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# MPA Materials Matter

## INSIDE

**2**

From Tanja's desk

**3**

From Andrew's desk

**5**

MPA staff in the news

**7**New oxygen  
stabilization method**8**Alkaline exchange  
membrane fuel cell  
technology**9**Research into  
crystalline lattice in the  
Weyl semimetal NbAs

Celebrating service

**10**HeadsUP!  
Housekeeping events  
planned for ADEPS

Success in excess

Electrical safety 101



Photo by Sandra Valdez, XIT TSS

## Supporting scientific discovery

### Introducing MPA's newest administrative staff members

by Kris Fronzak, ADEPS Communications

Three new Materials Physics and Applications (MPA) Division employees hail from as close as Espanola to as far as New England. Jessica Herrera, Valerie Lovato, and Nicole Strother may have come from different places, but their common ground is an interest in the Lab's scientific challenges, an appreciation for its collaborative environment, and gratitude for the strong communication between the division's leaders and staff.

Each contributes to the Laboratory's national security science mission by ensuring the smooth day-to-day operations of their groups. On any given day that can mean juggling the demands of scheduling meetings, arranging travel, purchasing equipment, tracking property, and providing guidance on safety and security for scientific staff, postdocs, and students.

Lovato is part of the administrative team for the Center for Integrated Nanotechnologies (MPA-CINT), which is home to a nanoscale science national user facility. Herrera and Strother are the office support team for the Condensed Matter and Magnet Science group (MPA-CMMS); Herrera working at the National High Magnetic Field Laboratory (NHMFL) at Technical Area 35 and Strother in the group office in the Materials Science Complex in Technical Area 3. Read on to discover more about these women and their essential roles in helping to make their organizations and the institution a success.

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*Los Alamos is investing in new experimental capabilities that address mission needs, and many of these are directly connected to our materials strategy.*

”

*Tanja*

## From Tanja's desk ...

Our materials strategy from 2010 has served us well. Since then, our capabilities have advanced and mission requirements have evolved, and as such, we are currently engaged in a refresh of LANL's "Materials for the Future" strategy. Progress on our strategy was one of the focus areas of the Materials Capability Review, held in early May.

At the start of 2016, a series of diverse groups representing all aspects of the LANL materials community have been reviewing and identifying the key science and engineering challenges that will exist over the next decade for the materials that will be critical for the success of Los Alamos's missions. We identified seven Areas of Leadership in which we must excel to successfully meet our mission. They are: Actinides and Correlated Electron Materials, Energetic Materials, Integrated Nanomaterials, Complex Functional Materials, Manufacturing Science, Resilience in Harsh Service Conditions, and Materials Dynamics. The Areas of Leadership are connected through common Science Themes with the goal to provide materials solutions for new and emerging mission needs in nuclear deterrence, global security, and energy security. A key motivation is to ensure that LANL capability remains agile for stockpile and national security needs.

To that end, the materials strategy advocates support of basic research to push scientific frontiers and to enable a forward-looking science profile that will attract a new wave of bright and energetic scientists. Mesoscale science and the opportunities presented by the phenomenal advances in light source user facilities are already key to many of the Areas of Leadership and will remain central elements of the materials strategy for the next decade. The strategy explicitly acknowledges that close coupling between experiment, theory, modeling, and simulation is essential for success in developing robust, validated, and verified predictive tools to address mission needs.

This enhanced definition of the co-design process depends on advanced models and algorithms, next-generation codes, appropriate experimental tools such as MaRIE, and sophisticated, next-generation architectures and platforms as developed for the Exascale Computing Project. This approach also requires bridging both time and length scales as well as understanding systems far from equilibrium.

Los Alamos is investing in new experimental capabilities that address mission needs, and many of these are directly connected to our materials strategy. For example, the Sigma facility is being reconfigured to support manufacturing science. Progress is underway to develop an integrated advanced manufacturing capability (ITAM). Subcritical experiments at Nevada continue to gain momentum with enhanced capabilities (ECSE) to support material dynamics and actinide and correlated electron systems. We are also planning for a new characterization facility to support synthesis and energetic materials characterization (EMCF), and we have identified the need for a modular materials science facility to expand the scope of integrated nanomaterials and complex functional materials. Finally, LANL remains steadfast in the commitment to complete MaRIE with advancements in mesoscale science and support for the Momentum Initiative.

It continues to be an exciting time for material science at Los Alamos National Laboratory. Your dedication and outstanding contributions continue to be important to our future. I am extremely proud of our staff and accomplishments from MPA, and thank you for your support.

