ICTAS Connection

Issue No. 4 | February 2008

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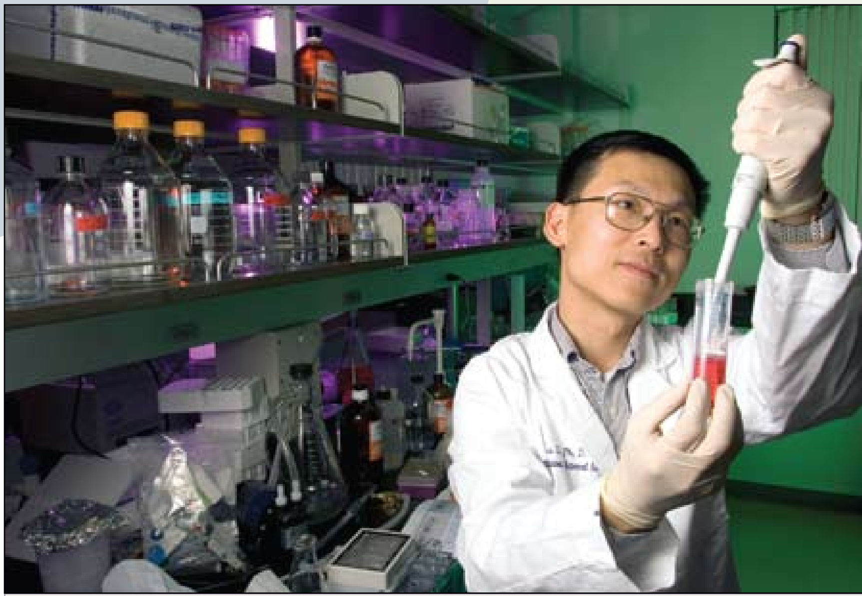
Investing to Win



Professor Liwu Li, Biological Sciences (Infectious Diseases), in the Innate Immunity and Inflammation laboratory.

There are several ways that the Institute for Critical Technology and Applied Science (ICTAS) invests in the long-term growth of university research. Although all of the investment methods are strategic and deemed key to the success of the university-wide initiative to grow research, some are more easily recognized or acknowledged than others.

The direct **award of funding** to faculty for research is widely recognized as the most obvious way that ICTAS investment is accomplished. This year's three-fold increase in the number of proposals submitted in response to the ICTAS proposal call is convincing evidence of faculty interest in this strategy. The receipt of 68 proposals involving more than 200 faculty members across varied disciplines represents an unprecedented response to the call. Additionally, a noticeable increase in the quality of the proposal content and in expanded intellectual thinking is encouraging and further evidence of interest and enthusiasm from the research community.

So far, 15 awards have been funded for the 2007-08 fiscal year for a total of $1,470,107. The awards are listed in alphabetical order by title.

Autonomous Personal Transportation (APT)
Akshay Sharma - CAUS, Robert Dunay - CAUS, Richard Goff - Mechanical Engineering, Michael Fleming - TORC Technologies.

Bio-based Materials Center (BBMC) at Virginia Tech
F. Agblevor - Biological Systems Engineering, Justin Barone - Biological Systems Engineering, Kevin Edgar - Wood Science and Forest Products, Alan Esker - Chemistry, Paul Gatenholm - Materials Science and Engineering, Sean McGinnis - Materials Science and Engineering, Abby Morgan - Materials Science Engineering and Chemical Engineering, Scott Renneckar - Wood Science and Forest Products, Maren Roman - Wood Science and Forest Products, Zhiyou Wen - Biological Systems Engineering, Percival Zhang - Biological Systems Engineering

Bone Healing Grafts Fabricated by Nanoscale Assembly of Biological Building Blocks
P. Gatenholm - Materials Science and Engineering, F. Agblevor-Biological Systems Engineering, J-H. Bohn - Mechanical Engineering, A. Esker - Chemistry, A. Goldstein - Chemical Engineering and Biomedical Engineering, K. Lu - Materials Science Engineering, L. O'Rourke - Biomedical Sciences and Pathobiology, I. Puri - Engineering Science and Mechanics, G. Wang - Biomedical Systems Engineering

Chemosensory Evaluation of Training and Oxidative Stress in Long-Distance Runners
P. Mallikarjunan - Biological Systems Engineering, P.G. Brolinson - Virginia College of Osteopathic Medicine

Constructing Building Blocks (Recombinant Thermophilic Enzymes) and Investigating Their Interactions: A Novel Carbohydrate-Based Hydrogen Production by Synthetic Biology
P. Zhang - Biological Systems Engineering, Liwu Li - Biological Sciences

Continuous Plasma Torch Production of Fullerenes and Trimetallic Nitride Endohedral Metallofullerenes
H. Dorn - Chemistry and CSAND, W. O'Brien - Mechanical Engineering

Development of Trimetallic Nitride Templated Endohedral Metallofullerenes and Peapod Structures for Imaging

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DEAN'S CORNER

The Game Is Afoot

J. Michael Kelly, Professor and Dean, College of Natural Resources

Baxter Black — cowboy poet, philosopher, and former large animal veterinarian — is well known to fans of early morning public radio for both his literary wit and provocative insights on society and the human condition. In the prologue to one of his poems Black states: "In feast or famine at least examine the game we came to play, 'cause win or lose it's how we use the cards that come our way." As we look beyond the literal meaning of those few simple words, we can see a very powerful message on the need for careful planning, informed utilization of available resources, and formulation of a game plan that takes into consideration the known and allows us to adapt to opportunities and setbacks that occur with the evolution of any program.

Over the past three years the university, participating colleges, and the ICTAS strategic plans have moved forward together. At all three levels we have identified and inventoried our resources, both capital and intellectual, analyzed our strengths and weaknesses, assessed both current and future landscapes in terms of opportunities and pitfalls, and agreed to focus our efforts on those things where we can be competitive and have a meaningful impact. And very importantly, we have identified where resources are needed and formulated plans to bolster our strength and capability in those key areas. In today's highly competitive environment, the ability to focus on a limited number of areas and to resource those areas adequately is what separates the winners from the also-rans. Having said that, it is also critical to recognize that we rarely have the optimum level of resources or facilities and thus it becomes doubly important that we are disciplined in the formulation and execution of our operating plan while at the same time providing the appropriate level of stimulation to the research community that will result in creative thinking and new and effective research partnerships.

