MPA MaterialsMatter

June 2012

INSIDE

2 From Cathy's Desk

3 Scientists take a giant step forward in understanding plutonium

5 Jaqueline Kiplinger named Fellow of the Royal Society of Chemistry

MPA postdoctoral researchers make their mark

7 Quantum interference in carbon nanotubes

8 Electrochemical Society names Garzon president

Using ionic liquids for forensic analysis

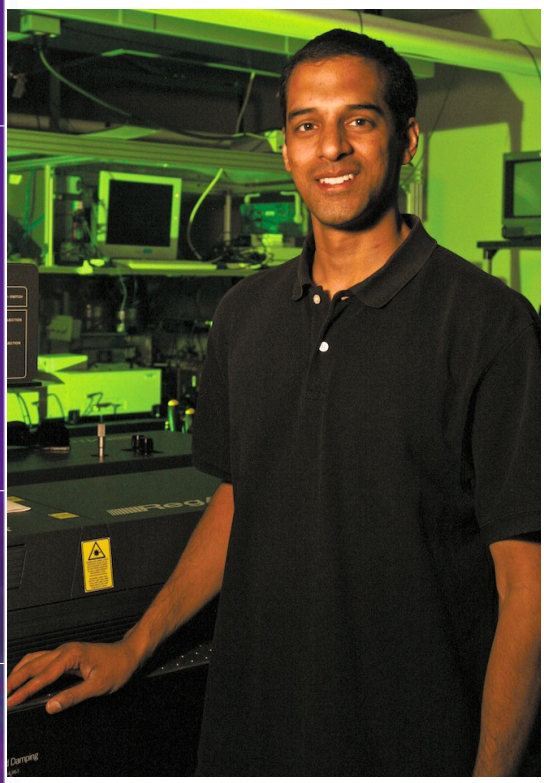
9 Heads UP!

10 From Steve's desk

Rohit Prasankumar

Lighting the way with lasers

By Diana Del Mauro
ADEPS Communications



Rohit Prasankumar doesn't work in a dance club; he leads several optical research laboratories. His approach to studying complex materials, however, is similar to how a club's strobe light illuminates and freeze-frames dancers, making it appear as if slices of time stand still.

At the Center of Integrated Nanotechnologies (MPA-CINT), he designed laser systems that produce a strobe light effect. They strike a material with short optical pulses, producing snapshots at less than a trillionth of a second.

"Rohit is a very inventive instrumentation scientist," CINT Director David Morris said.

Ultrafast microscopy is just one unique capability that Prasankumar has developed at CINT, a Department of Energy nanoscale science research center jointly operated by Los Alamos and Sandia National Laboratories. His research at the national user facility builds upon work he began in college.

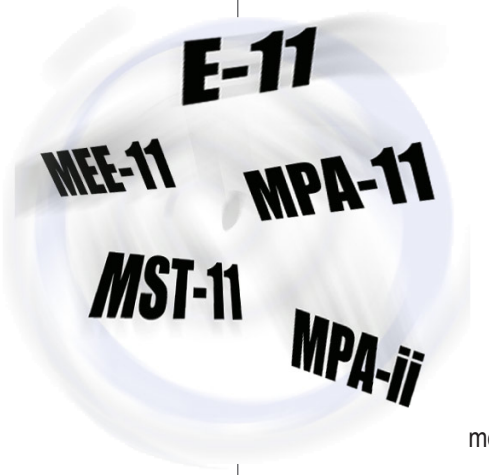
As an undergraduate student in electrical engineering at the University of Texas at Austin, Prasankumar used lasers to look at human tissues, and in the process became intrigued with laser physics. However, his graduate institution, the Massachusetts Institute of Technology (MIT), didn't have an applied physics program so he enrolled in as many physics courses as he could, focusing his research on ultrafast optics and ultrafast phenomena.

"A lot of things happen too fast to be measured with electronics," he said. For his doctoral thesis, he designed and built novel ultrashort, pulsed lasers with performance on par with conventional ultrafast titanium-sapphire crystal lasers, at a fraction of the cost.

In 2003, after MIT, Prasankumar headed straight for Los Alamos and CINT, which, he said, is one of the few research institutions where scientists who grow new kinds of materials interact with theorists and experimentalists who characterize

continued on page 3

What's with the 11?



We have been *E-11*, MEE-11, MST-11, proposed MPA-ii when numbers were going to be disallowed, and now we are MPA-11. Why always 11?

Global energy needs continue to rise as developing countries continue to develop, and the developed world continues to consume. Energy, environmental, and security challenges caused by our nation's dependence on petroleum imports have long been drivers for DOE's investment in applied research at LANL. Whether it is new transportation technologies or improved tools for oil exploration, "11" has the answer.

Programs within the DOE/EERE Office focus on the transportation sector as the primary target market for the introduction of hydrogen and fuel cell technology, because of the potential impact that re-powering this sector could have on reducing oil consumption, reducing greenhouse gas emissions, and enhancing energy security. Transforming the transportation sector, where the internal combustion engine (ICE)has been under continuous development for more than a century and gasoline is a (relatively) cheap, reliable and high energy-density fuel and energy storage medium, represents a formidable challenge. LANL's "11" has had a decades-long lead role in the development of the technologies that will one day replace ICEs with hydrogen-powered fuel cells.

"11" has participated in or been responsible for key breakthroughs that enable today's fuel cell technology, including the key discoveries in PEM fuel cells which form the basis for currently commercialized low-temperature fuel cells. Our continuing work is aimed at developing the fundamental understanding and the technical underpinnings of current fuel cell platforms as well as developing new membrane materials and non-precious metal electrocatalysts. Los Alamos's fuel cell research program ranges from fundamental investigations of ion transport and electrochemistry through materials development to component durability, through component testing and optimization.

