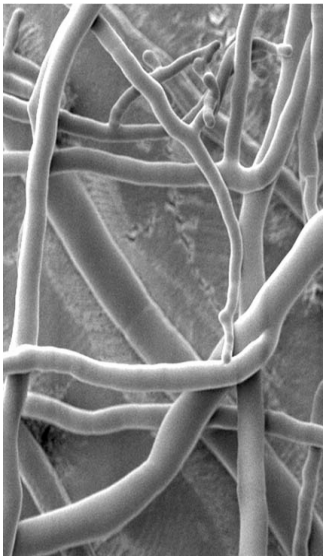
[AIMS] Arizona Imaging and Microanalysis Society

Using light, electrons, ions, electromagnetism and x-rays

Program, Abstracts & Biographical Information

March 8th, 2007

Carson Ballroom
Old Main
Arizona State University



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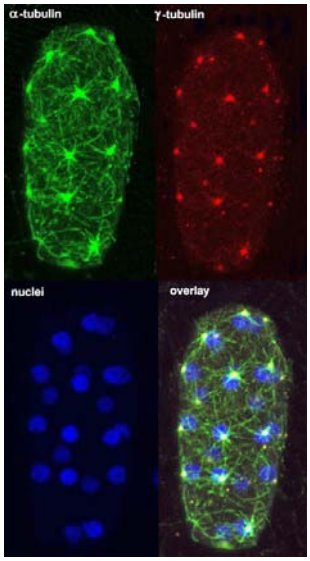

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AIMS - Program - 2007

Check-In
| 7:30 - 8:30 |

Morning Session (subject to change)
Opening remarks
Charles Kazilek - AIMS President
| 8:30 - 9:00 |

CAT Scans of Single Cells at Better than 50 nm Resolution
Carolyn Larabell (Keynote Speaker), Head of the National Center for X-ray Microscopy
| 9:00 - 9:50 |

Morning Break
Coffee and Pastries
| 10:00 - 10:30 |

Atom Probe Tomography of Materials
Thomas F. Kelly, Imago Scientific Instruments Corporation
| 10:40 - 11:10 |

Implementing Genetically-encoded Optophysiological Probes to Investigate Neural Circuits
William J. Tyler, Assistant Professor, ASU School of Life Sciences
| 11:20 - 12:00 |

Lunch
| 12:00 - 1:00 |

Afternoon Session (subject to change)

Progress and Perspectives for Atomic-Resolution Electron Microscope
David Smith, Regents' Professor of Physics at Arizona State University
| 1:00 - 1:40 |

Student Poster Presentations
Presentation and judging of student poster presentations
| 2:00 - 2:30 |

Afternoon Break - Vendor Exhibit - Judging
| 2:30 - 3:30 |

Geometric Reconstruction of Neuronal Shape and Synapse Localization from Confocal Image Stacks
Carsten Duch, Associate Professor, ASU School of Life Sciences
| 3:50 - 4:30 |

Closing Remarks and Student Award Announcement

Annual Society General Meeting (open to the public)

Speaker Abstracts & Biographies

CAT SCANS OF SINGLE CELLS AT BETTER THAN 50nm RESOLUTION

Dr. Carolyn Larabell

X-ray tomography generates 3-D reconstructions of whole, hydrated cells at a resolution now approaching 15 nm. Cells are imaged in the "water window" where the X-ray photons at that energy (2.4 nm wavelength) can readily penetrate the aqueous environment of the cell, yet they are significantly absorbed by carbon and nitrogen containing material. This difference in transmission is readily quantifiable – organic material absorbs approximately an order of magnitude more than water – and provides a natural contrast. This eliminates the need for contrast enhancement procedures, such as those used in Electron Microscopy. Immunogold labeling techniques similar to those used for TEM can be used to localize proteins in whole cells, making it possible to determine the spatial distribution of labeled proteins throughout the entire cell. We are also developing probes and methods to simultaneously detect multiple proteins to obtain information about proteins in complexes. X-ray tomography has the potential to be very successful at meeting this challenge since it can generate three-dimensional views of whole cells, at 15 nm isotropic resolution, and each tomographic data set – the information required to determine the position of the protein in the cell – can be obtained in less than three minutes. This makes it possible to obtain large amounts of statistically significant data in short periods of time.

