

inquiry

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Issue 2

Science & Technology at the Ames Laboratory

Faces

of The Ames Laboratory

Faces of 10

P A G E

THE AMES LABORATORY

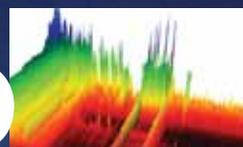
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The Ames Laboratory is a U.S. Department of Energy national laboratory seeking solutions to energy-related problems through the exploration of chemical, engineering, materials and mathematical sciences, and physics. Established in the 1940s with the successful development of the most efficient process to produce high-purity uranium metal for atomic energy, Ames Lab now pursues much broader priorities than the materials research that has given the Lab international credibility. Responding to issues of national concern, Ames Laboratory scientists are actively involved in innovative research, science education programs, the development of applied technologies and the quick transfer of such technologies to industry. Uniquely integrated within a university environment, the Lab stimulates creative thought and encourages scientific discovery, providing solutions to complex problems and educating and training tomorrow's scientific talent.

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U.S. DEPARTMENT OF ENERGY

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From the Director

FACES OF THE AMES LABORATORY

IF YOU FOLLOW THE POPULAR MEDIA, SCIENTISTS appear to be a quirky bunch of people. I'm not too concerned about that image, though, for a couple of reasons. First, I work around a group of truly outstanding scientists, so I know the truth. Second, I have observed over the course of many decades that the media – and TV in particular – present new groups first as caricatures and slowly develop mainstream roles for them over several seasons of programming and casting. Scientific characters are on that path, but we still have a little way to go.

This issue of *Inquiry* is devoted to introducing some of the Ames Laboratory's people to our readers. Our people are the core of our success, and the Ames Lab's team includes some really interesting ones. Like all other scientists, they are regular people of all kinds, with regular lives and regular sorts of interests, but they do share a handful of distinguishing features. First and foremost, they are all high achievers. Second, they all pursue their work – and the rest of their lives – with great intensity. Third, they see connections between their work and the rest of their lives that may or may not be obvious to the casual observer.

Here is an image of me, somewhat outside of the context of my work, with a few of my favorite things. You may well ask what connects a collection of guitars to directing a DOE national lab. Well, the Ames Laboratory does the fundamental science in chemistry and physics, and the applied science that allow new materials to be invented and engineered for use in products that we all use. The guitars in my collection all contain non-traditional materials such as polymers, metals, composites, and even ceramics (in some of the magnetic pick-ups). As a materials scientist, I am fascinated with the ways in which materials affect the performance of the products in which they are used, and these guitars provide endless examples of materials chosen for various reasons, both good and bad, with varying degrees of success.

Read on to see how some of the Ames Laboratory's scientists relate their work to the rest of their lives.

In this issue, we've also highlighted some of the work being done by the Midwest Forensics Resource Center. The MFRC serves regional partners, particularly state crime laboratories, in some 16 states. Ames Laboratory researchers are working to bring basic research techniques and knowledge to bear in identifying new ways to make connections between evidence and criminal activities.



... these guitars provide endless examples of materials chosen for various reasons, both good and bad, with varying degrees of success.

Alex King
Alex King, Director



Iowa Powder Atomization Technologies (IPAT) won \$25,000 in the John Pappajohn Entrepreneurial Center's business plan competition. From left: IPAT cofounder Andrew Heidloff, IPAT business developer Doug Moore, John Pappajohn and IPAT cofounder Joel Rieken.

IPAT wins Pappajohn Iowa Business Plan Award

Iowa Powder Atomization Technologies, a start-up company based on technology developed at the Ames Laboratory, won the 2012 John Pappajohn Iowa Business Plan Competition. The competition honors top business plans of companies in business for four years or less, with an aim of stimulating business development. The prize includes \$25,000 in seed money.

Iowa Powder Atomization Technologies plans to use several Ames Lab-developed technologies to make fine spherical titanium powder for use in military, biomedical and aerospace applications. Their technique will increase the efficiency of the titanium powder making process and, thus, lower the cost of the powder to manufacturers.

CLEM RECEIVES IEEE SUPERCONDUCTIVITY AWARD

John R. Clem, senior physicist emeritus, Ames Laboratory and Distinguished Professor of Physics Emeritus, Iowa State University, was selected to receive the 2012 IEEE Council On



John Clem

Superconductivity Award for Significant and Sustained Contributions to Applied Superconductivity. The award, consisting of a plaque, a medallion made of niobium, and an honorarium, were

presented at the 2012 Applied Superconductivity Conference in Portland, Ore.

Prozorov named APS Fellow

Ames Laboratory physicist Ruslan Prozorov was selected as an American Physical Society Fellow. He was chosen for "high-resolution measurements of the London penetration depth of superconductors." Prozorov was nominated by the APS Division of Condensed Matter Physics.

Prozorov, who is also an associate professor of physics at Iowa State University, specializes in understanding the electromagnetic response of superconducting, magnetic, hybrid and nanosized materials at low temperatures.



Ruslan Prozorov

Virtual Reality spray paint training software wins FLC Award

Ames Laboratory recently partnered with the Iowa Waste Reduction Center at the University of Northern Iowa to improve spray paint training using a virtual engineering software toolkit. The software enhancements won a regional Federal Laboratory Consortium award for applying federally developed technology to industry needs.

VirtualPaint software, developed by the Iowa Waste Reduction Center, is a painting simulator designed to teach military personnel, commercial painters and other paint spray technicians the correct techniques for spray paint operations. Practicing paint skills in a virtual environment rather than a spray booth reduces hazardous air emissions, saves paint and reduces travel time for paint trainees.

IWRC staff sought to expand the capabilities of VirtualPaint and knew they needed a software solution that could handle the program's large data models and maintain realistic real-time virtual painting simulations. Ames Laboratory's VE-Suite, an open source virtual engineering software toolkit, fit the job.



Deb Covey (center), Ames Laboratory associate director for sponsored research administration, accepts the Federal Laboratory Consortium Midcontinent Excellence in Technology Transfer award for improvement to VirtualPaint. Susan Sprake (left), FLC Midcontinent coordinator, presents the award, joined by Karina Edmonds (right), the Department of Energy's technology transfer coordinator.

MacDonald selected for ASME Young Investigator Award



Erin MacDonald

Erin MacDonald, an affiliated researcher at the Ames Laboratory and an assistant professor of mechanical engineering at Iowa State, recently received the ASME Design Automation Young Investigator Award. The award recognizes an outstanding young investigator who is making noteworthy contributions in the area of design automation, including research in design representation, design optimization, design evaluation, and/or design integration.

Barton elected president of the American Chemical Society

Thomas Barton, retired director of the Ames Laboratory and distinguished professor emeritus of chemistry at Iowa State University, has been elected president of the American Chemical Society. During his three-year succession, Barton will serve as ACS president-elect for 2013, president of the society in 2014 and immediate past-president in 2015 and will also serve on the board of directors.



Thomas Barton

Barton said his priorities will be improving elementary and secondary science education in America, boosting the public's appreciation of chemistry and addressing employment and globalization issues.



Material Witness:

Midwest Forensics Resource Center lends scientific expertise to law enforcement

BY LAURA MILLSAPS

Taylor Grieve, graduate research assistant in the MFRC, prepares a tool mark sample for scanning by profilometer.

IN THE JUSTICE SYSTEM, A MATERIAL WITNESS POSSESSES knowledge or expertise so vital to the case that their testimony is critical to the outcome of the trial.

The field of science itself has become a material witness and just as vital to the justice system and homeland security, as demand grows for an ever higher degree of scientific accuracy and reliability in the investigation of forensic evidence.

The Ames Laboratory has built an international reputation in materials science, including the development of advanced tools and techniques for materials characterization of surfaces, structure, chemistry, and physical behaviors. While the principal mission of the laboratory is finding solutions to energy challenges, these new and increasingly accurate and sophisticated characterization techniques have key benefits in other fields, such as homeland security and forensic science.

Ames Laboratory's excellence in materials characterization makes the Midwest Forensics Resource Center a good fit for the Lab, which oversees the program in partnership with Iowa State University's Institute of Physical Research and Technology. The MFRC brings together the Ames Laboratory's unique research capabilities to support the needs of crime laboratories in 16 states in areas as diverse as molecular and elemental spectroscopy of inks and toners, fracture analysis, toolmark identification, and bloodstain analysis.

