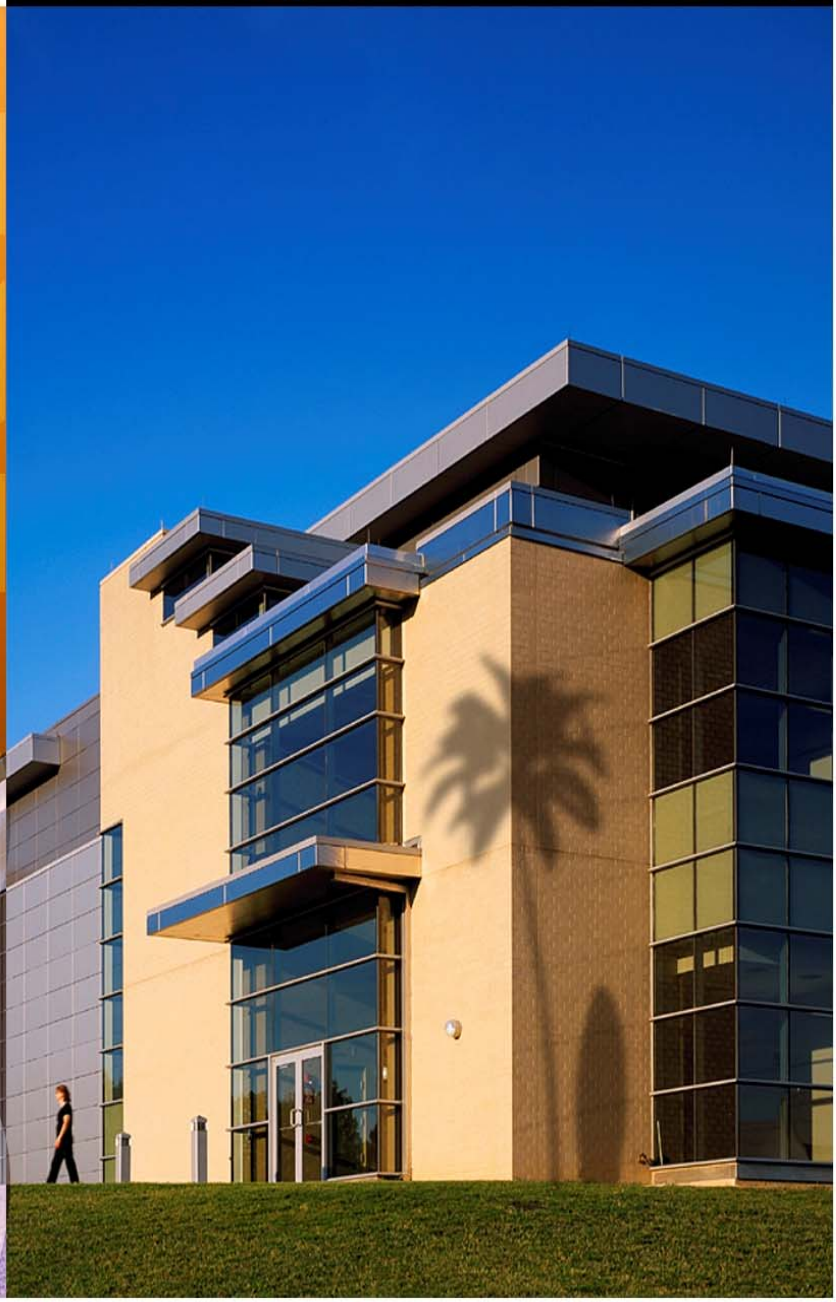
PROGRAM AND ACTIVITIES

summer undergraduate research fellowship

SURF's UP 2009



NIST
National Institute of Standards and Technology
U.S. Department of Commerce

NSF

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Table of Contents

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2009 SURF Summer Seminars and Tours

May 26 First official work day and orientation for SURF Session I students

June 4 Kristen Markham, Esmaeel Paryavi, and Phil Sandborn
University of Maryland College Park Students

Engineers Without Borders – Building a Better World – One Community at a Time

Speakers were officers within the University of Maryland, College Park's Engineers Without Borders chapter. Speakers met with and answered questions from the NIST SURF fellows and NIST staff following the symposium.

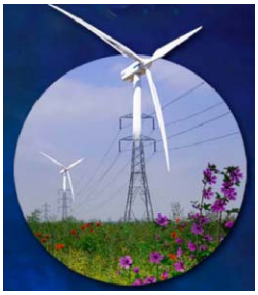
June 11 Bob Shull
NIST Materials Science and Engineering Laboratory, Metalurgy Division

Nanomagnetism – What is it? Why should we care?

As has been found for many other properties, the magnetic character of materials possessing some material dimension in the nanometer regime can be quite different from that commonly associated with convetional macro-scaled materials. New magnetic penomena, unusual property combinations, and both enhanced and diminished magnetic property values are just some of the changes observed. As a consequence, these materials are being investigated for their potential as the next generation soft ferromagnets in addition to their future as pioneered hard ferromagnets with vastly improved energy products. Why that is the case andwy you should care was presented. In addition, the unique domain kinetics, the "Giant Magnetoresistance (GMR)" effects, and the "Enhanced Magnetocaloric Effects" of this class of material were also described. These nanostructured materials were one of the reasons for the excitement surrounding the "Nanotechnology Revolution" that has presently captured the imagination of the world.

June 18 Dave Wollman
NIST Electronics and Electrical Engineering Laboratory, Quantum Electrical Metrology Division

What's So Smart about the Smart Grid?



By upgrading our existing electric power grid with two-way communications and advanced sensors, monitoring and control, the resulting Smart Grid will support increased use of renewable energy sources, allow more efficient and effective use of electricity, and reduce the potential for blackouts and power disturbances. In the Energy Independence and Security Act of 2007, NIST is charged with "primary responsibility to coordinate the development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems...". This talk helped to explain what makes the Smart Grid unique, and why this topic is of great interest in the U.S. and around the world. NIST's Smart Grid efforts were presented within the context of numerous challenges, including significant national visibility, bringing together multiple stakeholders with varying goals and objectives, and developing a standards roadmap to organize and accelerate standards development in the private sector to support and enable new Smart Grid technologies.

June 25 Tom Juliano
Academic Programs Manager, American Society for Engineering Education

Creating a Competitive Application for the NSF Graduate Research Fellowship Program

Using the National Science Foundation Graduate Research Fellowship Program (NSF-GRFP) as the working example, this presentation introduced attendees to the program and ways they can be more competitive when applying.The strategy can be applied to other various award programs, graduate school applications, and employment positions.

The National Science Foundation Graduate Research Fellowship Program offers

up to 3 years of graduate school support worth over $120,000 to each awardee – this year 1,236 awards were offered. Benefits include a $30,000 stipend, a $10,500 annual cost of education allowance, a one time $1,000 international travel allowance, and access to TeraGrid supercomputing facilities. U.S. citizens, nationals, and permanent residents at or near the beginning of their graduate study seeking research-based Master's and/or PhD degrees in NSF-supported science (including

social science and psychology) and engineering disciplines are eligible to apply. The NSF welcomes applications from all qualified students and strongly encourages women in engineering and computer science, under-represented minorities, and persons with disabilities to apply for this fellowship. For more information, please visit www.nsfgrfp.org or www.nsf.gov/grfp.

July 2

Brian Paegel
Scripps Research Institute Florida

Oceans and Archipelagos: Landscapes for Extracellular Darwinian Evolution

Natural selection and the evolutionary adaptation of organisms to their environments are direct reflections of the Darwinian process of selection and imperfect reproduction at work on the molecular level. RNA and DNA, the informational molecules of modern biology, can be evolved directly using the tools of biochemistry to achieve selection, amplification, and mutation. These extracellular Darwinian systems enable systematic control over the entire evolutionary process, from population size, to selection pressure and mutagenesis. Over the past decades the molecular and physical sophistication of these experiments has blossomed. Reactions of simple replicating RNAs have expanded into muti-species experiments with RNAs competing to catalyze the key reaction of biological information transfer. And, the test tubes of conventional chemistry are yielding to computer controlled microchip reactors and microfluidic droplet generators that precisely create billions of microscopic islands, each populated with a single progenitor molecule. On the 200th anniversary of Charles Darwin's birth, we can now recreate in the laboratory the quintessential evolutionary experiment of the Galapagos finches entirely from molecules!*

* Beaks and feathers not included.

July 9

Bill Phillips, Nobel Laureate
NIST Physics Laboratory, Atomic Physics Division

Time, Einstein, and the Coldest Stuff in the Universe

At the beginning of the 20th century Einstein changed the way we think about nature. At the beginning of the 21st century Einstein's thinking is shaping one of the key scientific and technological wonders of contemporary life: atomic clocks, the best timekeepers ever made. Such super-accurate clocks are essential to industry, commerce, and science; they are the heart of

the Global Positioning System (GPS), which guides cars, airplanes, and hikers to their destinations. Today, atomic clocks are still being improved, using atoms cooled to incredibly low temperatures. Atomic gases reach temperatures less than a billionth of a degree above Absolute Zero, without freezing. Such atoms are at the heart of Primary Clocks accurate to better than a second in 80 million years as well as both using and testing some of Einstein's strangest predictions. This was a lively, multimedia presentation, including experimental demonstrations and down-to-earth explanations about some of today's most exciting science.

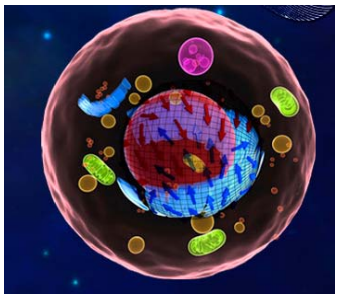
July 16

Rob Ivkov
School of Medicine, Johns Hopkins University

Cindi Dennis
NIST Materials Science and Engineering Laboratory, Metallurgy Division

Treating Cancer with Magnets: Fact or Fiction?

Magnetic nanoparticles are being developed for a wide range of biomedical applications. These range from diagnostic tests like DNA assays and clinical Magnetic Resonance Imaging (MRI) contrast agents to a variety of disease treatments through drug delivery and hyperthermia (artificial fever). MRI is a well-established technology with FDA approved commercial contrast agents to enhance the visibility of abnormal tissue. However, both drug delivery and hyperthermia are still in the early stages of development. Here we will focus on hyperthermia, as aspects of it also play a critical role in drug delivery applications.



Biologically, it is well-established that heat has a profound effect on cells and tissues. It has also been known, for about two thousand years, that heat can be an effective treatment for cancer. However, the question has long been how to deliver heat locally to cancer without overheating the normal tissue. This is where magnetic nanoparticles may provide an answer. Hyperthermia involves heating magnetic nanoparticles through exposure to an alternating magnetic field. This promises to be a successful method if there are enough particles in the tumor possessing a sufficiently high specific absorption rate (SAR) to deposit heat quickly while minimizing thermal damage to surrounding tissue.

However, there is a complex relationship between heat production, physiological methods for dispersing that heat, targeting of the nanoparticles, and RF radiation interactions with tissue, resulting in a not well understood system, either physically, chemically, and biologically. The various factors were discussed that play a role, both on the biology/physiology side as well as in the physics/chemistry. In addition, methods for characterization and quantification

both *in vivo* (in live animals) and *in vitro* (in glass dishes) of these parameters were described. Finally, to illustrate the interplay between physiology and physics, recent studies were discussed about new magnetic nanoparticles, including their effectiveness.

July 23 Antonio Possolo
NIST Information Technology Laboratory, Statistical Engineering Division

Statistics – A Contact Sport

The subject of "statistics" more often than not stirs memories of boring lectures, irrelevant textbooks, and impossible homework – just ask any student of nursing or anthropology (who, in most schools, must take at least one statistics course), about their encounters with statistics.

The funny thing about statistics is that it has made (and undergone) its most consequential advances in the hands of geneticists, chemists, geophysicists, and agronomists.

Then there is the probability part, which we all are familiar with because we know abut odds in gambling, and chances of rain. Statistics courses usually dedicate a good deal of attention to probability. But do we ever get to figure out what relation there may be between familiarity with games of chance and the evaluation of risks in real life (of an earthquake or a hurricane, or of an accident at a nuclear power plant)?

This talk told several statistical tales that attempted to suggest that there is a lot more to statistics than has met the eye of many the suffering nurse or pained anthropologist; that probability is the language of statistics; that statistics is the art of dealing with vagueness and with interpersonal differences in decision situations; and that statistics is best practiced, and then makes a difference, when it involves collaborations between professional statisticians and scientists (geneticists, chemists, geophysicists, agronomists, etc.), jointly to advance knowledge – that is, when it is "played" as a "contact sport."

August 4 Final presentations by SURF students moderated by invited guests.

August 4 Lunch: SURF Directors and special invited guests.

August 5 Final presentations by SURF students moderated by invited guests.

August 6 Final presentations by SURF students moderated by invited guests.

August 7 Last day for SURF students and farewell pizza party.

2009 SURF Summer Activities

It's difficult when you're in a new city and starting a new job. Many of the NIST Gaithersburg SURF students all find themselves in the same boat and thus forge bonds that may last a lifetime. A number of the students also come back for a couple years so they're more than willing to help the new students with the benefit of their experience. They work together AND play together. In fact, to make life easier NIST SURF Director Lisa Fronczek created a Facebook group just for the SURFers called "NIST SURF 2009 – Gaithersburg. In fact, two students found the site before she even finished creating it.

SURF BBQ – NIST Picnic Grove

Burgermeister Cameron Miller at the grill (PL SURF Director)

Whether you call them perrito calientes or just plain old American hot dogs – Chris White in his chef's white (BFRL SURF Director) is grillin' them up

The SURF Directors' continued the tradition of welcoming the SURF students with a BBQ at the NIST Picnic Grove. The Directors' provide burgers/dogs, fruit, chips, and dessert. All the students needed to do -- show up and provide the entertainment with Frisbees, footballs, etc. This year the University of Maryland Materials Science Research and Engineering REU was touring NIST on the day of the BBQ and got to join the NIST SURFers for the goodies -- surely much better than that brown bag lunch they brought along. It also gave the two REUs a chance to compare notes. NIST is always a top tour spot for the UMD REU to tour during the summer.