Dr. Carolyn Larabell

Dr. Larabell holds a joint position as Professor in the Department of Anatomy at the University of California, San Francisco School of Medicine, and Faculty Scientist in the Physical Biosciences Division at the Lawrence Berkeley National Laboratory. She is also the Director of the UCSF/LBNL National Center for X-ray Tomography.
Dr. Larabell received her B.S. from Arizona State University in 1981. She received her Ph.D. from Arizona State University in 1988 and did postdoctoral training at both Stanford University and the University of California at Davis. She has been at Lawrence Berkeley National Laboratory since 1990 and was appointed as the Advanced Light Source Professor at LBNL in 1999 and Professor in the Department of Anatomy at UCSF in 2000.

Dr. Larabell's research interests center on the development of novel imaging techniques and their application to cell and developmental biology, including events involved with establishing cell polarity, cell differentiation, and cancer. She has extensive experience with a variety of imaging technologies including electron microscopy; freeze-fracture and quick-freeze, deep-etch, rotary-shadow TEM; and confocal and multiphoton microscopy, with an emphasis on live-cell imaging of dynamic events. Since 1997 she has been leading the efforts at Lawrence Berkeley National Laboratory to develop soft x-ray microscopy for imaging cells. In 2004 she established the National Center for X-ray Tomography (NCXT), funded by the National Center for Research Resources of the NIH and the Office of Biological and Environmental Research of the DOE. She serves on the Scientific Advisory Committee for the Advanced Light Source, LBNL; the

Biophysics Collaborative Access Team at the Advanced Photon Source; and the Synchrotron Radiation Facility at the University of Wisconsin. She also has served on the Advisory Board for a study on Revealing Chemistry through Advanced Imaging Technologies organized by the National Academies of Sciences and as a panel chair or member of 40 NIH, NSF, and DOE Study Sections/Proposal Merit Review panels and 14 proposal review panels for Synchrotron Radiation Centers. She is on the Editorial Board for the Journal of Structural Biology and is an ad hoc reviewer for 10 major journals.

ATOM PROBE TOMOGRAPHY OF MATERIALS

Dr. Thomas F. Kelly

An atom probe tomograph is a point-projection microscope that uses time-of-flight spectrometry to identify each atom in the image. It provides three-dimensional structural and compositional analysis of materials at the atomic scale and is the highest spatial resolution analytical characterization technique.
With recent developments in technology, the atom probe's compositional imaging capabilities are now available to microscopists for analysis of a wide variety of materials. Imago's LEAP® technology has many advantages in analysis speed, field of view, and ease of operation. With laser pulsing, it is possible to analyze metals, semiconductors, dielectrics and even organics. Maturation of a FIB lift-out specimen preparation methodology has enabled the straightforward preparation of samples extracted directly from a specific site on a specimen or a Si wafer. Example analyses of thin film structures, dopant atom distributions in semiconductors, silicide structures, SiGe multilayers, thin dielectrics and organics will be shown.