*MPA Division Leader Tanja Pietraß*



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*The institution has provided MPA with funds to re-start cleanroom operations in an existing facility, TA-3, SM-40, room N-100.*

”

*Andrew*

## From Andrew's desk...

This month I wanted to provide an update on the re-establishment of a cleanroom facility (also known as the flexible fabrication facility) in MPA Division. While we plan on opening the facility to users towards the end of FY17, I thought it would be useful to start advertising the capabilities that will be available.

The institution has provided MPA with funds to re-start cleanroom operations in an existing facility, TA-3, SM-40, room N-100. This facility operated as a cleanroom—a controlled environment free of dust and other environmental pollutants—for many years and still contained the needed ventilation system, i.e., HEPA filtration, for such operations. Since the beginning of FY16, we have re-certified three rooms for cleanroom activities.

Cleanrooms are certified based on the average number of particles (usually 0.1-0.5 microns in diameter per cubic meter of air in the room. We have a certified ISO Class 3 cleanroom (formerly called a Class 1,000 cleanroom) complete with operational chemical fume hoods and yellow lighting to allow for photolithography, which uses light-activated polymers as photoresists. We have set up a spin coater and a mask aligner for making patterned thin films and a laser scanning profilometer to characterize the samples. In our ISO Class 4 cleanroom (formerly called a Class 10,000 cleanroom), we have the ability to deposit a variety of thin films (both metals and oxides) through chemical vapor and e-beam deposition techniques. We also have a powder x-ray diffractometer available for sample characterization. The third room is also an ISO Class 4 cleanroom for donning of cleanroom garb prior to entering the operational rooms.

We have purchased and are in the process of installing a reactive ion etching system for nanometer-scale etching of materials. We have ordered an atomic layer deposition system, which should be operational before the end of FY17, for conformal and precise nanometer-scale deposition of dielectric materials, such as  $\text{Al}_2\text{O}_3$ ,  $\text{HfO}_2$ ,  $\text{TiO}_2$ , etc. There are additional pieces of equipment that may eventually be located in the facility, too.

We expect primary users of the facility will come in through the Center for Integrated Nanotechnologies, which is a DOE Office of Science User Facility. However, we also expect that this open facility will be available to support programs in Global Security and LDRD, as well as the Fuel Cell Program, which is funded by the DOE Fuel Cell Technologies Office.

If you or your colleagues have need for a cleanroom facility, please do not hesitate to contact me for more information about access to this capability.

*MPA-11 Group Leader Andrew Dattelbaum*

Introducing cont.



## Jessica Herrera

*Condensed Matter  
and Magnet Science (MPA-CMMS)*

Herrera, who grew up in Illinois, spent the past 15 years at Argonne National Laboratory, providing administrative support to its programmatic and operational staff, most recently to members of the Environment, Safety, and Quality Assurance Division. She began working at the magnet lab, an experimental facility dedicated to high magnetic field research using pulsed magnets, in January, providing administrative support to its staff and management. Together with Julie Gallegos, the NHMFL User Program Administrator, she also helps welcome the 100 visitors and researchers who come through this national user facility every year.

### Skills to succeed

Having the opportunity to work at a different Department of Energy (DOE) laboratory has prepared and given me the skills I believe will help me to succeed in my role at Los Alamos. For the past few years I worked with Argonne's safety department and assisted different safety committees. This work familiarized me with DOE requirements, Occupational Safety and Health Administration regulations, and other regulatory drivers that the Laboratory is required to follow. My safety background will help me recognize and avert potential hazards at Los Alamos.

### Family tradition

I love to cook and try new recipes with my family. Every week we discuss what recipes we should try. So far our favorite recipe is carne asada with arroz and frijoles.

### What piques her interest?

The different science being conducted at the Laboratory is what I find most interesting, and is the reason I decided to stay with a laboratory after leaving Argonne. Although the entire group may not be present for the latest science breakthrough, we all work together, feel like we've contributed and are part of a team.



## Valerie Lovato

*Center for Integrated  
Nanotechnologies (MPA-CINT)*

Lovato, who is from Espanola, joined Los Alamos in 1994 as an undergraduate student. She has held a range of positions as a Lab contractor—providing support in administration, computer technology, budget analysis, access control, information technology, employee training, and document control. She became a Lab employee in August. In MPA-CINT, a multi-program organization with a broad research program in support of discovery science and national security missions, she assists staff and management with everything from arranging travel to international conferences to coordinating details of personnel transitions.

