INSIDER

Newsletter for the Employees of Ames Laboratory ■ Volume 15, Number 3 ■ March 2004

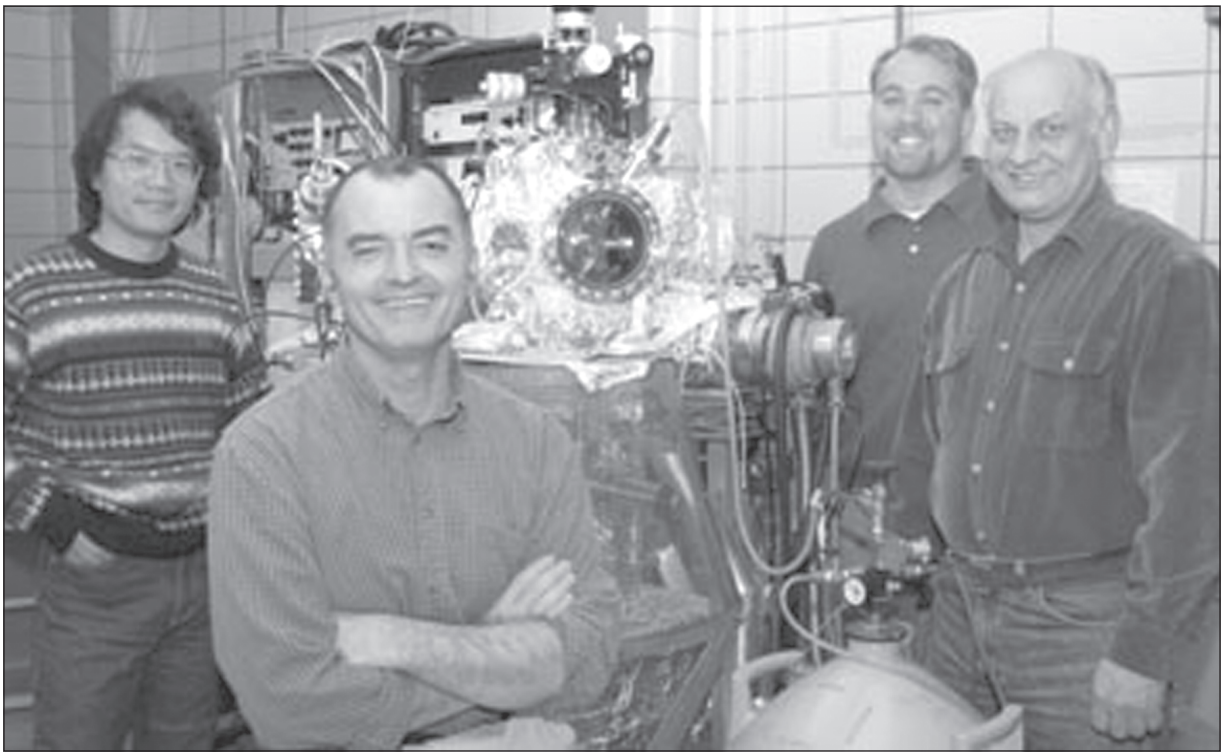
"Stepping" up to Nanoscience

Unusual growth mode leads to more control over atomic-scale structures

Advertisers tout them, consumers clamor for them, and manufacturers scramble to meet consumer demand. What causes all this hoopla?

It's the need or desire to have the latest-and-greatest, most technologically advanced version of just about anything.

However, the most up-to-date version of a product debuts only after substantial groundwork has been laid. In reality, we owe the availability of new and improved technologies that make our lives easier to a whole lot of hard work at the research bench. That's where fundamental science takes place, where researchers study materials and their properties with the goal of developing new materials with better properties. *continued on page 4*



Michael Tringides and his research group are seeking what he calls the "Holy Grail" in nanotechnology — gaining control of layer thickness and atomic uniformity of thin films and nanostructures. (from left: Vincent Yeh, Tringides, Michael Yakes and Myron Hupalo)

Growing the Bioeconomy

Lab participates in ISU's bioindustry conference

Ames Laboratory's Biorenewable Resources Consortium was one of the sponsors of ISU's Biobased Industry Outlook Conference, March 7-8. The conference hosted producers, developers and manufacturers and offered them a unique opportunity to learn more about the bioindustry in Iowa and throughout the Midwest.