This disciplined approach has already brought us some notable early successes as research teams have coalesced and their combined synergies have brought forward unique concepts and approaches to important research issues. Although we have made significant progress, we are still very much in the early phases of our growth of the Institute as we continue to build essential research infrastructure and add the remaining key personnel to our scientific roster.

The important contribution of land-grant universities to economic vitality and social change continues to be under-valued and underestimated. Much of the economic prosperity and quality of life that we currently enjoy is the direct result of our efforts in learning, discovery, and engagement. The Institute provides us with an opportunity to again bring these resources to bear in new and exciting ways. Ways that will contribute to the training of a new generation of researchers and teachers while at the same time addressing the growing needs of society in areas ranging from drug delivery systems to supporting our increasing demand for high quality water and sustainable energy.

Returning to my beginning analogy, the game has begun and the initial hands have been played. We are blessed with capable players and our stack of chips is growing. We need only to continue to play our cards wisely, effectively, and with discipline to have the impacts we all hope to achieve as an engaged institute and university.

DIRECTOR'S CORNER

Roop Mahajan
Director, ICTAS

Looking Back ... Marching Ahead

2007 was a year in which ICTAS made great strides in laying the foundation for cutting-edge research at the intersection of engineering, science and medicine. After careful benchmarking and assessing the strengths of Virginia Tech, we identified a few thrust areas for growth and investment with the long-term goal of putting Virginia Tech at the forefront of interdisciplinary research geared toward societal needs. These include, among others, the targeted delivery of nanomedicine, technologies for sustainable energy (solid oxide, chemically and biologically-derived fuel cells, organic photovoltaic cells), cognitive radio network, bio-based materials for bio-fuels and functional foods, tissue engineering, research in water and waste water covering infrastructure sustainability, the groundwater/surface water interface and urban watersheds, nanotechnology and environment, and novel carbon-based nanomaterials. We have engaged and formed interdisciplinary teams of faculty, students and researchers from different academic disciplines to advance these areas.

To fully understand the underlying physics and unleash the power of emerging fields of life sciences and engineering, a new 32,000 square-foot building was constructed and equipped with state-of-the-art experimental tools for fabrication and characterization at the nanometer scale. This facility was officially inaugurated on September 21, 2007, and is already serving researchers from different disciplines in understanding and discovering phenomena in matter and life at the nanometer scale.

At the organization level, we added a number of experienced and dedicated scientists and staff members to advance the mission of ICTAS. We are in the middle of a nation-wide search for an Associate Director for Research, and are also planning to add talented individuals to support our faculty and students.

With a strong foundation in place in 2007, we are moving forward in 2008 with confidence, optimism, and a strong commitment to excellence. We are making major investments in our research thrust areas and new initiatives including those on Implantable micro-Oncologists, Healing Bio-materials, Cardiovascular Non-invasive Diagnostics and Therapies, Characterization and Therapeutic Intervention of Human Inflammatory Disease, Turning Bytes to Knowledge Using Compositional Data Mining, Solar Fuel Cell Power Systems for Sustainable Homes, Non-Intrusive Monitoring for Gait and Posture for Fall Prevention for Telemedicine, and others.

We are looking forward to bringing a new 99,000-square-foot building equipped with exceptional laboratory and office space on board during the Fall of 2008. It will serve as ICTAS' headquarters but more importantly, it will provide a vibrant intellectual environment for interdisciplinary research and for stretching our students' minds.

We are excited about the role of ICTAS in working with our talented faculty and students to reach higher levels of achievement in areas we are already good at and to explore the undiscovered and the untapped with a bias toward sustainable development. As we march ahead, we welcome your feedback and continued support.

TECHNOLOGY FOCUS

Microfossils preserved in high metamorphosed rocks: A new window into the early biosphere?

JAMES D. SCHIFFBAUER and **SHUHAI XIAO**
Virginia Polytechnic Institute and State University
Department of Geosciences

The Precambrian Earth encompasses almost 90 percent of Earth history, ranging from the formation of the planet at approximately 4500 Million years ago (or Ma – Mega anna) to the base of the Phanerozoic Eon (Cambrian Period, 542 Ma). Perhaps more importantly, it contains some of the most important events in the evolutionary history of life, including the origin of life itself, and transitions from simple prokaryotic life to more complex eukaryotic life and finally to multicellular animal life near the Precambrian–Cambrian boundary. However, when we observe the Precambrian fossil record, we can easily read two distinct and incongruent chapters in the story of life.

We notice that Proterozoic (2500–542 Ma) fossils are abundant and widely accepted by the scientific community. For instance, the Proterozoic is dominated by fossils known as acritarchs, a group of organic-walled vesicular microfossils with diverse evolutionary histories, which are typically recovered from relatively unmetamorphosed cherts and shales. These taxonomically unresolved organisms provide a great deal of information about the evolution of early cellular life (1), some of which have been interpreted to be among the earliest representatives of eukaryotic life in the fossil record. In stark contrast, Archean (3800–2500 Ma) fossils are comparatively few and typically much more contentious in terms of biological interpretation. The Archean fossil record is primarily based upon a limited number of often controversial microfossils, such as filamentous structures from ~3500 Ma low metamorphic grade cherts in Australia, which have been interpreted both as bacterial fossils (2-4) and as carbonaceous structures shaped by crystal growth (5-7).