### Broad background

In my positions [at Los Alamos] I have been fortunate to learn so much in different aspects. That background has definitely been beneficial in my new role and enables me to step in and take charge of tasks confidently whether I need to get info, look to resources, or handle complex projects. Having good working relationships with people helps too.

### Lab veteran

The surprised expressions people get when they learn how many years I have been at the Laboratory is something I enjoy seeing. I am grateful for the knowledge and experience I have gained here. I am grateful for what the Laboratory has taught me and am blessed for the diversity, different nationalities, and friendships I have established through my tenure here. Through my opportunities at the Lab I have not only seen old technologies, but gradually seen those technologies evolve into new technologies.

### Peeking into the future

A year from now, I hope to know more of what CINT as a whole does, know more about nanotechnology, and definitely add to my knowledge base. I hope to also mentor and share my skills with everyone at CINT, while also enjoying the wonderful people and new friends I have met throughout MPA.



## Nicole Strother

*Condensed Matter  
and Magnet Science (MPA-CMMS)*

After a childhood in Boston, Strother moved to Nevada to be closer to extended family. The slower pace and openness of the West appealed to her, so she decided to make her home in the region. Strother, who has a background in accounting, joined MPA-CMMS as a group office administrator in June, working with researchers studying condensed matter physics, correlated electron materials, high magnetic field science and technology, and thermal physics.

*continued on next page*

Introducing cont.

### Day-to-day duties

Simply put, I provide support. My contribution to accomplishing the Lab's mission is minimizing the time our scientists spend being distracted by administrative duties. On a daily basis, I might do anything from procurements to helping visitors and data management. I support the staff so that they can focus on science.

### About me? Sci-fi and pie

Some of my colleagues might already know this, but I am a huge Star Trek fan. Kirk or Picard? I pick Picard without hesitation. Also, I love baking pie. My favorite pies to make are apple and pumpkin.

### A universe of opportunities

The Lab is the embodiment of imagination and discovery. It lets the most brilliant scientific minds from all over the world collaborate on high-impact scientific research. These collaborative efforts give all individuals involved, including support staff, chances to experience different cultures and learn new things.

### Celebrating service

Congratulations to the following MPA Division employees celebrating service anniversaries recently:

Mahlon Wilson, MPA-11 .....	25 years
Michael Gordon, MPA-CMMS .....	20 years
Piotr Zelenay, MPA-11 .....	20 years
Jennifer Martinez, MPA-CINT .....	15 years
Jason Lucero, MPA-CMMS .....	5 years

## MPA Materials Matter

Materials Physics and Applications

Published by the Experimental Physical Sciences Directorate

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## MPA staff in the news

*Doorn invited to share recent advances in carbon nanotube research at international materials conference*

Stephen Doorn (Center for Integrated Nanotechnologies, MPA-CINT) presented recent research on exciton localization in carbon nanotubes (CNTs) at an invited talk during the 2016 Materials Research Society (MRS) Fall Meeting in Boston. "Defect-Induced Exciton Localization for New Carbon Nanotube Functionality," given during the Nanotubes and Related Nanostructures symposium, highlighted several experiments Doorn and his colleagues published in fall 2016.



The talk revolved around new red-shifted emitting states in CNTs that are introduced by chemical modification of the nanotube structure. These states are gaining attention for their potential to boost photoluminescence quantum yields. Such states also add new functionality, serve as single photon emitters, and present a rich array of new photophysics for exploration.

As examples, Doorn presented depictions of low-T photoluminescence (PL) probes of defect-state electronic structure and demonstrations of exciton localization, or trapping, at individual dopant sites critical for enabling new functionality. Trapping significantly alters exciton dynamics, which extends PL lifetimes. His talk presented results on defect-state relaxation dynamics, revealing that exciton trapping increased PL lifetimes by around a factor of 10 in comparison to the lifetime of the  $E_{11}$  exciton.

Doorn presented research on the dependence of lifetimes on nanotube chirality, specific dopant, and dielectric environment, and showed these lifetimes exhibit a strong dependence on emission energy. He discussed trapping and detrapping dynamics in the context of new functionality, including room-temperature single photon emission.

With a membership of almost 14,000 materials researchers from academia, industry, and government, the MRS strives to provide interdisciplinary, diverse insight into advancing materials and improving quality of life. Its fall 2016 conference included more than 50 symposium sessions.