Dr. Thomas F. Kelly

A professor of materials science and engineering in the UW-Madison College of Engineering until September 2001, Tom Kelly took a sabbatical and founded a company to commercialize his recently-invented Local Electrode Atom Probe (LEAP®) tomograph. This technology enables researchers to view and analyze materials such as computer chips at the atomic scale. LEAP technology, uses a high electrical field to capture an atom-by-atom "picture" of a material and render that image on a computer screen in 3-D.
Thomas F. Kelly received his Bachelor of Science in Mechanical Engineering with highest honors from Northeastern University in June 1977. He then entered graduate school at the Massachusetts Institute of Technology and received a Ph.D. in Materials Science in December 1981. After one year as a postdoctoral associate at M.I.T., he joined the faculty of the Department of Metallurgical and Mineral Engineering of the University of Wisconsin-Madison in January 1983. He was a Full Professor from 1994 until his departure from the renamed Department of Materials Science and Engineering. Tom was also Director of the Materials Science Center from 1992 to 1999.
Tom Kelly, Founder and Chief Technical Officer of Imago Scientific Instruments, has been active in the fields of analytical electron microscopy, atom probe microscopy, rapidly solidified materials, and electronic and superconducting materials for over 25 years. He has published over 120 papers and 6 patents in these fields in that time. Dr. Kelly is an authority on microstructural characterization. He is expert in most forms of transmission electron microscopy, scanning electron microscopy, and atom probe tomography and has brought innovations to the instrumentation and practice. Tom is currently President of the International

Field Emission Society and has recently served a three-year term as Director of the Microscopy Society of America.

IMPLEMENTING GENETICALLY-ENCODED OPTOPHYSIOLOGICAL PROBES TO INVESTIGATE NEURAL CIRCUITS

Dr. William J. Tyler

Determining how activity and experience shape the structure and function of the nervous system represents one of the most pervasive problems in modern cellular molecular neuroscience. Using the rodent hippocampal and olfactory systems as models, various optical approaches useful for investigating activity-dependent neural plasticity will be discussed. A special emphasis will be placed on optical methods useful for investigating neurotransmitter release and synaptic vesicle cycles. Our discussion will span the techniques we employ ranging from modified wide-field approaches to using genetically-encoded optophysiological probes to investigate plasticity in intact neural circuits in live animals.

Dr. William J. Tyler

Jamie earned his PhD at the University of Alabama at Birmingham under the guidance of Lucas Pozzo-Miller. Jamie's investigations were designed to investigate the role of Brain-derived neurotrophic factor in the structural and functional plasticity of hippocampal pre and postsynaptic compartments at excitatory CA3CA1 synapses. Using a combination of electron microscopy, whole-cell electrophysiology, confocal and two-photon laser scanning microscopy his investigations provided fundamental insight into the mechanisms by which BDNF regulates excitatory synaptic transmission in the hippocampus. Following his graduate studies at UAB, Jamie studied in the Department of Molecular and Cellular Biology at Harvard University under the guidance of Venkatesh Murthy. As a postdoc, Jamie studied several methods for using genetically-encoded fluorescent probes of neuronal activity to study intact neural circuits. Jamie also spent time at Cold Spring Harbor Laboratories where he studied many optical approaches useful for investigating structure and function in the nervous system. While his investigations have primarily focused on hippocampal circuits, in the past few years he has begun to shift his attention to the olfactory system and the role of sensory experience in the modification of synaptic strength.

PROGRESS AND PERSPECTIVES FOR ATOMIC-RESOLUTION ELECTRON MICROSCOPY

Dr. David J. Smith

The atomic-resolution capabilities of the electron microscope have had a major impact across many disciplines. Resolving powers close to or exceeding the one-Ångstrom (0.1-nm) barrier have been achieved by high-voltage HREMs, as well as by dedicated scanning and conventional medium-voltage instruments.

Other more recent instrumentation developments have included aberration correctors and electron monochromators. These latest developments have generated great interest and enthusiasm from within the microscopy community, and attracted much attention from the broader materials community.
David J. Smith is Regents' Professor of Physics at Arizona State University. He was Director of the Cambridge Univcrsity High Resolution Electron Microscope (1980-1984) and Director of the ASU Center for High Resolution Electron Microscopy (1991-2006), and he is currently a Council Member of the Microscopy Society of America, as well as Editor (Materials), Microscopy and Microanalysis. He is the author/co-author of 20 book chapters and more than 400 refereed journal articles. His long-term research interests have centered around the ongoing development and applications of atomic-resolution electron microscopy.