LANL is recognized as a world leader in the performance testing and analysis of single cells. We established precise fuel cell test procedures that result in reproducible baseline characterization, the Single Cell Testing Protocol, which is used extensively worldwide to characterize and compare component performance. The durability of PEM (polymer electrolyte membrane) fuel cells is a major barrier to the commercialization of these systems for both stationary and transportation power applications. Our approach to improving durability involves developing an understanding of the degradation mechanisms and methods that enable more rapid screening of individual components to determine their durability characteristics. Work is also aimed at evaluation of the effects of hydrogen and air impurities on fuel cell performance and the development of methods to alleviate impurity effects.

In addition to transportation applications, there is a need for higher-energy-density storage for small-scale systems. Small-scale fuel cells that can utilize a liquid or solid fuel would provide an alternative to batteries and are of interest for a range of applications, from portable electronics to military uses. Our strong foundation in direct methanol fuel cells, stemming from past funding from DOE and DARPA, and current funding from DOE/EERE, continues to focus on the development of simple systems for powering portable electronics.

In the meantime, "11" continues its legacy of working with government agencies and industry to develop acoustic-based sensors and imaging devices that solve once-intractable problems in fields as far-ranging as medical imaging, chemical weapons detection, and oil exploration. Some of "11"s most recent inventions include the real-time and noninvasive measurement of flow and composition of oil and gas from oil wells using sound, an acoustic flashlight that uses sound waves like a light beam to create images of the rock formations around boreholes deep underground, an acoustic camera that uses sound waves to obtain 3D images of objects buried in optically opaque fluids for detecting and visualizing particulate matter flowing with oil from oil wells from outside the pipes, and a device to detect defects in natural gas pipelines without touching the pipe surface. We can separate and concentrate small particulate matter in air and gases using sound, and can determine physical properties of liquids and chemicals inside containers from outside without touching the container.

"11" takes up challenging scientific, technical, and industrial problems and finds solutions.

So, what's with the "11"? Nothing really. It's just been kept over the years. It's our lucky number.

MPA-11 Group Leader Cathy Padró

Prasankumar… those samples using advanced laser-based techniques. "We're really trying to understand the properties of complex materials at a very fundamental level," he said. "If there's an experiment you can imagine, there's a good chance we can do it." To study a nanowire in both time and space, for instance, Prasankumar and his colleagues developed a method to focus light pulses through a microscope and record time-resolved images, the results providing scientists a unique look at newly emerging phenomena.

Managing science brings new momentum

In less than six years at CINT, Prasankumar has gone from being a postdoctoral researcher to recruiting and directing them. From his base at the CINT Core facility in Albuquerque, where he supervises two postdoctoral researchers, he travels weekly to Los Alamos to advise three postdoctoral researchers. He oversees labs at both sites as they carry out research using experimental systems he helped design.

He is a reviewer for numerous scientific journals and recently co-edited a book with MPA Division Leader Toni Taylor, a pioneer in terahertz science and technology who mentored him as a postdoctoral researcher. *Optical Techniques for Materials Characterization*, published in 2011, also includes a chapter he co-wrote with Taylor on emerging optical techniques.

As a staff member of a national user facility that attracts hundreds of projects each year, Prasankumar also guides CINT users as they perform ultrafast spectroscopy over an ultraviolet-to-terahertz frequency range. "We are fortunate to have many outstanding scientists from different universities and government labs who are interested in collaborating with CINT, which enables us to produce high-quality science and explore new scientific directions," he said.

Prasankumar said he is involved with 10 to 20 projects a year, spanning a wide range of science—from ultrafast dynamics in semiconductor nanostructures and correlated electron materials, to organic interface layers used in solar cells and negative refraction in optical metamaterials and plasmonic devices.

"Rohit fills a very special niche in our nanophotonics and optical nanomaterials thrust in the Center for Integrated Nanotechnologies," said Morris. "He is a truly first-rate ultrafast spectroscopist, and he has a tremendous grasp of condensed matter physics. This combination enables him to address some of the most interesting and challenging problems in functional nanomaterials, as well as attract CINT users from some of the very best research institutions in the world."

Prasankumar's favorite experiment

What: Coupled charge-spin dynamics in a colossal magnetoresistance (CMR) material

Why: We were studying CMR, in which a material's resistance substantially decreases by reducing the temperature or applying a magnetic field, in a new material, $Tl_2Mn_2O_7$.

When: 2005

Where: Los Alamos's Laboratory for Ultrafast Materials and Optical Science

Who: Rohit Prasankumar, Laboratory colleagues Richard Averitt, Stuart Trugman, and Toni Taylor, and colleagues in Japan.

How: We used ultrashort optical pulses to create electrons and "holes" (imagine electrons with a positive charge) in $Tl_2Mn_2O_7$, after which we sent in ultrashort mid-infrared pulses to measure their lifetimes.

The a-ha moment: Our experiments revealed that some carriers lived for a really long time near the phase transition temperature, where the material becomes magnetized. It took us a while to figure out that this was because electrons and holes, which would normally annihilate each other if they got too close, could lower their energies by separating into different domains (regions where the magnetization switches direction). This work, published in *Physical Review Letters* in 2005, thus indicated that CMR in $Tl_2Mn_2O_7$ might be due to the way electrons move through these domains, which was completely different from what was thought to occur in more standard materials.

Scientists take a giant step forward in understanding plutonium

Nuclear magnetic resonance offers new insights into the element

Plutonium is the most complex element in the periodic table, yet it is also one of the most poorly understood ones. But now a well-known scientific technique, nuclear magnetic resonance (NMR) spectroscopy, may turn out to be the perfect tool for uncovering some of plutonium's mysteries.