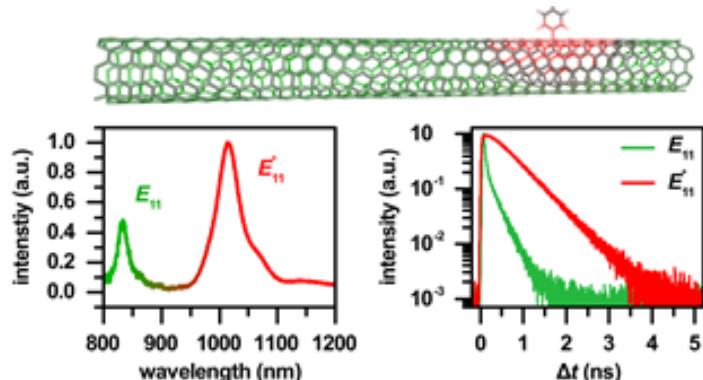
The research supports the Laboratory's Energy Security mission and its Materials for the Future science pillar. It was performed, in part, at the Center for Integrated Nano-

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## MPA staff cont.

technologies, a DOE Office of Basic Energy Sciences User Facility operated jointly by Los Alamos and Sandia national laboratories. Reference: "Photoluminescence Dynamics of Aryl  $sp^3$  Defect States in Single-Walled Carbon Nanotubes," *ACS Nano*, **10**, 8355 (2016).

Technical contact: Stephen Doorn



A defect (at top, red) inducing a red-shifted PL (left plot) relative to normal exciton emission (green). Exciton localization at defect increased PL lifetime (right plot). Lifetimes were strongly dependent on nanotube structure.

### Mara receives International Journal of Plasticity's Young Research Award

Nathan Mara (Center for Integrated Nanotechnologies, MPA-CINT, and the National Security Education Center's Institute for Materials Science) is the recipient of the 2016 Young Research Award from the *International Journal of Plasticity*. The award recognizes his contributions to the field of plasticity, especially modeling plastic deformation and the mechanics of metals and nanocomposites. Award recipients are selected for a combination of publication citations, service to the journal, and overall quality of research and impact on the deformation plasticity field.



As CINT nanoscale electronics and mechanics thrust co-leader and the co-deputy director of the Institute for Materials Science, Mara focuses on the relationship between microstructure and mechanical behavior across length scales from the atomic to bulk. His research emphasizes manufacturing bulk nanocomposite material for structural applications in extreme environments, and combines materials synthesis, mechanical testing, and materials characterization techniques using microstructural analysis tools at CINT and the Laboratory. He has more than 110 peer-reviewed publications in his field.

Mara, who has a PhD in materials science and engineering from the University of California, Davis, joined Los Alamos as a Director's Postdoctoral Fellow and became a staff scientist in 2008. He is past chairman of the Nanomechanical Materials Behavior Committee of The Minerals, Metals, and Materials Society (TMS) and recipient of the 2012 TMS Young Leaders Professional Development Award. He also received the LANL Distinguished Mentor Performance Award in 2010 for his dedication to undergraduate and graduate student education at Los Alamos.

Mara's work supports the Lab's Energy Security and Global Security missions and the Materials for the Future science pillar through developing lightweight structural materials with enhanced performance under extreme environments, advanced structural materials for use in nuclear reactor applications, and new test methodologies for investigating the mechanical behavior of materials across length scales. CINT is a DOE Office of Basic Energy Sciences User Facility, operated jointly by Los Alamos and Sandia national laboratories.

The award was presented at the 2017 International Symposium on Plasticity and its Current Applications, in Mexico.

Technical contact: Nate Mara

### Ramshaw receives 2017 Lee Oscheroff Richardson Science Prize

Brad Ramshaw is the recipient of the 2017 Lee Oscheroff Richardson Science Prize, recognized "for his outstanding contributions to the exploration of correlated electron systems in extreme magnetic fields."

The award is presented annually by Oxford Instruments to young scientists conducting low temperature, high magnetic field, or surface science research in North and South America. A committee of leading physicists from the Americas selected Ramshaw, who was recognized during a special event by the United Kingdom manufacturing and research company at the 2017 APS March Meeting in New Orleans.

Ramshaw, who earned his PhD in physics from the University of British Columbia, joined the Laboratory's Condensed Matter and Magnet Science group (MPA-CMMS) in 2012 as a postdoctoral researcher at the National High Magnetic Field Laboratory-Pulsed Field Facility(NHMFL-PFF). There he used ultrasound spectroscopy and pulsed field transport to study high-T<sub>c</sub> and heavy fermion superconductors. In 2013 he was named a Directors Fellow before becoming a staff scientist in 2015. He is now an assistant professor at Cornell. He remains a close collaborator with the group's topology and correlations Laboratory Directed Research and Development project and is an active user of the NHMFL-PFF.