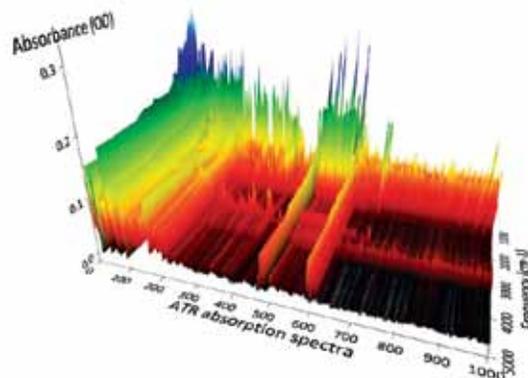
Finding print media's true signature: ink analysis

In the discipline of questioned documents investigation, one of the key clues to verifying the authenticity of a signature or the document itself is the ink on the page. The MFRC is researching ways to bring a higher degree of speed and accuracy to ink analysis.

Ames Laboratory scientist John McClelland and his research team are working with the U.S. Department of Homeland Security and the National Institute of Justice to develop a comprehensive data bank of printing inks and toners as well as computer search software for sample identification.

It's a painstaking job, building the database

"Our researchers are in the process of collecting samples from manufacturers, and it's been a slow process, since inks and toners are highly proprietary. They understand the importance of what we're doing, but we've been signing a lot of non-disclosure agreements," says McClelland about the project under way.



A side-by-side stacked comparison of the infrared spectra of 450 different inks and toners. The Midwest Forensics Resource Center is assisting the Department of Homeland Security and the National Institute of Justice to establish a comprehensive databank of printing inks and toners.

The researchers are using multiple spectroscopic analytical techniques to characterize samples: mass spectrometry, infrared spectroscopy, and x-ray fluorescence.

Ames Laboratory scientist Tonu Reinot has developed computer search algorithms and software that combines and interprets the data from all three of the techniques.

“We find that this approach provides search capability that is more robust, and less subject to false alarms,” says McClelland. “This is particularly important as more and more ink data is put in the library and increasingly only small differences exist between various inks in the library.”

The MFRC also helped the U.S. Secret Service, one of the foremost questioned document authorities, in establishing a similar database for handwriting inks. For decades, the Secret Service maintained an extensive library of physical ink samples, along with thin-layer chromatography data that identified the unique characteristics of each ink.

“The problem with thin-layer chromatography is it’s fairly time consuming, and not a really easy thing to implement when you have many samples to test and identify,” says McClelland of the process, which uses an adsorbent material on a plate to separate out various analytes of a substance.

McClelland’s research group tested a variety of techniques, including infrared spectroscopy, Raman spectroscopy and also a relatively new mass spectrometry (MS) technique called Direct Analysis in Real Time-MS (DART-MS), which allows a substance to be analyzed without sample preparation and in the open air.

“It turned out that mass spectra are the most definitive for searching and identifying an unknown sample against a database of known samples,” says McClelland. “Thin layer chromatography is a respected analytic technique; but mass spectrometry is more easily applied, and you can get more detail in a mass spectra analysis than in a thin layer chromatogram. It’s a better fingerprint, you could say.”

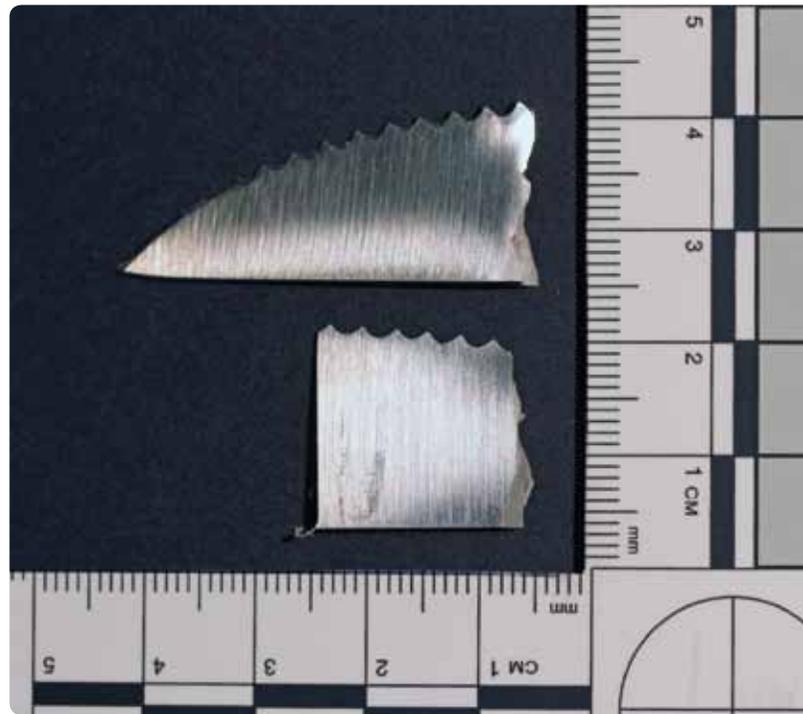
Break in the case: fracture analysis

Often a crime or accident scene is littered with evidence that comes in pieces: shattered plastic, glass or metal, torn fabric or tape. It’s up to forensic investigators to determine how the pieces of the evidence, and therefore the story, fit together.

A team of materials scientists is applying fracture analysis methods to the study of broken knife blade tips to determine if there is a scientific methodology that can be applied to bolster visual inspection of evidence.

“Much of the forensic examiner’s work is by eye, to see if they can match one piece of a broken object to another,” says Barbara Lograsso, associate scientist with the Ames Laboratory. “Instead of only trying to match the surfaces visually, we want to be able to show that a technique can significantly and measurably discriminate between matches and nonmatches.”

The scientists are analyzing the fractured surface areas using a 3-D interferometer, which generates a surface height



A sample broken knife blade. MFRC scientists are researching methods to describe the unique characteristics of fractured surfaces to aid in forensic investigation.

topographical map of the surfaces. A MATLAB software program was developed to “read” the data and perform match analyses. At this level of analysis, the scientists can provide a lot more detail about the fractured surfaces.

“Some of those features are quite unique to the event,” says Ashraf Bastawros, an Ames Lab associate and an associate professor of aerospace engineering at Iowa State University who specializes in fracture mechanics. “If I break two surfaces I will find some commonalities because they are from the same material, but the additional information is how it was broken. Was it bent? Or bent and twisted? All of those leave unique characteristics on the surface of the fracture.”

That precise level of detail may be vital in cases where visual inspection of evidence isn’t sufficient to prove a definite match.

“Investigators may have pieces that broke a couple of times and you cannot put it together like a jigsaw puzzle,” says Bastawros. “There may be pieces missing altogether. So when you cannot do that, this method can tell more from the unique fractured surface characteristics, something less likely to be disputed in court.”

“What forensic examiners don’t have right now is a technique or process that has some determination of uncertainty, a statistical error rate, to bolster their judgment,” says Lograsso. “We hope to provide that with a method and citable literature.”

They also intend to produce an open-source software program that allows an image of the material sample to



Researchers collect toolmark samples by dragging a screwdriver tip across a lead plate. Scientists at the MFRC have developed statistical algorithms to compare toolmarks to tools and determine matches. Ultimately researchers hope to develop a software program that can generate virtual tool marks for comparison to a sample tool.

be analyzed, with statistical tools to quantify the quality of a match.

“It’s not possible to measure the total population of all possible specimens, but we’ve got a start with knife tips,” Bastawros says. “We’ll be measuring some materials and once we finish the basic platform, it will have a lot of other applications. We are now working in metal, but it could be applied to ceramics, plastic or glass.”

The tools to build a case: impression evidence analysis

Criminals often leave their mark in the most literal sense—marks left by scrapes and impacts of common household objects like tools. Forensic examiners are tasked with matching this impression evidence to a tool, under the assumption that individual tools and their marks are unique.