Because Archean fossils frequently generate debate, a great deal of caution must be implemented and multiple lines of evidence (morphological, ultrastructural, and geochemical) must be sought during their analysis and interpretation. Additionally confounding, most Archean rocks have been subjected to high temperatures and pressures. Thus, on top of the controversies surrounding Archean microfossil interpretations, Archean paleobiological exploration is complicated by the predominance of these high metamorphic grade rocks. The question then becomes: was evidence for biological

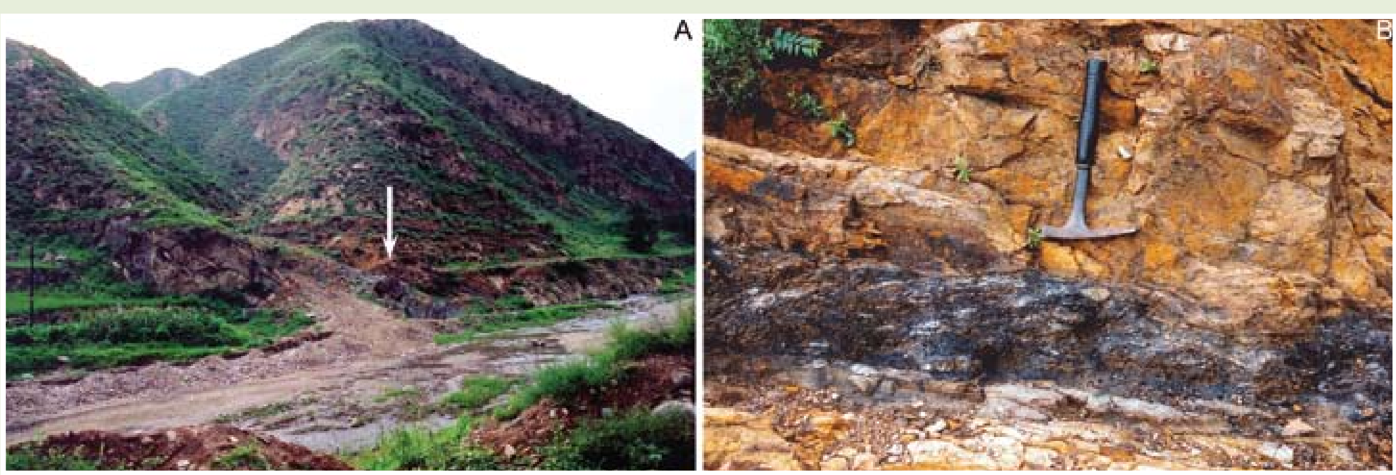

FIG. 1. Field photographs. (A) Field photograph of sample locality, Wutai Metamorphic Complex, North China (39°07.386'N, 113°55.223'E). Sampled unit indicated by arrow. (B) Close-up of sampled unit of carbonaceous quartzite (black layer below rock hammer).

activities, if any, completely erased from these highly metamorphosed rocks? It is traditionally accepted that high temperatures and pressures are detrimental to fossil preservation; and accordingly, Archean microfossils with recognizable biological morphologies previously have been reported chiefly from low metamorphic grade cherts (8-12). However, recent studies of Precambrian and Phanerozoic rocks have shown that bona fide filamentous bacteria, organic-walled microfossils (e.g., acritarchs, chitinozoans, and lychophyte spores) can be preserved in high grade metamorphic rocks (13-19).

In our recent study published in the August issue of Astrobiology (20), we considered the above-stated question by searching for morphological evidence of possible biological origin in high metamorphic grade Archean carbonaceous quartzites of the Wutai Complex in North China (see Fig 1 for field collection site). The immediate goal of this study was to characterize the morphological, ultrastructural, and geochemical features of the carbonaceous material contained in these rocks using a combination of light microscopy, electron microscopy, Raman spectroscopy, and ion microprobe techniques. Our study resulted in the recovery of abundant, indigenous graphite particles from the Wutai quartzites, most of which are irregular in shape and show recognizable, hexagonal graphite crystal morphologies. However, we discovered a distinct subpopulation of graphite particles that can be best characterized as circular discs with marginal folds and surficial wrinkles (see Fig 2 for EM micrographs).