The BRC, headed by Lab associate and Iowa State University chemistry professor George Kraus, has as its mission the development of agricultural alternatives to fossil resources and petrochemicals. To fulfill that mission, the BRC unites interdisciplinary research teams to advance biorenewable resource technology and expedite the growth of new products and processes. As such, the BRC was a natural player in the Bioconference that was designed to stimulate attendees to explore opportunities for growing the bio-economy in their communities.

The Bioconference opened with an evening reception and poster session on March 7, where the BRC displayed results from seed projects that included oxidation of soybean oils, novel biolubricants, adhesives from biorenewable materials, and environmentally friendly wood preservatives.

Monday's Bioconference agenda featured speakers from the U.S. Department of Energy, U.S. Department of Agriculture, Iowa Energy Center and BIOWA, a nonprofit organization dedicated to the development and growth of Iowa's biobased industries. Ames Lab Director Tom Barton was on hand to introduce the DOE guest speaker, James Fischer, who is a member of the board of directors for the DOE's Office of Energy Efficiency and Renewable Energy. Fischer's efforts involve building partnerships and developing unique collaborations with universities, especially land-grant universities; foundations; and the agricultural, industrial, and business communities.

Fisher's comments focused on the concept of reflecting on biorenewables. "We learn by reflection," he said. He put forth the idea that by considering and contemplating the potential and promise offered by biorenewables, we would be encouraged to begin building a biobased economy.

In talking about our nation's energy challenges, Fischer said, "Ninety-four percent of our energy comes from nonrenewables and only six percent from renewables. How long can this go on? The bottom line is that we must bring the supply curve up for biorenewables."

Fischer drew attention to the National Energy Policy's support of research and development in the area of biomass and the importance of turning biomass feedstock into useable products. He also emphasized the need to continue exploring hydrogen fuels to reduce emissions from our vehicles while still maintaining a transportation community.

Fischer concluded his remarks by restating his belief that by reflecting on the advantages and rewards associated with biorenewables we could build a biobased economy that would lead to a more prosperous future where energy is clean, abundant, reliable and affordable.

Remarks by Mike Blouin, director of the Iowa Department of Economic Development, highlighted the lunch hour for Bioconference attendees. Blouin discussed the Iowa Value Fund, a seven-year, $500 million effort to recreate the value of Iowa and establish the kind of climate that will keep people in the state.

(left to right) James Fischer, Tom Barton and George Kraus take a few minutes to chat during the morning break at the Biobased Industry Outlook Conference.

"Quality is taking a terrible hit in Iowa," he said, citing education as just one example. "Quality is in jeopardy because our resources aren't sufficient enough to maintain our values."

Blouin stressed that finding our special niche within the area of life sciences was critical to Iowa's ability to increase its resources. "We're in for a revolution in life sciences in this state," he said. "We need to get into the game, and agriculture gives us a leg up that nothing else can. We're beginning a process to create our own new network of worth for years to come, and nothing has more payoff to this state than life sciences."

Following his luncheon remarks, Blouin took the opportunity to experience the C6 Visual Reality Theater at the Visual Reality Applications Center. Later Blouin visited TASF for a chat with Barton. ■

~ Saren Johnston

Mike Blouin and Tom Barton share a handshake at the close of their meeting.

Procurement Officials Come to Lab

Visit focuses on unique Ames Lab/ISU relationship

"Getting the lay of the land," is how Mark Murphy, division director of Technical and Administrative Services, described the purpose of the March visit to Ames Laboratory by DOE officials from the Headquarters Office of Procurement and Assistance Management and the Chicago Operations Office of Acquisition and Assistance.