Scientists at Los Alamos National Laboratory (LANL) and the Japan Atomic Energy Agency (JAEA) have detected the faint signal of

continued on page 4

Plutonium . . . plutonium-239's unique nuclear magnetic resonance signature. This signal promises to become a Rosetta stone for deciphering the complex atomic-scale electronic properties of this perplexing element. Their paper on the subject, "Observation of ^{239}Pu Nuclear Magnetic Resonance," was published in the May 18 issue of *Science* magazine.

For more than 50 years, chemists and physicists have been searching for the plutonium-239 magnetic resonance signal. Only now, in an international collaboration between Los Alamos National Laboratory and the Japan Atomic Energy Agency, a team of chemists and physicists at Los Alamos has together determined just the right conditions for observing the signal. The team led by visiting professor Hiroshi Yasuoka (JAEA) and Georgios Koutroulakis (Condensed Matter and Magnet Science, MPA-CMMS) observed the plutonium-239 resonance from a high purity solid sample of plutonium dioxide, PuO_2, at a temperature of 4 Kelvin as a function of magnetic field.

Georgios Koutroulakis and H. Yasuoka in the condensed-matter NMR lab at Los Alamos National Laboratory after having observed the magnetic resonance signal of Pu-239 for the first time.

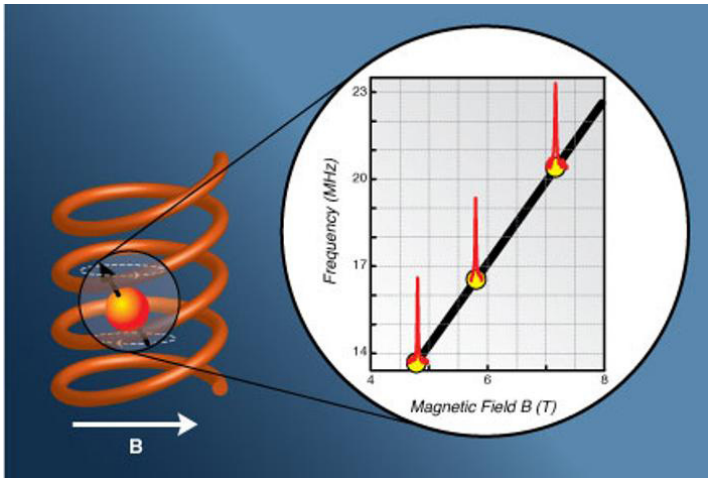
Since its discovery in 1946, NMR spectroscopy has evolved into one of the most widely used techniques for the characterization of materials at the atomic and molecular levels and has formed the basis for magnetic resonance imaging (MRI). NMR has revolutionized the practice of chemistry, physics, and medicine by providing a noninvasive method for the observation of matter at atomic scales.

"Just as knowing the NMR properties of other nuclei has advanced so significantly our ability to understand complex materials and phenomena as well as to image matter on a microscopic scale," said Koutroulakis, "this discovery of the plutonium-239 magnetic resonance promises to revolutionize our understanding of plutonium solid state physics, chemistry, biology, and materials science."

From such studies the team has been able to determine the important physical constant (gyromagnetic ratio) that should allow future studies of plutonium by this technique, they say. This constant is a fingerprint of plutonium's nucleus, but it allows scientists also to study plutonium's electrons. Significantly, these electrons play a decisive role in controlling the metallurgy and chemical reactivity of plutonium alloys and compounds. They are crucial to determining the structural instability of elemental plutonium itself, the formation of molecular complexes as plutonium interacts with the environment and biological matter, and even the creation of unconventional superconductivity.

In view of the importance of plutonium compounds for nuclear fuels, power generation for interplanetary exploration, environmental behavior, and long-term storage of nuclear wastes, the ability to explore plutonium materials using NMR should prove particularly powerful, the scientists say.

Collaborators of Yasuoka and Koutroulakis in this discovery were Hiroyuki Chudo (JAEA), Eric D. Bauer (MPA-CMMS), David L. Clark (Institutes, INST-OFF), Gordon D. Jarvinen (Seaborg Institute), Scott Richmond and Alice I. Smith (Nuclear Materials Science, MST-16), Joe D. Thompson (MPA-CMMS) and Douglas K. Veirs (Actinide Processing Support, MET-1), all at LANL. This work was supported by the U.S. Department of Energy, Materials Sciences and Engineering Division, Office of Basic Energy Sciences and the Division of Chemical Sciences, Geosciences, and Biosciences Division, the Los Alamos Laboratory Glenn T. Seaborg Institute, and the Los Alamos Laboratory Directed Research and Development program. High-purity plutonium oxide was provided by the Surveillance and Monitoring Program at Los Alamos National Laboratory supported by DOE Nuclear Materials Disposition EM-33.



In nuclear magnetic resonance spectroscopy, a resonance between the energy levels of the nuclear spin (black arrow) in a magnetic field (B) is achieved with the help of a coil. For the first time, the nuclear magnetic resonance signature of plutonium-239 was observed at Los Alamos National Laboratory.

Jaqueline Kiplinger named Fellow of the Royal Society of Chemistry

Jaqueline L. Kiplinger (Materials Chemistry, MPA-MC), has been admitted as a Fellow of the Royal Society of Chemistry (FRSC). The Royal Society of Chemistry is Europe's largest professional and academic society for chemistry and traces its roots to the Chemical Society of London, established in 1841. Fellowships are awarded to nominees who have made sustained outstanding contributions to the advancement or application of chemical science or who have demonstrated excellence in the chemical science profession.