July 4th in the Nation's Capitol

Many of our 151 SURF students are out of the area and are given a chance to see the celebration that takes place in our Nation's Capitol. Take the "History Buffs" test of July 4th knowledge. 1) "Which of our Founding Fathers created the blueprint for our Fourth of July celebrations by suggesting that the day be celebrated with "bonfires and illuminations from one end of this continent to the other" by succeeding generations of Americans?" 2) On July 4, 1976, Americans all over the country celebrated our nation's 200th birthday. How many tons of fireworks were exploded in a magnificent display above the Washington Monument in Washington, DC — 5, 24 or 33? 1) John Adams ; 2) 33 tons!

2009 SURF T-Shirt Design

What better way to remember your summer at NIST than to design your very own souvenir T-shirt. Unlike the shirts you buy at an Orioles or Nationals games, these T-shirts are designed by a group of fellow SURFers. All the fashon conscious are seen sporting the latest design across the 578 acre NIST campus. It lets all those students at their home university know what they were doing during the summer!

NIST Summer Institute for Middle School Science Teachers

The third NIST Summer Institute for Middle School Science Teachers was held from July 6 – 17, 2009. The workshop sponsored 16 middle school science teachers. The Summer Institute, a collaboration between NIST and local school districts, is an innovative combination of hands-on activities, lectures, tours, and visits with scientists in their laboratories. Designed to coordinate with the middle school curriculum, the teachers are provided with resources and instructional tools for teaching math and science, with an emphasis on measurement science used at NIST. Led entirely by NIST scientists, the Summer Institute translates the cutting-edge research done in the laboratory to activities designed to be carried out in the classroom. Networking among the scientists and teachers provide long-term resources through the on-going relationships for the teachers and their students. Since the SURFers were working on interesting projects they were asked to help in the project. It's important for the SURFers to learn to explain what they are doing to others. This made them great examples for the teachers. It's a small world out there – maybe they got to connect with a science teacher from years ago – something I'm sure all the teachers would like to have happen in the future!

Neighbor Helping Neighbor

The honor, spirit and resources of the American people comes forth with neighbors helping neighbors in need — during earthquakes, floods, fires, storms — and also for the deeply personal and often quiet disasters that require a gift of blood. Quietly, without fanfare, SURFers gave the gift of blood during the NIST blood drive.

Pentagon Tour

The Pentagon is virtually a city in itself. Approximately 23,000 employees, both military and civilian, contribute to the planning and execution of the defense of our country.

The Pentagon tours program was established on May 17, 1976 to support the nation's Bicentennial Celebration. Initially, the program was to last through the 4th of July and then be disbanded; however, internal support and public demand were so great that the program has been continued ever since – with a few SURFers adding to those numbers.

Tour of University of Maryland College Park

A few professors in the Physics Department of the University of Maryland College Park offered the students a tour through some of the labs (Condensed Matter, Atomic Molecular and Optical Physics), then invited them to a lunch to talk with some of the current grad students to ask questions about what grad school is really like.

Volunteers Wanted – Survey of Information Habits and Preferences of Millennial Scientists

A previous SURF student who was hired in the Informtion Services Division at NIST extended a call to participate in a survey on their research habits. A total of 91 SURFers participated in the survey.

SURFers and Netflix

An inexpensive way to spend a summer night with a bunch of friends – Netflix the latest comedy by Jim Carrey and you're on your way.

Baltimore National Aquarium

The SURFers headed over to Baltimore to check out the Baltimore National Aquarium.

When the National Aquarium began taking shape on Pier 3 in the 1970s, Baltimore had never seen anything like it, and once it opened, the city's historic harbor would never be the same. In the same way, the extensive renovation of the National Aquarium in Washington, DC, opens up new opportunities for visitors to connect with nature in our nation's capital.

Together, the two National Aquarium locations have offered millions of visitors transforming experiences that inspire them to enjoy, respect, and protect the aquatic world. Action follows experiences that change our thinking. For some, seeing the Chesapeake Bay for the first time through a school field experience is a catalyst to do something. For others, getting face-to-face

with the Aquarium's amazing animals or attending a thought-provoking lecture will challenge ideas and change perspectives.

Washington, DC Museums

How could you come to the Nation's Capital and not check out all the wonderful museums. They range from The Aircraft Museum, The Museum of Modern Art, International Spy Museum, Smithsonian National Air and Space Museum, National Museum-America History, National Museum-Natural History (I always like to check out the Hope Diamond), and the National Museum of Crime of Punishment (one that you might want to visit but never have your name associated with).

Annual Summer Horizons Program

Tawny McManus, PROMISE Coordinator, UMBC, issued the annual invitation to the SURF students to attend the Summer Horizons program at the University of Maryland, Baltimore County (UMBC). Participants in Summer Horizons had an opportunity to: 1) learn about "Gradute School 101: The Road to Gaduate School", the graduate school application process, e.g., GRE, funding, applications; 2) meet with UMBC faculty, tour laboratories and talk with current graduate students about their experiences, motivations, and succeeding in graduate school, and 3) hear a thought provoking address from UMBC's President, Dr. Freeman Hrabowski. He is well-known for his speaking ability. (As an aside, one of the SURFers last year said she chose UMBC over several other big-name schools because she heard Dr. Hrabowski speak.) Breakfast refreshments and lunch was served, along with a dessert reception that accompanied the keynote address by President Hrabowski.

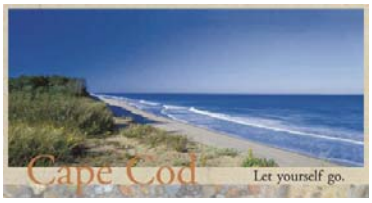
Trips – New York

I ♥ NY

New York, New York, is everything they say
And no other place that I'd rather be
Where else can you do a half a million things
All at a quarter to three (AM??)

Sounds like a trip tailor-made for a group of energetic SURFers.

Trips – Cape Cod



"Let yourself go" -- sounds like something a group of SURFers might feel like doing after putting in a grueling week of research.

GRE® – Graduate Record Examinations®

One of the SURF students organized a physics GRE study group to prepare for the test. The **Graduate Record Examinations® (GRE®) General Test** measures verbal reasoning, quantitative reasoning, and critical thinking and analytical writing skills. The **GRE® Subject Tests** gauge undergraduate achievement in 8 specific fields of study.

Soccer and Volleyball

They may not have been wearing DC United soccer jerseys and had the trappings of 11 domestic and international champions dominating the NIST lobby, but the competition beween the teams (Grumpy Gumbo, Ferocious Fondue, and Jam'n Jambalaya) was just as fierce, well maybe fierce isn't the correct word – more like fun! In fact, some of the teams had matching shirts that they made that were pretty cool! They also played volleyball (probably not on the same scale as Misty May-Treanor and Kerri Walsh, who dominated both the AVP and FIVB beach volleyball tours and the 2008 Beijing Olympics) but I'm sure they had fun just the same.

SURF Farewell Pizza Party

Every year the SURF Directors treat the students to a farewell pizza party. This year the SURF T-shirt committee made a few dollars profit selling NIST's hottest fashion item – the SURF 2009 T-shirt. Luckily for their fellow SURFers, the T-shirt committee decided to treat everyone to Rita's Ice in three yummy flavors – cherry, cotton candy, and a mystery flavor – pizza (54 of them!) and dessert, what's not to love.

Student Abstracts
2009 SURF Program

American University

Development of Single Magnon Cross-Section/Spinwave Dispersion Software
William Flynn

Crystal structures are composed of repeating arrangements of atoms. Due to an interplay of the Pauli Exclusion Principle and Coulombic interactions, the spins in some materials order in regular patterns on crystal lattices. Above this ground state, there are low lying collective excitations known as spin waves. At higher temperatures, these spin waves destroy the ground state. We can use neutrons to probe these excitations and to determine the basic magnetic interactions in a material.

To probe the system, we can observe the properties of neutrons before and after a collision with the sample. We consider a scattering system consisting of a thermal neutron beam and a magnetic crystalline sample. The scattering of neutrons off of the sample can be expressed in terms of the differential cross-section, $d^2\sigma/d\Omega dE'$, the number of neutrons scattered per second into a small angle $d\Omega$ in a direction θ,φ with a change in energy dE'. In a basic sense, the differential cross section measures the strength of the signal we will see when the neutron exchanges energy and momentum with the system, either creating, or annihilating spin waves. While in simple cases, this cross section can be calculated analytically, it is rather tedious, and in the general case, it is impossible.

To solve this problem, we extended a Python program, created in the 2008 summer by Thomas Sarvey, which runs Monte Carlo simulations to find the ground state spin configurations of atoms in magnetic crystals based on interactions which the user enters using a GUI. The previous program also calculated spin wave dispersions (the relationship between the energy and position in reciprocal space). This summer, we added one magnon cross section calculations as well as fitting, and latex printing capabilities. We have also provided new optimization routines for determining the magnetic ground state. Finally, we have developed tests for the cases where an analytic form is known for the dispersion. The development of this program will allow researchers to quickly and easily test several models against their data.

Appalachian State University

Development of an Ion Capture and Transport System for Atomic Spectroscopy
Nicholas Pope

An ion trapping system for atomic spectroscopy is currently being developed using a permanent magnet penning-type ion trap. This apparatus will be used to capture and confine highly charged ions created in and extracted from the electron beam ion trap (EBIT). Numerical simulations were performed for the development of an ion transport system, which directs the ions from the permanent-magnet penning-type ion trap to a position-sensitive micro-channel plate (MCP) ion

detector. An electron gun system is also being developed for the creation of low charge state ions. Details about the development of the trapping apparatus will be presented.

Boston University

High-Throughput Measurement of Cellular Oxygen Consumption
Eugenia Romantseva

Dissolved oxygen plays a critical role in mammalian cell culture. Research has shown that oxygen concentration significantly modulates the rate of cell growth, cellular viability and differentiation pathways. During conventional *in vitro* cell culture, oxygen partial pressure averages 0.2 atm (ambient) but is uncontrolled and can fluctuate during experiments. The mean oxygen concentration in living tissue is about 0.03 atm. Recently, NIST developed a thin-film oxygen sensor that is compatible with real-time microscopic observation of living cells. This sensor was fabricated by dissolving a phosphorescent platinum porphyrin dye (PtTFPP) in a poly(dimethylsiloxane) (PDMS) substrate. The current work focuses on redesigning and optimizing this sensor for high-throughput cell-based assays in a multiwell plate format.

The new oxygen sensor formulation was comprised of three thin-layer films on the order of microns thick that were sequentially deposited in each well. The first layer contained the oxygen sensitive PtTFPP dye dissolved in PDMS (40 μm thick). In the presence of oxygen the dye phosphorescence was significantly quenched and yielded a linear calibration with oxygen concentration following a Stern-Volmer relationship. The second layer, Teflon AF (4 μm), allowed gas transport while preventing the dye from leaching out of the bottom layer. Finally, PDMS without dye (40 μm) was deposited to facilitate extracellular matrix adsorption for cell attachment

Using this high-throughput sensor, no cytotoxic or phototoxic effects were observed for cells in culture. Further, changes in oxygen concentration in solution were measured with sensitivity comparable to previous sensor designs. Ongoing experiments allow evaluation of oxygen concentration during the culture of 3T3 mouse fibroblast cells, VERO monkey kidney cells, and human umbilical vein epithelial cells (HUVEC) over 72 hours. The platform developed here will be useful for high-throughput evaluation of cellular oxygen consumption rates as well as the effects of novel therapeutics on cellular metabolism.

Bucknell University

Toward Estimating the Harvestable Energy from Human Motion
Alyssa Okita

Energy Harvesting (EH) is a process through which energy is captured and stored from external sources or surrounding environment. Small wearable bio-sensors are among the most attractive application areas for EH. Energy obtained through an EH mechanism will prolong the lifetime of such battery-powered devices; and therefore this technology could have a huge impact in the widespread commercial use of these products. While there are currently extensive researches

going on to develop appropriate technology to harvest energy, a fundamental question to answer is the amount of power that can be generated using relevant methodologies.

Here, we focus on kinetic energy from human-motion as a convenient option for EH. An ideal EH-enabled body sensor that is worn on a human forearm can harvest this kinetic energy and convert it into an auxiliary battery power source. Our goal in this project is to characterize the distribution of acceleration generated by typical human forearm motion. Knowledge of this distribution will help us understand the statistical behavior of harvestable power. Using acceleration data created by human arm motion from about 30 different people over the course of a day, we apply statistical modeling tools to analyze the data. We have also characterized the variability of the measurements and determined the ideal duration of periods of observation of "typical" activity. In addition, we can group these "typical" activities according to statistical attributes of the corresponding time series of accelerations. These analyses give researchers the necessary insight on the applicability of using kinetic-based EH to power wearable sensors.

California Institute of Technology

The Structural and Magnetic Purity of Sub-Nanometer Co │Ni Multilayers

Danil Kitchaev

As magnetic media shrinks and approaches the goal of Tb/in^2, magnetic interactions between bits make it increasingly difficult to read and write individual bits without perturbing its neighbors. One solution is to reorient the magnetic easy-axis perpendicular to the media surface, thus reducing unwanted cross-talk between bits. In thin-films, magnetic moments normally lie within the sample plane, but by exploiting interface effects it has been theoretically predicted and subsequently shown that very thin (t = 1 to 6 A) repeating layers of [t Co | 2t Ni] grown on Au produce perpendicularly magnetized structures [1]. When these layers are grown on Cu, however, the perpendicular magnetism is unexpectedly lost [2].

Resonant x-ray diffraction revealed that Cu, Co, and Ni layers all form similar face-centered cubic crystallites in which the Cu strains the Co and Ni lattices, compressing them by 0.64% out-of-plane and expanding them 1.3% in-plane for thin layers, which does not occur with layers grown on Au. Reorientation of magnetic moments along a trigonal expansion has been theoretically calculated [3] to be equal to the perpendicular energy obtained from the layering and thus could explain the lack of perpendicular magnetism.

In order to confirm that the lattice strain is the reason for the rotation of the magnetic axis, it was necessary to determine the structure of the multilayer samples (nominally 5nm Pt| 10 nm Cu | [t Co | 2t Ni] x12| 10 nm Cu | 5nm Pt on SiO_2 and Si with t = 3 A and 6 A). For this purpose, a combination of x-ray and neutron reflectometry was used. This method is a very precise depth-sensitive probe as the x-rays are very sensitive to the electron density, precisely characterizing the Pt and Cu layer thicknesses as well as the overall multilayer thickness while the polarized neutrons are especially sensitive to both structural and magnetic differences between the Co and Ni, elucidating the exact structural profile of the Co | Ni multilayer stack. The degree of layering can be described numerically by the difference between the measured and ideal scattering length density (SLD) and magnetic scattering density (MSD) profiles, which describe how effectively a

given material scatters. It was found that in both t=3A and t=6A samples, the SLD of Co is within 35% of its bulk value and the SLD of Ni is within 15% of its bulk value, and while it is more uncertain, the MSD of both metals is within 50% of its bulk values in both samples. Even taking into account these uncertainties, both samples appear to be significantly layered, with some layer mixing caused by diffusion during fabrication.