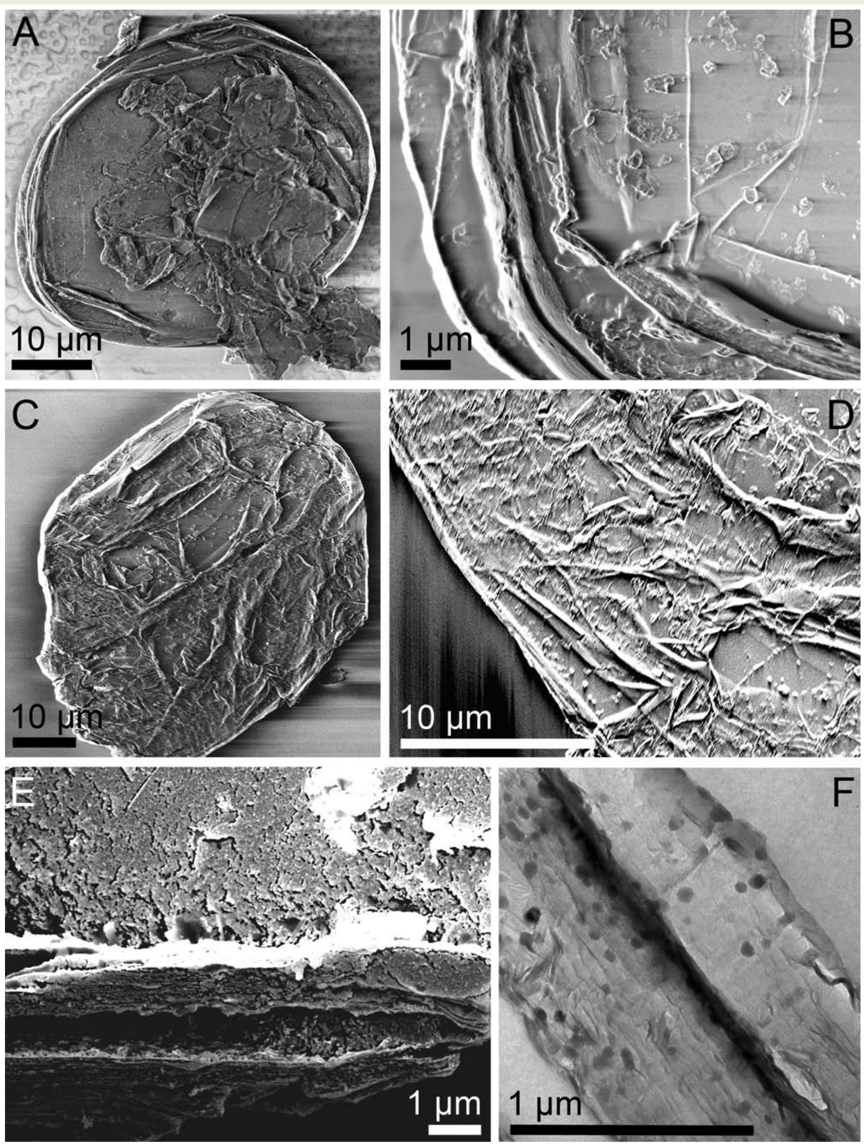

FIG. 2. SEM and TEM images of graphite discs. (A) Circular to elliptical disc with concentric marginal folds and amorphous carbonaceous material on surface. (B) Magnified view of lower left region of A showing concentric marginal folds. (C) Subhedral specimen with irregular surficial wrinkles and fragmented edge. (D) Lower right edge (rotated) of C, illustrating marginal folds and irregular surficial wrinkles. (E) Cross-sectional view along fracture of elliptical disc specimen (overview not shown here). Note central gap between two sets of graphite sheets. (F) TEM of graphite disc showing electron-dense central layer. Images A-E are SEM photomicrographs collected using secondary electron detector, F is a TEM photomicrograph.

Although the morphology of these graphite discs must have been overprinted by fragmentation, crystal growth, and other non-biological processes, perhaps the most plausible interpretation, based on the presence of the consistent circular to ovate shape, concentric marginal folds, and surficial wrinkles, is that these discs are graphitized biological structures. Our interpretation suggests that these discs were originally spherical, organic-walled vesicles that were then deflated, flattened, and graphitized during compaction of the host rock

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and later metamorphic heat and pressure. The above mentioned morphological features are expected during the compression and elastic deformation of organic-walled vesicles, and in fact are commonly observed in compressed organic-walled microfossils of younger Proterozoic and Phanerozoic rocks (21). Further, some specimens exhibited nanoporous structures, which are remarkably similar to those found in younger and uncontested Mesoproterozoic acritarchs (22), although the presence of similar nanoporous structures in other acritarchs remains to be verified. In addition, a gap is apparent between two sets of graphite sheets in some specimens, which may be interpreted as internal vesicle space between the compressed walls. Indeed, TEM observations show that some specimens have an electron-dense central layer, rather than a gap, which may represent material trapped within the compressed vesicle. Lastly, isotopic analysis of bulk carbonaceous material and individual graphite discs yielded depleted carbon isotope values, which are consistent with a biological interpretation.

At present, the morphological, ultrastructural, and geochemical evidence for a biological origin is still equivocal, but this study represents a first attempt to characterize carbonaceous material from highly metamorphosed Archean–early Proterozoic rocks using a combination of analytical tools. If our interpretation is correct, then it implies that organic-walled microfossils may survive significant heating and metamorphism, and this study may further broaden the Precambrian taphonomic window from greenschist- to amphibolite-grade metamorphic rocks. In an effort to provide more support for our biological interpretation, we are currently conducting additional analysis of these possible fossils at the ICTAS Nanoscale Characterization and Fabrication Laboratory, conducting comparative ultrastructural analysis of the Wutai graphite discs and younger, well-known organic-walled vesicles utilizing the high-precision sectioning capabilities of the FEI Company Helios 600 NanoLab focused ion beam electron microscope.

References

1. A.H. Knoll, E.J. Javaux, D. Hewitt, P. Cohen, *Philosophical Transactions of the Royal Society of London* B Biological Sciences 361, 1023 (2006).
2. J.W. Schopf, B.M. Packer, *Science* 237, 70 (1987).
3. J.W. Schopf, *Science* 260, 640 (1993).
4. J.W. Schopf, A.B. Kudryavtsev, D.G. Agresti, T.J. Wdowiak, A.D. Czaja, *Nature* 416, 73 (2002).
5. M. Brasier, N. McLoughlin, O. Green, D. Wacey, *Philosophical Transactions of the Royal Society* B 361, 887 (2006).
6. M.D. Brasier et al., *Nature* 416, 76 (2002).
7. M.D. Brasier et al., *Precambrian Research* 140, 55 (2005).
8. A.H. Knoll, E.S. Barghoorn, *Science* 198, 396 (1977).
9. S.M. Awramik, J.W. Schopf, M.R. Walter, *Precambrian Research* 20, 357 (1983).
10. J.W. Schopf, M.R. Walter, in *Earth's Earliest Biosphere: Its Origin and Evolution*, J.W. Schopf, Ed. (Princeton University Press, Princeton, NJ, 1983), pp. 214–239.
11. M.M. Walsh, D.R. Lowe, *Nature* 314, 530 (1985).
12. W. Altermann, J.W. Schopf, *Precambrian Research* 75, 65 (1995).
13. D.L. Kidder, S.M. Awramik, *Palaios* 5, 124 (1990).
14. A.H. Knoll, *Palaeontology* 35, 751 (1992).
15. S. Bernard et al., *Earth and Planetary Science Letters* 262, 257 (2007).
16. R.J. Squire, I.R. Stewart, W.L. Zang, *Australian Journal of Earth Sciences* 53, 697 (2006).
17. W.L. Zang, *Precambrian Research* 156, 107 (2007).
18. M. Hanel, M. Montenari, A. Kalt, *International Journal of Earth Sciences* 88, 49 (1999).
19. S.G. Molyneux, *Journal of the Geological Society*, London 155, 741 (1998).
20. J. Schiffbauer et al., *Astrobiology* 7, 684 (2007).
21. J.W. Schopf, C. Klein, *The Proterozoic Biosphere: A Multidisciplinary Study*. (Cambridge University Press, Cambridge, 1992), pp. 1348.
22. A.J. Kaufman, S. Xiao, *Nature* 425, 279 (2003).