Kiplinger is internationally recognized for her contributions to the field of organometallic actinide chemistry. In addition to discovering new actinide reactivity patterns and bonding motifs, she developed a novel synthetic approach that led to the systematic isolation of an entirely new class of molecular uranium complexes, in the rare pentavalent oxidation state, and she pioneered the use of copper and gold reagents as one-electron oxidants for actinide compounds. Kiplinger designed a photochemical synthesis that established the first-ever evidence for the formation of a uranium complex that contains a terminal uranium-nitrogen triple bond. Recently, she has developed simple and safe techniques to make thorium and uranium halide starting materials. She has published nearly 80 journal articles and has received more than 1900 citations.

Kiplinger earned a doctorate in organometallic fluorocarbon chemistry from the University of Utah. Her thesis work on carbon-fluorine bond activation and functionalization garnered the Union Carbide Student Innovation Recognition Award, the Iota Sigma Pi Anna Louise Hoffman National Award for Outstanding Achievement in Graduate Research, and the American Chemical Society's Nobel Laureate Signature Award. She came to Los Alamos as the first Frederick Reines Postdoctoral Fellow in 1999 and received the Lab's inaugural Postdoctoral Distinguished Performance Award in 2001. She joined the Laboratory as a technical staff member in Chemistry Division in 2002.

Los Alamos has recognized her scientific contributions with a STAR Award, Fellows Prize for Research, and a Distinguished Mentor Award. She has received a R&D 100 Award for her development of Th-ING: Thorium Is Now Green, is a cost-effective, environmentally green, and safe method for preparing thorium chloride materials. Kiplinger won three LANL Pollution Prevention Awards and two prestigious NNSA Pollution Prevention Awards, Best-in-Class and Environmental Stewardship. Kiplinger was appointed to the rank of Fellow by the American Association for the Advancement of Science (AAAS) for her contributions in lanthanide and actinide chemistry. In addition to her research accomplishments, Kiplinger has served as a reviewer and subject matter expert for national science funding agencies and international peer-reviewed journals. She completed a three-year term on the editorial board for the American Chemical Society journal *Organometallics* and as an alternate councilor for the American Chemical Society's Division of Inorganic Chemistry.

The Royal Society of Chemistry is the largest organization in Europe for advancing the chemical sciences. Its 47,500 members come from diverse areas of the chemical sciences. FRSC is the senior category of membership.

Technical contact: Jaqueline Kiplinger

MPA postdoctoral researchers make their mark

Marisa Monreal and Ni Ni receive LANL Distinguished Postdoctoral Fellowships; Nan Li awarded Postdoc Distinguished Performance Award

Marisa Monreal (MPA-MC) has been awarded a Frederick Reines Distinguished Postdoctoral Fellowship in experimental sciences. This fellowship is named after the former Los Alamos researcher who won the 1995 Nobel Prize in physics. Awarded to the highest-ranked candidates in experimental sciences, the candidates must have the ability to obtain a DOE "Q" Security Clearance, which usually requires U.S. citizenship.

In 2010, Monreal was a G.T. Seaborg Institute Summer Fellow at LANL, working for Jaqueline Kiplinger (MPA-MC). During this fellowship, she helped to develop the new uranium starting materials, UI_4(1,4-dioxane)$_2$ and UI_3(1,4-dioxane)$_{1.5}$. The method used to synthesize these useful reagents is simple, mild, high-yielding, and generates little waste. It vastly improves upon the

continued on page 6

Celebrating service

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

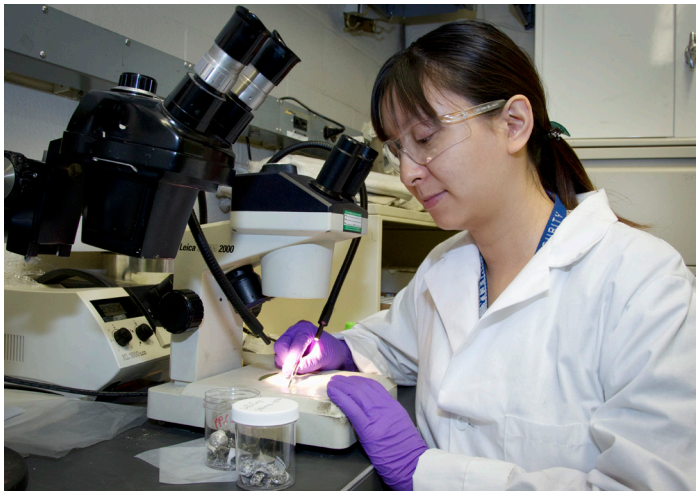
David Langlois, MPA-11	20 years
Jonathan Betts, MPA-CMMS	15 years
Michael Gordon, MPA-CMMS	15 years
Karen Rau, MPA-11	15 years
Manuelita Martinez-Brito, MPA-11	10 years

During her Reines Fellowship Marisa Monreal (MPA-MC) will prepare uranyl fluoride complexes and study their chemistry.

Postdoctoral . . . classic methods used to synthesize uranium halide starting materials. These new uranium iodide reagents are synthesized from depleted uranium metal waste. Scientists around the world use the uranium reagents to facilitate chemistry, catalysis, materials science, and energy research.

After earning her doctorate in chemistry from the University of California, Los Angeles, Monreal joined MPA-MC as a Director's Postdoctoral Fellow in 2011. She worked with Kiplinger (MPA-MC), focusing on the synthesis and chemistry of uranium and thorium fluorides. Due to the role of UF_6 in uranium processing, the uranium fluoride research could find relevance in the nonproliferation community. Very few thorium fluoride compounds have ever been isolated. Therefore, little is known about the chemistry of thorium-fluoride bonds. Monreal has developed new and general routes for synthesis of thorium fluoride compounds, such as thorium tetrafluoride, which is a candidate fuel for liquid fluoride thorium nuclear reactors.