[1] G. H. O. Daalderop, et al, Physical Review Letters, 68, 682 (1992); [2] J-M. . Beaujour, et al, The European Physical Journal B, 59, 475 (2007); [3] T. Burkert, et al, Physical Review B, 69, 104426 (2004)

California State University Fresno

Aggregation of Titanium Dioxide Nanoparticles – The Role of Suface Chemistry

Kennedy Vu

The growing use of engineered nanomaterials has increased concern that some nanoparticles may have a detrimental impact on the natural environment. While nanosized titanium dioxide (TiO_2) is currently used in such products paints, sunscreens and cosmetics, the fate and behavior of these nanoparticles in aquatic environments remain largely unknown. This research closely investigates the particle size distribution, surface charge, and early stage aggregation kinetics of a commercially available TiO_2 powder using time-resolve dynamic light scattering (DLS).

A stable solution of primary TiO_2 particles could not be generated through any investigated means (extended sonication, ultrasonication, pH adjustment, and polymer addition). Therefore, this work focuses on the behavior of stable, primary particle aggregates (nanoaggregates) that are either bare or have been coated with environmentally relevant molecules, including natural organic matter (NOM), alginate (a biopolymer produced by algae), or a combination of the two under slightly basic conditions (pH range = 8.0 - 8.3). The ionic strength was adjusted with different concentration using $MgCl_2$ salt and the aggregation kinetics was analyzed with DLS. In addition, surface charge was measured using the Zeta Potential Analyzer and morphology images were retrieved using the scanning electron microscope (SEM).

Aggregation of bare TiO_2 nanoaggregates was observed to reach its critical cation concentration (CCC) with the increase of $MgCl_2$, which was expected. However, surface coated TiO_2 with, (aligniate, NOM, NOM/alginate), was observed to undergo radical behaviors in its aggregation state. As a result, the major implications of this study reveal that the behavior of TiO_2 is greatly influenced by environmental conditions.

Carnegie Mellon University

Immobilization of Tissue Cells using Positive Dielectrophoresis and Polyelectrolyte Multilayers

David Jia

Cell manipulation techniques (e.g. dielectrophoresis, cell patterning using adhesive materials) have been important components of the lab-on-a-chip toolbox for the last few years. Precise positioning of cells in microfluidic systems using electronic means had relied, in many instances, on dielectrophoresis (DEP) trapping forces. Although the first uses of DEP in microfluidic

applications were to sort cells for analyses post treatment, growing interest in trapping cells for further anchorage onto a surface for on-chip cell-based studies have flourished. Our group has previously shown the use DEP trapping forces along with polyelectrolyte multilayers (PEMs), specifically the positively charged polyallylamine hydrochloride (PAH) as the outermost layer, to trap and hold cells after dielectrophoretic forces are no longer applied. Here we present the use of polystyrene sulfonate (PSS), a negatively charged polyion, and fibronectin (Fib), an extracellular matrix protein, as adhesive materials to study the forces and effects of DEP/PSS and DEP/Fib on mouse NIH-3T3 cells. Indium tin oxide (ITO) electrodes were fabricated using standard photolithographic methods. The electrodes were connected to a waveform generator to apply the sine wave and voltage to generate trapping forces. Microfluidic devices were built by irreversibly bonding polydimethylsiloxane (PDMS) channels onto the ITO/glass substrates. We found that NIH-3T3 cells were trapped at 870 kHz when suspended in a 0.32 M sucrose solution (positive DEP). Cells were trapped and finally anchored onto Fib and PSS after the trapping forces were no longer applied. Current efforts are directed towards the measurement of the forces holding the cells to the adhesive material and decreasing the time the cells spend suspended in sucrose. This work has applications in cell migration, cell differentiation and cell-cell communication studies.

Effects of Molecular Weight on the Viscoelastic Properties of Polystyrene Thin Films Utilizing Thermal Wrinkling

Ellen Tworkoski

Although techniques exist for measuring the elastic and viscous properties of bulk polymers, few are available for easily measuring these properties in polymer thin films. This information has become increasingly important in the face of a wide variety of developing technology ranging from electronic data storage to adhesives to biomedical devices. A new technique known as thermal wrinkling has been successfully developed to measure the modulus and viscosity of polymer films that are only a few hundred nanometers thick. By placing the film on a rigid substrate, capping it with a metal layer and applying heat, sinusoidal wrinkles can be observed whose wavelength and amplitude can be measured through small angle light scattering (SALS). These quantities are then used to determine the material properties. Our research investigated the effects of the molecular weight of the polymer chains on the film's viscoelastic properties by using polystyrene as the test polymer. Thermal wrinkling was used to measure the viscoelastic properties of polystyrene thin films with molecular weights ranging from 6400 g/mol to 451000 g/mol at temperatures above its glass transition. The data indicated that this approach is capable of tracking the changes in material properties as a function of polymer chain structure. In general, an increase in polymer molecular weight at a given annealing temperature led to an increase in the modulus and viscosity. These results will aid the selection of an appropriate polymer structure for a given thin film application.

Centre College

Digital Data Preservation Strategy and Implementation
Scott Albertine

For the SURF 2009 project, a team of three students worked together to prototype and strategize digital data preservation framework and tools. The project consists of two phases: (a) Because of the portable devices (cell phones, personal digital assistants, etc.) play a vital role in our society today and the future to come, the team had strategized and implemented a set of cell phones (Apple's iPhone, RIM's Blackberry, and Google's Android) players to access the preserved ISO/IEC 23000-3 images content which provides ISO/IEC MPEG-7 metadata descriptions and the rich ISO/IEC MPEG-4 file format standard technologies; (b) Apply the lesson learned from phase (a) to strategize what generic infrastructure framework to handle multimedia content (images, audio, video, text). A set of digital data preservation tools has been investigated and developed for the generic framework.
Specifically, my responsibility for the Digital Data Preservation was to: (a) design and implement an iPhone client to access and search the images, (b) investigate and install a web crawler to obtain content to test the framework for part B above, (c) work with the team to create the infrastructure framework implementation. I learned Objective-C, the language used on iPhones, during the program, and made the actual client with assistance from my teammates on certain sections, such as the file parser. I installed, configured, and managed Heritrix (a production level web crawler), and also assisted in the setup, writing, and networking of the generic infrastructure, particularly the user client that interfaces with the managing frontend.

See Also: Jason Young and William Killian

City College of New York Hunter

Energy Transfer Between Conjugated Quantum Dots
Catherine Callo

Achieving the desired structure by assembling photo luminescent nanocrystals such as quantum dots (QDs) has been one of the most important subjects in nanotechnology. Forster resonance energy transfer (FRET) measures the distance between photo luminescent particles at the nanoscale. The focus of my research is on FRET measurement between two different types, carboxyl- or amine-functionalized, of type I quantum dots (QDs) using a fluorometer. Most commercially available QDs are type-I colloidal QDs, consisting of a CdSe core with a ZnS shell. We measured the FRET between these two types of QDs in a variety of forms, solution, solid in a dry film, and microarrayer. Amidation linkage between the two types of QDs showed increased FRET efficiency, where control experiments without linker amidation reagents did not show FRET characteristics. Works in progress include water-soluble functionalization of type II QDs to use them as FRET donors. In type-I QDs, the electron energies across the band gap of the core lie between the energies of the shell, leaving the exciton's electron and hole within the core upon photo-excitation. In type-II QDs, the energies of the core and shell are offset or staggered such that either the electron or hole moves into the shell. This separation substantially increases the QD's radiative lifetime from O(10 ns) to O(1 □s to 1 ms) and makes the energy levels sensitive to both core and shell thickness. Lifetime, emission distribution and blinking

pattern of the type I and type II pairs are being simultaneously measured by a confocal microscope in an effort to understand the fundamental FRET mechanism from a type II QD to a type I QD.

College of New Jersey

The Influence of Growth Conditions on Surface Properties of Facillus Spores

Alexander Clark

The surface properties of *Bacillus* spores are of interest for study due to the potential use Bacillus anthracis as a biological weapon. In particular, measurements of surface charge and hydrophobicity can be used to predict and understand how spores interact with various surfaces in the environment. Surface charge and hydrophobicity were measured on several strains of *Bacillus* spores grown using three different growth media formulations to determine the impact of growth conditions on surface properties. Strains of *Bacillus thuringiensis* and *Bacillus cereus* spores were studied because they are safe and because they are closely related to *Bacillus anthracis*. Surface charge was measured using a Zeta PALS Zetasizer to determine electrophoretic mobility, which was converted mathematically to zeta potential. Hydrophobicity was measured by using a contact angle goniometer and converting results to hydrophobicity by applying the Young-Dupré equation. To investigate spore preparation purity, spore samples were examined through microscopic counting and traditional microbiological plating on LB agar nutrient media. In certain spore strains, different growth media appear to have an effect on surface charge, whereas in other strains, no significant effect is observed. Zeta potential values ranged from -29.37 mV to -53.02 mV for BT35646, a strain consistently observed to self aggregate. Surface charge measurements for BT33679 and BC10987 were less negative and ranged from -21.07 mV to -34.42 mV and -13.07 mV to -29.52 mV, respectively. On samples where contact angle measurements were collected, some significant variations in hydrophobicity are seen due to varied growth conditions. Contact angle measurements resulted in a larger variation of reported hydrophobicity from growth conditions (average variation of 11 mJ/m^2) than from lot-to-lot variation (average variation of 6 mJ/m^2).

Phase Equilibrum Relations in the Ceramic SrO-Y_2O_3-TiO_2 and SrO-Y_2O_3-ZrO_2 Systems

Jason Krizan

In recent times, nuclear energy has received a lot of attention both for its reliability and lack of greenhouse emissions. However, this process produces byproducts that need to be managed. The title phase diagrams were studied for their application in the immobilization and processing of radioactive waste. Nuclear reactions produce an abundance of different radioactive isotopes; one of particular interest is strontium-90. This isotope decays to yttrium and then zirconium. Even though only six percent of the nuclear reaction products are strontium, this element and its decay pathway are of particular interest because strontium is biologically active and will substitute for calcium in the bones. As it decays, it not only gives off high energy radiation, but produces a large amount of heat. Hence, it is particularly important to store nuclear byproducts in a manner that will withstand the tests of time. Due to the stability of oxides in the earth's crust, ceramic oxide systems are often used as nuclear waste hosts. The first diagram studied

contains the three elements in the decay pathway, whereas the other contains titanium since titanate-based ceramics are being investigated as host materials for storing radioactive waste.

Nuclear waste containers are exposed to a large amount of heat over a long time, giving them all of the conditions that promote reaching equilibrium. Solid state chemistry is the study of reactions that occur between solids, making it an ideal tool for studying these equilibria. The resulting phase diagrams allow predictions of the phases and mixtures that will tend to form in the waste. To map out these diagrams, samples were prepared from various mixtures of the oxides of strontium, yttrium, zirconium, and titanium which were reacted at high temperatures. Fully reacted samples were characterized by powder X-ray diffraction, and the resulting data was used to map out the phase equilibrium relationships.

College of William and Mary

Lead Resistance Measurements of Cryostat for Graphene Device Contact Resistance Tests

William Ames

Graphene devices offer to potential for a more easily maintained and propagated quantum hall resistance standard than the current Gallium Arsenide standard. Unfortunately, graphene devices are plagued by high contact resistances, which prevent resistance measurements with the degree of precision necessary for a standard. As part of the effort to find techniques to reduce graphene device contact resistances, the Fundamental Electrical Metrology group wishes to use a small crysostat to make initial contact resistance measurements. This work presents the results of the rewiring and repair efforts of this cryostat, and measurements of the lead resistances of the cryostat's electrical connections.

Characterization of Standard Reference Materials through High Reslution X-Ray Diffractometry (HRXRD) and X-Ray Reflectometry (XRR)

Brian Richards

X-ray metrology standard reference materials (SRM) are used to calibrate X-ray diffraction instruments for measurements that are traceable back to NIST. These SRMs allow the semiconductor industry and other prominent industries to make full use of X-ray diffractometry and reflectometry techniques. For NIST SRMs to be useful to the X-ray diffractometry and reflectometry community, they must be properly characterized so that the properties of each SRM are known. This lecture will focus on the characterization of SRM 2000, a NIST SRM that provides the high resolution X-ray diffraction (HRXRD) community with wavelength and angle calibration. The presentation will look at how X-ray's are produced, HRXRD and X-ray reflectometry (XRR) techniques, and how HRXRD data is analyzed using a genetic algorithm. Finally, information from the modeling of the HRXRD data will be used to create a three-dimensional image of the thickness and Ge concentration of SRM 2000. Information from all of the wafers analyzed will be compared to look for common trends in the wafer compositions.

Colorado School of Mines

Development of 6/d Spectral Reflectance Calibration Service for Colored Samples

Amanda Meier

The National Institute of Standards and Technology (NIST) has been providing calibration measurement services for 6/d spectral diffuse reflectance of spectrally flat materials for many years. In response to recommendations by industry, the Optical Technology Division at NIST is expanding their measurement capabilities to measure 6/d reflectance factor of colored materials. In order for NIST to provide any calibration service, the measuring instrument has to go under rigorous testing to determine an uncertainty budget. The sources of uncertainty for the 6/d reflectance factor measurements were identified from the characterization of the instrument. Some of the sources of uncertainty identified in this study are stray light, wavelength accuracy, photometric accuracy, misalignment of the sample, non-linearity of the detector, and calibration of the NIST transfer standard. The procedure for determining these uncertainties follows the approach given in *The Guide to Expression of Uncertainty in Measurement*. This international document describes methods for estimating uncertainties using a systematic, analytical approach which requires consideration of the measurement equation and the characterization of the measuring instrument. Knowing this uncertainty budget is important for anyone requesting a calibration service to understand how to minimize the error on their instrument and to achieve the most accurate results.