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GEOMETRIC RECONSTRUCTION OF NEURONAL SHAPE AND SYNAPSE LOCALIZATION FROM CONFOCAL IMAGE STACKS

Dr. Carsten Duch

Normal brain function relies on precise regulation of neuronal properties, such as dendritic shape, electrical characteristics and the sub-cellular distributions of synapses and ion channels. Each neuron must acquire a specific set of these properties during development and maintain them within critical ranges through life. However, in an adapting and learning computing system such as the brain, these properties must also retain functional plasticity.

A precise geometric description of dendritic shape and the sub-cellular distribution of synapses and of ion channels is a fundamental prerequisite to study the underlying developmental mechanisms and also the functions resulting from these properties. Therefore we have developed a tool set for semi-automatic or fully automatic geometric reconstruction of neuronal architecture from stacks of confocal images. Semi-automatic reconstruction must be used for very complex dendritic trees with multiple 1000 branches of strongly varying diameters, whereas automatic reconstruction can be conducted for neurons as complex as cerebellar Purkinje cells. Either way, user time investment is strongly reduced by automatic methods, which fit a skeleton and a surface to the data, while the user can interact and thus keeps full control to ensure a high quality reconstruction. The reconstruction process composes a successive gain of metric parameters. First, a structural description of the neuron is built, including the topology and the exact dendritic lengths

and diameters. We use generalized cylinders with circular cross sections. The user provides a rough initialization by marking the branching points. The axes and radii are fitted to the data by minimizing an energy functional, which is regularized by a smoothness constraint. The investigation of proximity to other structures throughout dendritic trees requires a precise surface reconstruction. In order to achieve accuracy of 0.3 micrometers and below, we additionally implemented a segmentation algorithm based on geodesic active contours that allow for arbitrary cross sections and uses locally adapted thresholds. The high accuracy of geometric surface reconstruction allows analysis of labeled molecule distribution along neuronal surfaces, e.g. the analysis of putative input synapse distribution throughout entire dendritic trees from in situ light microscopy preparations, or the sub-cellular distribution of labeled ion channels. The validity of these methods is currently tested by electron microscopic and electrophysiological approaches. All geometric reconstruction can be directly exported into the multi-compartment modeling environment of NEURON for further analysis of the functional consequences of dendritic shape and sub-cellular synapse distribution for single neuron excitability and computational properties.

Dr. Carsten Duch

Our work involves development and function of central neurons. Understanding an adaptive and learning computing system such as the brain requires an understanding of the functions and computations performed by its basic components, the individual neurons. Towards this goal we want to unravel the roles of single neuron properties for behaviorally adequate brain function. Our current research focuses on the functions of dendritic structure, sub-neuronal distribution of synapses and membrane conductances for network output. In parallel to analyzing the functional properties of neurons we want to understand the mechanisms controlling the development of behaviorally important single neuron properties. To this end we currently focus on the role of intrinsic and synaptic activity for dendritic structure, synapse distribution, and membrane channel expression.

To address these questions we use holometabolous insects such as Drosophila melanogaster and Manduca sexta as model systems to combine a blend of neuroanatomical, imaging, electrophysiological, genetic, biochemical and computational techniques.