“That’s been the problem,” says Scott Chumbley, an Ames Laboratory materials scientist. “I’ve worked with many examiners and they have a high level of experience and integrity. When they say there’s a match, I’ve agreed with them. But an attorney can always argue ‘this is just your opinion.’ So that became the question. If you have a tool, can you show quantitatively that the marks left by it are unique to only that tool?”

Chumbley joined with Max Morris, an associate professor in the departments of statistics, and industrial and manufacturing systems engineering at Iowa State University, to find out if they could develop a way to computationally compare toolmarks to the tool that made it, resulting in statistically valid matches.

They began with a common toolbox item, a flat head screwdriver.

“That was the starting point,” says Morris. “Practically speaking, it was not going to get them where they need to

be in the crime lab, with a database of hundreds of types of tools, but you have to start with a version of the problem you can get your hands around.”

The research team obtained 50 screwdrivers that were sequentially made on the same manufacturing line. Striations were made by dragging screwdriver tips across sheets of lead at set angles, and traced using both stylus and optical profilometers. Morris developed a statistical algorithm to analyze the toolmarks and compare them with a tool, with the aim of determining whether the tool and toolmarks match.

“We’ve shown that you can have 50 screw drivers that are nearly as identical as possible coming off the manufacturing line, and we are still able to tell one from the other with fairly high degree of certainty,” says Chumbley.

The research team is now studying another common tool, slip joint pliers, and the marks they leave when cutting wire.

“It’s a more complicated version of the original research,” says Chumbley. “In this situation we have two separate cut marks, different from each other but related to the same tool.”

Song Zhang, an associate professor of mechanical engineering at Iowa State University and a specialist in facial recognition technology, is developing an open source computer program to generate sample toolmarks for comparison, using Chumbley and Morris’ research as a foundation.

“The idea is to scan a tool tip, get a 3-D representation, and then write a software program that can generate any possible mark from that tool in the virtual world, in any way that we want, with any resolution we want, at any angle we want,” says Zhang.

Zhang envisions a system, possibly portable, that relies on an optical profilometer to scan marks and tool tips.

“Optical profilometers present some design challenges because of data quality, but they are preferred by forensic examiners because they don’t touch the sample and compromise evidence,” he says.

The program could simplify much of the painstaking sample comparisons that forensic examiners do to substantiate a match.

“This software tool will eliminate a lot of the possibilities they might otherwise have to consider before making a determination. We will still need forensic examiners to make the final judgment.”

A pattern of evidence: blood impact spatter analysis

It’s often the most disturbing evidence of a crime: spatters of blood on floors, walls, and other objects. But the patterns formed by these droplets can give investigators a better picture of how a criminal event unfolded.

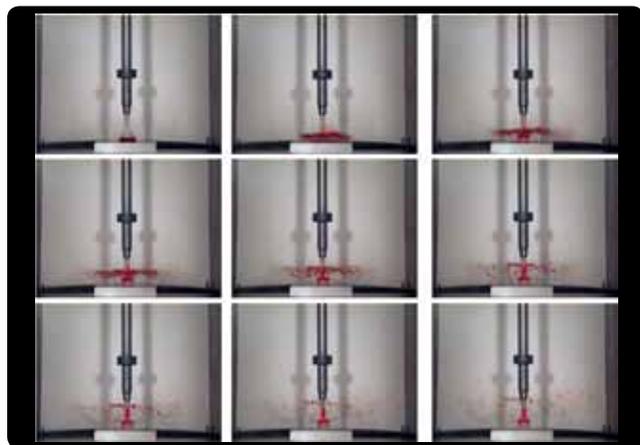
David Baldwin, director of the MFRC, says what’s been missing from blood spatter study is basic research.

“There was a lot of forensic training that went on where they said ‘this is what happened and this is what you see at the end.’ But they didn’t really know how it got there. People were trained based on experience at crime scenes, not as physicists or as fluid dynamicists. Their explanations may not have made any realistic sense to a scientist.”

To fill the need for research, the MFRC has amassed a library of 500 video clips of blood spatter experiments showing how blood as a fluid behaves when it falls or spatters in relation to objects like bullets, cloth, wood and tools.

“The library is one of our best products, and it’s used constantly. It has very quickly become invaluable to crime scene analysts,” says Baldwin.

The MFRC is continuing that research by characterizing blood impact spatter, or what happens when an object strikes an open source of blood.



A series of still photos from a high speed video of a blood impact spatter experiment. Researchers at the MFRC are studying the physics of how blood spatter is formed under different variables such as the quantity of blood and the velocity of impact.



A single frame of a high speed video of blood impact spatter.

“This is basic science. This is physics,” says Baldwin. “I want to understand the parameters that are involved in determining the appearance of bloodstain patterns. No one’s really bothered to study the physics of the distribution, the size of the drops, their locations, and how they are affected by physical parameters that might matter, like velocity and mass. If we don’t do these types of physics experiments, we won’t know that you can or can’t say anything definitive about those end products.”

Baldwin’s team of scientists is conducting experiments by constructing a rig or apparatus in a controlled lab environment that eliminates extraneous crime scene details.

“This is a very physics-oriented experiment where we control the surface area, the depth of the blood, the diameter of the pool, the velocity of the impact, the diameter of interaction. Our goal is to determine parameters for the distribution of stains that are relevant and tell us something about what happened,” says Baldwin.

Though the focus of this research is understanding the physics of blood spatter, Baldwin says he could foresee technology that takes an image of blood spatter at a crime scene and analyzes the possible causes, “but that’s in a farther-off future.”

Blood impact spatter research and the more than 60 other research projects supported by the MFRC over the past decade, says Baldwin, are part of the ongoing effort to bring more exacting science to evidence investigation.

“The entire discipline of forensics is about trying to say something based on the end observables, without any control over or knowledge about what happened on the front end,” explains Baldwin. “Scientists would call that inverse problem engineering. Because of the growing demand in the justice system for a citable scientific justification for admitting physical evidence, we’re here to help forensic investigators do just that.”





ANY INSTITUTION HAS RECOGNIZABLE LANDMARKS. But it's not the bricks and mortar that define the place. People are necessary to give it character, reputation and unique qualities – in other words, a face. An organization requires people quite literally as its life blood.

The Ames Laboratory is no exception. The Lab's character and reputation rely on the intellectual power of its researchers' minds to drive the engine of discovery. And while there are requisite staff who are vital to help keep that engine finely tuned and humming, the Lab exists because of the knowledge, expertise and curiosity of its researchers.

So how do you put a face on the Ames Laboratory? That's a tough call, given the wide range of fields of study, personalities, backgrounds, ages and interests to be found among its researchers. But despite their differences, they all possess a keen interest in what they do and work hard to solve the unanswered questions in front of them.

While it's not possible to share the stories of all of the Lab's 250 some scientists and engineers, here's a closer look at just a few of the



Faces of The Ames Laboratory

Emily

BY KERRY GIBSON

S M I T H



In her spare time, Emily Smith loves to go hiking in places such as Bryce Canyon National Park.

AN ELEMENTARY SCHOOL EXPERIMENT to identify several common household “compounds” was all it took to hook Ames Laboratory researcher Emily Smith on the field of analytical chemistry.

“It was probably fourth grade and we had several substances that we were supposed to identify, based on their properties,” Smith says. “I think there was sugar and baking soda ... I don’t remember the rest. What I do remember is that I was fascinated by how we analyzed things like crystal structure or pH to figure out what they were.”

That keen interest in finding out what makes up materials still drives Smith’s career as she uses state-of-the-art instruments to analyze the various composite parts of various types of biomass in search of the best feedstocks for producing biofuels. Her work includes developing new instrumentation, such as a scanning angle total internal reflection Raman microscope which, by changing the angle of a laser directed on the sample, can provide a 3-D image of the sample’s chemical content.

“When people ask what I do, I usually say I’m an instrument builder,” Smith explains. “I work to solve problems and answer questions by finding new ways to measure the chemical makeup of samples.”

Like many Ames Lab researchers, Smith also holds a faculty appointment at Iowa State University. Recruited by well-known Ames Lab and ISU analytical chemist Ed Yeung in 2006, she’s currently seeking tenure in addition to her regular duties in the research lab and the chemistry classroom. That academic and national laboratory duality provides the best of both worlds and was key in her decision to move to Ames, which is unique in having a national lab physically colocated on a college campus.