Spectral Irradiance to Spectral Radiance Transfer Using a Plaque and Monochromator

John Rose

The optical sensors of remote sensing satellites usually measure spectral radiance of a portion of the Earth's surface. In order to calibrate these sensors, light sources with calibrated and uniform spectral radiances must be used. One method of creating a calibrated radiance source is to use a source of known spectral irradiance combined with a surface of known reflectance; this talk will focus on using this method and validating it with a source of known radiance.

Integrating sphere sources of known spectral radiances were measured by a monochromator-photodiode system. Temperature-controlled silicon and InGaAs photodiodes were used to cover a spectral range from 300 nm to 2.5 μm. Using the known spectral radiances of the spheres, the responsivity of the monochromator system was calculated as a function of wavelength. A plaque was then oriented normal to an FEL lamp of known irradiance, and the spectral radiance of the FEL-plaque system was measured using the monochromator at 45° with respect to the surface of the plaque. This result was then assessed with the theoretical value obtained using the irradiance of the FEL lamp, the distance between the FEL and the plaque, and the 45°/0° reflectance factor of the plaque.

Cornell University

Design and Construction of a Simple Magneto-Optical Trap
Eric Huang

A magneto-optical trap (or MOT) uses a combination lasers and magnetic fields in order to confine and cool atomic gases. Such traps can be used to achieve the low temperatures necessary for several areas of study, most notably being the prerequisite for the production of a Bose-Einstein condensate (BEC). The goal of this project was to develop and build a MOT as simply and as easily as possible.

One essential component of a MOT is the presence a three-dimensional counterpropagating optical cavity. Traditionally, this has required the precise alignment of several mirrors and lasers, but by using an axicon mirror, the necessary optical environment can be achieved with only one laser beam. Furthermore, due to the retro-reflective nature of the cone-shaped axicon cavity, only the crudest of optical alignment is required. Another benefit to the axicon design is that the trap laser is reflected back towards the atomic beam, which makes it possible to slow and trap the atomic beam with only one laser.

Designing and operating a working MOT is a lot of work for only eleven weeks, and the process is fraught with uncertainties, hastily-engineered solutions, and perplexing setbacks. The intricacies of MOT construction, as well as the trials and tribulations of an undergraduate researcher with minimal optics experience, will be discussed.

Unsupervised Part of Speech Tagging of Blog Data Using Map-Reduce
Benjamin Strauss

Part of speech (POS) tagging is an important first step for many natural language processing applications, including named entity recognition and syntactic/semantic parsing. The highest-performing POS taggers have traditionally been supervised, meaning they require a large amount of manually tagged text on which to train. However, this data is often not available, for example in the area of blog posts. Unsupervised taggers solve this problem by training on raw, untagged text, which is readily available. We implement an unsupervised tagger for blog posts that automatically groups words into meaningful POS clusters based on the contexts in which they appear in the untagged training data. To gain in performance, we use the Map-Reduce paradigm to parallelize the computations across a cluster of computers.

Eastern Kentucky University

Analysis of Stairwell Movement in High-Rise Office Buildings
Timothy Howarth

Researchers from the Building and Fire Research Laboratory collected video data on people movement during high-rise building evacuations from eight different buildings in cities across the U.S. During each evacuation, video was taken of people movement and behavior inside the stairways, and people movement through doorways. Video analysis will identify trends in

occupant movement and behavior throughout the stairwells. Data analysis of the video footage collected from previous events is performed in an effort to provide a basis for performance-based building code requirements. From the data analysis, evacuation results are obtained, such as occupant speeds, merging behavior, body sway, and response times. In addition, there are possibilities for future publication of the results.

The building being studied contains two stairwells; the North and the South stairwells. Tim studied the North stairwell, while Jillian studied the South stairwell. Due to the vast amount of people exiting via the North stairwell, there was not enough time to complete all of the videos for this stairwell. Therefore, the quantitative data (speeds, response times, etc.) is coming from the South stairwell, while the qualitative data (visual observations, strange behaviors, etc.) is coming from the North stairwell.

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Multi-Phase Study on Firefighter Safety and the Deployment of Resources
Craig Van Norman

A study of Firefighter Safety and Deployment of Resources is a study of different firefighter crew sizes, and their response times during an incident. During year 1 of this study, a literature review was put together telling the major ways a firefighter could die, what are the ways of notification, and how firefighters respond to an incident; a theoretical model of all the background and incident data was put together; developed a survey for the fire departments to use. During year 2 of this study, a laboratory experiment was conducted by putting together different size pallets and testing the different heat release rates and different concentrations of

gases; timing of two different fire departments were conducted to see how long and what tasks have to be conducted on a fire ground.

During year 3 the data from the field tests that were conducted in year 2 were collected and put into a computer models called Fire Dynamic Simulator. The program Fire Dynamic Simulator (FDS) is a computer modeling program that is used to create fires and study the results of the tests. These tests were used to verify the efficacy of the computer model compared to the actual field experiments. The data from the FDS models was compared to the field experiments and then put into a graph and put together with T-squared models in order to compare the severity of the field tests to other products that tend to be in fires.

Franciscan University of Steubenville

System Dynamics Modeling of the Corn Ethanol Industry
Stephen Nowak

Within the last 10 years, corn ethanol has acquired great importance to the United States as an alternative "biofuel" and annual corn ethanol production in the U.S. has increased by over 100%. Recent political pressure to achieve "energy independence" has placed a high priority on expensive decision-making in this industry. However, corn ethanol's effects, both from its manufacture and its use, on other sectors of our economy is not well understood. For instance, ethanol manufacture displaces corn that would otherwise have been diverted to other uses, e.g. for animal feedstock or industrial processing.

This project's goal was to develop a computerized tool with which NIST can simulate the complex non-linear behavior of these systems' interactions. My work centered on creating a System Dynamics (SD) model that can be used to further effective decision-making. A synopses of the nature of this pressing multi-dimensional problem and my own work on finding a solution will be presented in this presentation.

George Mason University

Phase-Field and Atomistic Modeling of Grain Boundaries in Copper
Michael Atkins

Grain boundaries are of paramount importance in Materials Science; they influence the macroscopic properties of materials in very profound ways such as tensile strength and creep. Thus, the ability to accurately describe their behavior and extract material properties from their behavior is important. In this talk, we present a phase-field model that incorporates the effect of temperature of the structure and free energy of grain boundaries in order to describe the behavior of grain boundaries. The model was obtained numerically using a copper bicrystal with symmetrical tilt grain boundaries of different misorientaion angles. To evaluate the accuracy of this phase-field model, its solutions will be compared with molecular dynamics simulations of the same set of grain boundaries.

George Washington University

Bias-Induced Changes in the Vibrational Spectra of Next-Generation Organic Electronic Materials

Marian Ackun

Molecular electronics is the emerging field designed around the concept of replacing existing solid-state electronic components with organic molecules. Organic layers incorporated on silicon are of considerable interest because the semiconductor is the current basis of the electronics industry and can be doped to offer different electrical properties. Previous studies have reported the vibrational and electrical properties of a monolayer between a silicon substrate and a gold electrode, taken on different device structures.. The goal of my project is to examine the effect of an electric field on the vibrational spectra of organic electronic materials. Two types of samples were examined; a single monolayer for molecular electronics applications and an organic polymer blend that is used for state-of-the-art solar cells. Infrared spectra of buried molecular junctions were acquired using a p-polarized backside reflection geometry to detect the chemical and conformational structure of organic materials between two electrodes. A bias applied across these electrodes can induce changes in the vibrational spectra by inducing polarization in the molecules or by inducing chemical charge-transfer reactions. The data was collected and analyzed via Igor to examine any changes in the original vibrational spectra of the sample.

Multijunction Thermal Converters for Precision AC Voltage and Current Metrology

Marjan Aslani

Multijunction thermal converters (MJTCs) are the most accurate devices used for the measurement of AC voltage and current and they are the primary standards in AC metrology. In this method, the heating effect of an unknown AC waveform is compared to that of a known DC signal using thermal voltage and current converters to find the rms value for the AC signal. Today, the design and fabrication of MJTCs are based on thin-film technology in which MJTCs are fabricated on a silicon (for high currents) or quartz (for high frequencies) substrate with a dielectric membrane over it. They consist of a heater resistor and an array of thermocouples on either sides of the heater to measure the heater temperature along its length. The ability of a thermal converter to relate an rms AC voltage or current to a DC value is characterized by a quantity called `ac-dc transfer difference' that is ideally zero. Currently the average ac-dc difference of thin-film MJTCs is less than 1 μV/V in the audio frequency range and up to a few μV/V at 1 MHz.

The AC-DC laboratory at NIST offers calibration services to national and commercial laboratories, and is also engaged in research to advance the thermal, electrical, and mechanical properties of these devices in order to reduce their ac-dc difference. The ongoing research includes measuring electrical properties of various points on the chips at different frequencies between 1 KHz to 1MHz for use in simulations using software application such as Pspice and Tanner tools, and subsequently finding ways to improve these devices.

Using the Anodic Dissolution of Tungsten in Determining the Mass of Nanoparticles

Sarah Bever

Nanotechnology, the ability to manipulate matter at the atomic and molecular level, promotes both improvement in existing technology and advancement into new areas of science. To move these technologies from research to industry, new measurements and standards must be developed to ensure quality in the final manufactured product. One such measurement is the traceable measurement of mass in nanoscale systems. Because traditional methods of mass determination are currently limited to values greater than 5 mg, this project seeks an accurate way to measure masses smaller than 1mg. The proposed method uses the electrochemical reaction of a tungsten wire electrode in a potassium hydroxide solution. An externally applied electrical potential causes oxidative dissolution of the wire, resulting in a mass change. Since the electrical current generated in this process is traceably measured, Faraday's second law can then be used to determine a mass change for comparison with a precision mass balance. In addition to providing a possible direct path to small mass reference artifacts, the development of this type of small mass measurement can also be applied to the calibration of various sensor properties, such as the spring constant of microfabricated cantilevers used in scanning force microscopy (SFM). These measurements, in turn, help to improve industry products and facilitate the next generation of technology.

Wetting Properties of Superhydrophobic Surfaces

Nicole Messier

In recent years, super-hydrophobic surfaces have gained increasing attention from the fundamental physics and the industry. Super-hydrophobic surfaces exhibit high contact angles and low resistance to liquid flow on the surface. These properties could result in a better signal from many liquid based nano-sensors such as nano-electro mechanical devices (NEMS).

In this work, we have studied the wetting characteristics of a liquid on a surface. Wetting defines how a liquid acts on a surface, and the differences are categorized between hydrophilic, hydrophobic, and super-hydrophobic surfaces. Surface energy and roughness helps to differentiate these categories. To develop a super-hydrophobic surface, we will be using micro- and nano-processing technologies. Our experiments involve various techniques from stamping hydrophobic chemical compounds such as polydimethylsiloxane with nanoporous ceramic membranes to making stencil mask with stencil lithography. In addition, this project involves using photolithography to create roughness on the silicon wafers. The developed substrates will be differentiated with distinct chemical coatings and roughness parameters. The developed substrates will be tested and categorized using drop shape analysis software and images from a SEM.

Gettysburg College

Automated CHARM: Retroreflector Measurements and LED Traffic Signal Distributions

Christine Kuhn

The NIST Center for High Accuracy Retroreflection Measurements (CHARM) provides accurate measurements of national calibration standards for retroreflectivity. CHARM was created in 2005 in response to a Congressional directive to the Department of Transportation to set a minimum level of retroreflectivity for street signs and pavement markings. Prior to CHARM, national calibration standards for retroreflectivity traceable to NIST did not exist. The availability of national calibration standards should reduce the large variance in measurements currently existing. This summer, the CHARM measurement system was fully automated minimizing the effort required to calibrate and characterize dozens of samples that will be used in an ASTM interlaboratory comparison to test the variance of the measurement community. In addition to retroreflectivity measurements, luminous intensity distributions of LED traffic lights were measured using the CHARM facility. A mathematical procedure was developed to determine the uncertainty of those distribution measurements that will be used in the general lighting measurement community.

Hamilton College

aCORN: Measuring the Electron Antineutrino Angular Correlation in Neutron Decay

Glenn Smith

The "a" Correlation in Neutron Decay experiment (aCORN) seeks to measure the neutron beta decay electron-antineutrino angular correlation coefficient (little a) to within 1% of its value. When a neutron decays in the apparatus, it produces a proton, electron, and an anti-neutrino in one of two configurations. The electrons and protons are detected in separate detectors. By measuring the proton's time of flight relative to the electron's, the configuration can be determined. In addition, the electron energy must be measured. The apparatus consists of a large tower with a magnetic field to guide the protons to the proton detector and the electrons to a segmented beta spectrometer of 19 electron and 8 veto detectors.

While a large portion of the experiment is currently in Indiana, the beta spectrometer is being prepared at NIST. These scintillation detectors are being tested using various radioactive sources that produce electrons with varying energy spectra. Before the rest of the experiment is shipped to NIST, we have to be sure the beta spectrometer is working. One of the more crucial requirements of the detection is having a time window for detections capable capturing both the electron and the proton. The beta spectrometer must also be able to reproduce the energy spectra of our sources. Given an energy and hit location for an event, the events can be divided into various regions and calibrated by region to correct for small deviations in sensitivity between detectors. Using these tools, an accurate value of the electron's energy can be calculated.

Hampshire College

Building AvailTechs to Commercialize NIST-Developed Inventions and Technologies

Maryette Haggerty Perrault

AvailTechs will be a searchable, online database used by the Office of Technology Partnerships to commercialize the inventions of NIST scientists and researchers for commercial use by industry. Many of the inventions described on AvailTechs have been patented and all are available for some form of licensing or use. The goal of this SURF project was to populate the database with various types of information derived from multiple primary and secondary sources related to each invention.

After working with the web developer on trouble-shooting and debugging the website, AvailTechs was ready for population, and approximately 150 technologies will be uploaded for marketing by mid-August. Technologies explained on the site vary from chemical microsensors and optical trap devices to dry-dock alternatives and refreshable Braille readers; from digital signatures and time-stamp services to liposome immunoanalysis and microfluidic flow manipulation devices. In each technology's page the user will find at the very least, the abstract of the project and other crucial information such as inventors, applications, technical fields, and any reference materials in existence. Ideally, each of the 150 technology records will have "Technical Description," "Benefits," and "Uses" fields containing all the information required for a non-specialist in the field to comprehend its applications in real world settings; for example, a company's business development unit, or CTO, researching new methods and tools to better the productivity and quality of their business' merchandise. The major challenge of this project is to present the highly technical language of a Patent to the public in a way that anyone can grasp. To aid the user's understanding of each technology, photos, PowerPoint Presentations, and articles are included and summarized.