As a Reines Postdoctoral Fellow, Monreal plans to prepare uranyl fluoride complexes and study their chemistry. Within the field of actinide chemistry, this work will have a considerable impact, not only because examples of these complexes are so uncommon, but also because the methods used to prepare these compounds will be adaptable for widespread use by the chemistry community, beyond uranyl complexes and across the actinides. More broadly, this work will provide a major step forward in understanding how to chemically modify the uranyl ion and could lead to essential improvements in processing and separation.

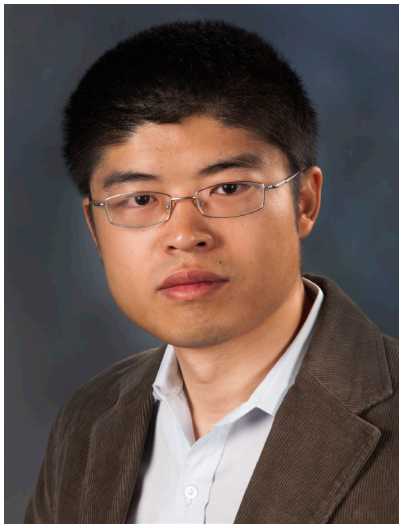


As the Marie Curie Fellow, Ni Ni (MPA-CMMS) will investigate the design, discovery, and characterization of new d-electron heavy fermion materials.

Ni Ni (MPA-CMMS) has received LANL's newest Distinguished Postdoctoral Fellow appointment, the Marie Curie Distinguished Postdoctoral Fellowship. This appointment, named after the eminent nuclear scientist and only person honored with two Nobel Prizes in different scientific categories (physics in 1903 and chemistry in 1911), is open to outstanding women scientists and engineers of all nationalities who are engaged in research aligned with the Lab's missions. Ni is the first person to receive this fellowship.

Ni received a doctorate in physics from Iowa State University in 2009. Filip Ronning (MPA-CMMS) is the postdoctoral mentor for her research topic, "Developing a Materials Strategy for *d*-electron Heavy Fermion Systems." She plans to investigate the design, discovery, and characterization of new *d*-electron heavy fermion materials. The essential challenge in this task is to inhibit the *d*-electrons' natural tendency to hybridize strongly. To generate the weak hybridization necessary for heavy fermion formation, Ni will explore compounds where the transition metal element is only marginally soluble in the metallic host compound or in geometrically frustrated lattices. She will perform density functional theory calculations, exploratory synthesis, and characterization to test whether target compounds are weakly hybridized and heavy fermion states are achieved. Her goal is to discover the first *d*-electron heavy fermion superconductor. This research will unveil new classes of strongly correlated materials and emergent phenomena. In comparison with the *f*-electron heavy fermion systems, additional energy scales such as spin-orbit coupling will also differ and lead to the modification of the relative hierarchy of energy scales. This research will assist in elucidating emergent phenomena that develop in heavy fermion materials. It will help determine whether localized *d*-electrons can carry the spin anisotropy necessary to act as possible replacements for *f*-electron

continued on page 7



Nan Li is the recipient of a Postdoctoral Distinguished Performance Award for his research in MPA-CINT.

Postdoctoral… rare-earth magnets. By comparing the localized and itinerant dual nature of *d*- and *f*-electron heavy fermion materials and transition metal oxides, Ni seeks to bridge this mapping experimentally. The results will enrich the understanding of other strongly correlated electron phenomena, such as correlated magnetism, high Tc superconductivity, and metal-insulator transitions.

Recipients of Distinguished Postdoctoral Fellowships must display extraordinary ability in scientific research and show promise of becoming outstanding leaders in the research they pursue. These fellowships provide the opportunity for recipients to collaborate with LANL scientists and engineers on staff-initiated research. Appointments are for three years.

Nan Li (Center for Integrated Nanotechnologies, MPA-CINT) is the recipient of a Postdoctoral Distinguished Performance Award, for his contribution in the areas of physical vapor deposition synthesis of nanometal, transmission electron microscopy (TEM), radiation damage, and nanomechanics. Li was nominated by his mentor, Amit Misra.

The award recognizes individual postdoctoral researchers or teams of no more than three postdoctoral researchers who have made an outstanding and unique contribution resulting in a positive, significant impact on the Lab's programmatic or organizational efforts, or status in the scientific community during the 2011 fiscal year.

Quantum interference in carbon nanotubes

Quantum interference in the resonance Raman response from carbon nanotubes is expected when certain conditions are met, but it has been a long-standing challenge in nanotube spectroscopy to demonstrate the effect. In work recently published in *Physical Review Letters*, Steve Doorn (MPA-CINT), Juan Duque (Physical Chemistry and Applied Spectroscopy, C-PCS), and Hagen Telg (MPA-CINT), with collaborators at Boston University (BU), National Institute of Standards and Technology (NIST), and the University of New Mexico (UNM), show for the first time clear evidence of the phenomenon in carbon nanotubes. Quantum interference is a general wave concept for any coherent interaction, with the most prominent example being the double slit experiment. While this example has its classical analog in interfering electromagnetic or particle waves, other cases of quantum interference usually lack a classical equivalent. Thus, the phenomenon can only be understood more generally as the interference of probability