“You wear two hats, but you also get to take advantage of both sides,” Smith says. “In academia, you’re typically conducting more focused research on your own, where the national lab system requires you to be part of a collaborative

team. It’s built into the infrastructure and culture from the way projects are funded and the research is conducted, to the way results are published.”

That also provides an advantage for students studying under Smith, giving them opportunities they would not typically have in a strictly academic setting. And training the next generation(s) of researchers is an important measure as Smith views her career.

“I don’t have Nobel aspirations,” she says with a chuckle. “I hope in the next 10 to 20 years, that I’ve built a solid reputation and helped move technology forward... and that I still enjoy coming to work every day! But I’m more interested in seeing how my students progress and the contributions they make to the field. Their success will hopefully be a reflection on me as their mentor.”



*I'm an
instrument builder*

Rock climbing is also one of Emily Smith's outdoor pursuits.



Aaron

B R Y D E N

BY BREEHAN GERLEMAN LUCCHESI

AARON BRYDEN WAS ON A TWO-WEEK RESEARCH field trip in high school, camping and collecting data on frog habitats, when he realized what he wanted to do when he grew up. It wasn't the frogs that caught his attention. It was the amount of data he and his classmates generated.

"I could already see then that we were creating a huge amount of information and that the data we were collecting would be most useful visualized in map form, and it was then that I figured out that I wanted to use computer tools to help understand large amounts of data," says Bryden.

As an undergrad at Iowa State University, Bryden helped with research at ISU's Virtual Reality Applications Center, and he started an informal collaboration with Ames Laboratory scientists who developed VE-Suite, a virtual engineering software toolkit.

"For my graduate work at the University of Wisconsin, I worked with the visualization of proteins," Bryden says. "So, it was a natural progression to try the techniques for other atomic structures. And since I had stayed connected to the ideas in VE-Suite, I returned to Ames Laboratory for a postdoctoral post."

Bryden is now expanding the use of VE-Suite, first designed to engineer complex systems like power plants, to materials science.

"I'm using some of the visualization tools in VE-Suite and applying them to understanding data from atom probe microscopy experiments," says Bryden. "We modified a technique known as spherical impostor rendering so that we can now visualize and interact with a 10-million-atom data experimental data set."

For these types of data, scientists would perhaps not draw quantitative conclusions from just a look at the visualized data. But, Bryden and his colleagues believe that seeing materials science data more accurately and



efficiently can help guide scientists' experimentation and analysis, and, ultimately, help guide the overall search for new and better materials.

"My work in materials science is a bit odd, because I don't do much creating or characterization of materials myself," says Bryden. "But it's exciting to be part of the larger community and really help people understand their data more effectively."

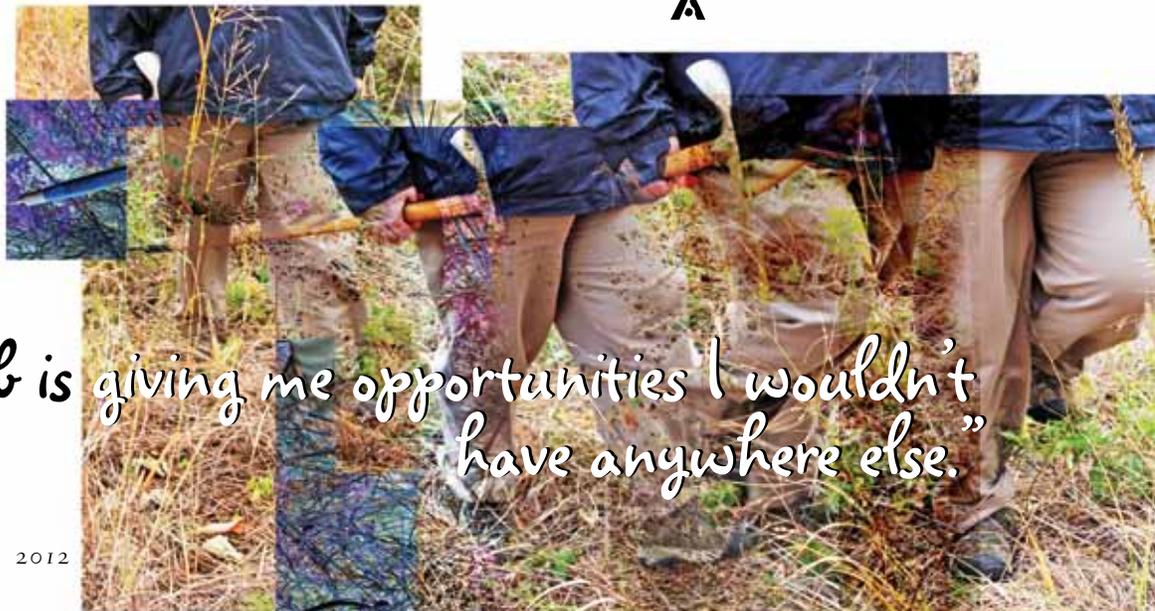
"Working with the materials scientists at Ames Laboratory is opening up new areas to apply my research," says Bryden. "Ames Lab is giving me opportunities I wouldn't have anywhere else."

Bryden's next aim is a staff researcher at a national laboratory or faculty member at a university.

"It's funny that all these years later after that frog research field-trip, I'm still doing the same sorts of things," he says.

Outside of work, Bryden still loves to travel, the outdoors and hiking. He recently made a trip to Honduras and plans to trek in Chile later this year.

"And at work, just like with the frog habitat data in high school, my whole goal is still to use visualization to help people do better science and engineering."



... Ames Lab is giving me opportunities I wouldn't have anywhere else."



Javier Vela enjoys camping, complete with roasted marshmallows, when he's not working in his research lab or teaching chemistry.

“... we wouldn't be able to conduct our research at such a high level.”

Vela's father helped spark his son's interest in science and technology. A chemical engineer by training, the elder Vela worked “as an IT guy” at the research center of a large power company in Mexico where Javier often visited. Influenced by his high school chemistry teacher and his subsequent participation in Chemistry Olympiad, he majored in chemistry at the Universidad Nacional Autonoma de Mexico in Mexico City where he graduated with honors in 2001.

“I came to the United States for grad school at the University of Rochester where I worked mostly in catalysis and inorganic metallics, and developed an interest in materials,” he says.

That led to postdoctoral appointments at the University of Chicago and Los Alamos National Laboratory. It was a trip between Chicago and New Mexico that gave Vela his first exposure to Iowa.

“My car broke down just outside Iowa City on Thanksgiving Day,” Vela says. “I'd never been in Iowa and had heard it was just corn fields, but the people were great and I had one of the best Thanksgiving dinners I've ever had.”

That exposure to Iowa stuck with him and when he began looking for an academic position and to form an independent research group, he gave Iowa State University a serious look.

“Iowa State's chemistry department had an excellent reputation, and (former chemical and biological sciences program director) Victor Lin was very supportive,” Vela says. “I was also aware of Ames Lab and its strength in materials research from working at Los Alamos. And Ames is a safe, low-stress place to live so it was a great opportunity.”

Vela has been making the most of that opportunity, studying the fabrication, characterization and properties of novel heterostructured nanomaterials, a key tool in developing catalysts to solve the biofuels problem mentioned above. And Ames Lab has been vital in those efforts.

“Ames Lab has obviously been extremely helpful in the scientific area. Electron microscopy is very important to what we do, and the Lab provides us access to those resources,” Vela says.

“A large part of developing new technologies is convincing the public, the taxpayers if you will, that this is actually worth investing in,” Vela adds. “The Lab helps by reaching out to the public, raising awareness and building advocacy. Without that help, we wouldn't be able to conduct our research at such a high level.”