Murphy's comment referred to the fact that the procurement officials had come to Ames Lab to learn more about the Lab's close association with Iowa State University and how uniquely the two organizations are integrated. The visit helped them get a better perspective on the Ames Lab/ISU connection relative to competing the Lab's contract in two years.

The procurement group saw a brief slide show that introduced them to the Lab and some of its award-winning research. Murphy then discussed the ISU resources and services that benefit Ames Laboratory. From the staffing aspect, he emphasized shared senior faculty, research associates and graduate students. He also highlighted other areas that included employee benefits and services; environment, safety and health; research support facilities; operations support; and administrative support.

Following his presentation, Murphy and special guest Warren Madden, ISU vice president for Business and Finance, fielded several questions from group members, most of whom had not previously been to the Lab. Based on the questions asked, they were obviously quite impressed with how intricately the Lab and ISU are interconnected.

The procurement officials concluded their visit with a tour of the Lab's Materials Preparation Center, where assistant scientist Trevor Riedemann acquainted them with the MPC's internationally recognized work in preparing research-quality pure metals and alloys for use in research laboratories throughout the world. ■

~ Saren Johnston

Richard Hopf (left), director of the DOE Office of Procurement and Assistance Management, visits with Warren Madden about the unique relationship between Ames Lab and ISU.

Lab Wows Kids with Chemistry

Chromatography a hit at Northwood

February's Science Night at Northwood Elementary School proved that Ames Lab's nifty, little experiment involving liquid chromatography could hold its own in the midst of "creepy crawlies" from Iowa State's entomology department and the science-based antics of SCUM, an ISU chemistry club more formally known as the Society of Chemistry Undergraduate Majors.

Liquid chromatography is an analytical technique that allows chemists to separate mixtures into individual components. Among its many applications, LC is a well-accepted investigative tool in forensics, where it is used for the analysis of liquids, such as ink, blood and urine. However, students attending Northwood's Science Night had a somewhat more appealing liquid on which to practice — grape soda!

Not only did the fizzy liquid's dark purple color separate easily into its red and blue components, the soda's distinct "grapey" aroma was deliciously familiar! After completing the LC separation experiment, the students were able to recreate the soda's original purple color by combining the red and blue components.

The popular chromatography activity was coordinated by the Lab's Public Affairs Office in collaboration with volunteers Chris Strasburg and Bill Sears, Information Systems, and Cheryl Kamman, a former Lab employee who is now the director of the Innovations Development Facility at ISU's Plant Sciences Institute. Kerry Gibson and Saren Johnston, Public Affairs, also helped staff the activity. ■

~ Saren Johnston

Courtney Kamman, daughter of Cheryl Kamman, demonstrates how to attach a column to a syringe for the liquid chromatography experiment.

In the foreground, Chris Strasburg watches Northwood students combine the red and blue components of grape soda to recreate its original purple color.

Stepping up to nanoscience *continued from page 1*

Everything we see, use or produce — from cookware to computer chips — is made from materials, which are, in turn, made up of atoms. How the atoms are arranged in a material determines the kind of properties exhibited by that material and ultimately by the manufactured products made from it.

At Ames Laboratory, senior physicist Michael C. Tringides is involved in a basic research effort to broaden the knowledge base about materials and their properties. He and members of his research group, associate scientist Myron Hupalo and graduate students Vincent Yeh and Michael Yakes, focus their efforts on the microscopic processes that control the growth of custom-made materials.

"Control is the name of the game," says Tringides, talking about the importance of growing atomic structures in uniform sizes and with highly ordered geometries. Potential applications for such structures include sensors, switches, lasing materials and semiconductors that allow computer chips to run faster.

Exciting as the potential is for the development of these nanotechnologies (artificially fabricated structures in the nanometer range of 0.1-100 nm) and other microminiature equipment, Tringides is acutely aware of the long hours of fundamental research required to bring them about. The work he and his colleagues pursue may prove critical in the further miniaturization of silicon-based electronic devices, a major undertaking in light of the silicon industry's huge role in technological innovation and production.