Student Abstracts

Green Fluorescent Protein Technology: The molecular biological approach to visualizing the dynamic behavior and organization of microtubules in the fungus *Rhizopus* (Zygomycota)

Christopher Altamirano, Robert W. Roberson
School of Life Sciences, Arizona State University, Tempe, AZ 85287-4501

Of the five phyla of true fungi, Chytridomycota, Zygomycota. Glomeromycota, Ascomycota, and Basidiomycota very little is known regarding hyphal cell growth. This is especially true for the Zygomycota. Members of the Zygomycota are considered less evolved than those in the Ascomycota and Basidiomycota. This status is represented at the cellular level in that hyphae of the Zygomycota lack cellular cross walls (i.e., sepatations) and do not produce a prominent apical body (i.e., Spitzenkörper). Members of the genus Rhizopus impact humans in a number of ways, though the most important is the fact that some species cause disease in humans (i.e., zygomycosis), particularly those with compromised immune systems. Rhizopus oryzae, a common bread mold, was chosen for this study due to its nonpathogenic nature as well as its fast growing hyphae, making it a desirable model organism to study polarized hyphal growth in the Zygomycota. The Spitzenkörper, a common cytoplasmic structure at the hyphal tips of Ascomycota and Basidiomycota, is a non-membrane bound structure in which a mass of secretory vesicles, cytoskeletal elements and signaling proteins are organized. The Spitzenkörper is intimately involved in the final delivery of secretory vesicles to the growing point of the cell, thus playing a critical role in polarized hyphal extension and regulating the direction of cell growth. The fact that the Zygomycota lack a Spitzenkörper, yet have the ability to undergo polarized growth has long perplexed fungal cell biologists. Ordinary light microscopy methods by themselves aid in a limited way the elucidation of the apical cytoplasmic organization and mechanisms of polymerized cell growth.
Green Fluorescent Protein (GFP) technology has demonstrated its utility as a live cell bioimaging tool for visualized a plethora of important proteins. For example, associating GFP to a protein that makes up microtubules, i.e., β-tubulin, has helped in clarifying the behavior and function of these cytoskeletal elements in eukaryotic cell growth. The objective on my work has been to develop the techniques to successfully create a β-tubulin::GFP strain of R. oryzae. In doing so, the dynamic behaviors and organization of microtubules of hyphae within a zygomycetous fungus will be directly visualized in vivo for the first time. This poster presentation documents the progress to date towards achieving this goal.

Allurin, a *Xenopus* Sperm Chemoattractant, Binds to Mouse Sperm and Elicits Chemotaxis in Vitro

Lindsey Burnett, Allan Bieber, and Douglas Chandler.
School of Life Sciences and Department of Chemistry and Biochemistry, Arizona State University, Tempe, AZ 85287-4501

Fertilization consists of a series of well-choreographed sperm-egg interactions including chemotaxis, a directed movement of sperm in response to a chemical gradient. Sperm chemotaxis has been demonstrated in vitro in a number of mammalian species in response to follicular fluid, cumulus cell-conditioned media and ovary extracts and progesterone; however, the identity of the in vivo mammalian sperm chemoattractant(s) is still a matter of discussion. Recently, allurin, a 21 kD sperm chemoattractant, has been characterized and purified from frog egg jelly. Allurin is homologous to TPX-1 and AEG, mammalian sperm binding proteins that are members of the cysteine-rich secretory protein (CRISP) family but the possible role of allurin-like proteins in mammalian sperm chemotaxis has not been studied. Here we demonstrate that Oregon-Green 488-conjugated allurin binds to the postacrosomal region of mouse sperm in a dose-dependent manner. In addition, allurin can mediate mouse sperm chemotaxis in vitro as determined in a transwell assay. These findings suggest that an allurin-like protein in the female reproductive tract might play a role in sperm guidance. Currently, we are evaluating this possibility using western blotting and immunocytochemistry. Indeed, western blots reveal an anti-allurin cross-reacting protein with a molecular weight of approximately 20 kD in mouse ovary extracts. Our preliminary results using immunocytochemistry demonstrate the presence of an allurin-like protein associated with mural granulosa cells in antral follicles while the ovary stroma is negative. Future studies will focus on identifying this anti-allurin cross-reactive protein and its possible role in mammalian reproductive physiology. This study was supported by NSF grant IOB-0615435.