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MPA staff cont.



**Brad Ramshaw conducting a 2015 experiment at the mag lab at Los Alamos.**

According to nominator Ross McDonald, Ramshaw has built an internationally prominent record of research in quantum materials. As examples McDonald cited Ramshaw's 2011 publication of "Angle dependence of quantum oscillations in  $\text{YBa}_2\text{Cu}_3\text{O}_{6.59}$  shows free-spin behavior of quasiparticles" in *Nature Physics*; his *Proceedings of the National Academy of Science* reporting an "Avoided valence transition in a plutonium Superconductor," and his *Science* paper "Quasiparticle mass enhancement approaching optimal doping in a high-T<sub>c</sub> superconductor." These high-profile publications, for which Ramshaw was nominated, involved research that was uniquely available at Los Alamos through access to the world's strongest magnetic fields and superconducting plutonium compounds.

*Technical contact: Ross McDonald*

#### **Thompson recognized for service to scientific community**

Joe Thompson (Condensed Matter and Magnet Science, MPA-CMMS) is the recipient of two awards recognizing his contributions to the scientific community.

Los Alamos National Laboratory presented him with a 2016 Postdoctoral Distinguished Mentor Award. These annual awards recognize the contributions a mentor makes during a postdoctoral researcher's appointment and are awarded to those demonstrating a level of mentoring substantially beyond expectations.

Thompson was nominated by previous postdoctoral researcher Priscila Rosa (MPA-CMMS), and endorsed by previous postdoc Yongkang Luo (University of California, Los Angeles) and current postdoc Adam Dioguardi



(MPA-CMMS). According to the nomination, Thompson was recommended for his leadership, kindness, and exceptional dedication to postdocs and to MPA-CMMS at large. Over 40 years, he has guided 28 postdocs to successful careers, and the condensed matter community speaks very highly of him.

IOP Publishing selected Thompson as a 2016 Reviewer of the Year for his work assessing manuscripts for publication in *Reports on Progress in Physics*. The publisher's selection is based on review quality, quantity, and timeliness for each of its affiliated journals. IOP Publishing, an Institute of Physics subsidiary, works to promote physics and unite physicists for the benefit of all. It has a worldwide membership of about 50,000 physicists and maintains journals, e-books, magazines, conference proceedings, and websites. This is the first year IOP has published its list of top reviewers from the previous year.

Thompson is a fellow of the American Association for the Advancement of Science, American Physical Society, and Los Alamos National Laboratory, and is the capability leader of MPA-CMMS's Novel Materials at Extreme Conditions team. He received the 2014 Frank H. Spedding Award and held the honorary title of Distinguished Visiting Chair Professor of Physics at Sungkyunkwan University, South Korea, from 2012-2013. He is part of the Institute for Scientific Information's inaugural group of the 250 most frequently cited physicists in the world.

*Technical contact: Joe Thompson*

#### **New oxygen stabilization method controls structure and physical properties of $\text{SrFeO}_{3-\delta}$ thin films**

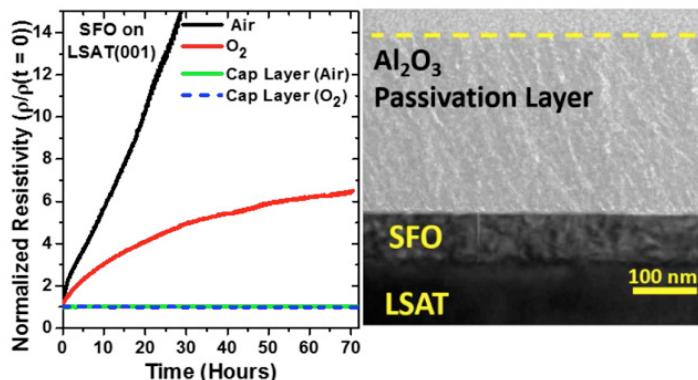
$\text{SrFeO}_{3-\delta}$  (SFO) perovskite thin films have garnered great interest from the scientific community for their unique magnetic structure and are an attractive material for spintronics and other technological applications. However, the strong dependence of the magnetic and electrical properties on the crystal structure is not yet well understood, presenting synthesis and stability challenges that have impeded research efforts.

To overcome this challenge, Center for Integrated Nanotechnologies (CINT) scientists and users explored the impact of controlled variations in oxygen content and substrate effects on the SFO thin films, establishing a method to control SFO structure and physical properties by stabilizing oxygen content.