STUDENT SPOTLIGHT

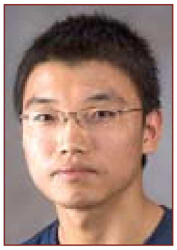
GETTING TO KNOW
Carter Fox

Currently a Ph.D. candidate in Interdisciplinary Macromolecular Science and Engineering in the Wood Science and Forest Products Department and a member of the inaugural class of elite ICTAS Doctoral Scholars, Carter is advised by Dr. Kevin Edgar. Carter earned his B.S. in Wood Science and Forest Products with minors in Chemistry and Music from Virginia Tech. He earned a Masters in Forest Products at the University of Idaho under advisement of Dr. Armando McDonald.

While pursuing a B.S. at Virginia Tech, Carter spent five seasons with the Marching Virginians marching band playing the baritone. Carter enjoys outdoor activities, especially hiking and backpacking. He has hiked all over the contiguous U.S., including a complete thru-hike of the Appalachian Trail in 2003. While at the University of Idaho, Carter met Rhiannon Chandler who shares this interest, and they were married on December 22, 2007. Together, they plan to hike the complete Pacific Crest Trail, from the Mexican border to the Canadian border.

Carter's research is currently focused on chemically derivatizing cellulose for pharmaceutical drug delivery applications. His previous research experience includes a summer with the Macromolecules and Interfaces Institute (MII) at Virginia Tech evaluating the fracture mechanics of phenol formaldehyde/isocyanate hybrid adhesive systems, characterizing and derivatizing industrial lignins while at the University of Idaho, and characterizing and evaluating cellulosic feedstocks for ethanol production while employed by the Biological Systems Engineering department at Virginia Tech.

GETTING TO KNOW
Qian He



Currently a Ph.D. candidate in the Department of Physics and a member of the inaugural class of elite ICTAS Doctoral Scholars, Qian is advised by Dr. Uwe Tauber. Qian came to Virginia Tech from Tsinghua University where he earned a B.S. degree.

Qian is partial to the outdoors and enjoys hiking. When conditions are not conducive to outdoor recreation, he enjoys bowling and table tennis. Recently, Qian has acquired an interest in cooking.

His research interests are focused on theoretical condensed matter physics, using a variety of complementary techniques, including mean-field method, stochastic process and Monte Carlo simulation to understand Reaction-diffusion systems in statistical mechanics. Qian's interest is driven by the many applications for reaction-diffusion systems such as enhancing understanding of the chemical reaction in chemistry, biological problems, and population dynamics in ecology. He is preparing for advanced research through reading, math, and physics exploration.

GETTING TO KNOW
Amin Karami

Currently a Ph.D. candidate in the department of Engineering Science and Mechanics in the College of Engineering and a member of the inaugural class of elite ICTAS Doctoral Scholars, Amin is working in the Center for Intelligent Material Systems and Structures (CIMSS) under the supervision of Dr. Daniel J. Inman. Amin previously earned a Master of Applied Science in Mechanical Engineering from The University of British Columbia in Vancouver, BC, Canada under the tutelage of Dr. Farrokh Sassani and a B.SC. in Mechanical Engineering from Sharif University of Technology, Tehran, Iran.

For enjoyment, Amin hikes, plays volleyball, skis, and swims. He also enjoys Persian traditional music and philosophical studies and discussions.

His research interests include dynamics, robotics, nonlinear control, and mechatronics and instrumentation. His Ph.D. research is currently focused on micro-scale energy harvesting. His masters research centered on nonlinear control of underactuated satellite and spacecraft.

GETTING TO KNOW
Tila Khan

Currently a Ph.D. candidate in the department of Biomedical Science and Pathobiology of the Virginia Maryland Regional College of Veterinary Medicine and a member of the inaugural class of elite ICTAS Doctoral Scholars, Tila is advised by Dr. Paul Christopher Roberts.

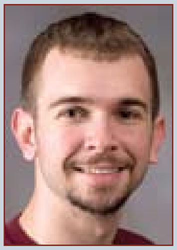
Tila completed undergraduate studies in Veterinary and Animal Science (equivalent to a D.V.M in the U.S.) at Govind Ballabh Pant University of Agriculture and Tech in India and also a Masters of Veterinary Science at the same institution. She was awarded a Junior Research Fellowship by the Government of India to study at JawaharLal Nehru University where she performed research in the field of molecular biology and the infectious bursal disease virus of poultry, an experience she credits with motivating her to pursue a Ph.D. in virology.

In her spare time, Tila enjoys reading scientific books, fiction and novels. She also enjoys traveling and generally exploring planet Earth, including the many cultures, languages, traditions and cuisines therein.

Tila's current research work is centered on the development of Cytokine based influenza vaccines. She is particularly interested in evaluating the potential of CYT-IVACs or Cytokine bearing influenza virus vaccines to boost antiviral humoral immune responses and protect against lethal challenge using a mouse model of infection.

STUDENT SPOTLIGHT

GETTING TO KNOW
Justin Lemkul

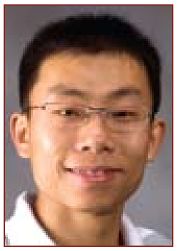


Currently a Ph.D. candidate in the Department of Biochemistry and a member of the inaugural class of elite ICTAS Doctoral Scholars, Justin is advised by Dr. David Bevan of the Biochemistry Department. Justin earned his B.S. in Biochemistry at Virginia Tech, also under the tutelage of Dr. Bevan.

Justin is an accomplished guitarist and violinist, and spends much of his free time listening to and playing music. He is an active member of the Alpha Chi Sigma Professional Chemistry Fraternity and served as Reporter, Professional Activities Committee Chair, and President during his undergraduate years.