Morphological Alteration of Small Cutaneous Neurons in Morbidly Obese Subjects

Ashley Casano, Lindsey A. Burnett, Rogier Windhorst, Jerome Targovnik, Kaz Tamura, Richard Herman, and John H. Olson
Program in Molecular and Cellular Biology, School of Life Sciences, Arizona State University, Tempe, AZ, 85287-4501, USA
Program in Physics and Astronomy, Arizona State University, Tempe, AZ, 85287-4501, USA,
Clinical Neurobiology and Bioengineering Research Center, Banner Good Samaritan Medical Center, 1111 E. McDowell Rd, Phoenix, AZ 85006, USA

Type II diabetes is one of the leading causes of death and disability in developed nations; the rising incidence of Type II diabetes in the past decade has engendered interest in understanding the causal mechanisms as well as the temporal progression of clinical symptoms. Although morbid obesity is well-correlated with an increased risk of development of Type II diabetes the relationship between these two conditions is not completely understood. Type II diabetes development typically involves development of peripheral neuropathy of cutaneous nerve fibers. Cutaneous nerves innervate the skin and contain general

somatic afferent fibers as well as postganglionic sympathetic autonomic fibers. These fibers are comprised of both unmyelinated C-fibers, and poorly myelinated Ad- nociceptors. These fibers are predominantly capsaicin sensitive and are responsible for slow, dull and burning skin pain sensations; as a result capsaicin-sensitivity can be used to clinically assess functionality of these fibers. These fibers are functionally and morphologically impaired in obese individuals with/without Type II diabetes and pre-diabetes (impaired glucose tolerance) as demonstrated by functional testing and microscopic morphology. Type II diabetes and pre-diabetic (IGT) conditions are often clinically correlated with the presence of morbid obesity. Morbid obesity is a well-known risk factor for future development of Type II diabetes; however, the functional and temporal relationship between these conditions and development of diabetic neuropathy remains unclear. Previously we reported functional impairment of small fibers in morbidly obese subjects, both with and without hyperglycemia through direct skin stimulation experiments. Here we report a 1.7 fold reduction in small fiber density in morbidly obese subjects compared to normal test subjects using fluorescent microscopic analysis. This finding is independent of the incidence of hyperinsulemia, hyperlipidemia, and hyperglycemia suggesting that obesity, not Type II diabetes, may be a major causative factor in small fiber impairment.

Impact of Nanoparticles on Human Intestinal Cells

Brian A. Koeneman[1], Yang Zhang[2], Kiril Hristovski[2], Paul Westerhoff[2], Yongsheng Chen[2], John C. Crittenden[2], David G. Capco[1]
Cellular and Molecular Biosciences Faculty, School of Life Sciences, Arizona State University, PO Box 874501, Tempe, AZ 85287-4501 [2] Civil and Engineering Department, Ira A. Fulton School of Engineering, Arizona State University, PO Box 875306, Tempe, AZ 85287-5306

Manufactured nanomaterials, measuring a few billionths of a meter, are already used in commercial products such as anti-aging creams, sunscreen, and toothpastes. Recently the applications for nanomaterials (including drug delivery and medical diagnostics) have been rapidly rising. However, only scattered investigations into the potential toxicity of these nanomaterials have been conducted so far. This investigation provides fundamental information about the potential risks of nanomaterials in drinking water. Specifically, this study examines the effects of two nanoparticles, titanium dioxide and aluminum oxide. A model system to mimic the human intestinal lining was developed to study both acute and chronic exposures to varying concentrations of nanoparticles. Investigations were designed to give insight into whether the nanoparticles could penetrate the lining and identify potential transport mechanisms. Additional studies imaging the surface of the intestinal cells were conducted to determine if there were any effects on the intestinal microvilli. Transepithelial electrical resistance, scanning laser confocal microscopy, and scanning electron microscopy were utilized to monitor cell-cell junctions, cellular uptake of nanoparticles, and microvilli stability. Results indicate cells both uptake nanoparticles and allow particles to pass through the monolayer of cells, and cause a reduction in the number of microvilli.