Manipulating miniatures

Tringides explains that vital to the success of these miniaturization efforts is the ability to achieve exact control of layer thickness and atomic uniformity of thin films and nanostructures — what he refers to as "the 'Holy Grail' in nanotechnology, the next major industrial revolution."

Noting the great demand for these materials within the silicon industry, Tringides says, "It's essential that these structures are grown in a robust and reproducible way, with easy size selection. Contrary to conventional wisdom, we've discovered that an intriguing type of self-organization is possible with lead (Pb) deposited on silicon (Si) if the growth is carried out at low temperature — around 185 Kelvin, or minus 126 degrees Fahrenheit."

He adds that in all other systems studied so far, the deposited metal atoms stack up in islands of very different height variation. But for Pb grown on Si (oriented along the (111) crystal axis), he says the atoms seem to be "intelligent" and make only one height choice.

"The selected height of these nanostructures is related to their electronic structure," Tringides continues. He explains that keeping electrons confined in small metal islands requires them to occupy sharp energy levels as dictated by the laws of quantum mechanics. This confinement implies that the total energy of the electrons depends strongly on the nanostructure's size or shape. "This is called Quantum Size Effects, or QSE," says Tringides, "and a consequence of this relationship is that certain film thicknesses are more stable than others."

Charting new islands

Tringides and his research group were the first to observe and monitor the highly unusual formation of uniform-height Pb/Si islands. They observed the 7-step (or 7-layer), steep-edged, flat-top islands using two complementary techniques. Quantitative electron diffraction, used by Yeh and Yakes, samples the island height uniformity by reflecting electron waves from the surface.

Scanning tunneling microscopy, or STM, allows scientists to see the structure of the islands with atomic resolution. STM, used primarily by Hupalo, images the islands and gives the island size and shape directly, without further data analysis.

"As a result of our investigations, we have shown that not only can QSE be observed in small objects, but QSE can dictate the island uniformity and height," says Hupalo.

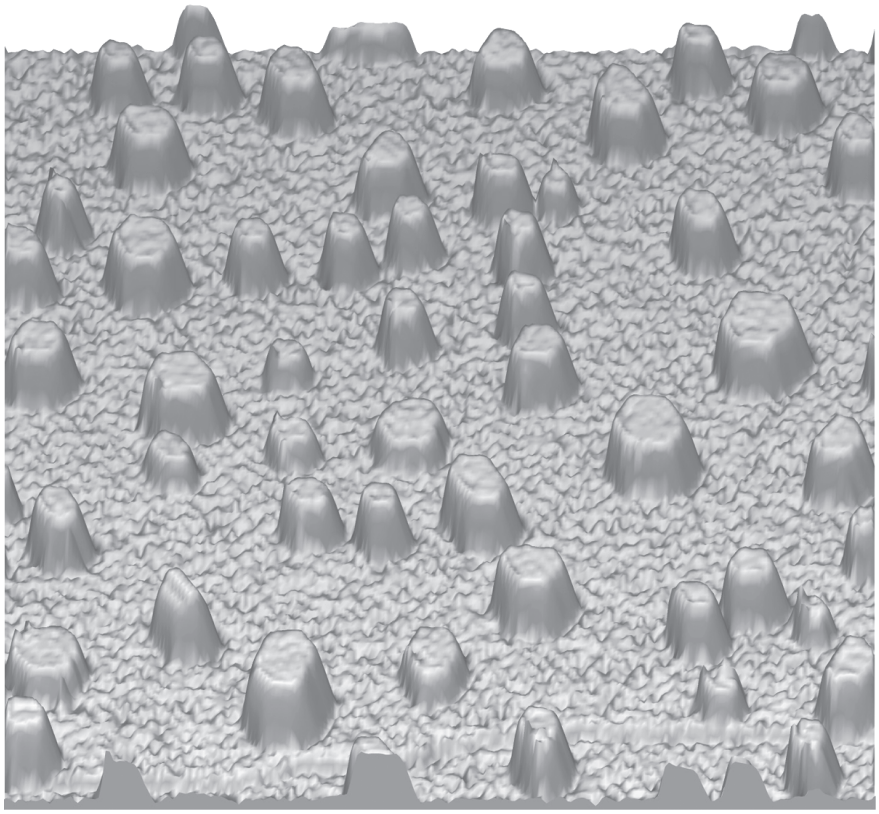
The scientists were amazed to see this uncommon growth mode of the 7-step Pb islands, which clearly shows that the deposited atoms seem able to "climb" and select preferred, final positions.