His research interests include computational modeling of protein-protein and protein-lipid interactions. Justin is specifically interested in understanding protein aggregation processes on an atomic level, with special focus on the amyloid β-peptide, its self-association, interactions with other cellular macromolecules, and the resulting oxidative stress that leads to the symptoms of Alzheimer's disease. These studies employ molecular dynamics simulations and free energy calculations, utilizing high-performance parallel computing available through Virginia Tech's system supercomputer.

GETTING TO KNOW
Qingqing Li

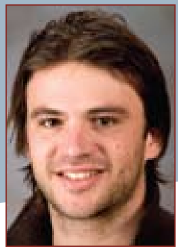


Currently a Ph.D. candidate in the Department of Wood Science and Forest Products and a member of the inaugural class of elite ICTAS Doctoral Scholars, Qingqing is advised by Dr. Scott Renneckar of the Brooks Products Center at Virginia Tech. Qingqing came to Virginia Tech from the Beijing Forestry University in Beijing, China where he earned an M.S.

Qingqing enjoys music and has performed as both a singer and as an instrumentalist. He plays saxophone and piano. Qingqing competes in table tennis and intramural basketball. On the more scholarly side, he enjoys writing, editing, and engaging in debate. He has held numerous leadership positions while involved in school, demonstrating a talent for organizing, promoting, and hosting events.

His research interests to date include wafer-board processing technology, non-wood based panel processing technology and wood dyeing mechanism and processing technology. Qingqing's current research interests are centered on layer-by-layer directed nano coating.

GETTING TO KNOW
Marcel Remillieux

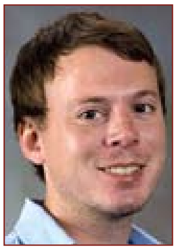


Currently a Ph.D. candidate in the department of Mechanical Engineering in the College of Engineering and a member of the inaugural class of elite ICTAS Doctoral Scholars, Marcel is advised by Dr. Ricardo Burdisso (Mechanical Engineering) and Dr. Georg Reichard (Building Construction). Marcel earned an Engineer Diploma in Mechanical Engineering with minor in Economics from the University of Technology of Compiègne (UTC), France. He earned his M.S. in Mechanical Engineering at Virginia Tech under the tutelage of Drs. Ricardo Burdisso and Dr. Wing Ng.

Marcel was born in Ajaccio on the island of Corsica, France. There he developed a love of everything related to the ocean, particularly harpoon fishing. He also enjoys beach volleyball, snow skiing, and snowboarding. He earned a black belt in Karate and is also interested in any activity that involves speed, such as car racing. He speaks 4 languages (French, English, Spanish, Italian) and plans to take flying lessons soon.

As part of his undergraduate education, Marcel was selected for a yearlong study abroad program sponsored by the University of Technology of Compiègne at the University of Pennsylvania School of Engineering and Applied Science where he worked on the active control of flow patterns under advisor Dr. Haim Bau. Master's studies included an aeroacoustic study of a model-scale landing gear in a semi-anechoic-wind-tunnel test section funded by NASA, various aeroacoustic projects on a model scale aircraft wing for the Japanese Aerospace Exploration Agency (JAXA), and wind turbine airfoils research sponsored by the National Renewable Energy Laboratory (NREL). He also participated in the upgrade of the VT hard-walled wind tunnel to an aeroacoustic wind tunnel. Currently, his research is focused on the development of a model for prediction of the transmission of sonic booms inside buildings funded by NASA.

GETTING TO KNOW
Jon Weekley



Currently a Ph.D. candidate in the Department of Horticulture in the College of Agriculture and Life Sciences and a member of the inaugural class of elite ICTAS Doctoral Scholars, John is advised by Dr. Jerzy Nowak, Horticulture Department Head. Jon earned his B.S. and M.S. in mechanical engineering at Virginia Tech before moving to horticulture. Jon's master's thesis dealt with image analysis for identifying and tracking vegetative growth.

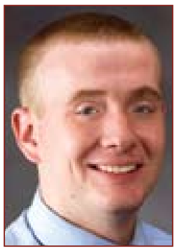
Jon enjoys hiking and playing Frisbee golf in his spare time. He is also an avid reader, favoring authors such as Ernest Hemingway, Tom Robbins, and Kurt Vonnegut, Jr.

Jon's current research is centered on a project known as the "Smart Greenhouse." The project is designed to enable high school

STUDENT SPOTLIGHT

students to have the ability to control and manipulate biologically significant greenhouse variables such as temperature, moisture and lighting. He is also developing a subterranean sensor suit for monitoring hydrogen, oxygen and carbon dioxide levels to promote and monitor growth of beneficial bacteria.

GETTING TO KNOW
Matthew Williams

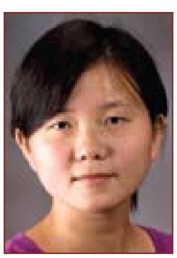


Currently a Ph.D. candidate in the Department of Statistics in the College of Science and a member of the inaugural class of elite ICTAS Doctoral Scholars, Matthew is following the Environmental Track under the tutelage of Dr. Eric Smith. He is an honors program graduate of Clarkson University with dual degrees in Biology and Mathematics.

A cross-country competitor and service fraternity enthusiast in undergraduate school, Matthew is recently more inclined toward reading and stimulating discussion among colleagues and friends in his spare time.

Matt's research interests include sustainability, epidemiology, point source and non-point source pollution, and human dimensions projects in environmental management. While his academic program expectations are focused on preparing for the qualifying exams in the spring, he is engaged in work with the Conservation Management Institute at Virginia Tech to analyze survey data for the Virginia Birding and Wildlife Trails. He is also taking a spatial data analysis course in the Geography Department and attending a weekly GIS and Remote Sensing seminar.

GETTING TO KNOW
Sihui Zhang



Currently, Sihui is a Ph.D. candidate in the Cell and Developmental Biology program in the Department of Biological Sciences advised by Dr. Jeffrey Kuhn and a member of the inaugural class of elite ICTAS Doctoral Scholars Program. Before coming to Virginia Tech, Sihui did her undergraduate work in the Honors Program of Life Sciences at China Agricultural University, where she learned to do research on cytoskeleton of plants. Sihui completed her B.S. thesis work in the National Institute of Biological Sciences (Beijing) advised by Dr. Ligeng Ma, and focused on genetic dissection of regulatory pathways controlling plant development.