continued on page 8

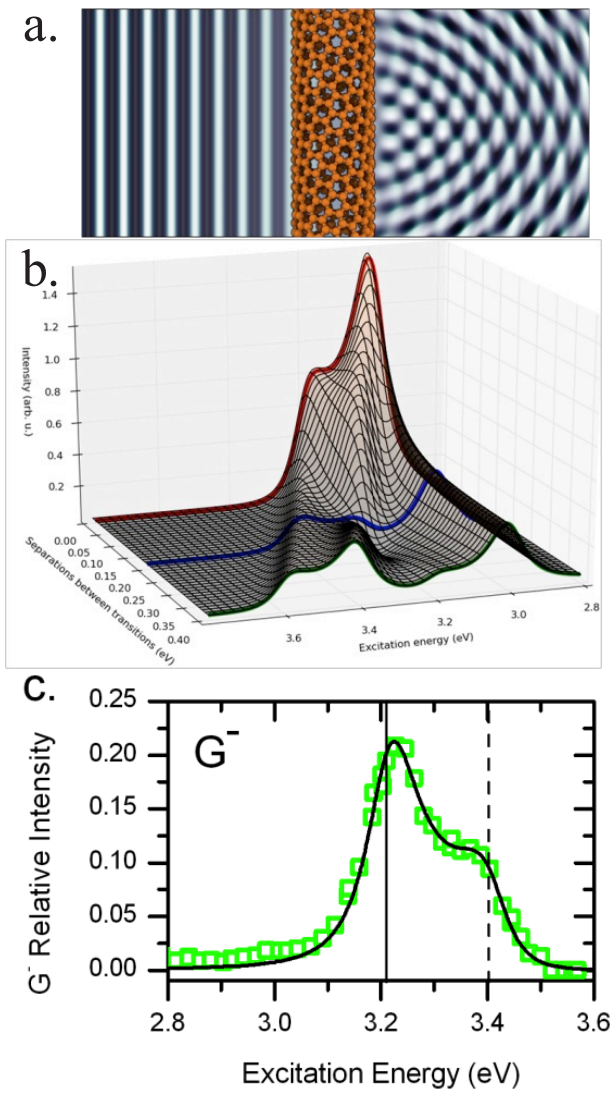


Figure 1. a) Conceptualization of Raman interference effect in carbon nanotubes. b) Simulation of Raman response for G- phonon mode at varying energy separation of the two interfering electronic states and reflecting response for non-interacting states (green trace), destructive interference at moderate energy separations (blue) and strong constructive interference at near-zero energy separation (red). c) Experimental G- phonon Raman intensity response as a function of excitation energy displaying nearly exactly the strong constructive interference case of the model (note the reversal of the energy axis in (b) and (c)).

Quantum… waves resulting from the mathematical construct behind quantum mechanics. Resonance Raman spectroscopy is one case in which the observed signal can be strongly affected by interference, but typically responses are not easily interpreted, as the interference arises from broad, poorly resolved optical transitions. However, the unique signatures of interference can be a powerful tool for revealing fundamental underlying behaviors, including demonstrating changes in electron-phonon interactions and mixing of electronic states that may determine optical relaxation pathways critical to photonics and energy harvesting applications of carbon nanotubes.

In their new work, the Los Alamos researchers have demonstrated that the Raman equivalent of the double slit experiment (depicted conceptually in Fig. 1a) can be observed in semiconducting carbon nanotubes. The ability to work with samples highly enriched in specific nanotube structures (provided by NIST), paired with LANL-unique tunable UV Raman capability, was critical for enabling the findings. To show the effect, the researchers chose nanotube structures with two closely spaced optical transitions, with Raman interference occurring between the two. The narrow, well-defined transitions found in carbon nanotubes were essential to their ability to observe nearly textbook quantum interference behavior. The result also enabled the team to extract the sign-behaviors of the related electron-phonon coupling, which can only be observed in the presence of interference. Structural tuning of the transition energy spacings allowed the researchers to access behaviors ranging from strong constructive interference to nearly complete destructive interference (see Fig. 1b and 1c).

Reference: "Quantum Interference Between the Third and Fourth Exciton States in Semiconducting Carbon Nanotubes Using Resonance Raman Spectroscopy," by Juan G. Duque (C-PCS), Hagen Telg (MPA-CINT), Hang Chen (Boston University, BU), Anna K. Swan (BU), Andrew P. Shreve (UNM), Xiaomin Tu (NIST), Ming Zheng (NIST), and Stephen K. Doorn (MPA-CINT); *PRL* **108**, 117404 (2012).

The research was performed in part at the Center for Integrated Nanotechnologies (CINT), a DOE Office of Basic Energy Sciences User Facility.

Technical contact: Stephen Doorn

Electrochemical Society names Garzon president

Fernando H. Garzon (Sensors & Electrochemical Devices, MPA-11) was recently elected president of the Electrochemical Society for the 2012-2013 term. As ECS celebrates its 110th anniversary and continues to cultivate research related to the sustainability of our planet, Garzon serves as the chief scientist and the principal representative of the society. Having taken office in May, he presides over all meetings of the executive committee, the board of the directors, and the society, while also overseeing the publications.

A member of ECS since 1986, Garzon served for three years as senior vice president of the board of directors, which involved scientific coordination, meeting organization, symposium planning, and financial oversight.

At Los Alamos National Laboratory, Garzon is the MPA-11 materials chemistry team leader. His current research is focused on polymer fuel cells and high-temperature, proton-conducting electrolytes.

A high achiever in the field of energy science and technology, he is co-inventor of an R&D 100 award-winning, high-temperature combustion control sensor and a new class of solid-state gas sensors. He has co-authored more than 100 peer-reviewed scientific publications, with more than 1,500 citations. He also co-authored two *Handbook of Fuel Cell* chapters, edited the S*olid State Ionics Devices Technical Series*, and made numerous invited conference presentations. Garzon earned his PhD in materials science and engineering from the University of Pennsylvania. During his postdoctoral appointment at LANL he studied supercapacitor materials under Ian Raistrick, who is now retired.

Garzon is the past chairman of the High Temperature Materials Division of Electrochemical Society, is a member of the Materials Research Society, the International Society for Solid State Ionics, and the American Ceramics Society. He also won the 2009 DOE Hydrogen and Fuel Cell Program Award.