Javier

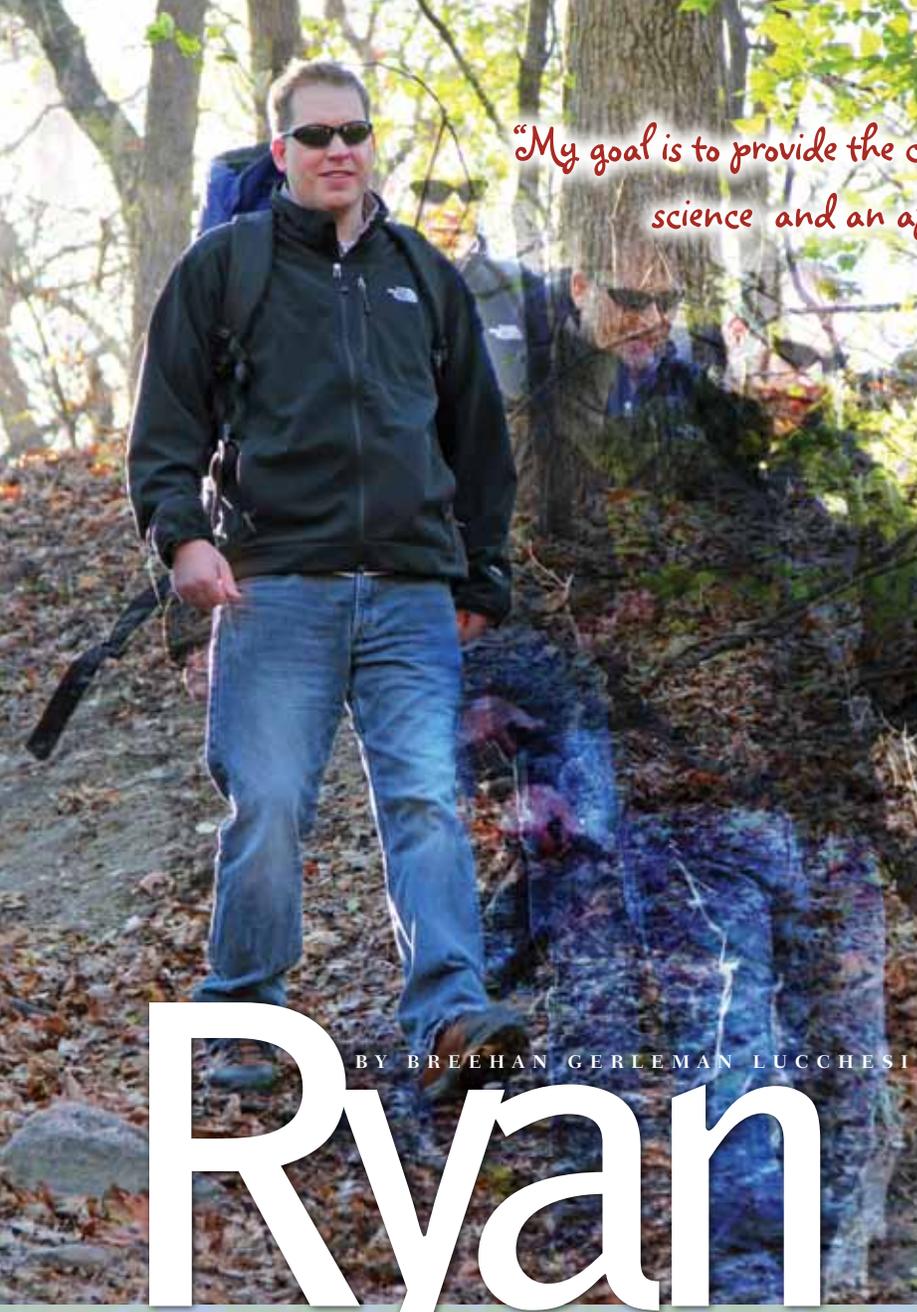
V E L A

BY KERRY GIBSON

AS A BOY GROWING UP IN MEXICO, JAVIER Vela took an early interest in science and planned to become an engineer or a physicist. But an “excellent” high school chemistry teacher helped steer him onto the path to perhaps solving one of the stumbling blocks that's hampering the biofuels industry.

“My ultimate scientific goal is show the viability of photocatalysis – to convert biomass into fuel using only sunlight as the driving force,” says Vela, who is in his third year as an Ames Lab chemist. “We're working to develop catalysts that can harness solar energy and turn it into chemical energy. Basically take water or biomass and turn it into hydrogen or other fuels.”





“My goal is to provide the connection between that fundamental science and an application to create new technologies.”

BY BREEHAN GERLEMAN LUCCHESI

Ryan OTT

WHEN RYAN OTT GETS AWAY, HE REALLY GETS away, backpacking into the Canadian wilderness.

“We canoe across a few lakes and tent in,” says Ott. “We’re off the grid with no contact with the outside world. Just eating the fish we catch.”

“And when I’m backpacking, I like to go new places and explore different areas,” he continues.

Ott’s zest for variety can be seen in his career as a materials researcher. His work spans nanostructured materials, mechanical behavior of materials, materials synthesis, X-ray synchrotron characterization of materials, and critical materials, like rare earths.

“I’d say I’m all over the board,” says Ott. “And that’s one of the things that keeps me interested. I like that I’m not confined to one narrow area of research.”

In fact, variety is what originally drew Ott to materials science and engineering.

“When I was in high school, I found I enjoyed the chemistry and physics and even math classes. But I didn’t love any of them enough on their own. I liked them all put together,” says Ott.

When it came time to choose a major in college, Ott was browsing the course catalog and came across an entry for metallurgical and materials engineering.

“I noticed that the major seemed to combine all the subjects I liked, and I thought ‘well, that looks interesting,’” says Ott. “It was just the thinking of a relatively naïve 18-year-old, but all these years later, I know it was a good decision.”

Ott now sees his role as helping to bridge the gap between fundamental materials research and developing and improving energy technologies. For instance, he’s now Ames Laboratory’s lead researcher on a project to help improve the processing techniques to reclaim rare-earth materials. The project harnesses fundamental materials science to help address possible shortages in rare earths, which are necessary ingredients in many green-energy technologies.

“At heart, we need to do fundamental research to solve many of the big scientific challenges we are facing,” says Ott. “My goal is to provide the connection between that fundamental science and an application to create new technologies.”

The Ames Laboratory is helping Ott reach his goals, and he hopes to stay and establish a research group that focuses on a range of topics that are important to energy technologies.

“Here at the Ames Lab there is just a large amount of materials synthesis and research capability,” says Ott. “Working here puts you in contact with collaborators and staff that are just excellent sources of knowledge. That’s especially notable in rare-earth research, where Ames Lab has very long and distinguished history.”

“My work is interesting and you really have to be able to shift gears from one day to another to tackle different projects,” adds Ott. “It requires you to be constantly thinking about what’s next for everything you’re working on.”

And what better way to do some thinking than in the quiet of the forest?

“I have about four different devices that keep me in constant email contact,” says Ott. “But when I’m out backpacking, I leave all that behind. It’s great.”





Rob

M C Q U E E N E Y

BY BREEHAN GERLEMAN LUCCHESI

ROB MCQUEENEY SPENDS ONE OR TWO LUNCH hours a week on the basketball court, playing against fellow scientists and researchers.

“I was a late-comer to basketball, because I didn’t play in high school,” says McQueeney. “But, now I have height, the one thing you can’t coach”

While McQueeney was late to his lunchtime hobby, he knew early on that he wanted to spend the rest of his days as a scientist.

“One Christmas, my parents gave me a choice between getting an Atari video game system and a telescope, and I chose the telescope,” says McQueeney. “I was always interested in space and deep sea exploration.”

A fear of water ruled out studying the sea, so he double majored in chemistry and physics, and completed graduate school in physics at the University of Pennsylvania.

scattering,” says McQueeney. “But I soon realized that the more important asset here at the Ames Lab is the people. I get to work with scientists who focus on new materials. So, yes, I have my expertise in my neutron scattering, but the really valuable thing is when a new material is discovered, like the iron-based superconductors that were discovered in 2008, I’m able to collaborate with Ames Lab colleagues by saying, ‘these are the kinds of things we can learn by neutron scattering.’”

McQueeney travels to neutron scattering facilities to perform his experiments and collect data.

“The real work starts when you come back, analyzing the data and developing models,” says McQueeney. “I like that. Doing calculations and fitting models to data gives me the opportunity to really think about the scientific challenges I can help solve.”

“Getting to help answer scientific questions was a life-long goal of mine, ...”