During her spare time, Sihui enjoys playing table tennis, and was once a university champion. Also, she is interested in painting and is currently learning photography.

Consistent with her interest in cell and developmental biology, Sihui is now exploring cell motility during animal development on the molecular level toward improving understanding of cell motility in the context of development and some of the developmental diseases.

FACILITIES NEWS

ICTAS A – NANOSCALE CHARACTERIZATION AND FABRICATION LABORATORY (NCFL)

During the last couple of months, the FEI Titan FE-STEM and the Philips EM 420 TEM were successfully moved from campus to permanent homes in the NCFL. Both instruments are up and running, and are now conveniently co-located with the rest of the analytical tools in the NCFL.

This month we bid farewell to Joerg Jinschek, ICTAS Research Assistant Professor and Director of the Electron Microscopy Laboratory at Virginia Tech. In January 2008, Joerg joined FEI Company in Eindhoven NL as an application engineer for its Titan microscopes. Joerg was responsible for establishing Virginia Tech's Titan facility and running it for the past two years. We wish him the best in his new position.

At the same time, we welcome Mitsu Murayama, Research Scientist and electron microscopist at the University of Virginia, who is spending a portion of his time in Blacksburg at the NCFL operating the Titan. Mitsu is an experienced analytical microscopist. Mitsu and John McIntosh, NCFL Lab Instrument Specialist, will assist researchers interested in using the Titan.

ICTAS I

Plans for lab upfits that will be incorporated into the original project completion plan continue to be refined. The building is tentatively scheduled for completion in the fall of this year.

ICTAS II

This building is one of a few buildings on campus that is being built under a new process called Construction Manager at Risk. This is an alternative to the traditional process in which an architect completes the design, the drawings and specifications are put out for bid, and the contractor with the lowest bid is selected. The Construction Manager at Risk process allows the contractor (construction manager) selection to occur prior to the completion of the design through a request for proposal process that takes into account the previous experience of the firm and the proposed personnel.

The construction manager has input into the design from a cost and constructability standpoint and assumes some of the financial risk as part of producing a GMP (guaranteed maximum price) prior to the completion of design. This method facilitates a smoother transition from design to construction, a shorter timeframe from start of design to completion of construction, and a better product with fewer change orders due to identification of design discrepancies during the design phase. The architect on this project is Smithgroup and the selected construction manager is Skanska. The project is currently in design development and Skanska plans to mobilize on the site in mid-May.

Biological Systems Engineering Student Tameshia Ballard with Professor P. Kumar Mallikarjunan in a BSE research laboratory.

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Therapeutic Applications

N. Rylander - Mechanical Engineering and SBES, H. Dorn - Chemistry, S. Huxtable - Mechanical Engineering, C. Rylander - Mechanical Engineering and SBES

Evaluation of a Nanoscale Targeted Antioxidant Delivery System in an Equine Model for Human Asthma and Pulmonary Inflammation

C. Thatcher - Biomedical and Veterinary Science, B. Lepene - Biomedical and Veterinary Science.

Implantable μ-Oncologists

M. Agah - Electrical and Computer Engineering, R. Davalos - Biomedical Engineering and Sciences, P. Gatenholm - Materials Science Engineering, I. Lazar - Virginia Bioinformatics Institute, L. Nazhandali - Electrical and Computer Engineering, S. Raman - Electrical and Computer Engineering, I. Puri - Engineering Science and Mechanics, G. Wang - Biomedical Systems Engineering

Interdisciplinary Design of Engineering Muscle Tissue

T. Long - Chemistry, D. Baird - Chemical Engineering, J. Freeman - SBES, A. Goldstein - Chemical Engineering

Microbial-driven Electrical Currents in Nanobiofilms

J. Falkinham - Biological Sciences, A. Dietrich - Civil and Environmental Engineering, I. Puri - Engineering Science and Mechanics

Nanoparticle Markers for High-Efficiency Non-Linear Microscopy: Combining Cancer Imaging and Treatment

H. Robinson - Physics, R. Davis - Chemical Engineering, Y.W. Lee - SBES

Neural Tube Defects in Mice from Tap Water

T.C. Hrubec - Biomedical Sciences and Pathobiology, VCOM, D.J. Blodgett - Biomedical Sciences and Pathobiology, College of Veterinary Medicine, F.A. Etzkorn - Chemistry

Newcastle Disease Virus Bionanoparticles for Tumor-Selective Targeting and Oncolysis

E. Subbiah - Biomedical Science, J. Riffle - Chemistry

Synthesis and Characterization of New Reverse Osmosis and Nanofiltration Membranes for Water Purification

J. McGrath - Chemistry

Significant funding for **research equipment** is coordinated and supported through ICTAS. Over the past two years more than $5.5 million in research equipment has been acquired by ICTAS through allocation of Commonwealth Research Initiative (CRI) funds, State Council of Higher Education (SCHEV) support, and ICTAS general equipment support. Additionally, ICTAS provides and supports facilities that are designed to house specialized equipment and research needs. ICTAS provides technical support for some of the more highly specialized equipment items. This support serves to bring together people and tools that might not come together otherwise, enabling an atmosphere that is conducive to interdisciplinary collaboration, interaction, and research.

A little less obvious, but no less important, is ICTAS' **investment in new faculty recruitment and hiring**. Over the last fiscal year, ICTAS has invested more than $400,000 in university hiring initiatives. Funds provided by ICTAS for this purpose enhance the offerings to world-class candidates, ensuring recognition of Virginia Tech as a competitor for the best and the brightest research minds of the 21st century. Research potential and talent is also tapped through **investment in graduate students**. ICTAS routinely provides funds to support more than 40 graduate students, involving more than 25 disciplines. Additionally, ICTAS created, supports and coordinates the elite ICTAS Doctoral Scholars Program that enhances recruitment potential and, in steady state, fully funds 40 top Ph.D. candidates.