"No one was expecting to see the uniform-height, self-organized growth," says Tringides. "We couldn't believe how quickly the islands formed following deposition. Nature, itself, was doing the work for us!"

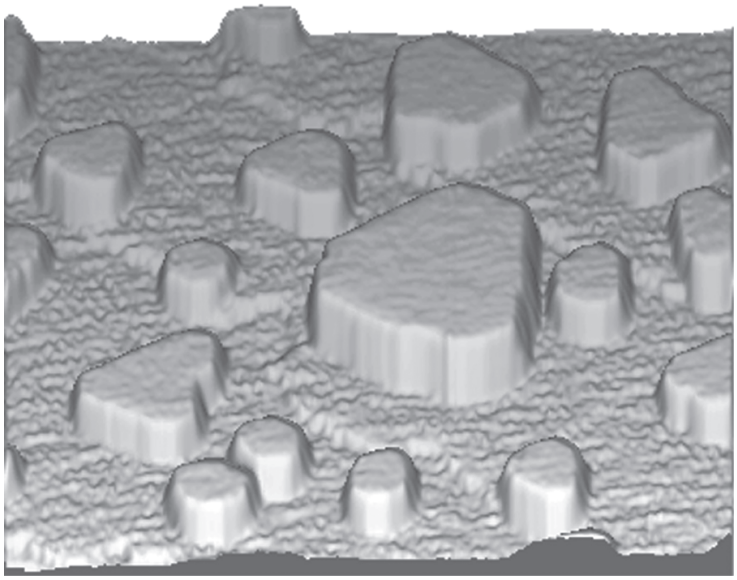
Taking control

Tringides explains that although QSE is the driving force for height uniformity, one still needs to find the right temperature and surface coverage conditions for the islands to form. These variables make it difficult to predict when the self-organized growth is possible and explain why it has never been seen before.

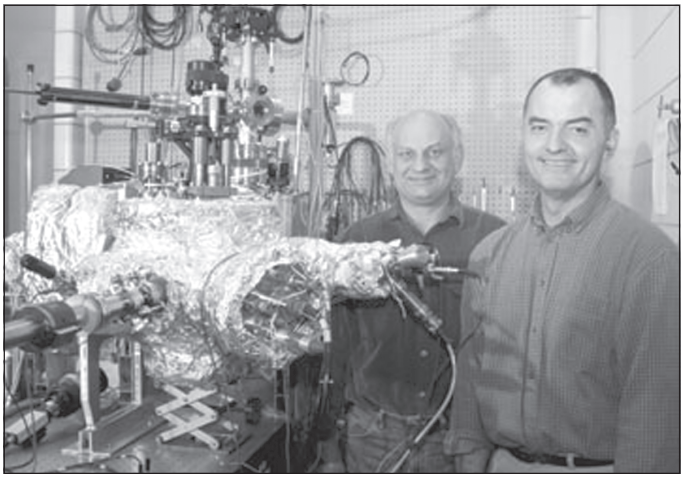
"It's necessary to study the



This scanning tunneling microscopy, or STM, image reveals the uniform height of the PbSi(111) islands studied by Michael Tringides and members of his research group.



Tringides is able to grow Pb islands of five layers by using a different type of silicon surface as the substrate.