“High-temperature superconductors was a new field then. My graduate advisor was using neutron scattering to study superconductors, among other materials,” says McQueeney. “And neutron scattering was what I grabbed onto.”

Neutron scattering helps scientists understand the atomic and magnetic structures of materials, along with how the atoms in the structure vibrate when energy is added to the material. Neutron scattering requires specialized, large-scale instruments that are only located at a few facilities throughout the country.

From graduate school, McQueeney accepted a postdoctoral research job at just such a facility, Los Alamos National Laboratory, where he was responsible for the Pharos spectrometer at the Lujan Center for neutron scattering.

“I came to the Ames Laboratory and Iowa State University in 2003 because I knew both had long histories in neutron

“Getting to help answer scientific questions was a life-long goal of mine, and I’m happy where I am,” adds McQueeney. “But, that’s not to say there aren’t bigger projects to take on out there, like making sure that our neutron scattering research community is a healthy one.”

McQueeney is now serving in a special Department of Energy Office of Science post to support the neutron scattering program, a job that requires visiting scattering facilities with his “DOE hat on.”

Whether he visits with his DOE hat on or his Ames Laboratory hat on, McQueeney always remembers to bring something else: his basketball shoes.

“A lot of guys at the Spallation Neutron Source at Oak Ridge play ball, and I like to get into a few games there, too.”



Karl

BY KERRY GIBSON

G S C H N E I D N E R

EVEN AFTER 61 YEARS, SHOWING UP AT THE OFFICE most work days is never a chore for Ames Lab senior metallurgist Karl Gschneidner Jr. And the main reason this world-renown researcher, affectionately known as “Mr. Rare Earth,” comes to work is the same one that’s powered him from the start – he’s having fun!

“If it wasn’t still fun, I’d have retired years ago,” Gschneidner says. “I enjoy what I do and have always tried to do my best. There’s still plenty to learn so I keep at it!”

His crowded office in Spedding Hall is a testament to Gschneidner’s reputation and staying power. Dozens of awards, including a National Academy of Engineering membership, cover a fair amount of the available wall space, and floor-to-ceiling bookcases hold a career’s worth of reference materials. Multiple file cabinets hold volumes of notes, presentations and articles and neat stacks of unfiled work cover the tops of a desk and two tables. Much of it bears Gschneidner’s name –he published his 500th refereed research journal article earlier this summer, in addition to untold numbers of presentations, lectures and keynote addresses.

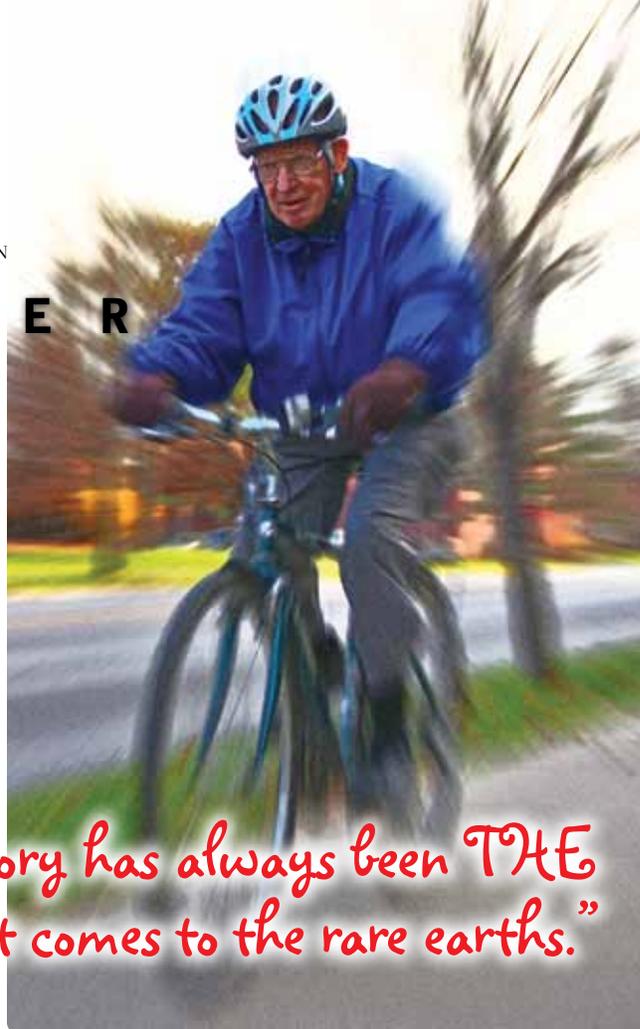
An early love of chemistry and physics set Gschneidner on his career path, but it wasn’t until he attended graduate school at Iowa State University, and worked as a research associate at Ames Laboratory, that he became involved in the study of rare earths.

“I’d been interested in the metallic elements alloys, but it wasn’t until I came here that I began working with rare-earth materials,” he says, “and Ames Laboratory has always been THE place when it comes to the rare earths. It was such a fascinating field, I never really considered anything else.”

Advances in technology, particular computational power and refinements in analytic instrumentation, have been invaluable to Gschneidner’s work.

“One of my first assignments as a new graduate student was to produce a 500-gram sample of gadolinium for another senior grad student to study,” he explains. “It took him months of work to plot the heat capacity as a function of temperature. The chart was a roll of paper that extended clear down the hall.

“Now, we can take a very small sample, put it in the calorimeter and the process is entirely automated,” he continues. “We can get the same results overnight that required months before. You can’t beat that.”



“Ames Laboratory has always been THE place when it comes to the rare earths.”

Weather permitting, Karl Gschneidner still rides his bike several miles back and forth to work every day as he has for much of his tenure at the Ames Laboratory.

Gadolinium has been one of several focal points of his research, particularly its ability to exhibit a giant magnetocaloric effect, or GMCE –it heats up when exposed to a magnetic field and cools down when the field is withdrawn. Gschneidner was instrumental in development of refrigerators that harnessed this phenomenon in place of traditional gas-compression-driven cooling.

“The biggest stumbling block we now face is coming up with a GMCE material that doesn’t progressively break down into smaller pieces over the billions of magnetization/demagnetization cycles required for a 15-20-year appliance life,” he says. “We also need to reduce the time dependence of the transformation.”

Based on the current pace of research and the growing number of working prototypes around the world, Gschneidner expects magnetic refrigeration to become commercially viable by 2016 or so, a fruition he plans to witness.

“We’re finding all kinds of new phenomena in low temperature and low magnetic field research,” he says, “and that’s what brings me back to the laboratory.”



Ning FANG

BY STEVE KARSJEN

THE THOUGHT OF NOT HAVING ACCESS TO A computer in today's elementary classrooms would be hard to imagine. But in 1986, when Ning Fang was a fourth grader in China, there were only four computers in the entire school, and very few students were "qualified" to use them. Luckily Fang was one of them.

"They experimented with us to see how we could achieve new concepts and other things, and I ended up taking part in a lot of computer competitions," says Fang, who remembers coming in second in a prestigious high school information olympics competition in his province.

Equal to his love of computers, however, was Fang's interest in chemistry and mathematics, in which he excelled as a student and academic competitor. "I was lucky to be able to combine all of my strengths, which helped form the basis for my love of science."

Fast forward 25 years to his present-day office in Hach Hall, Iowa State University's chemistry building where Fang sits comfortably with not one, but two computers within arm's reach. A research scientist at the Ames Laboratory and an assistant professor of Chemistry at Iowa State,

"I was lucky to be able to combine all of my strengths."

Fang's research focuses on chemical and biological discovery through novel optical imaging of single molecules. Although computers don't hold quite the same sway over him they used to, they're still "a critically important tool" to write the code for his imaging research.

Like many young people, Fang remembers back to a special moment that helped changed his life. It began with a conversation about college with his uncle, who happened to be a chemistry professor at a college in China.

"I was planning on majoring in computer science," says Ning. "But when he found that I also loved chemistry, he suggested that I study chemistry and use the computer as my tool. He was very open minded and saw the future of research."

Fang took his uncle's advice and studied chemistry at China's Xiamen University, with a double major in computer science. Upon graduation, he was accepted for graduate school at the University of British Columbia in Vancouver where he majored in chemistry.