The team grew SFO thin films on various substrates and demonstrated that changes in structural and electrical transport properties over time in various conditions were correlated with the loss of oxygen in the SFO thin films. They

*continued on next page*

New oxygen cont.



Normalized resistivity vs. time for SFO film grown on  $(\text{LaAlO}_3)_{0.3}(\text{Sr}_2\text{AlTaO}_6)_{0.7}$  (001) in air and O<sub>2</sub>, in comparison with that of the films covered by 300-nm Al<sub>2</sub>O<sub>3</sub> passivation layer (right) and corresponding cross-sectional transmission electron microscopy image (left).

determined that the films' initial resistivity relied heavily on the substrate on which they were grown and demonstrated that oxygen content was the dominant factor in overall film properties. To address this finding, the team used an Al<sub>2</sub>O<sub>3</sub> passivation layer to stabilize the oxygen content, and therefore the crystal structure and electrical conductivity of SFO thin films. These results mark an important step towards stabilizing the SFO metallic phase in thin films for research and technological applications.

The work at Los Alamos involved pulsed laser deposition—a unique precision thin film synthesis capability within CINT—as well as structural characterization that was enabled by CINT's x-ray diffraction system. The team also manufactured a setup to perform electronic transport measurements for SFO over time under various ambient gas conditions.

The experiment was supported by the Laboratory-Directed Research and Development program and performed, in part, at CINT, leveraging the materials preparation capabilities of this DOE Office of Basic Energy Sciences User Facility, which is operated jointly by Los Alamos and Sandia national laboratories. The research supports the Laboratory's Energy Security mission and its Materials for the Future science pillar, including its emergent phenomena theme by furthering efforts to tailor materials for controlled functionality, a central vision of the Laboratory's materials strategy.

Researchers: Erik Enriquez, Aiping Chen, Xujie Lü, Paul Dowden, and Nicholas Koskelo (MPA-CINT); Marc Janoschek (Condensed Matter and Magnet Science, MPA-CMMS); Zach Harrell (MPA-CINT and University of Texas at San Antonio); Chonglin Chen (University of Texas at San Antonio); and Quanxi Jia (MPA-CINT and the University at Buffalo, State University of New York). Reference: "Oxygen vacancy-driven evolution of structural and electrical properties in SrFeO<sub>3-δ</sub> thin films and a method of stabilization," *Applied Physics Letters* **109**, 141906 (2016).

Technical contact: Erik Enriquez

## Alkaline exchange membrane fuel cell technology is 2016 *Nature Energy*'s editors' pick

Research demonstrating a new class of fuel cells based on a newly discovered polymer-based material was named a 2016 editors' pick by *Nature Energy*. The work was featured in a selection of highlights honoring the journal's first publication anniversary.

The discovery, made by Materials Synthesis and Integrated Devices' (MPA-11) Fuel Cells team, could bridge the gap between the operating temperature ranges of two existing types of polymer fuel cells, thereby accelerating the commercialization of low-cost fuel cells for automotive and stationary applications. The team, in collaboration with Cy Fujimoto (Sandia National Laboratories) and Yoong-Kee Choe (National Institute of Advanced Industrial Science and Technology, Japan), found that fuel cells made from phosphate-quaternary ammonium ion-pair can be operated between 80-200°C, enhancing the fuel cells usability in a range of conditions.

Two main classes of polymer-based fuel cells exist. One is the low-temperature fuel cells that use sulfonated polymers. The low-temperature fuel cells require water for proton conduction, and therefore cannot operate above 100°C. The other type is high-temperature fuel cells that use phosphoric acid-doped polymers. The high-temperature fuel cells can operate up to 180°C without water; however, the performance degrades under water-absorbing conditions below 140°C due to the leaching of phosphoric acid from the membranes.

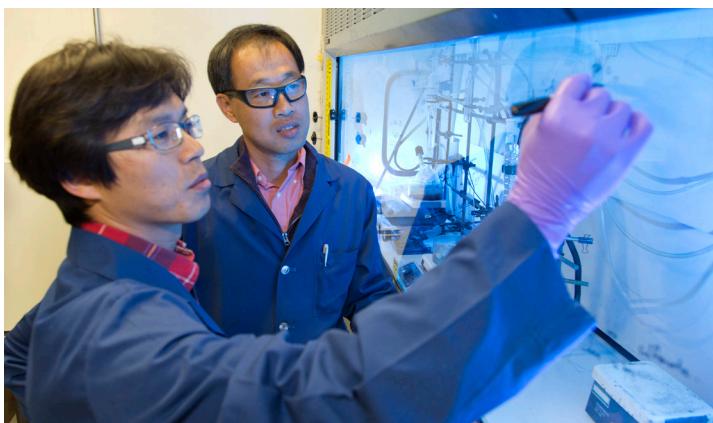
The research team found that a phosphate-quaternary ammonium ion-pair has much stronger interaction than the phosphoric acid-base interaction, which allows the transport of protons effectively even under water-condensing conditions. The prototype fuel cells made from the ion-pair-coordinated membrane demonstrated excellent fuel-cell performance and durability from 80- 200°C, which is unattainable with existing fuel cell technology. The performance and durability of this new class of fuel cells could even be further improved by high-performing electrode materials, according to Yu Seung Kim (MPA-11), who cited an advance expected within 5 to 10 years that is another critical step to replace current low-temperature fuel cells used in vehicle and stationary applications.