In Situ Observations of Carbon Nanotube Synthesis

Megan Brown[2], Gaohui Du[1], Peter Rez[2], MMJ Treacy[2], Edward Moore[1], Renu Sharma[1]
[1]Center for Solid State Science, Arizona State University, Tempe AZ 85267-1704
[2]Department of Physics, Arizona State University, Tempe AZ 85267-1704

Carbon nanotubes (CNT) exhibit very useful mechanical and electrical properties. For example, they have the highest specific strength of any known material and their band gap varies with their chirality so that they may be either insulators or conductors. However, the process of CNT growth is poorly understood and selective synthesis at low temperatures remains an unresolved issue. We have used an environmental (scanning) transmission electron microscope (ESTEM) to make in situ observations to gain insights into the kinetics and reaction mechanisms of CNT synthesis. CNT were grown by chemical vapor deposition (CVD) with acetylene gas precursor catalyzed by Ni nanoparticles on silica support in an ESTEM. Video of the reactions, recorded dynamically by a TV-rate camera, were carefully analyzed and the growth rates of several individual nanotubes were measured. Reaction temperatures between 450-650°C and pressures ranging from 0.8 to 20 mTorr C_2H_2 were explored and statistics for CNT numbers and their number of walls were gathered. Our observations show that the tip growth mechanism is kinetically favored at lower temperatures, while the root growth mechanism is predominant at high temperatures. Further, that straight, single-wall, carbon nanotubes can be selectively grown at high temperatures and low pressures. When the flux of carbon atoms over the surface of the catalyst particle is modeled we find that only a small percentage of carbon available for growth is being utilized by the CNT and we do not see a simple correlation between pressure, temperature and growth rate.

Towards Predicting Cytoplasmic Function from Order and Dynamics: 4-D Cytoplasmic Analysis of Polarized Hyphal Tip Growth

Maho Uchida and Robert W. Roberson.
School of Life Sciences, Arizona State University, Tempe, AZ 85287-4501, USA

Fungi produce tubular-like hyphae through polarized growth. Mechanisms of this mode of growth are believed to be the result of directed and constitutive exocytosis controlled by cytoskeletal function. Previous observations lead us to speculate that microtubules (MTs) are involved in long-distance transport of vesicles from Golgi-equivalents to the Spitzenkörper (SPK), followed by a switch at the SPK from MTs to actin microfilament-based motility. We employed both advanced light and electron microscopy methods to evaluate SPK dynamics and its organization, and to map the distributions of MTs and other cytoplasmic components in fungal hyphae to better understand the mechanisms of polarized growth. The images obtained by digital phase contrast light microscopy revealed a unique organization of the SPK and novel details of internal dynamics in *Neurospora crassa*. The SPK consisted of three discrete phase-dark layers subtended by a phase-bright core. Unidentified materials, at or below the level of resolution of light microscopy, traveled through the core towards the hyphal apex. Serial cross-section reconstructions and quantitative analysis of transmission electron microscopy data of apical and sub-apical hyphal regions have

been analyzed. Furthermore, the 3-D ultrastructural organization of the apical cytoplasmic components has been analyzed using dual-axis electron tomography and modeling in *Aspergillus nidulans*.

Assessing Mechanisms of Granite Decomposition

Caitlin O'Grady, Jason Church, Dr. Mary Striegel and Dr. Tye Botting

Granite materials are used widely in archaeological and architectural contexts. Several different mechanisms of deterioration have been identified including hydrolysis, salts formation and biodeterioration. Hard water (resulting in hydrolysis and salts formation) and its effects on granite have not been adequately addressed, as indicated by rapid deterioration of granite grave markers from cemeteries in the southwestern United States. In this preliminary study, samples from markers and irrigation water used in cemetery maintenance are analyzed to characterize their relationship using FESEM-EDS, ion chromatography and XRF.