The Electrochemical Society, www.electrochem.org, is a nonprofit educational organization concerned with a broad range of phenomena relating to electrochemical and solid-state science and technology. It has a membership of 8,000 scientists and engineers in more than 70 countries, publishes journals, and holds international biannual meetings.

Technical contact: Fernando Garzon

Using ionic liquids for forensic analysis

Rico Del Sesto (MPA-MC) recently gave an invited talk at PittCon 2012 on the use of ionic liquids to break down the extremely robust keratin protein structure that comprises wool, and extract organic

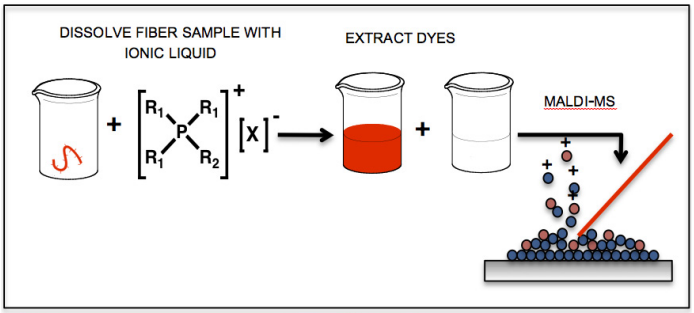
continued on page 9

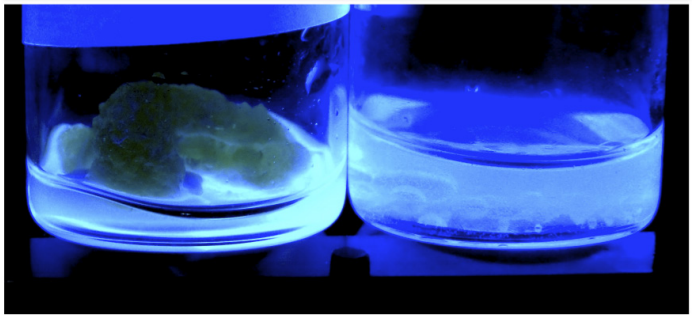
Ionic… and inorganic compounds and contaminants for direct forensic analysis. The technique, which was also highlighted in the April 2, 2012 issue of *Chemical and Engineering News*, could lead to new methods in forensic analysis of IED (improvised explosive device) and criminal sites. This research was supported by the Intelligence Community to develop new methods for analysis of wool textiles, as there are no standard methods that can extract and analyze contaminants in those textiles without destroying the analytes in the process. The method developed by the LANL team is so powerful due to the non-destructive nature in extracting contaminants, the one-pot approach to extraction-analysis, and small volumes, all of which will reduce time and cost of processing samples, with the potential to deploy on-site analytical methods.

In his talk, he presented the use of ionic liquid to break down the extremely robust keratin protein structure that comprises wool. This is primarily due to the strong interactions that occur between the dyes and wool fibers, which are comprised of the protein keratin, as well as nonpolar nature of the dyes used. The binding of the dye to the wool is through extensive and cooperative electrostatic, hydrogen-bonding and hydrophobic interactions. This makes aqueous extractions ineffective. Ionic liquids are ideal for addressing this challenge, due to their inherent ionic nature and tunability for disrupting hydrogen bonding and hydrophilic or hydrophobic interactions.

The team used room temperature ionic liquids (RTILs) based on tetraalkylphosphonium cations as the basis of a platform that enabled them to separate dyes from wool textiles and extract dyes from aqueous solution. MALDI-MS (matrix-assisted laser desorption ionization mass spectrometry) identified dyes in a single experimental step for forensic purposes. Multiple dyes can be identified from complex mixtures, simply by heating the dyed wool fiber in the ionic liquid, then spotting 1 mL for the MALDI analysis. Detection limits for this method are approximately 5 femtomoles of dye material, and the extraction and analysis can be performed on very small (less than 5 mm) length fibers. Future development of this method will include application to a wider range of forensic and environmental sampling.

The team involved in this research includes Rico Del Sesto, Katherine Lovejoy, Geraldine Purdy, Alexander Lou and Lauren Davis (MPA-MC); Andrew Koppisch (Northern Arizona University); and Srinivas Iyer, Timothy Sanchez, and David Fox (Biogenergy and Environmental Science, B-8). Funding for the Los Alamos portion of the research was provided by the Intelligence Community and LDRD. The work supports the Laboratory's efforts in the Global Security mission and the Signatures of Science pillar. Read the highlight at cen.acs.org/articles/90/i14/Ionic-Liquids-Improve-Separations.html.





(Top) A single-pot approach to extraction and forensic analysis of wool fibers with an ionic liquid; (bottom) An ionic liquid extracts dyes used in wool textiles, shown under UV-light.

HeadsUP!

New website for ADEPS Worker Safety and Security Team

The ADEPS WSST has a resource and information page located on the ADEPS internal website: int.lanl.gov/org/padste/adeps/wsst.shtml.

The site includes the team's most recent meeting minutes as well as links to a wide range of related safety and security information.