Los Alamos has been a leader in fuel cell research since the 1970s. Fuel cell technologies can significantly benefit the nation's energy security, the environment and economy through reduced oil consumption, greenhouse gas emissions, and air pollution.

The project was funded by the DOE's Office of Energy Efficiency and Renewable Energy (EERE) Fuel Cell Technol-

continued on next page

Alkaline cont.



Kwan-Soo Lee (left) and Yu Seung Kim (right) discuss the chemistry behind fuel cell membranes.

ogy Office. The research supports the Lab's Energy Security mission area and its Materials for the Future science pillar through the development of materials for clean energy. Researchers: Kwan-Soo Lee (Chemical Diagnostics and Engineering, C-CDE), Jacob Spendelow, Yu Seung Kim (MPA-11), Cy Fujimoto (Sandia National Laboratories), and Yoong-Kee Choe (former LANL visiting scholar, now National Institute of Advanced Industrial Science and Technology). Reference: "An operationally flexible fuel cell based on quaternary ammonium-biphosphate ion pairs," *Nature Energy* 1, 16120 (2016).

Technical contact: Yu Seung Kim

## Research into crystalline lattice in the Weyl semimetal NbAs one of *Journal of Physics: Condensed Matter*'s Highlights of 2016

Research by Condensed Matter and Magnet Science (MPA-CMMS) scientists on the effect of hydrostatic pressure on the magnetotransport properties of the Weyl semimetal niobium arsenide (NbAs) was selected as one of the *Journal of Physics: Condensed Matter*'s Highlights of 2016. Criteria for selection included referee endorsements, presentation of outstanding research, and popularity with the journal's online readership.

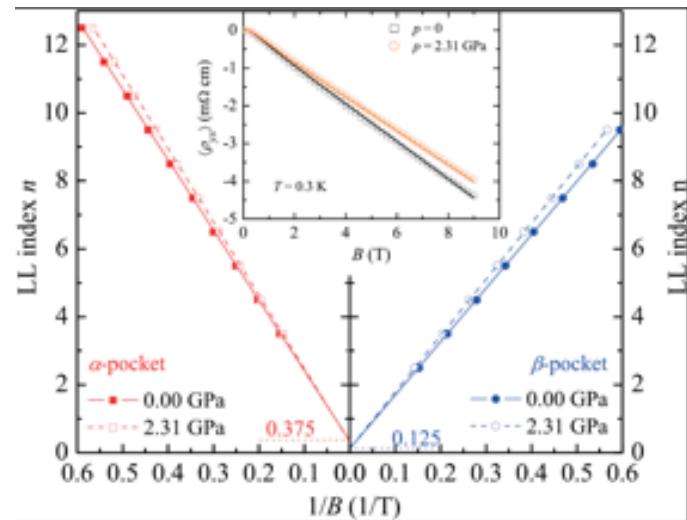
The Weyl fermion, a long-sought particle in high-energy physics, was recently discovered in condensed matter physics in the so-called Weyl semimetals (WSMs). These WSMs manifest with many exotic properties, and have potential applications in electronics. One way to find a WSM is to look into the materials that lack spatial inversion symmetry; this has been realized in a class of binary transition-metal monopnictides of the form TmPn (where Tm=tantalum or niobium, and Pn=arsenic or phosphorous). Pressure is an effective non-thermal control parameter, and in general tunes the properties by a variety of means. There have only been a few studies on the effect of pressure on the members of the TmPn family of WSMs.

The researchers found only small changes to the physical structure and the electrical properties as a function of pressure. This contrasts with the behavior of other related materials. They attributed the material's resilience to the hardness of the crystalline lattice and the large electronic energy scales that they determined from measurements of the heat capacity. In addition, the researchers studied the so-called Kadowaki-Woods relationship, which compares the scattering rate of the electrons in a material to its electronic properties. They found that the scattering rate is remarkably suppressed leading to a high electronic mobility in this material, which is important for potential technological applications. The authors speculated that the origin of the suppressed scattering rate arises from the topological origin of the Weyl fermions in this semimetal.