A guide for future AvailTechs Technology Liaisons will also be created as a handbook for the website and for the process of dissecting each invention. Once the page has been developed fully, the Office of Technology Partnerships will maintain up-to-date records of the newest and most advanced inventions.

Harvey Mudd College

Real-Time Laser Calibration and Environmental Isolationof Nanophotonic Device Characterization Setups

Robert Hoyt

Narrow linewidth tunable lasers are an indispensible tool for characterizing the properties of optical nanostructures such as resonant cavities. By continuously sweeping the laser through a range of wavelengths while sampling a photodetector's voltage using a data acquisition card, high resolution scans of novel optical nanostructures can be recorded in seconds. Unfortunately, this method assumes that the laser's wavelength is a predictable function of time. From results obtained in our laboratory this is not the case. By developing efficient, customized MATLAB algorithms to process data from an acetylene gas reference cell and a Mach-Zehnder

interferometer, tuning nonlinearities were eliminated and absolute wavelength error was decreased to about one picometer on most scans.

Nanophotonic device characterization often requires environmental isolation, for example, to fix the separation between a near-field probe and the device under interrogation. Despite the strong gains described above, low frequency vibration of the probe due to ambient air currents and possible acoustic response isn't correctable using software. This sensitivity to the surroundings inspired the design of an isolation chamber to protect the fiber from environmental effects. In this case, the proposed chamber is a well-sealed, two-box system fed with an external nitrogen supply to maintain a constant atmosphere. This new testbed promises to reduce probe motion, allowing longer scans to be taken with greater repeatability.

Testing Power MOSFET Reliability: A Novel Approach
Benjamin Keller

Power MOSFETs have a wide variety of uses in electronics applications. The practicality of using novel materials such as SiC in power MOSFETs is being explored. Such devices suffer from time-dependent dielectric breakdown (TDDB), a phenomenon that results in device failure after a certain amount of use. TDDB must be carefully studied and quantified in order to ensure device reliability. TDDB is a statistical process, so large numbers of devices must be simultaneously subjected to high temperatures and voltages for extended periods of time in order to determine device reliability.

The test equipment currently employed for these experiments is bulky, expensive, and limited to testing only twenty devices at a time. I present the design of the electronics of a novel test apparatus that will be small, relatively inexpensive, and able to test hundreds or thousands of devices simultaneously. The electronics will control each individual device under test, set the stress condition, collect and precondition the data, and interface with an external computer. A PIC microcontroller provides the on-board intelligence, enabling the complex task of measuring a large number of devices while minimizing the number of cables connected to the external computer. The user interfaces with this system via a PC running LabView to afford straightforward interaction with the system.

Haverford College

Software Validation and Verification on SOP 4
Joseph Howard

Software verification and validation is a critical component of any laboratory operation. Errors in software can impact measurement results, to the detriment of quality measurement results, and negatively impact laboratory reputation, health, and safety. In addition, software errors can have significant economic impacts. The NIST Weights and Measures Division uses a number of spreadsheets in training seminars and as job aids associated with calibration procedures and proficiency tests/interlaboratory comparisons. Formal verification and validation methods need

to be studied and implemented for the 25 Standard Operating Procedures (SOPs) in common use in the Laboratory Metrology Group.

The project includes a review of Standard Operating Procedure #4 (double substitution mass calibrations), checking spreadsheets for basic and complex errors. Calculation results using spreadsheets developed by different parties per SOP #4 have been compared based on established data sets; some have already been published as data sets and some have been selected as experimental and extreme. Ideally each data set must yield the same answers for each given data set (established through hand calculations and other means), and if for some reason they do not, the spreadsheets must be investigated to find and determine the source of the error causing the deviation on the computer.

Hood College

Heat of Hydration Prediction for Portland Cement
Kendall Dolly

Work by NIST's BFRL/MCRD and ITL/SED is directed toward enhancing performance prediction of cement materials through improved characterization and modeling. The goal is the accurate prediction of field performance metrics from accurate characterization of mineralogical composition and texture of materials.

Heat of Hydration (HOH) is critical when dealing with large masses of concrete or with high temperature curing. Standard construction contracts invoke a HOH clause. Current direct HOH testing is time, staff, and resource expensive, and employs noxious reagents. MCRD and SED are working to develop predictive models for HOH as a function of phase composition determined from X-ray Powder diffraction, and adjunct variables like fineness. To find models that improve on existing coarse rules of thumb used in industry we use multivariate graphics, principal components regression, all possible subsets regression, and alternating conditional expectation coupled with automated parametric modeling with TableCurve 2D. In this talk, we show explicitly how these techniques are used to develop workable models from an actual dataset incorporating 30 potential explanatory variables. We compare the performance of the models we derive to heat of hydration prediction models currently being used by industry.

The goal is to develop the quantification and predictive power of developmental NIST techniques further, and to transfer them to ASTM standards, which North American construction specifications rely on. Improvements in such standards will strengthen confidence in compositional analyses of these widely used products.

Packing of Polydisperse Systems and High Packing Fraction
Mara Levine

Whilst the packing behavior of monodisperse systems of hard spheres is largely known, the effect of polydispersity at a high packing fraction is not well understood. Real world particulate systems more often than not are polydisperse and densely packed. Such systems include ceramics and minerals as well as obviously particulate systems such as slurries, emulsions and

powders. Furthermore, a hard sphere description is not always truly valid. Many colloidal and nanoparticulate systems are in fact soft spheres. We have attempted to study two sets of phenomena; the first is the packing of polydisperse systems and the second is the behavior of soft spheres at a high packing fraction. We have initially considered a bi-modal size distribution as a step towards real polydispersity as it is more likely to be theoretically tractable.

To obtain similar model materials for both hard and soft spheres, temperature sensitive polymer gel particles of poly (N-isopropylacrylamide) (poly-NIPAM) were used. Below 32°C the particles are swollen and behave as soft spheres. Raising the temperature above 32°C causes the particles to collapse and behave as hard spheres. In addition to this useful behavior, knowing how poly-NIPAM particles act in a highly concentrated solution is relevant to proposed use of such materials as drug delivery vectors.

Particles were synthesized using suspension polymerization, with radii in the swollen state of 150 nm and 300 nm. Initial characterization of size was made using dynamic light scattering. Subsequent analysis was performed using small angle neutron scattering and ultra small angle neutron scattering. This allowed us to determine the packing density, spatial arrangement, and any distortion in shape of the particles. The two sizes were combined in various volume fraction ratios to determine the mixed system behavior as compared to the unmixed systems.

Surface vs. Bulk Degradation of P3HT: PCBM Blend Films for Organic Photovoltaic Cells

Julie Nyman

Organic photovoltaics constructed from poly-(3-hexyl-thiophene) (P3HT) and phenyl-[6,6]-C_{60}-butyric acid methyl ester (PCBM) are a smart alternative to other non-renewable and renewable sources of electricity due to their thin-film geometry. However, their useful lifetimes are not long enough (approximately three years) to be competitive with other forms of photovoltaics. By studying the photo-oxidation of the active layer blend (P3HT:PCBM) to see whether the oxidation is a surface or bulk phenomenon, the fundamental nature of active layer aging can be understood. Samples were constructed by spin-coating P3HT, PCBM or a mixture of the two onto IR transparent silicon wafers or UV-Vis transparent fused silica chips. These samples were then interrogated before and after aging under AM1.5G solar spectrum light for preset times by Fourier transform IR and UV-Vis spectroscopy. The spectra were analyzed to identify the rate and type of photo-oxidation reactions in the bulk state. To contrast the surface photo-oxidation behavior, the spectra results were compared to Near Edge X-ray Absorption Fine Structure (NEXAFS) spectroscopic analyses of similarly prepared and aged samples. Finally these spectroscopic analyses were correlated to device performance data collected on aged solar cells. A discussion of these results related to proposed mechanisms of P3HT degradation will be presented.

Tethered Bilayer Lipid Membranes for Protein Characterization

Hilary Stauffer

A relatively new technique of creating tethered bilayer lipid membranes (tBLMs) allows for the structure and function of integral membrane proteins (IMPs) to be studied. IMPs are found inside

the membrane of cells and typically span the lipid bilayer. They are important in performing certain functions such as ion conduction and transport across the membrane and are important drug discovery targets. The tBLM mimics the natural lipid bilayer membranes of cells — a disordered amphiphilic, fluid matrix with aqueous regions on both sides of the membrane — which can allow functional reconstitution of the IMPs. tBLMs consist of an inner leaflet composed of a small spacer molecule (β-mercaptoethanol), a tether molecule, and untethered lipids and an outer leaflet composed only of lipids. The tBLM is anchored to the surface with a lipid-like tether molecule to allow the application of surface science metrologies that can probe IMP structure, function or both. My work this summer was directed toward the synthesis of a new tethering molecule (HC18) that contains a double bond in the two hydrophobic alkyl chains. The presence of unsaturation in the hydrophobic segment is known to promote disorder bilayers and, thus, should add more fluidity to the tBLMs. All compounds were analyzed by thin layer chromatography (TLC) and nuclear magnetic resonance (NMR), and purified by column chromatography.

Illinois Wesleyan University

Terahertz Spectroscopy of Polypeptides

Mark Kaspercyzk

Introductory Quantum Mechanics dictates that the energy levels of any particle—electrons, atoms, etc.—are quantized. Bonds between atoms—such as the covalent bonds as found in polypeptides—also have excited states which are quantized. When light of the proper frequency is absorbed, the bond can stretch or bend or rotate in ways depending that depend on the number of atoms participating in the bond and the bond strength and length. A molecule, however, can also have vibrational or rotational excited states that involve all or most of molecule, rather than just two or three atoms in the molecule. For polypeptides, these states have energies corresponding to light with frequency on the order of a few terahertz (10^{12} Hz, or about 300 micrometers in wavelength). By using the difference frequency between two nearly identical lasers which lase in the infrared, it is possible to generate continuous wave terahertz radiation. Furthermore, by using a tunable laser, our measurements can span the region of the terahertz spectrum from 0 cm^{-1} (~0 Thz) to 100 cm^{-1} (~3 Thz). Depending on the polypeptide's secondary and tertiary structure, different terahertz wavelengths will be absorbed. Therefore, examining the absorbance of the polypeptide at various frequencies reveals its structure.

Iowa State University

Development of a Nanoindenter with Optical Microscopy and Raman Spectroscopy Capabilities

Elizabeth Welch

Nanoindentation is the process of using a small tip to make indentations in a material and using the measured forces and displacements to determine mechanical phenomena such as elasticity and plasticity. Other properties of the material, including fracture properties and molecular rearrangement are not accessible with conventional nanoindentation. To solve these problems, an "*in-situ*" nanoindenter is being built on a Raman-spectroscopy-equipped optical microscope to

study fracture, molecular rearrangement, and stress development at the indentation site. The Raman and optical microscopy capabilities have never been included in one machine before, which is why building one is necessary.

The main mechanical components of the *in-situ* nanoindenter include the LVDT (linear variable differential transformer), a voice coil, suspension springs, and the diamond tip. The displacement and force are controlled by altering the current in the voice coil. The challenge is to accurately measure and control the current, displacement, and force through the LVDT and voice coil. LabVIEW, a graphical programming language, is being used to develop a program to control the test and make all measurements. These results will provide a deeper understanding of the mechanical properties of many materials at the nanoscale.

Johns Hopkins University

Combinatorial Methodology Applied to the Exploration of Novel Materials for Advanced Metal Oxide-Semiconductor (MOS) Gate Statcks

Howard Joress

The continuation of Moore's Law scaling of integrated circuits requires novel materials. As devices become smaller, the traditional materials used in metal-oxide-semiconductor (MOS) gate stacks, an SiO_2 dielectric layer with a polysilicon (poly-Si) metal gate, begin to encounter a variety of serious problems including high leakage current density (J_L) and poly-depletion. This has led to the need for higher-κ dielectric and novel metal gate materials.

This project utilized combinatorial methodology to accelerate the search for novel MOS gate stack materials. Combinatorial methodology allows us to rapidly search through thousands of compositions by quickly creating a wide range of compounds and measuring them using high-throughput techniques.

In an approach to finding a novel metal gate material, we have focused on establishing a reliable metrology to extract the work functions (Φ_m) of metal gates. In order to more accurately determine Φ_m , we have attempted to remove experimental variation by using a single Si wafer with a dielectric thickness gradient, thereby allowing us to systematically extract the Φ_m of metal gates from a single deposition. The process of creating this gradient also created a high interface state density (D_{it}). We have identified the optimal conditions for forming gas annealing (FGA) to reduce D_{it} within a TaN/HfO_2 (3nm)/ SiO_2 (varying thickness)/Si gate stack.

In order to find a higher-κ dielectric material, we have focused our study on the ternary system (library) HfO_2-Y_2O_3-TiO_2, which we deposited by combinatorial pulsed laser deposition (PLD). In-situ metal-oxide- semiconductor capacitors (MOSCAPS) were created above the library by sputtering Mo through a shadow mask. With the help of an automated probing station and reflectometer, we were able to map the composition, thickness, and capacitance across the library. We found that compositions rich with TiO_2 and Y_2O_3 had higher dielectric constants (κ) than those rich with HfO_2.

Size Matters: Difficulties in Profiling Large-Diameter Optical Flats
Ian Richter

This project's goal was to use a computerized interferometer to measure the perpendicular diameter surface profiles of optical flats larger than the interferometer's six-inch aperture, with accuracy in the vicinity of two nanometers. This method would replace the time- and labor-intensive use of a pulfrey viewer to accomplish the same task. To this end, it was necessary to devise a means of correcting for systematic error resulting from the surface profile of the transmission flat mounted in the interferometer, develop an algorithm with which to stitch separate data sets together into a single profile, and devise a means of mounting and securing large optical flats in the interferometer's field of view. Interestingly, choosing a solution to any one of these problems significantly impacts the options available to solve the others. During the presentation, a discussion of the progress made toward each of these objectives, the major issues that arose over the course of my investigation, and a general outline of a procedure suitable to replace the current method will occur.

