IP). "His patience and attention to detail helped the weapons program veer away from what could have been an errant choice."

His unanticipated result suggested a major overhaul of the program's plan. It triggered a large follow-up experiment that confirmed his findings: the original plan would need to be modified, but these modifications would ultimately add decades onto the weapon's life and save the program millions of dollars.

To celebrate Anderson took his family out for dinner and ice cream. "Other people may consider it to be boring dad stuff," Anderson said, "but spending time with my family is really my favorite thing to do."

Developing uncharted measurements has driven Anderson's career for years. During his training, he fell in love with instrumentation, and after receiving his master's degree in analytical chemistry from Brigham Young University, Anderson joined the Lab to work using his favorite analytical technique—mass spectrometry.

Anderson got to work customizing a new, typical mass spectrometer purchased by the Lab. He developed new methods to ensure his measurements were accurate. He adopted new industry standards and adapted them to the unique challenges that Los Alamos faces as stewards of the stockpile. Soon his standards became the standards of the weapons complex.

His analyses rely on methods like gas chromatography mass spectrometry, Fourier-transform infrared spectroscopy, and surface-science techniques. With these tools and more, his work at LANL has allowed him to discover new chemistries, and the collaborative nature of his colleagues has enabled serendipitous findings.

For years, Anderson's team has consisted of just him and his instruments. Now, as the Lab is expanding—increased pit manufacturing, weapons surveillance, and special projects—so is Anderson's work.

For the first time, he is leading a team to cover the increased need for analytical chemistry. Anderson said that the experience of transferring his knowledge has been beneficial for everyone involved. "Having people whose abilities I know and trust not only helps with the workload, it allows me to specialize more than I could before," he said. "I've learned from their ideas and experience."

After Anderson spent more than 10 years tailoring the mass spectrometer to suit the weapons complex's needs, it's now time to get a new one. Coming fresh from the vendor, this model will get its own set of additions and modifications that Anderson will develop to bring it up to his standards, and this time Anderson has a crew to help him. ■

Joseph Anderson's favorite experiment

What: B61 Life Extension Program: pit sub project realization team.

Why: The purpose is to assess shot-to-shot variability, which provides insight into machine performance and assists in density reconstructions.

When: 2014-present

Who: Joseph Anderson, Richard Salazar, Ernesto Gallegos, Scott Richmond, Dave Moore, Joe Reynolds (all MST-16); Iven Gonzales (formerly MST-16, now TA-55 Waste Facilities Operations, TA55-WF); and Steve Joyce (retired).

The "a-ha" moment: Realizing that the program should not execute the change to the weapon system. This occurred after a few years of waiting and watching the data unfurl one data point at a time into an unexpected result. By working with the system, an alternate forward path was formulated and a novel idea was implemented and tested to understand the future of the weapon system. The results of the tests were favorable and part reacceptance proceeded as expected.

Advances in aerial payload vessels: Spherical aerogel shells hold vacuum

Is it possible to create an air-buoyant solid—a material that floats without helium or hot air? Can it hold a vacuum? Engineered Materials (MST-7) scientists are researching both those questions, and they are more confident than ever that both answers will be yes. Their latest research proved the answer to the second question that an aerogel shell can indeed hold a vacuum.

The shell was made of a polyimide aerogel—an ultralight synthetic material comprised of mostly empty space. The capability to hold a vacuum was a welcome surprise to the researchers, who expected that air would permeate freely through the material's void space.

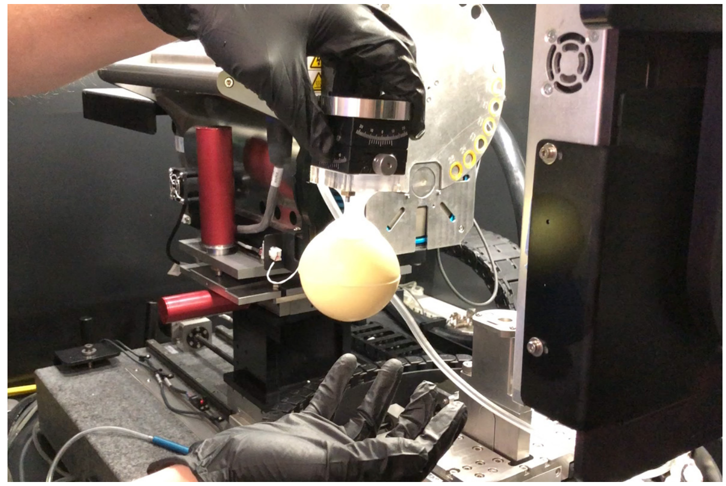
The behaviors observed for these materials have surpassed expectations and will likely lead to applications the researchers hadn't anticipated, said Miles Beaux, principal investigator.