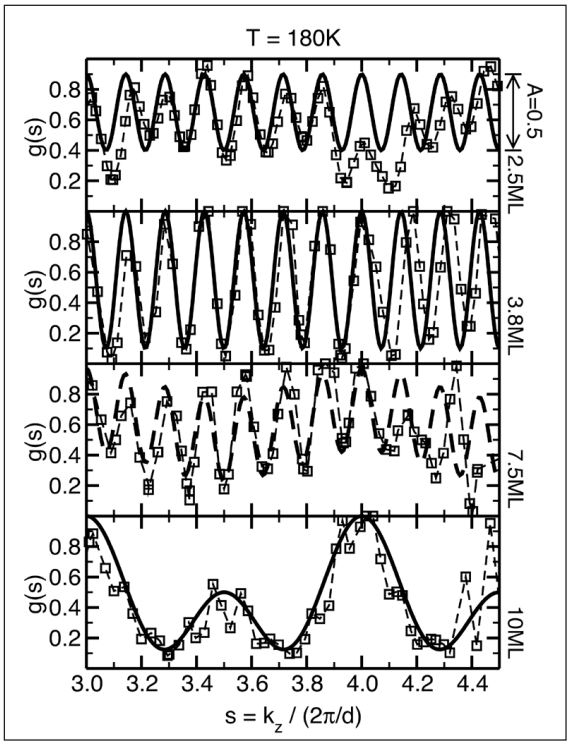
A scanning tunneling microscope allows the atomic resolution necessary for Michael Tringides (foreground) and Myron Hupalo to directly see the structure of the Pb islands — their size and shape.

growth as a function of the different growth parameters, such as temperature and deposition rate, to discover when such self-organized nanostructures form," says Tringides. By varying these parameters in the Pb/Si(111) system, he and his co-workers found that only odd island heights, i.e. 5, 7, and 9 layers, are possible. Using these growth parameters, they developed a kinetic phase diagram that serves as a guide to select the desired island height.

But Tringides warns that island height uniformity exists only at sufficiently low temperature. At higher temperature, the islands evolve into multiheight mounds, limiting their potential for room-temperature applications. Working to resolve the problem, Tringides and members of his research group have discovered that they can "manipulate the growth" by adsorbing oxygen, which restricts the upward motion of the Pb atoms, allowing the islands to maintain the same height at higher temperatures. This process extends their potential for technological applications. "At the same time, it raises important theoretical questions about how the potential energy surface of the Pb islands is modified by oxygen adsorption," he says. ■

~ Saren Johnston

Research funded by:
DOE Office of Basic Energy Sciences,
Materials Science and Engineering Division



Electron diffraction "fringes" (similar to the ones formed when light scatters from a very thin air wedge, but of much larger size) can be used to deduce that practically all islands are seven layers high for lead coverages between 2.5 ML, or monolayers, and 7.5 ML.

DOE Honored

The Department of Energy has been recognized with the "Excellence in Management" award for exemplary performance on implementation of the President's Management Agenda. Issued in 2001, the President's Management Agenda seeks to improve the management and performance of the federal government by making it more citizen-centered, results-oriented and market-based. Secretary of Energy Spencer Abraham is fully committed to making management improvement a hallmark of his administration using the President's Management Agenda as the foundation for bringing about improvements.

Volunteer Call for Middle School Science Bowl

Ames Laboratory is still seeking volunteers for its inaugural Middle School Science Bowl regional competition, April 23-24. If you are interested in helping with this event, please complete the volunteer form below.

Volunteer Incentives

A first-ever Ames Lab/ISU Middle School Science Bowl T-shirt.
Free pizza supper (Friday volunteers)
Free parking in the Union ramp and a free lunch (Saturday volunteers)
Opportunity to see SCUM (Society for Chemistry Undergraduate Majors) on Friday at 7 p.m. in 1002 Gilman (all volunteers)

I would like to help with the Middle School Science Bowl by volunteering on:

____ Friday, April 23, Hydrogen Fuel Cell Car Challenge, 1-5 p.m.

Saturday, April 24, Academic quiz-bowl-style competition
____ 8-11:30 a.m.
____ 12:30-3 p.m.
____ 8 a.m. to 3 p.m.
____ No preference

Please return form to Saren Johnston, Ames Laboratory Public Affairs, 111 TASF, as soon as possible.