A Director's Postdoctoral Fellowship funded a portion of the work; electrical transport measurements were supported by Los Alamos's Laboratory-Directed Research and Development program; and samples were synthesized under the auspices of the Department of Energy's Office of Basic Energy Sciences, Division of Materials Science and Engineering. The research supports the Laboratory's Energy Security mission and Materials for the Future science pillar by studying the fundamental properties of materials in an effort to tune those properties and achieve controlled functionality, a central vision of the Laboratory's materials strategy.

MPA-CMMS researchers include Eric Bauer, Joe Thompson, Filip Ronning, and former postdocs Yongkang Luo (now University of California, Los Angeles) and Nirmal Ghimire (now Argonne National Laboratory). Reference: "Hard' crystalline lattice in the Weyl semimetal NbAs," *Journal of Physics: Condensed Matter*, **28** (2016).

Technical contact: Filip Ronning



Landau level indices  $n$  as functions of  $1/B$  for  $B \parallel c$  illustrating a minimal change to the electronic structure with pressure. This analysis shows that the  $\alpha$ -pocket of the Fermi surface remains topologically non-trivial, while the  $\beta$ -pocket remains trivial. The inset displays a comparison of  $(\rho_{xy}(B))$  at 0.3 K between ambient pressure and 2.31 GPa.

# HeadsUP!

## Housekeeping events planned for ADEPS

ADEPS is planning a series of housekeeping events to salvage or recycle items as part of its Environmental Action Plan. The event makes it easier for employees to correctly discard items ranging from paper products to binders, printing cartridges, thermometers, media such as CDs and DVDs, old office and laboratory supplies, and recyclables such as metal, wood, aluminum, cardboard, and plastics.



MST-8 employees clean out a lab to install a new operation in the Materials Science Laboratory.

The initial housekeeping days took place in the Materials Science Complex in April with directorate-wide events planned for throughout the summer.

Questions? Contact Dianne Wilburn at [dianne@lanl.gov](mailto:dianne@lanl.gov).

## Success in excess

Representatives of Acquisition Services Management–Property Management (ASM-PM) recently coordinated two “Excess Days” for employees from Materials Physics and Applications, Materials Science and Technology, Sigma, Bioscience, Chemistry, and Earth and Environmental Sciences divisions and their support organizations to drop off unwanted electronics, computers, and computer-related gear. The equipment was sorted, delivered to the excess yard, and removed from custodian accountability statements.



The haul from an electronics collection day organized by Nix Mattson (ASM-PM).

In total, the two excess days resulted in 153 active property numbered items—from desktops to laptops, phones, and cameras, as well as 84 monitors, about 50 printers and scanners, 25 boxes of cables, keyboards, speakers, mice, and other peripherals—to be salvaged or recycled.

## Electrical safety 101

Electrical safety isn't just for field employees. Office, meeting rooms, and group spaces can present hazards too. Rather than making your next meeting a shocking experience, familiarize yourself with the following precautions:

### Office electrical checklist

- Is the electrical equipment you use UL listed or approved by an electrical safety officer (ESO)?
- Are cords and wires neat and organized so they do not present a tripping hazard?
- Are cords and plugs in good condition and ground pins intact with no frayed or cracked insulation?
- Do space heaters have automatic shutoffs if they tip over? Are they located 3 or more feet from combustible material?
- If you use a window air conditioning unit is it plugged into a dedicated circuit (i.e., the unit is the only load on that circuit), and if plugged into an extension cord is the cord properly sized?
- If you use an uninterruptable power supply (UPS) has it been properly maintained with the battery replaced per the manufacturer's recommendation? (Note: the LANL Electrical Safety program strongly discourages the use of UPSs.)

### Make sure

- electric cords are not run through openings in doors, walls, ceilings, or under carpets;
- extension cords or multi-outlet strips are not plugged into other extension cords or multi-outlet strips;
- your multi-outlet strip is not overloaded;
- electrical devices show no signs of overheating; and
- electric fans are protected with mesh guards to prevent fingers getting inside the guard.

If you have any questions about electrical safety in your work environment, an ESO is the best resource for guidance. Other resources include the Electrical Safety Program website, Center of Excellence for Electrical Safety, Electrical Safety Foundation International, and the Consumer Product Safety Commission.