The scientists' work is part of an effort to capitalize on the low density of aerogel materials and produce a vacuum vessel light enough to achieve buoyancy in air when evacuated. The proposed vacuum vessel would be an alternative to helium-lofted payloads used in scientific and military ballooning applications, but there are many commercial applications as well.

Helium balloons may be common, but helium is expensive and balloons don't float forever; there is a lifetime associated with these filled vessels. Spheres made from aerogel, however, could be filled with nothing (vacuum) and remain floating in air forever.

The groundwork for this goal has now been established. The Los Alamos researchers noted that the degree to which the aerogel material can hold vacuum corresponds to an optimal density. The team hypothesized local deformations of the random nanostructured lattice of the material are responsible for the air impermeability.

The sphere was created by molding two hemisphere shells of polyimide and sanding the equatorial surface to create a smooth contact between the two shells. To create the vacuum, the interior space of the aerogel sphere was evacuated using a roughing pump. The sphere did not measurably deform, even down to an internal pressure of less than 1 torr. Low-vacuum conditions were achieved even when there was minimal overlap of the two hemisphere shells. Without active pumping, the vacuum vessel was supported by atmospheric pressure for approximately 50 seconds before the sphere fell from its inverted vacuum chuck.



A hollow spherical shell of polyimide aerogel, 6 cm in diameter with a wall thickness of 4 mm and an internal pressure less than 1 torr, is held upside down by its vacuum chuck. The aerogel density is about 120 mg/cm^3.

Miles Beaux's concept of using aerogel vacuum vessel supported floating WiFi hotspots received "Best Pitch" at LANL's 2017 DistrupTECH. This 2019 research has significantly advanced the development of this technology.

The vacuum vessel also showed resistance in gentle- to medium-impact blows. The sphere remained intact when struck with a ball-peen hammer. It took a heavy blow to actually punch through the sphere.

Researchers: B. Patterson, B. Bennett, L. Kuettner, V. Siller, C. Hamilton, I. Usov, and M. Beaux (MST-7). The work is supported by the Los Alamos Laboratory Directed Research and Development Program and follows prior seed funding from the Institute for Materials Science. This work is relevant to air buoyant payload applications of interest to the Defense Threat Reduction Agency and the National Reconnaissance Office. The work supports the Laboratory's Global Security mission and the Materials for the Future capability pillar. ■

Technical contact: Miles Beaux

New materials deformation details emerge through combination of neutron and high-energy x-ray diffraction measurements

Accurately predicting failure of a structural material relies on understanding how stress and strain affect a material's microstructure.

Although widely studied, the specific standards for damage initiation in polycrystalline materials are not fully established, in part because generating experimental data to test current theories at the appropriate length scale is challenging. As a result, this lack of microscale understanding means structural materials can fail prematurely compared to their lifetime predicted by models using macroscopic data.

Using multiple nondestructive experimental probes, Reeju Pokharel (Materials Science in Radiation and Dynamics Extremes, MST-8) and her Los Alamos and external collaborators studied the evolution of stress during damage initiation and accumulation in a two-component material consisting of a ductile copper (Cu) matrix with a randomly dispersed brittle tungsten (W) phase. Their experimental observations are invaluable for validating microstructure-sensitive damage models for polycrystalline materials. The research was featured on the cover of the January issue of *JOM*.

Using the SMARTS (Spectrometer for Materials Research at Temperature and Stress) beamline at the Los Alamos Neutron Science Center, the researchers completed neutron diffraction measurements to examine the macroscopic strain partitioning between the two phases during a uniaxial tension test. Using the F2 beamline at the Cornell High Energy Synchrotron, the same material was then examined with high-energy x-ray diffraction microscopy (HEDM) and micro-computed tomography (μ-CT) measurements to monitor micromechanical field evolution. This novel multi-modal measurement combined bulk-averaged lattice strain information from neutron diffraction data with three-dimensional, spatially resolved stress data from HEDM and density measurements from μ-CT to provide a detailed understanding of the underlying physical mechanisms of microstructure and damage evolution under stress.

From their observations, the researchers concluded that high-stress triaxiality development in the W particles leads to decohesion of the interface between the Cu and W phases. The debonded regions eventually grew and coalesced with neighboring voids leading to material failure.