Silver Nanoparticle Stability and Speciation in Aquatic Environments
Stephanie Chinnapongse

The use of silver nanoparticles (AgNPs) in both medical and consumer products has become increasingly widespread over the past decade. Though AgNPs are desirable for their antimicrobial properties, their dissolution to silver ions (Ag^+) may introduce separate problems for both humans and the environment. The lack of available literature on AgNP behavior indicates that many of these effects have not been quantitatively studied, leaving the question of AgNP toxicity largely unanswered. This project focuses on the fate and stability of leached AgNPs in fresh and seawater, and assesses the potential impact they will have on the environment. AgNPs were synthesized in the lab and characterized using dynamic light scattering (DLS) and UV-Vis spectrometry. These methods were then used to evaluate the colloidal stability of the AgNPs in different aqueous environments. AgNPs were tested in seawater, local pondwater, and also in the individual chemicals prevalent in each. The AgNPs aggregated in most of the water samples within a few hours of mixing, forming a layer of sediment instead of dissolving into Ag^+. There were certain water samples though, mostly those with lower salinity, in which the AgNPs maintained colloidal stability after 15 hours of sample interaction. Longer-term studies of these stable AgNPs, as well as the nanoparticle sediment formed in the more saline solutions, are two important considerations for future research. The speciation of silver in each AgNP sample was determined using an Ag^+ ion-selective electrode (ISE). Using the ISE along with stirred-cell ultrafiltration was found to be a simple way to isolate the Ag^+ and quantify the amount of AgNPs that had dissolved into ions. The use of the ISE was limited by interference from chloride ions. These results stress the importance of finding improved methods of monitoring and slowing AgNP dissolution in our waterways. It is also clear that many steps are left to be taken in order to obtain a thorough risk assessment of AgNPs in the environment.

Lehigh University

Evolution of Surface Roughening in Relation to Grain Orientation in 6022 T4 Aluminum

Scott Olson

More than one third of an automobile's gross weight is stamped sheet metal components typically fabricated from conventional steel alloys. In order to increase fuel economy, there is a push for using stronger steels with thinner gages or lighter weight alloys such as aluminum. One alloy is AA 6022 T4, which is aluminum alloyed with silicon and magnesium. This alloy is not as well characterized as the conventional steels under straining modes encountered during metal stamping, and so a better understanding is required before this alloy can be extensively used in automotive part formation. One of the limiting factors towards its widespread use is the in situ development of surface roughness during forming which affects the limiting strains of the material and the aesthetic appearance of the component. A main factor that influences surface roughness is grain orientation. Grain orientation is important as roughening occurs through the process of crystallographic slip, where dislocations progress through a grain. Slip occurs most readily when the grain is positioned in the material with the optimum orientation between the slip system, {111}<011> in aluminum, and the stress axis. By gaining insight of the relationship between crystallographic orientation, the straining mode, and concomitant surface roughening, a better understanding of the material's properties can be determined. To quantify this relationship experimentally, Scanning Laser Confocal Microscopy (SLCM) was used in situ to determine the surface roughness at given uniaxial strains, with electron backscatter diffraction (EBSD) used before and after mechanical testing to characterize the orientations of the grains. The results of this experiment will be discussed.

Loyola College of Maryland

Detection and Differentation of Bacterial Endospores Through Fluorescence Spectroscopy

Natasha Hochlowski

The expedient and accurate detection of dangerous bio-agents is of integral importance to first responders in a biohazard emergency. An understanding of the properties of bacterial endospores, such as anthrax and other pathogens, will aid responders in the identification of different species. Fluorescence spectroscopy is able to detect and differentiate different molecular species within a particular material, ideally creating a fluorescent "fingerprint" for that sample. By detecting intrinsically fluorescent molecules in spore samples, it is possible to create a standard to which spores can be compared and thereby identified.

Fluorescence instruments were used to detect and differentiate between spores of different species grown in different media. Two different strains of Bacillus thuringiensis and a strain of Bacillus cereus, simulants for Bacillus anthracis (anthrax), were examined in three growth media. Each sample was scanned for the presence of endogenous fluorescenct molecules, including various enzymes, coenzymes, and amino acids. Results were compared with those in the literature to determine the molecules present. Contribution of growth media, time elapsed

after sample preparation, and concentration were considered during the analysis of the fluorescence spectra.

Performance Evaluatiion of External Calibration of a Camera and Laser Range Finder

Lisa Schneider

Manufacturing companies wish to boost plant floor productivity through greater integration of flexible robots into automation. To increase flexibility, it will require the greater use of robot perception to sense objects and people in the workplace. A key aspect of perception in manufacturing is the ability to accurately recognize the position and orientation of objects with multiple sensors, and the use of multiple sensors requires sensor to sensor external calibration to determine relative position and orientation of each.

This project seeks to examine and implement existing methods for external sensor calibration with the emphasis calibration between a SICK 1-dimensional range sensor and a camera. Three methods were implemented and evaluated. Each method used a different target and technique to obtain the relative orientation and position between the camera and the SICK. Data from the camera and sensor are used to determine the relative orientation and position. The different methods include multiple steps to attain the external calibration including a closed form solution and an optimizing step. Through testing, our evaluation seeks to assess the robustness of the different methods. Furthermore, this evaluation will better establish the validity of the fusion of visual data from multiple sensors and help provide recommendations for robotics in manufacturing automation.

Miami University Ohio

Determining the Synthesis Mechanism of Ultra-Small Ligand-Capped Gold Nanoparticles

Ryan Bratton

We have used ultraviolet and visible optical spectroscopy (UV-VIS) and electrospray ionization mass spectroscopy (ESI-MS) to measure and record the appearance and decay of (Au_n, n = 1-13) species during the synthesis of diphosphine ligand-protected clusters $[Au_6L^3_4]^{2+}$ and $[Au_6L^3_3]^{2+}$ (L_3 = 1,3-bis(diphenylphosphino)propane) and their subsequent storage in sample jars over the course of several weeks. The reaction environment (solvent composition and concentration, temperature, reducing agent, pH of solution and oxygen exposure) of this synthesis was varied greatly to see what these effects had on the major and side products and whether or not certain reaction conditions favored the formation of the $[Au_6L^3_4]^{2+}$ and $[Au_6L_3^3]^{2+}$ ions. The chosen solvent had a dramatic effect on this reaction. The 1:1 chloroform:methanol synthesis solutions containing L^3 exhibit an orange-red-blue-orange colorimetric display over an interval of approximately two weeks and solvated clusters resist air oxidation after their formation. Two different reducing agents, tBAC and $NaBH_4$ (tBAC = tert-butyl amine complex and $NaBH_4$ = sodium borohydride) were used in these reactions and only synthesis solutions with tBAC were observed to vary from an orange hue where, in contrast, the $NaBH_4$ solutions were black shortly after mixing and became orange over the next couple days. These reactions present themselves

as a rare case of where chemical changes and ions in solutions can actually be seen due to their color and not just observed via instrumentation. We have also seen evidence of gold nucleation growth under certain conditions where a gold film (or 'mirror') formed around the sides of the sample container. Our observations of these solutions after being prepared under different experimental conditions assist us in understanding what consequences are realized when these changes occur, providing us with an opportunity to propose a viable mechanism for these reactions.

Phase and Amplitude Modulation with a Spatial Light Modulator and Its Appliations

Megan Marshall

Spatial light modulators (SLM) are devices that can modify the phase or amplitude of a laser, making it a useful tool in many areas of research. The goal of this project was to develop a method that will allow control of both of these characteristics by the SLM to enhance the range of applications. One of these applications is to improve homodyne detection techniques for non-classical light, such as what might be produced by Four Wave Mixing. Light from non-classical light sources has significantly different properties than classical sources like a laser or light bulb, such as noise levels, which can be made much lower in non-classical light. I will be discussing the calibration tests used in the preparation of the system, the method used to allow modulation of both amplitude and phase, and the specific applications to broader research interests. Also, I will discuss how the masks used to shape the beam were created and how the beam was adjusted to improve matching between it and the desired shape. Finally, I will describe the difficulties I had in this experiment and possible ways of overcoming them, as well as other adaptations that could improve and expand the applications of this device, including the creation of a computer program to automate the adjustments currently being made by hand.

Neutron Tomography of Alkaline and Lithium Primary Cells

Grant Riley

High resolution neutron tomography has been employed to observe the changes in the internal structure of alkaline and lithium AA batteries during a full discharge. Neutron tomography (3D-imaging) is a tool at the NIST Neutron Imaging Facility used to determine, non-destructively and *in situ*, the changes in the internal structure of metallic devices. Neutrons are heavily attenuated by hydrogen and other light elements and pass through many metals which have a lower neutron attenuation. This is in contrast to x-rays, which are scattered (attenuated) by electron dense materials such as bone and metal. Thus measuring the movement of light elements in a metallic matrix cannot easily be done using x-ray imaging. Previously the changes in internal structure of the primary cells were mainly measured via destructive techniques; the battery would have to be opened after discharge and therefore could not be discharged further. With neutron tomography, the metallic composition of the battery presents almost no barrier to imaging the inside of the device and so changes in the electrolyte composition are clearly visible. In these experiments, alkaline and lithium batteries were discharged at two different constant currents for a set time period. Following the discharge, the battery was imaged using a scintillator screen and a CCD camera. The 3D structure of the battery was then reconstructed with computerized tomography. Beyond the differences in internal structure, the two battery chemistries were seen to behave

quite differently. In alkaline cells the separator loses electrolyte, with a loss rate that depends on the discharge current rather than depth of discharge, the anode pin region loses electrolyte during operation while the outer radius of the cathode is becomes filled with an excess of electrolyte. In the lithium battery, the "jellyroll" electrolyte expands to fill the empty core of the battery. This corresponds to a loss of material from the jellyroll, and these changes are similar regardless of current.

Millersville University of Pennsylvania

Digital Data Preservation Strategy and Implementation
William Killian

For the SURF 2009 project, a team of three students worked together to prototype and strategize digital data preservation framework and tools. The project consists of two phases: (a) Because of the portable devices (cell phones, personal digital assistants, etc.) play a vital role in our society today and the future to come, the team had strategized and implemented a set of cell phones (Apple's iPhone, RIM's Blackberry, and Google's Android) players to access the preserved ISO/IEC 23000-3 images content which provides ISO/IEC MPEG-7 metadata descriptions and the rich ISO/IEC MPEG-4 file format standard technologies; (b) Apply the lesson learned from phase (a) to strategize what generic infrastructure framework to handle multimedia content (images, audio, video, text). A set of digital data preservation tools has been investigated and developed for the generic framework.

Specifically, my responsibility for the Digital Data Preservation was to:
A) Design and implement a client for Google's Android mobile platform.
B) Investigate data management software (such as iRODS - Integrated Rule-Oriented Data System)
C) Work with teammates to setup a prototype implementation of the generic framework.
D) Make the Android client compliant with the generic framework.

See Also: Jason Young and Scott Albertine

Montgomery College

Interaction Mechanisms of Gold Nanoparticles with DNA
Andrew Dillon

Reactive oxygen species (ROS) are generally small molecules such as free radicals, oxygen ions and peroxides that are naturally present in the body. However, an overabundance of ROS can overwhelm the body's natural antioxidant defense system and lead to a condition termed oxidative stress. Oxidative damage to the body's genomic DNA is one of the consequences of oxidative stress and is a direct result of the interaction of ROS with our DNA. It is not known at a fundamental molecular level if gold nanoparticles promote or hinder the formation of ROS in the body. If excess ROS are formed by nanomaterials, oxidative damage to our DNA could occur, leading to genotoxicity and/or cytotoxicity. This short-term research project is focused on determining if specific oxidatively modified DNA lesions can be formed in simple bicomponent solutions containing calf-thymus DNA (ct-DNA) and selected gold nanoparticles (AuNPs).

Liquid chromatography tandem mass spectrometry (LC/MS/MS) and gas chromatography/mass spectrometry (GC/MS) will be utilized as tools to determine the presence of oxidatively modified DNA lesions after test solutions have been incubated at predefined conditions of temperature and time.

Mount Saint Mary's University

Anti-Body Mediated Self-Limiting Self-Assembly of Gold Nanoparticles

Carly Geronimo

Since the advancement of nanotechnology, nanoparticles (NP) have become of greater interest to the science community. Gold nanoparticles (AuNP), in particular, are valued for their stability and distinct optical, magnetic and electrical properties. As AuNPs loaded with drug proteins on their surfaces are now being investigated as potential cancer therapies, it is important to understand how to characterize the proteins on a NP surface and their interactions with antibodies. This work observed the antibody-mediated self-assembly of different sized AuNPs, effectively coating larger AuNPs with smaller AuNPs, to measure the protein coating density on the larger AuNPs. AuNP can easily be synthesized using the Turkevich method in which sodium citrate acts as both a reducing and stabilizing agent. For comparison to rigorously characterized AuNP, RM 8011 and RM 8013 (10-nm AuNP and 60-nm AuNP respectively) were also used. Antibodies, such as immunoglobulin G (IgG), are proteins produced by B cells in the body as part of the immune system's defense against antigens such as bacteria, viruses, and fungi. Three different kinds of antibodies –Rabbit anti-Goat (IgG), Goat anti-Rabbit (IgG), and Donkey anti-Rabbit (IgG) –were used to provide different levels of cross-reactivity and specificity. The nanoparticle-protein conjugates were also formed in varying antibody/NP ratios by controlling the amount of alkanethiol, here 3-mercaptopropionic acid (MPA), and then amide coupling the N-terminus of the proteins to the AuNP. By having small AuNP with only one antibody, self-limiting self-assembly onto larger AuNP-protein conjugates was possible, facilitating easier interpretation of subsequent AFM images. Additionally, the stability of the nanoparticle-antibody structures in certain biological conditions was evaluated to explore the potential behavior of the conjugates within the body. The physiological conditions studied include temperature, pH, and salt concentration.

Characterization of Organic Molecular Electronic Junctions by Transition Voltage Spectroscopy

Christine Wroge

Despite the appeal of low cost energy provided by organic solar cells, such devices have not yet been commercialized due to their low efficiency partially the result of high charge injection barriers at the electrode interfaces. This project directly measured this barrier for three molecular systems using transition voltage spectroscopy. Transition voltage (V_{trans}) refers to the voltage required to transition from direct tunneling to field emission and is linearly proportional to the energy difference between the Fermi energy level and the nearest molecular orbital. Self assembled monolayers of bithiophene phosphonic acid (BPA), quarterthiophene phosphonic acid (QPA), and decylphosphonic acid (DPA) were constructed on a conductive indium tin oxide (ITO) surface. The monolayers were gently brought into contact with a thin gold wire while

being held at ground. A voltage was swept through the wire and the current flow through the molecules was measured. The transition voltage was visualized as a minimum on a plot of ln (I/V^2) vs 1/V generated from the current-voltage data. It was noted that there was no significant difference between the three molecules, suggesting that the phosphonic acid common moiety may play a role in determining V_{trans}. Furthermore, hysteresis in the current-voltage curves was noted for all three molecules, a phenomenon possibly explained by charge retention in the phosphonic acid. These results will allow for further characterization of organic solar cell components.