They Did It Again!

Lab walkers and runners raise funds for Relay for Life

Yes, the Walking Wizards and Nimble Nerds proved their athleticism once again when they took part in the Story County Relay for Life to benefit cancer research. But more importantly, they proved they have what it takes in the fundraising arena. Together, the two Ames Lab teams collected $2,275 for the annual February event, which is held at ISU's Lied Recreation Center.

Ila Haugen, budget officer and a Walking Wizard, captained both of the Lab's teams masterfully, sending inspiring e-mail messages directing team members to go out and "get those donations." And they did!

As tradition would have it, the Wizards excelled in the fundraising endeavor for the third year in a row, collecting $1,432 to the Nerds' $843. Maybe next year, Nerds. After all, a little friendly competition among coworkers might result in more money for the Relay for Life!

The following individuals made up the Nimble Nerds: Tom Barton, Fran Dunshee, Mark Gordon, Jim Withers, Shawn Nelson, Wes Winterink, Steve Karsjen, Stan Welp, Ross Van Marel and Iver Anderson. The Walking Wizards team consisted of Sandi Bishop, Saren Johnston, Carol Cowan, Ila Haugen, Lynnette Witt, Larry Stoltenberg, Carol Mack, Deb Covey, Charyl Winterink, Katherine Bergmann and Heather Netzloff. ■

~ Saren Johnston

Walking Wizards Sandi Bishop (left) and Ila Haugen take a breather between half-hour walks at Relay for Life.

(left to right) Nimble Nerds Ross Van Marel and Fran Dunshee hang out with Walking Wizards Lynnette Witt and Larry Stoltenberg.

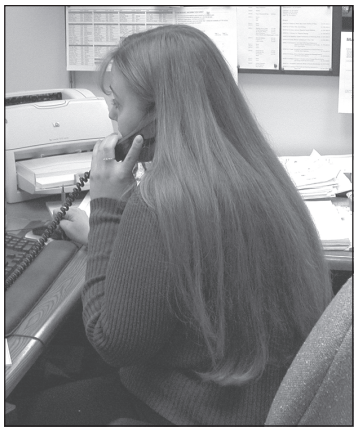
Here's a Feel-good Story for You!

Unusual donation will help a child

On first meeting Tera Lawson, most people would describe her as having medium-to-long hair. The fact is her current shoulder-length style is a good 12 inches shorter than it was a month ago. But Lawson, program assistant for the Midwest Forensics Resource Center, didn't decide to give up her "Rapunzel-like" tresses on a whim. She had a specific plan in mind — one that originated last summer.

"I was visiting my aunt on the Fourth of July, and she told me she was getting ready to pick out a wig," says Lawson. "She has multiple myeloma, a cancer of the plasma cells, and was starting to lose her hair because of chemotherapy treatments."

Lawson recalls what went through her mind on hearing about her aunt's decision to get a wig. "I remember thinking how rough it must be for people who are already so ill to have their hair taken away too. I had always been the girl with the long hair, and I began thinking how awful losing your hair must be for cancer patients and how devastating it could be to their self image, especially for young girls." Lawson made a decision right then to donate her hair to Locks of Love as soon as it was long enough.



Locks of Love is a nonprofit organization that provides hairpieces to financially disadvantaged children under age 18 who suffer from long-term medical hair loss. The organization uses donated hair to create the highest quality hair prosthetics. Helping restore self-esteem and confidence, the hair prostheses enable children who have lost their hair to better face the world and their peers.

In early March, Lawson's hair had grown long enough to donate the 12 inches she had committed to last summer. A trip to a local salon not only resulted in a gift to Locks of Love but also in a new look for Lawson. "This is the shortest my hair has been since I was two," she says of the shoulder-length style. "But I'm finally getting used to it."

If you'd like more information about Locks of Love, go to *http://www.locksoflove.org/*. ■

~ Saren Johnston

Tera Lawson before, during and after the haircut that resulted in a 12-inch braid for Locks of Love.