The work was initially supported by Los Alamos's Laboratory Directed Research and Development Program and subsequently by the Dynamic Materials Properties Campaign (LANL Program Manager Dana Dattelbaum) and is relevant to the DOE's Dynamic Mesoscale Materials Science Capability (DMMSC). The multi-modal material characterization methods being developed in this work are providing new insights on micro-mechanical phenomenon and guiding future experiment design, including imaging higher Z materials at higher rates which would be possible at next-generation facilities such as the MaRIE (Matter-Radiation Interactions in Extremes) free-electron laser proposed as part of DMMSC.

This cover image of *JOM* shows a three-dimensional initial state characterization of Cu-10%W. A microstructure map, obtained from HEDM measurements, shows the crystallographic grains of W embedded on a Cu matrix shown in gray. After the initial state characterization, the same specimen was loaded under uniaxial tension to monitor the local stress and strain accumulation due to imposed load. It was observed that high-stress triaxiality developed in W grains, which led to decohesion of the Cu-W interface. Upon further loading, the debonded regions grew and coalesced with neighboring pores, eventually leading to macroscopic failure.

The research supports the Lab's Stockpile Stewardship mission and its Materials for the Future science pillar.

Reference: "In situ grain resolved stress characterization during damage initiation in Cu-10%W alloy," *JOM* 72, 1 (2020). Researchers: Reeju Pokharel, Bjorn Clausen, Don Brown (all MST-8); Ricardo Lebensohn (Fluid Dynamics and Solid Mechanics, T-3); Timothy Ickes (Non-Destructive Testing and Evaluation, E-6); Ching-Fong Chen (Fabrication Manufacturing Science, Sigma-1); Darren Pagan and Darren Dale (Cornell University); and Joel Bernier (Lawrence Livermore National Laboratory).

Technical contact: Reeju Pokharel

Hans Herrmann named 2019 APS Fellow

Hans Herrmann (Engineered Materials, MST-7) has been named a 2019 American Physical Society (APS) Fellow. Nominated by the Topical Group on Instrument and Measurement Science, he was cited for "pioneering the use of Cherenkov radiation techniques for high energy gamma spectroscopy applications at the National Ignition and Omega Laser Facility."

Herrmann's career has focused on instrument and measurement science for experimental plasma and nuclear physics research. For 10 years, he served as project leader for gamma-ray diagnostics for the National Inertial Confinement Fusion Program. His accomplishments include advancing the gas Cherenkov detector technique that converts gamma rays to photons for fast optical detection and using a specific type of gamma ray to measure ablator areal density.

Herrmann, who has a PhD in astrophysical sciences from Princeton University, joined the Lab as a postdoctoral researcher in plasma physics. He is the MST-7 group leader.

Each year, no more than one half of one percent of the society's membership is recognized by their peers for election to the status of fellow.

Also named APS Fellows were Scott Hsu (Physics, P-DO), Kathy Prestridge (Neutron Science and Technology, P-23), Richard Van de Water (Subatomic Physics, P-25), and Alan Hurd (National Security Education Center, NSEC). ■

Technical contact: Hans Herrmann

Celebrating service

Congratulations to the following MST Division employees who recently celebrated a service anniversary:

George "Rusty" Gray III, MST-8 .... 35 years
Shuh-Rong Chen, MST-8 .... 30 years
Jon Bridgewater, MST-DO .... 30 years
David Moore, MST-16 .... 20 years
Jeremy Mitchell, MST-16 .... 25 years
Brian Patterson, MST-7 .... 15 years
Saryu Fensin, MST-8 .... 10 years
Xiang-Yang Liu, MST-8 .... 10 years
Roberta Beal, MST-8 .... 5 years
Melissa Espinosa, MST-16 .... 5 years
Meghan Gibbs, MST-16 .... 5 years

HeadsUP!

Staying safe around the TA-3 parking garage construction area just got easier

New signs, barricades, and lane stripes show new, safe routes of travel

Pedestrians and motorists will have an easier time navigating the construction area behind Otowi, thanks to new signs, safety barriers, and lane restriping that were recently introduced.

Since construction of the new parking garage began last month, crews have noticed several instances where employees have ignored detour signs and many have ventured too close to the work area.

Hoping to make the off-limits areas even more prominent, the Utilities and Infrastructure team recently placed more directional and warning signs around the site. In addition, cones were placed in the street (Pajarito) to indicate where the new fence boundary will soon be located.

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To submit news items or for more information, contact Karen Kippen, ALDPS Communications, at 505-606-1822 or aldps-comm@lanl.gov.

For past issues, see www.lanl.gov/org/ddste/aldps/mst-e-news.php.

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