Condition-dependence and morphology of coloration in male jumping spiders

Lisa Taylor, Kevin McGraw, and David Clark,
School of Life Sciences, Arizona State University, Tempe, AZ 85287-4501

The role of bright, conspicuous coloration as an honest indicator of male mate quality has been well-studied in many vertebrates (such as birds, reptiles, and fish), and in some invertebrates (such as butterflies and damselflies) but has rarely been examined in spiders. In Habronattus pyrrithrix jumping spiders (family Salticidae) females have dull and inconspicuous coloration, while males have a brilliant red patch of color on their face. Males display this facial coloration to females during an elaborate courtship dance. Because color is often a costly visual signal, male color has the potential to function as an honest signal of mate quality. If this is the case, males with the brightest colors should also be in the best physical condition. To test this prediction, we estimated the body condition of wild-caught adult males and quantified their coloration using microspectrophotometry. We found that aspects of male color (hue and red chroma) were indeed positively correlated with body condition, suggesting that this color has the potential to function as a mate quality signal. Since male facial color appears to be at least partly structural in nature, variation in color expression may be explained by underlying morphological variation in the facial scales in which this color is produced. To test this idea, we imaged a subset of the brightest and drabbest males using scanning electron microscopy (SEM) and compared several aspects of morphology between bright and drab males. Results of the SEM work will be discussed with the aim of gaining insights into the mechanisms of condition-dependence.

In Situ Measurement of the Activity of Individual Ceria Zirconia Nanoparticles

Ruigang Wang,[*,**] **Peter A. Crozier,**[*,**] **Renu Sharma,**[*,**] **and James B. Adams**[**]
[*]Center for Solid State Science, Arizona State University, Tempe, AZ 85287-1704
[**]School of Materials, Arizona State University, Tempe, AZ 85287-8706

Ceria zirconia solid solution nanopowders have been widely used as automobile three-way catalysts to adjust the local oxygen environment in order to reduce pollution. The origin of this application is the ability of cerium-based oxides to reversibly form mixed +3 and +4 valence oxides leading to excellent oxygen storage capacity. Considerable attention has been paid to understand the fundamental mechanisms that may improve the low temperature reducibility and reduction fraction after high temperature reduction treatment. The redox behavior of Ce is difficult to observe, as partially reduced cerium oxide is unstable at low temperatures and/or in high oxygen partial pressure. For this reason, we have undertaken a detailed *in situ* environmental TEM study of the dynamic nanostructural and nanochemical changes that take place in ceria zirconia during redox cycles. We are investigating correlations between the structure, chemistry and reducibility of individual ceria zirconia nanoparticles and hope to identify the critical factors that may improve their performance.

Visualizing organismal physiology & biomechanics: biofluid dynamics revealed by synchrotron x-ray imaging

James S. Waters
School of Life Sciences, Arizona State University, Tempe, AZ 85287-4501, USA

Synchrotron x-ray imaging makes it possible to directly observe the inner workings of a live organism that is neither very small nor transparent. To address questions such as how the tracheae of large insects compensate for increasing body size or how the airsacs of an insect power flight or how food is transported within the digestive system of small animals it is often necessary to actually be able to see how these organ systems operate. Here the method of synchrotron x-ray imaging is described as a solution to this problem and a way of visualizing the physiology of small animals in vivo. Data is presented on the forced convection of air in the tracheal system of a large passalid beetle, on the fluid feeding mechanism of adult *Drosophila*, and the coupling of that feeding with a cephalic respiratory pump. The imaging technique is described as well as guidelines for its use in answering novel questions about the physiology and biofluidmechanics of small animals. Use of the synchrotron at the Advanced Photon Source was supported by the U.S. Department of Energy, Office of Science, Basic Energy Sciences, under Contract No. W-31-109-Eng-38.