New Jersey Institute of Technology

Quantitative Evaluation of the Quality of Robot-Generated Maps
Uyiosa Abusomwan

As we witness the evolution of autonomous robots equipped to take on intelligent tasks, such as identification of victims in Urban Search and Rescue (USAR) scenarios and transportation of goods in warehouses, there is a demand for developing mapping algorithms which enable robots to efficiently accomplish their tasks. Consequently, performance measures of the robot's understanding of its environment are needed to validate the quality of resulting maps. Features such as walls and the topology of the mapped environment serve as good indicators towards quantifying the quality of such maps. Thus, assessing the accuracy and consistency of the robot-generated map defines the robot's understanding of its environment.

Motivated by the lack of adequate performance measures in quantifying robot-generated maps, this research at NIST is aimed at generating measurement and visualization tools and techniques for inspecting the metric quality and consistency of maps. The tool developed compares various robot-generated maps against actual maps (Ground Truth). Comparison is based on the accuracy of the explored region(s) of the map, distortion errors with respect to the ground truth, and task-based evaluation. Based on these three criteria, the map with the highest score represents the robot with a better understanding of its environment. This evaluation technique can be made sufficiently generic such that it can be extended to other domains (e.g. manufacturing).

Cell/Substrate Modulus Interaction. Polymer Characterization
Fatima Fabara

The purpose of this project is to experimentally evaluate the dependence of cell morphology on substrate modulus as theoretically described by Ni and Chiang.* According to their model, cells cultured on substrates with varying modulus exhibit changes in cell shape and migration over a range of moduli.

Polydimethylsiloxane (PDMS) substrates with a shear modulus ranging from 1.3 kPa to 460 kPa were prepared. The sample stiffness was characterized by rheometry and dynamic mechanical analysis. PDMS surfaces were treated with fibronectin (FN) to promote cell adhesion. The extracellular matrix protein FN was selected because of its function in cellular attachment and migration. The quality of the FN adsorption on surfaces was characterized for 2 h and 24 h incubation. Using immunohistochemistry, the FN surfaces were imaged with a confocal microscope and were analyzed for uniformity and relative amount. The 24 h incubation PDMS substrates had a more homogenous FN surface coating than the 2 h incubation plate; the 2 h incubation PDMS substrates, on the other hand, showed incomplete FN coverage with relative large voids, especially for substrates with low moduli.

The 24 h incubated FN protocol was subsequently selected for cell seeding because of its uniform FN surface coating. The surface hydrophobicity was characterized for substrates with and without FN using contact angle measurements. Lastly, cell morphology (shape) of vascular smooth muscle cells was evaluated for the entire moduli range of FN coated substrates. To further verify the theory by Ni and Chiang, additional experiments will be necessary using different cell types. Although different cell types may not show identical trends as the smooth muscle cells, it is expected that a transition in cell shape will be observed for substrates of a large modulus range.

*Ni Y, Chiang MYM. Cell Morphology and migration linked to substrate rigidity. Soft Matter 2007; 3(10): 1285-92.

New York University

A Mathematical Analysis of the Switch-Like and Oscillatory Behaviors of the Tumor Protein 53 Feedback Loop

Michael Sharpnack

Tumor suppressor protein 53 (p53) can exhibit oscillatory behavior in response to DNA damage. The mathematical model of p53 consists of non-linear ordinary differential equations obtained from the protein interactions and the Law of Mass Action. Using this model, our project seeks to answer questions relating to the importance of certain parameters and reactions over others in determining the qualitative behavior of the system. Through varying tests, we attempt to determine which reactions are necessary in the model for oscillation. We found that there is a threshold level of non-linearity, or number of chemical reactions modeled, that must be crossed for oscillation to occur.

In addition, using a similar method as Buchler and Louis (2008) we found that a model p53 network that is not subject to DNA damage exhibits switch-like behavior in response to changes in the synthesis rate of mdm2 and the total amount of p53.

USARSim 1.8 Upgrading Robotic Simulation

Nathaniel Weinman

The goal of the USARSim (Unified System for Automation and Robot Simulation) project is to create simulations of robots that are physically accurate as a research tool for the study of

human-robot interaction and multirobot coordination. Previously, NIST used Epic Games' Unreal Tournament 2004 software as an interface for the simulation because of its extensive capabilities in simulating physics. However, recent advances in simulation have rendered this game engine obsolete and an extensive survey was conducted last year to determine a new advanced simulation engine. It was decided that Epic Games' Unreal Tournament 3, which has better software for simulation than the previous release, would be used for this project.

In Unreal Tournament 2004, a variety of complex robots with various sensors, cameras, and other attachments, can be placed into complex environments with fairly accurate physics. However, in Unreal Tournament 3, at the beginning of the summer, it was only possible to place a simple box with four wheels into Unreal Tournament 3's simulated environment with invisible sensors. Over the summer, my work has been concentrated in bringing the simulation to the level of Unreal Tournament 2004; having working, drivable, physically accurate robots. It is now possible to place more complex robots and be able to place various sensors and other attachments on them. Although simulations in Unreal Tournament 3 are still not at the level of Unreal Tournament 2004, they have been improved. This presentation will describe the improvements that have been made to this point.

North Carolina State University

Design and Development of a Muon Veto System for an Ultra-Cold Neutron Lifetime Experiment

Daniel Marley

A free neutron will decay into a proton, electron, and an antineutrino in approximately fifteen minutes. At NIST there is an ongoing experiment aimed at improving the current average of the neutron lifetime. The Neutron Lifetime Experiment uses 0.89nm ultra-cold neutrons that are trapped within a quadrupole magnet for measuring the lifetime. The neutrons are constrained to a cell for decay inside the magnet filled with liquid ^{4}He. The resulting electron from the decay interacts with the helium to produce ultraviolet light that is down-converted to blue light for detection. The lifetime is being calculated in real time by mapping the exponential decay curve.

Very precise measurements of when the neutron decay occurs are critical, and any and all backgrounds need to be addressed and eliminated, if possible. One specific background is the muon background. Muons are produced by cosmic rays that undergo nuclear reactions with the upper atmosphere and shower down to the surface of the earth. The muons are traveling at almost the speed of light and have the same electric charge as the electron but are about two hundred times heavier. Because the muon is very similar to the electron, when one passes through the liquid ^{4}He, it is possible that the muon will interact the same way as the electrons from the decay do, producing a false signal. Therefore, by using scintillator paddles strategically placed around the apparatus it is possible to detect the muons entering the cell and veto any signal they induce. Data was taken to measure the energy deposited and angular distribution of the muon flux in order to optimize the coverage of the apparatus.

Millikelvin Temperature Rise in Water-Ultrasound Thermometry for Therapy-Level Radiation Dosimetry

Courtney Taylor

Radiation oncology is the process of administering a specified dose of radiation to a patient currently receiving treatment for a form of cancer. In this process, it is vital to know the delivered dose for a given radiation beam to correctly treat a patient. The primary reference standard for absorbed dose is established using water calorimetry. The absorbed dose, typically of order 1 Gy (J/kg) at therapy levels, is realized by measuring sub-millikelvin temperature changes using a thermistor in a sensitive Wheatstone bridge. Ultrasound technology has been investigated as an alternative to thermistor measurements since the speed of sound propagation in water varies with temperature. With ultrasonic time-of-flight and highly sensitive phase detection techniques, temperature sensitivity comparable to that of the thermistor bridge has been achieved without introducing non-water materials into the test area. A single ultrasound transducer transmitting and receiving at 5.0MHz throughout the length of the water phantom, and the phase change of the sound wave was used to determine temperature increase from an irradiative source at specified depths of the phantom. In this experiment, the exposure period was varied from 15 s to 160 s cyclically by modulating a heat lamp, and a profile of the measured temperature response as a function of the period was obtained using Fourier analysis. Due to the large temperature gradient in the water phantom, measurements are prone to convection which was indeed observed and will be discussed. The results of this laboratory heating experiment will provide insights to using the ultrasonic technique for measurements in radiation beams from a Co-60 source and a clinical accelerator commonly used in the radiation oncology field. Future research would allow for multiple transducers, which would serve to create a 3-D profile of absorbed dose.

Ohio University

Circuit Design for Charge-Based Capacitance Measurement of Sub-Femto-Farad-Level Capacitances

Michael Lorek

In this talk, a design approach for a Charge-Based Capacitance Measurement (CBCM) circuit is presented. Fundamental electrical and mathematical equations are used to derive a linear equation for extracting capacitance from measurable average currents in a CBCM circuit. A traditional CMOS-based four transistor pseudo-inverter CBCM design is compared to a similar topology using transmission gate devices. MATLAB code is described that simulates the operation of an Ammeter and averages SPICE simulation-generated transient current signals to yield Device Under Test (DUT) capacitance values. SPICE and MATLAB results are presented that show the circuit's theoretical ability to accurately measure capacitances to the atto-farad (10^{-18}) level. Extracted parasitics from a single transmission gate-based CBCM cell layout for an ON 0.5-µm process are used to yield more realizable simulation results. The extracted circuit was simulated to examine measurable current levels across various DUT capacitances, frequencies, and transistor widths. These results will be used to determine test points for the characterization of fabricated chips over a wide range and large quantity of semiconductor capacitances.

Oklahoma State University

Evaluation of Concrete Degradation Through the Use of X-Ray Fluorescence
Eric Kim

The scope of this project is to identify the mechanisms of concrete deterioration in cores and samples provided by California Department of Transportation (CDOT) on a level that ranges from the millimeter to centimeter length scale with the primary emphasis on the use of milli X-ray Fluorescence (mXRF) in conjunction with the scanning electron microscope (SEM) to accurately identify areas of distressed concrete.

The mXRF is used for non-destructive analysis that allows concrete sections to be chemically examined, providing spatially resolved compositional information in the form of X-ray images. In the analysis, an image of the section is recreated by scanning the X-Y stage under a stationary X-ray beam. The primary X-ray excitation causes the sample to fluoresce, and the X-ray spectrum up to 40 keV is recorded in a database file. The energy level used to excite the sample is recorded in a spectrum that is placed in a database file. The energy required for excitation must not exceed 40keV. Using NIST developed software; the databases are analyzed to provide the location of the damaged areas within the concrete sample. Once the damaged areas are identified, they can be further analyzed on the microscopic stage with the SEM to determine what type of damage is being done to the concrete.

The mXRF enhances the procedure of conducting studies on concrete by identifying the regions of deleterious processes on the large scale so that microanalysis can be concentrated and performed on those specific deleterious regions. With further development of mXRF technology, a more efficient and refined process has been developed for analyzing concrete.

Olin College of Engineering

Virtualization within NIST Security Protocol
Rhan Kim

Virtualization is a powerful new concept in the computing world. Virtualization systems allow one operating system to run as a "guest" under another host operating system. Guest operating systems can be preconfigured to conform to organizational security policies and images of these preconfigured systems can then be distributed to end users. However, a virtualized system is intrinsically more complex than a computer running just a native operating system. This could lead to unforeseen security vulnerabilities in the virtual environment, and virtualized systems may require unique security policy constraints. My research focus was to see if virtualization would be as secure as a normal operating system, and whether a virtualized system would require additional or unique security controls. After making some initial decisions on what should actually be tested and which combination of software and distribution should be used, the NIST secure configuration guideline was applied to a virtual Linux machine running under a Windows XP(tm) host operating system. This showed that there were no differences between a virtual

machine and a guest machine in terms of the security guidelines. Currently, I am trying to confirm that virtualization of machines does not affect the security concerns by creating a virtual Windows machine in a Linux host system.

Pennsylvania College of Technology

Machining a Calibration Artifact using a Non-Orthogonal 5 Axis Machine Tool
David Blumenfeld

This project investigates the validity of a 5 axis calibration artifact under consideration for inclusion in ISO standard 10791-6: "Test conditions for machining centers-Accuracy of feeds, speeds and interpolations." The part and the corresponding manufacturing process are described in National Aerospace Standard (NAS) 979. The standard describes how to machine and evaluate a frustum (truncated cone) using all 5 axes of a machine tool simultaneously in order to verify that a machine tool is capable of properly coordinating the motion.

Part geometries and tool paths for the frustum are created using a commercially available computer aided drafting/computer aided machining (CAD/CAM) package. The validity of the tool path is to be confirmed by the measurement of the finished frustum and comparison with data gathered by a transducer based commercially available ball bar system. Both the creation of the tool paths for the frustum and the ball bar test pose numerous problems ranging from designing fixtures to aligning the tool spindle. This presentation will discuss the challenges presented while doing this research, the solutions that have been derived from these challenges and the current results.

Three Dimensional Printing: An Exploration of Capabilities Using a Commercially Available Printing Solution
Matthew Cox

Three dimensional printing, a form of additive manufacturing, offers tremendous potential for both prototyping and production applications. Three dimensional printing creates parts by adding successive layers of material together to make a finished part. This is one of the production methods used in field of Rapid Prototyping (RP) as well as in the emerging field of Rapid Production. It is helpful for manufacturers to know the capabilities and performance characteristics of any piece of equipment that will be used on their production line. This project investigated the capabilities of a commercially available three dimensional printer.

To assess the quality and capabilities of our printer, a series of test artifacts were produced. The test artifacts created included: dimensional samples that were then measured using a Coordinate Measurement Machine (CMM), destructive testing samples for destructive tensile and compression testing, as well as parts for color capability samples. Each group of artifacts was used to determine the effects of part geometry, printing orientation, and post printing processing on the overall quality and accuracy of the final part.

Pennsylvania State University

Nanoplasmonic Fabry-Perot Resonators for Ultrasensitive Biosensing
Christopher Hong

Recent developments have greatly augmented the capability of optical biosensors based on surface plasmon resonance (SPR). Various forms of biosensing today rely on reactions that alter the target molecule. However, SPR-based biosensors offer a method of label-free sensing by detecting the change in the surface plasmon resonance frequency. A surface plasmon polariton (SPP) is a bound charge density wave that is coupled to an external electromagnetic field, and propagates along the boundary between a metal and a dielectric. The wave vector associated with SPP is larger than the free-space wave vector (or SPP wavelength is smaller than free space wavelength), resulting in subwavelength confinement of electromagnetic field near the metal surface. In the case of biosensing, molecular binding events that take place on or near the metal surface can cause a slight change in the SPP refractive index, thus producing a correspondingly small spectral shift in the external reflection signal used for detection. This technique enables detection of molecules by monitoring SPR spectral shifts over time.