Your ADEPS WSST members are

- ADEPS: Jeff Schinkel
- LANSCE-DO: Howard Nekimken
- LANSCE-LC: Eric Larson
- MPA-CMMS: Michael Torrez
- MPA-MC: Eve Bauer, chair
- MST-6: Erik Luther
- MST-8: Thomas Sisneros
- P-25: Jeff Bacon, co-chair

MPA MaterialsMatter

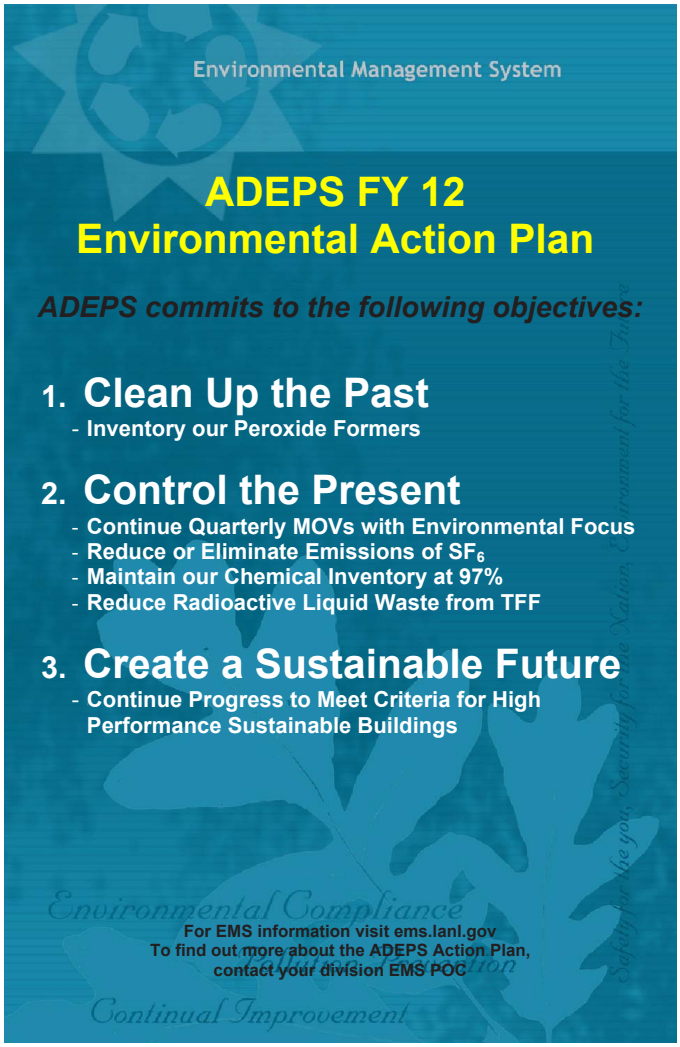
Published by the Experimental Physical Sciences Directorate.
To submit news items or for more information, contact Karen Kippen, ADEPS Communications, at 606-1822, or kkippen@lanl.gov
LALP-12-011
To read past issues see www.lanl.gov/orgs/mpa/materialsmatter.shtml

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by Los Alamos National Security, LLC, for the National Nuclear Security Administration of the U.S. Department of Energy under contract DE-AC52-06NA25396. A U.S. Department of Energy Laboratory.

It's time to come up to speed on the Directorate's implementation of the FY12 Environmental Action Plan (EAP) that was developed in support of the Lab's Environmental Management System. The ADEPS team responsible for developing and disseminating the plan includes Steve Glick from P Division (also serves as the Directorate Point of Contact), Jim Coy from MST, Cathy Padró from MPA, and Frances Aull from LANSCE.

Our 2012 Environmental Action Plan addresses our impact on the environment. You have seen the poster: we will attack this from three angles—the past, the present, and the future.

Let's look at our objectives, and the specific targets we have developed to meet the objectives. These objectives parallel the LANL institutional objectives, with the targets fine-tuned to fit our Directorate's needs.



Objective 1 – Reduce Environmental Risks from Historical Operations, Legacy, and Excess Materials and Other Conditions Associated with Activities No Longer a Part of Current Operations (CLEAN UP THE PAST). Last year, we worked with the Lab's Environmental Team to understand our chemical waste generation profile so that we can establish long-term waste-reduction goals. Our focus this year is peroxide formers—we will perform a focused inventory of out-of-date peroxide formers to ensure proper testing and to identify potential disposal pathways.

Objective 2: Control and Reduce Environmental Risks from Current, Ongoing Operations, Mission, and Work Scope (CONTROL THE PRESENT). Managers will continue to emphasize environmental aspects during MOVs, we will conduct an annual chemical inventory, and we will disseminate information on the EAP using posters, group briefings, and e-mails. In addition, we are specifically targeting reduction or elimination of SF_6 releases. SF_6 is an extremely potent greenhouse gas and reducing or eliminating emissions is an institutional goal associated with the Site Sustainability Plan. Finally, MST Division was in line to receive institutional funding to reroute non-RLW (rad liquid waste) discharges at Target Fab Facility that currently go to the RLW Treatment Facility, but the project is on hold due to the funding being withdrawn.

Objective 3 – Reduce Environmental Risk from Customer Expectations and Regulatory Requirements Associated with Future Conditions, Managing these in Alignment with Short- and Long-Term Planning, Work Scope Projects, etc. (CREATE A SUSTAINABLE FUTURE). We will continue to work towards the requirements for High-Efficiency Sustainable Building recognition for the MS-OB (03-1415), including additional tenant education and the formation of a Green Team.

To succeed, we need everyone to "up" their awareness and take action. Turn off lights in offices, conference rooms, hallways, and labs when not in use. Get that leaking faucet/toilet/urinal fixed (contact your facilities coordinator). Turn off computer peripherals when not in use. Alter your purchasing habits–Purchase GREEN. Use the blue and green recycling bins. Share chemicals, minimize chemical inventories, purchase safer alternatives, recycle and dispose properly. Salvage all unnecessary or unused (and not needed) equipment. Nominate a deserving colleague for a P2 (Pollution Prevention) Award!!

Document, Record & Report all significant environmental actions that you take that positively affect the environment. Remember, if it's not recorded, it didn't happen. Please send your environmental action reports (e-mails are fine) to your Division contact: jcoy@lanl.gov for MST; padro@lanl.gov for MPA; aull@lanl.gov for LANSCE, and sglick@lanl.gov for P Division. This will ensure that our efforts continue to get the deserved recognition for our environmental efforts.

Steve Glick, ADEPS EMS point of contact