While in graduate school, Fang began focusing on chemical separations using traditional chemical analysis tools, such as capillary electrophoresis (CE), which he used to analyze the drug MDMA, commonly known as ecstasy. His research caught the eye of Ed Yeung, now a retired Ames Laboratory scientist

and the inventor of multiplexed capillary electrophoresis (MCE), a chemical analysis device that's considered the "gold standard" of DNA sequencing instrumentation.

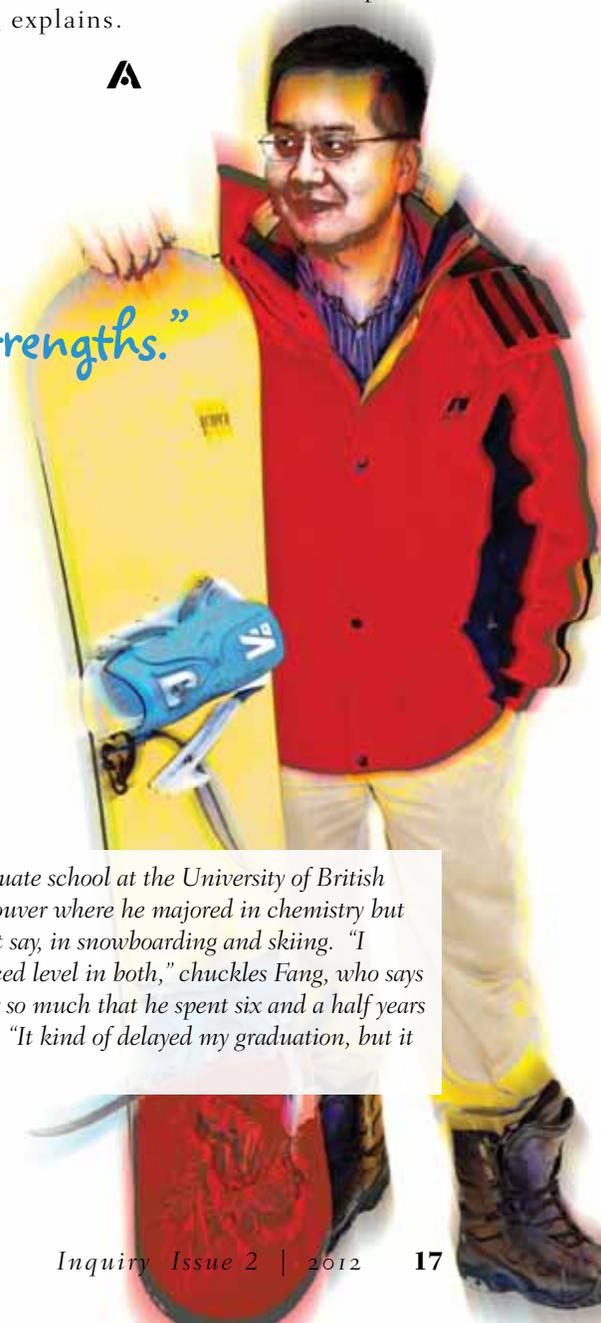
"I met with Ed three times at conferences, and felt very lucky and proud to be able to speak with him at length each time," says Fang.

It turns out Yeung also had reasons for the lengthy discussions because he eventually offered Fang the opportunity to be his postdoc at the Ames Lab and, ultimately, to take over his research program upon his retirement.

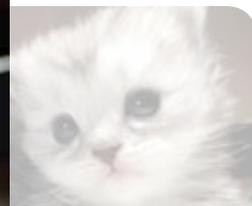
Since moving to Ames in 2006, life at Ames Lab and Iowa State has been a dizzying balancing act. Between his research, his duties as assistant professor, and raising a family, which consists of a five year old and a four month old, he has precious little free time. But, like many modern dads he spends some time playing with his five year old on an iPad, but not a computer....yet.

"My wife doesn't want him to touch computers too early," Fang explains.

A



Fang attended graduate school at the University of British Columbia in Vancouver where he majored in chemistry but minored, you might say, in snowboarding and skiing. "I achieved an advanced level in both," chuckles Fang, who says he loved Vancouver so much that he spent six and a half years in graduate school. "It kind of delayed my graduation, but it was well worth it."



“... I hope that my research will lead me to the answers.”

CURIOSITY COMES NATURALLY TO TANYA PROZOROV. As a child growing up in Moscow and now as a DOE Office of Science Early Career Research award winner, the desire to find out how things work has always been a driving force.

“For as long as I can remember, I wanted to know how people come up with what to make things of,” Prozorov says. “I was always bugging my dad about what things were made of and he finally told me, ‘if that’s what interests you, then that’s what you need to pursue with your education.’”

She followed that advice, getting two masters degrees in physical chemistry: one from the Moscow Institute of Steel and Alloys (now the National University of Science & Technology (NUST)), another from Bar-Ilan University, and a Ph.D. in Materials Chemistry from the University of Illinois, Urbana-Champaign under the supervision of well-known researcher Kenneth Suslick. After a short post doctoral research appointment at the University of South Carolina, Prozorov landed in Ames when her husband, Ruslan, was hired as a faculty member in the Department of Physics and Astronomy at Iowa State University and a scientist at the Ames Laboratory.

Tanya started at the Lab as a post doc researcher, but now serves as an associate scientist. Research is her passion and she loves spending time in the laboratory.

“I’m not really interested in conventional classroom teaching,” Prozorov says. “Instead, I would love to put together a course in modern materials chemistry to emphasize the latest laboratory research techniques and instrumentation.”

Prozorov was selected for the Early Career award for a proposal to study the growth of nanoscale magnetic crystals in biological systems using a unique electron microscopy

BY KERRY GIBSON
Tanya
P R O Z O R O V

technique. Once this is understood, she hopes to be able to grow such crystals in the lab and make better magnetic materials.

“I have several fundamental questions regarding the biomimetics, nanochemistry and nanomagnetism,” she says, “and I hope that my research will lead me to the answers.”

The Ames Laboratory is helping make that possible.

“I owe many thanks to many people at Ames Lab,” she explains. “I am new to tackling such a large project and receiving advice and guidance was a tremendous help and the facilities staff did a great job setting up the space. I was given the freedom to assemble a laboratory and funds to purchase the key equipment — a continuous flow liquid cell platform for the transmission electron microscope and a molecular printer for the specimen patterning.”

With two Ames Lab researchers living under the same roof, you might think the Prozorov family would talk shop about their discoveries, but that’s not always the case.

“We’re both very busy with our research so when we’re not working, we don’t have time to talk much about it,” Tanya says. “We spend most of our time at home with our five wonderful cats and our grown-up daughter. ‘Ruslan recently came to one of my presentations and I think he was surprised and interested in some of the work I’m doing.’”



John

BY KERRY GIBSON

C O R B E T T

DISCOVERY, BY DEFINITION, IS TO OBTAIN SIGHT OR knowledge of something for the first time. It could also describe what long-time chemist John Corbett has pursued most every day of his 60-plus-year career at Ames Laboratory.

“I’ve spent most of my career working with rare-earth and related metals trying to find novel or unusual compounds,” Corbett says, gesturing toward a period chart hanging on the wall in his office. “If you consider ternary compounds – some call them alloys – from just the metals, there are over 10,000 possibilities. So there’s lots to consider, and I just continue to run reactions and keep my eyes open.”

In keeping his eyes open, he and his coworkers have discovered hundreds of new materials, including the recent discovery of the first quasicrystal containing sodium, in a sodium-gold-gallium compound. A paper on that finding, to be published soon in *Angewandte Chemie*, will be the 485th of his career.

With the exception of a few days while he awaited proper clearance, Corbett has had the same office – 353 Spedding Hall – since he started at the Lab and Iowa State University in 1952. He wound up in Ames because at the time, “there were only three or four

“There was really nowhere else I could have done the work ...”

job openings in the whole country in inorganic chemistry, and one of the best was here. And at that time, you could count the number of solid-state inorganic chemists (in the U.S.) on one hand.”