Wilhelm Bowling Tourney Revived

Rehbein wins trophy

After a six-year hiatus, Ames Lab bowlers took to the lanes again on Feb. 28 to compete in the Harley Wilhelm Cup Bowling Tournament. The tourney featured a new scoring format but brought back the original trophy, a section of pipe with handles made from an actual reduction bomb used by Wilhelm, himself, and awarded to the winner since the tourney's inception in 1959.

"In the past, the championship simply went to the bowler rolling the best series," says tourney organizer and senior metallurgist Tom Lograsso. "The new format awards points for consistency among the three games bowled as well as for numbers of consecutive strikes and spares, and for picking up difficult splits."

Winner of the 2004 tournament was assistant metallurgist Dave Rehbein, who won on the power of six straight strikes in his third game on his way to a 532 series. While he lacked the overall consistency of many other bowlers – with games of 156, 174 and 202 – the streak of strikes put him solidly in first place.

Second-place went to Brett Bode, associate scientist, who had a spread of only four pins between his high and low games, 118-120-115 (354), and who picked up four bonus points. Yuri Janssen, post-doctoral fellow, was the most consistent with games of 74-74-73 (221), but didn't win any additional bonus points.

A total of 24 bowlers took part in the tournament, which was held at 20th Century Lanes. ■

~ Kerry Gibson

Dave Rehbein displays the 45-year-old trophy he won for taking 1st place in the Harley Wilhelm Cup BowlingTournament.

INSIDER

Volume 15 / Number 3 / March 2004

Ames Lab Insider is published 11 times a year for the employees of the Ames Laboratory by the Office of Public Affairs and Information. Ames Laboratory is operated by Iowa State University (ISU) for the U.S. Department of Energy (DOE) under Contract W-7405-Eng-82 and is part of the Institute for Physical Research and Technology (IPRT) consortium of fundamental and applied research centers.

Address comments to:
Editor, ***INSIDER***
111 TASF
Ames, IA 50011-3020
515/294-9557
FAX 515/294-3226

Address correction requested
P-208-9

Editor Saren Johnston
Layout Cynthia Feller
Photographer Dennis Sailsbury

Printed on Recycled Paper

"For Ames Lab scientists and engineers to win three R&D 100 Awards in a single year is both an unprecedented and truly meaningful event."
–Tom Barton

James Fritz

Gregor Junk

Harry Svec

Metal Intrigue

Rick Schmidt Retires After 42 Years

M

Promotions

New Employees

1

2

W

3

4

Bill Buttermore

Disposing of materials in preparation for the Tiger Team:

-
-
-

Working Out the Bugs

ISU Students to Derisk the Transfer of an Ames Lab Technology

James Vary, associate in Nuclear Physics, has been appointed by Admiral James Watkins to serve on the Nuclear Sciences Advisory Committee. Vary joins 18 other scientists from U.S. academic institutions and national laboratories in advising DOE and the National Science Foundation on basic nuclear science policies and planning. "During this time of strong fiscal constraints, our challenge is to make funding recommendations that will ensure U.S. excellence in basic nuclear science," says Vary.

Emmanuel Papadakis, senior scientist at the Center for Nondestructive Evaluation, ras named a Fellow of the Institute of Electrical and Electronics Engineers for xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx

"We'll be using the system to look at polymers, metals and ceramics and for a variety of other surface studies."

–Jim Anderegg

NRC/*Continued on next page.*

New Employees

Elena Babak, Postdoctoral Fellow (Hebert)

Jo Anne Holland, Secretary II (Noble)

Christoph Janowitz, Postdoctoral Fellow (Lynch)

Lisa Mathis, Postdoctoral Fellow (Rosenberg)

David Vaknin, Associate Physicist (Stassis)

Jing-Tai Zhao, Postdoctoral Fellow (Corbett)

Promotions

Colin Chriswell from Associate Chemist to Chemist

EXPERIMENTAL SOLAR TRUCK READY TO ROLL ▪ Page 4