ICTAS provides **matching funds, equipment, or facilities access** in support of proposals that require specific or targeted institutional support. Currently ICTAS is providing matching funds to four investigators representing a monetary investment of $150,000, and has committed to pending proposals an additional $577,000.

As ICTAS refines methods and resources to meet the technological challenges ahead in this century and beyond, new and creative ways of supporting research may be needed to ensure continuing growth in research at Virginia Tech. ICTAS welcomes ideas or suggestions for maximizing utilization and leveraging of available resources. In the meantime, ICTAS will invest to win, banking on the firm resolve, adventurous inquiry and indomitable spirit of our talented researchers.

ICTAS IN THE NEWS

Faculty, researchers, doctoral students all winners

Congratulations to two ICTAS affiliated faculty, Drs. **Stefan Duma** and **Michael W. Ellis**, on appointment as John R. Jones Faculty Fellows in Mechanical Engineering. The appointments were announced by the Virginia Tech Board of Visitors on November 12, 2007. The Jones Fellow of Mechanical Engineering provides the means for the department to recognize outstanding mid-career faculty through the award of supplemental funding for a period of up to five years. In addition to rewarding exceptional individual effort, the award is expected to help preempt loss of talent to aggressive (and often well-funded) external recruiting.

Top researchers in high performance computing were recognized by the Supercomputing Conference 2007 (SC07) held recently in Reno, Nevada. Sponsored by ACM and the IEEE Computer Society, this international conference showcases the latest advances in high performance computing, networking, storage and analysis. On November 15, 2007 the SC07 conference announced winners of the Best Paper, Best Student Paper, Best Poster, ACM Student Research Competition, Analytics Challenge, Bandwidth Challenge, Storage Challenge, and Gordon Bell Prize. The Synergy Lab at Virginia Tech, in collaboration with Argonne National Laboratory, was awarded the Storage Challenge Award. The winning entry is entitled "ParaMEDIC: Parallel Metadata Environment for Distributed I/O and Computing." The team includes **Jeremy Archuleta**, ICTAS Doctoral Scholar at Virginia Tech, Pavan Balaji of the Argonne National Laboratory, Wu-chun Feng of the Computer Science Department at Virginia Tech, and Heshan Lin of North Carolina State University. Jeremy's advisors are Drs. Wu-chun Feng and Eli Tilevich.

Duma

Archuleta

Ellis

Virginia Tech
Invent the Future

ICTAS Connection is published by the **Institute for Critical Technology and Applied Science** at Virginia Tech

ICTAS supports and promotes cutting edge research at the intersection of engineering, science, and medicine.

Roop L. Mahajan, Director

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FACULTY SPOTLIGHT: PADMA RAJAGOPALAN

Rajagopalan joins Virginia Tech in January

Professor Padma Rajagopalan joined the Department of Chemical Engineering in January 2007. She also holds appointments in the School of Biomedical Engineering and Sciences (SBES), in the Macromolecules and Interfaces Institute (MII) and in the Wake Forest Institute for Regenerative Medicine. Prior to joining Virginia Tech, she was the PC Rossin Endowed Assistant Professor in the Department of Chemical Engineering at Lehigh University. Prior to joining the faculty at Lehigh, Dr. Rajagopalan was a research associate at the Center for Engineering in Medicine, Harvard Medical School. Dr. Rajagopalan earned her bachelor's degree from the Indian Institute of Technology, Kharagpur, India and obtained her Ph.D. from Brown University. In 2007, she was the Chair of the Women's Initiative Committee at the American Institute of Chemical Engineers (AIChE). She is currently a member of AIChE's Engineers without Borders.

Dr. Rajagopalan's research focuses on the design and development of in vitro three-dimensional tissue constructs. Current research projects in her group include the design of multi-layered hepatic and corneal cellular constructs, the design of biocompatible elastin-like polypeptides, and the fabrication of biomimetic surfaces with nanoscale porosity and topography.

The Design of Liver-mimetic Cellular Architectures:

The successful design of tissue-engineered organs can be accelerated if model tissue constructs that mimic the structure in vivo are available to probe cellular response to a variety of cues. The design of tissue-engineered livers and liver-support devices can be accelerated if model three-dimensional (3-D) tissue mimics are available to systematically test responses to a range of stimuli. There is currently no generally applicable methodology to layer liver cells in vitro. A major thrust in Dr. Rajagopalan's research is the design of in vitro 3-D cellular architectures that mimic several aspects of liver architecture found in vivo. These cellular constructs are comprised of alternating layers of hepatocytes and endothelial cells separated by a nanoscale, biocompatible and biodegradable polyelectrolyte scaffold. An important aspect of these studies is to develop a comprehensive understanding of the systems biology of these cellular architectures. The goal of an ongoing collaboration with Professor T.M. Murali (Department of Computer Science, Virginia Tech) is to integrate diverse types of data generated by tissue engineering experiments into large-scale genome-wide models of circuits that represent how engineered tissues respond to external conditions.

Rajagopalan

Biomimetic Surfaces for Corneal Tissue Engineering:

A leading cause of blindness in the world is corneal opacity that arises due to several complications such as corneal dryness, diabetes and injuries sustained by the cornea. Tissue engineered corneas must incorporate the multiple cell types found in the cornea that are supported on substrata that exhibit the complex porosity and topography found in vivo. The basal membrane that supports corneal epithelial cells is composed of extracellular matrix proteins that exhibit topography on the nanoscale with the diameters of pores and fibers ranging from 20-200nm. In an ongoing collaboration with Professor Michael Rubner (Department of Materials Science and Engineering, MIT), biomimetic basal membranes based upon polyelectrolytes that exhibit nanoscale porosity and topography are being tested as substrata that can support corneal cells. The ability to control and tune porosity on polyelectrolyte assemblies makes such surfaces an attractive choice in understanding how cells respond to differences in porosity and topography.

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