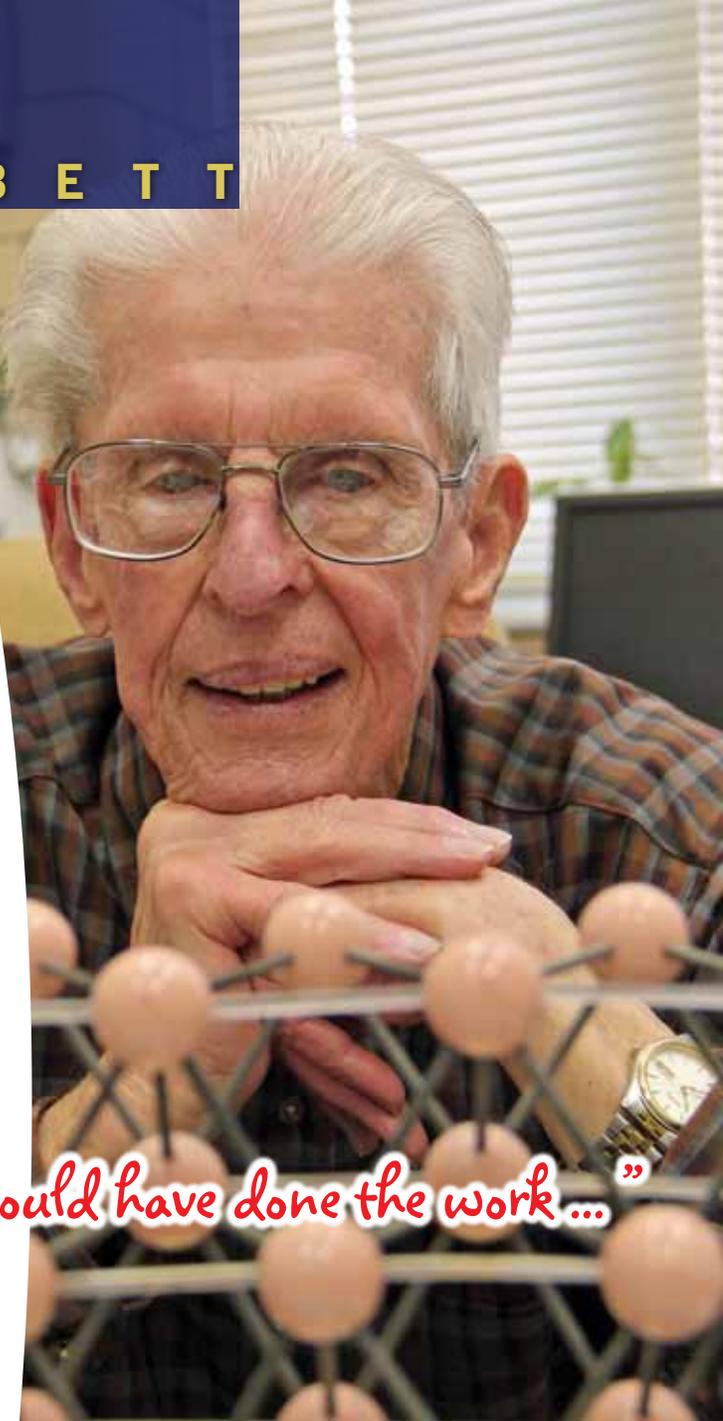
Corbett chose that career path via a stint in the military during World War II. Coming out of high school in Yakima, Wash., he enlisted in the Navy rather than be drafted. He enrolled in officer training and was two years into becoming an engineer when the war ended, which also brought his Naval career to a halt.

“I had half an engineering degree, but had taken a number of chemistry courses, so I went back home to Washington and got a degree in chemistry,” he says, “then went on to get a Ph.D. in physical chemistry.”

He credits Ames Lab with making his work, particularly in the early years, possible.

“There was really nowhere else I could have done the work,” Corbett says. “The innovation of using nonreactive tantalum containers was developed here and allowed us to carry out reactions that weren’t possible before.”

Improvements in analytical instrumentation have also contributed greatly to the field and his work. The Ames Laboratory’s service capabilities and having



John Corbett looks at a model of one of the materials he discovered.

“four diffractometers within 75 feet” of his office have made the work easier and produced much faster results.

Although he gave up classroom teaching after 48 years, Corbett has no plans to give up research and passing along his expertise to additional generations of graduate students and postdocs.

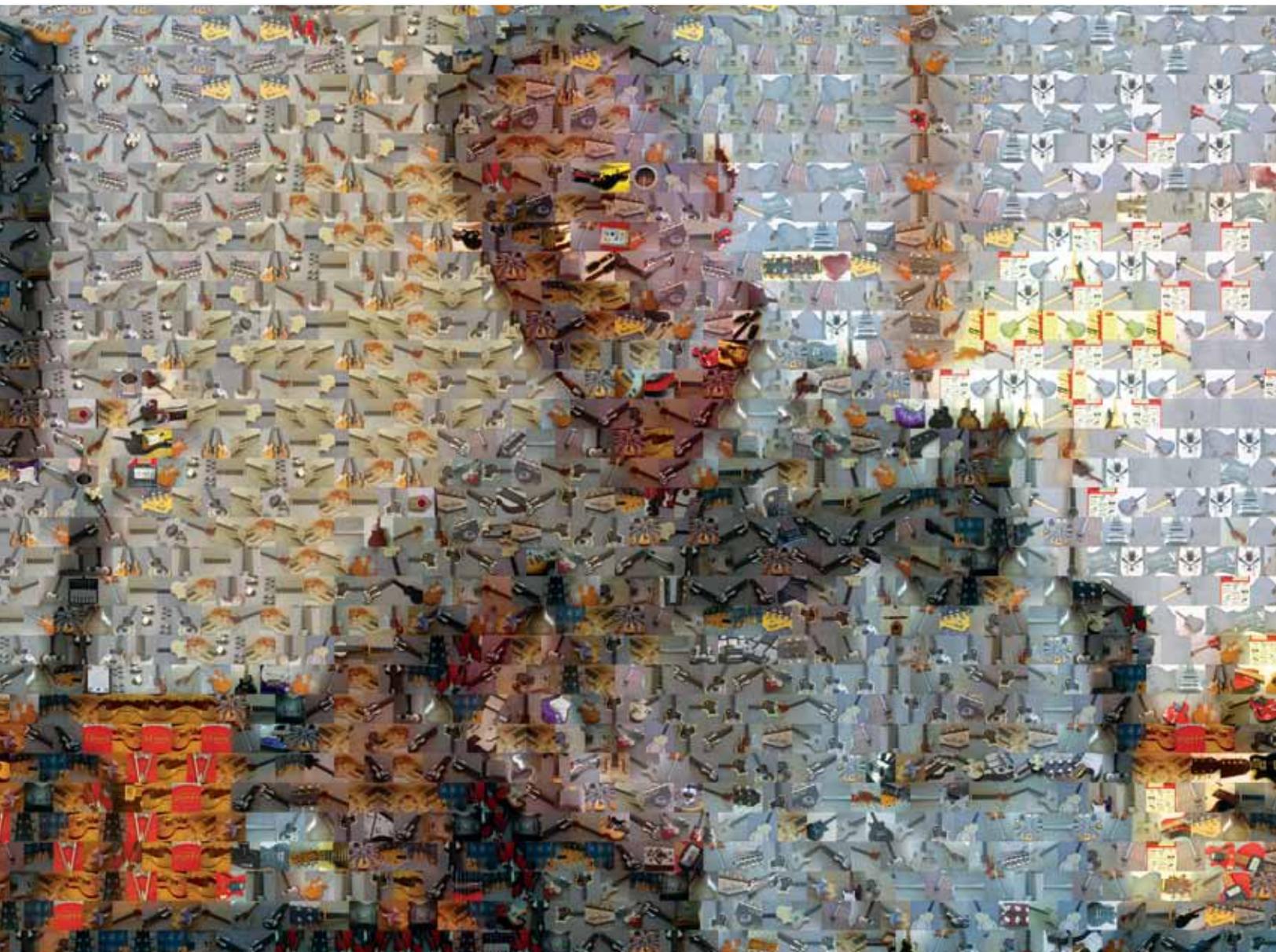
“I’ve been very blessed and lucky. My health is still good and I’m still having fun,” he says. “Besides, I can’t imagine doing anything else!”



inquiry ²⁰¹²

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