At optical frequencies, the losses associated with SPPs are large because of absorption in the metal film. This dissipation broadens the peaks of the resonance spectra, inherently limiting the detection sensitivity of traditional SPR based biosensors. In our project, we address this issue by devising a novel SPP-based biosensor in which an array of integrated Fabry-Perot resonators is used to significantly enhance spectral sensitivity. The primary mechanism exploited in the device consists of SPP resonant peaks associated with a periodic array of slits milled into an optically opaque Ag or Au film. The spectral positions of the peaks depend on the periodicity of the slits, as well as the dielectric constants of both metal and surrounding dielectric medium. We further enhance the spectral sharpness of the peaks by incorporating semi-transparent metallic mirrors on either sides of each slit, forming nanoscale Fabry-Perot resonant cavities. The device configuration is optimized by using numerical FDTD simulations (Lumerical), and the devices are fabricated using conventional e-beam lithography followed by electroplating. Based on simulation results, the addition of the resonant cavities is expected to lead to an approximate 10-fold enhancement in the quality factor (Q) of the associated resonances, compared to that of a device with open slits. This design provides the ability to significantly enhance the detection sensitivity of SPR-based biosensors.

Purdue University

Moiré Deflectometry Applications and Programming
Sarah Alexander

A laser-heating technique is used to determine the absorption characteristics of atmospheric particles that are collected on quartz-fiber filters. The technique involves monitoring the paticle temperature with a thermocouple while heating the sample. However, the presence of the filter can increase the absorption of the particles. To overcome this effect, the technique ws odified by levitating the particles without the filter, but a means of monitoring the particle temperature is needed since thermocouples are intrusive. Moiré deflectometry is one way of determining the

temperature of objects without the inconvenience of using a thermocouple. The technique has I ts parallel in interferometry but has distinct advantages. Moiré deflectometry does not need the isolated environment and expensive mirror that interferometry does. the set up only requires a collimated beam and two Ronchi gratings. One drawback of Moiré deflectometry is the extensive calculations that must be carried out to determine the temperature. For this reason, Matlab programs were developed using the image processing toolbox and other u ser defined functions.

Rice University

Interference from Decomposition in the Measurement of Diffusion Coefficients of Hydrocarbons

Naoki Nitta

Numerical combustion models can be affected by small changes in the binary diffusion coefficients of the fuels. However, accurate measurement of diffusion coefficients requires long residence times at elevated temperatures, and catalytic decomposition of the hydrocarbon chains can occur. In order to evaluate the accuracy of the diffusion measurements, the rate constant and products of this decomposition must be analyzed to determine the associated uncertainty. If this uncertainty is found to be unacceptable, decomposition mitigating methods must be employed in the measurement of the diffusion coefficients.

Hydrocarbon decomposition was studied using GC-MS by sampling from a reverse-flow gas chromatography apparatus used to measure binary diffusion coefficients. The effect of decomposition on the measurement of diffusion coefficients was calculated using a numerical model with a Crank-Nicholson time stepping for both the substrate and the product of the decomposition. This presentation will review the reverse-flow method and present results from the numerical modeling and the GC-MS experiment.

Saint Mary's College of Maryland

Solvent Vapor Wrinkling of Physically Confined Polymer Thin Films

Matthew Miller

Stress can be applied to physically confined polymer thin films in order to cause the films to wrinkle. The absorption of a solvent from the vapor phase induced wrinkling in the polymer films. Laser-light scattering and optical microscopy was used to measure the wavelength and characterize the morphology of the wrinkles. The wavelength measurement was used to determine viscoelastic properties of the films. Polystyrene films were created using spin-coating and flow-coating techniques. Polystyrene of molecular weight ranging from 6.4k to 450k g/mol was used for the polymer films. Polymer thickness was 250nm with a 45 nm aluminum coat evaporated onto the samples. Preliminary results suggest that the appearance and wavelength of wrinkles is dependent on both molecular weight and exposure time to the solvent. The elastic moduli of the films increase with increased molecular weight of the polymer and appear to decrease as solvent vapor exposure time increases.

Validation of the Fire Dynamics Simulator
Martin Mooney

To increase the quality and consistency of the Fire Dynamics Simulator application developed by NIST, the development team has been slowly introducing automated methods into the Software Configuration Management and QA testing processes through Verification and Validation. As part of the validation process, different sets of experimental data from a design application are compared to a simulated FDS model, and the differences are quantified with regards to uncertainties in both the experimental measurements and model inputs.

The FDS model of interest in this case is that of a two-story structure with long hallways and a connecting stairway. A gas burner is used to introduce heat into the structure and the resulting environment is measured experimentally. Trees of bi-directional probes and thermocouple sensors are used to measure velocity and temperature at several points throughout the structure, and the resulting data is directly compared to matching data from an FDS model of the same structure. Differences between the experimental data and the predicted results are analyzed to determine the suitability of the FDS model.

State University of New York Binghamton

Developing a Standard for Through Barrier Radar
Wesley Chiu

The development of Through Barrier Radar systems using RF-based technologies have vastly improved in their ability to detect either moving objects or persons behind barriers or walls. These technologies can be vital tools for military personnel, law enforcement, and emergency response teams and can aid in locating and determining weapons, suspects or civilians. However, currently there is no standard to assess and evaluate these systems and a standardized set of metrics must be developed. To accomplish this goal, a Through Barrier Radar system capable of transmission frequencies between 3.3GHz – 3.9GHz was acquired to test its capabilities in different scenarios. It contains two transmitters and three receivers to calculate velocity, range, angle and azimuth of moving objects. The system was placed behind various walls with targets on the opposite side with the intent on analyzing the signal reflected off the target. A small 20cm x 20cm aluminum plate attached to a mechanical shaker capable of varying amplitude and frequency was used target. The moving plate created the Doppler reflection of the radar waves to simulate a standing or moving person. Tests were aimed at determining signal loss through specific types of walls; the farthest distance the system could detect a target, and the effect of varying transmission frequency.

Visual Analysis of Fire Spread Rate on Flexible Polyurethane Foam
Gregory Hasapis

Polyurethane is a broad term that describes various polymers having a urethane bond at its basis. One use for these polymers is in the composition of flexible foams. For example, household items such as padded chairs to beddings are typically created with polyurethane. Polyurethane foam's airy composition leads to comfortable seating, but unfortunately it is also highly

flammable. These foams are a contributing factor in rapid fire spread and growth in many household fires.

Numerous experiments were conducted to become familiar with the flame spread rate on 1.2 m x 1.2 m square slabs of polyurethane foam. Heat flux at the foam's surface and four thermocouples of various heights placed within the foam were used to characterize the flame spread behavior. A number of experimental variables were considered, including foam thickness (ranging from 1"-8") and burning angle (ranging from ±25°). In some cases, both bare and fabric (polypropylene and rayon) samples were burned. Each experiment was video recorded by three cameras located at the north, south, and east edges of the foam. Prior to each experiment, a gridded template on the foam was recorded.

After superimposing the gridded template onto these three camera angles, the times were recorded for when the flame front edge reaches each grid mark. By comparing these times with measurements provided by data from the heat flux gauges and thermocouples an analysis of the fire spread rate was performed. With this approach, it is possible to validate the NIST Fire Dynamics Simulator and obtain patterns of fire spread and regression rates of flexible polyurethane foam as a function of time.

An Automated Software Tool for High Voltage Dielectric Stress Test Bed
Andrew Steinmann

A test-bed has been developed as part of the advancement of 10 kV, 100 A half-bridge silicon carbide power modules. The purpose of the test-bed is to stress the dielectric needed for high voltage isolation which is necessary for systems using the silicon carbide modules. Primarily, the test-bed will be used to determine the voltage breakdown of isolation transformers that are needed for the module gate drive. The test-bed is designed to apply a DC voltage from 0-40 kV and a 5 kV square wave operating at 20 kHz with a 200 ns rise-time and fall-time in order to emulate real world applications.

The goal of the SURF project is to develop software to control instruments that apply specific voltages and measure required parameters using LabWindows/CVI. The software provides the user with the ability to sweep a range of DC voltages, set the sample time, and control the AC sequence. The program also enables the user to create several trials to execute consecutively providing a simple way to perform and document long-term experiments.

Imaging the Adsorption of Methane and Hydrogen in Corncob Carbon
Eylon Winterstein

The adsorption of methane and hydrogen in a sample of a novel carbon material was probed using neutron imaging to determine how gas is adsorbed. The neutron imaging, radiography and tomography, was done through the Neutron Imaging Facility (NIF) at the NIST Center for Neutron Research (NCNR). NIF works by placing samples in a neutron beam. As the neutrons pass through the sample, some are scattered or adsorbed, and the remaining neutrons are captured by a neutron camera to produce digital images. Neutron imaging is especially useful when working with hydrogen because of its large scattering cross section.

The carbon used in the experiment was made from corncobs and was developed by collaborators from the University of Missouri associated with the ALL-CRAFT project. For these experiments the high surface area sample was gradually filled with methane, by varying the pressure up to 30 bar, imaged and then drained; the process was repeated with hydrogen. Once the data was collected through NIF it was reduced using a program developed in a commercial software language (IDL) designed to streamline the image reduction process. This image-processing program will be added to the Data Analysis and Visualization Environment (DAVE) currently in use at the NCNR facility once it is ready for distribution.

The images taken of the methane in the carbon revealed that the methane is mostly adsorbed in the carbon briquettes. The corrected images show strong scattering from areas defined by the carbon sample indicating that methane was adsorbed in these locations. However, when hydrogen was introduced in to the carbon sample the image was almost uniformly dark indicating that hydrogen was not particularly well adsorbed in the carbon structure as compared to the bulk gas at room temperature. More research has to be done to further investigate the interesting result obtained when imaging hydrogen in the sample and efforts to extract temporal information on loading.

Syracuse University

Mechanisms of Adhesion Loss at and Above a Critical Relative Humidity Range

Timothy Hatlee

Polymeric adhesives offer distinct advantages over the use of more traditional methods of joining—welding, riveting, brazing, and mechanical fasteners, for example—thus facilitating the increased use of such adhesives in technically demanding applications. Such advantages include more uniform stress distributions, improved fatigue resistance, increased design flexibility, decreased production expenses, and lower maintenance costs. However, the wider use of adhesives has been limited by the lack of knowledge concerning the durability of such adhesive joints upon exposure to an adverse environment. Therefore, understanding the mechanics and mechanisms of degradation of adhesive joints is a key factor for more extensive use in future engineering applications. The aim of this study is to develop a more complete understanding of mechanisms of moisture attack. The present study analyzes four different polymers with broadly similar chemical properties but varying mechanical properties: poly(methyl methacrylate) (PMMA), poly(propyl methacrylate) (PPMA), poly(butyl methacrylate) (PBMA), and poly(ethyl methacrylate) (PEMA) supported on glass substrates. A fracture mechanics approach based on a shaft-loaded blister test was adapted to measure adhesive fracture energy of the joints as a function of relative humidity (RH). A critical RH where sudden adhesion loss took place was clearly absent for PPMA/glass joints. Earlier studies have shown that the criticality in adhesion loss was observed for the PMMA/glass joints and PEMA/glass joints but was absent for the PBMA/glass joints. Further analyses using infrared spectroscopy, X-ray photoelectron spectroscopy, confocal microscopy, dynamic mechanical thermal analysis, and contact angle measurement were performed to elucidate the mechanisms of sudden adhesion loss at the critical RH. The results have begun to reveal that the fundamental mechanism governing the relationship of G_C and RH for the different polymethacrylates appears to be related predominately to their bulk rheological and polymer/substrate interfacial properties. Specifically, mechanisms of

sudden adhesion loss is the displacement of interfacial bonds by the interfacial water accumulation and stress built-up due swelling in PMMA and PEMA at the polymer/substrate interfaces. The rubbery polymers suppressed interfacial water accumulation and relieve swelling stresses, leading to the absence of criticality in adhesion loss for the PPMA and PBMA/glass joints.

Temple University

Validating Hydrogen Embrittlement Testing Using Electrochemical Techniques

Jordan Weaver

Hydrogen as a fuel and energy carrier is emerging as a prospective solution to the energy and pollution problems created by fossil fuels. For hydrogen to be a commercially viable energy carrier, a national infrastructure for the safe production, distribution, and use needs to be developed. One of the major concerns threatening the safety and efficient construction of infrastructure is the deleterious effect of hydrogen on the mechanical properties of materials known as hydrogen embrittlement. This is of particular interest in steel alloys in the pipeline industry. Existing hydrogen embrittlement testing relies on special high pressure facilities and experiments which are time consuming and expensive. The alternative testing method is to conduct electrochemical (cathodic) charging experiments; however, the accuracy of how well these experiments represent service conditions has yet to be concluded. To solve this problem, tensile tests of cathodically charged pipeline steel alloys, X52 and X100, were conducted for comparison with testing in hydrogen gas. The results of these tests and scanning electron microscopy of the fracture surfaces will be presented and discussed in relation to the available data on hydrogen gas testing.

Tennessee Technological University

Characterization of the UV Degradation of Photocatalytic Nanoparticle-Filled Polymers

Azurae Johnson

The objective of this work is to continue to investigate the effect of the photoreactivity of titanium dioxide (TiO_2) pigments on the photodegradation of coatings. Examining the effects of photoreactivity helps to establish experimental protocols in formulation, casting, resulting optical and mechanical properties, and the subsequent photodegradation of polymeric nanocomposites. Additionally, formulating photoreactive properties is hypothesized to have the potential to be used to create polymer nanocomposite coatings that self-sterilize by degrading chemical and bacterial contaminants through demineralization. In previous studies at the National Institute of Standards and Technology (NIST), TiO_2 filled polymers were studied under accelerated weathering conditions in the Simulated Photodegradation by High Energy Radiant Exposure (SPHERE) and were found to exhibit less degradation in terms of surface roughness and morphological changes under the dry conditions compared to the wet exposure conditions. In this experiment three pigments of varying photoreactivity and particle size in an acrylic urethane (AU) were studied under exposure conditions to determine the effects of high temperature and elevated relative humidity (RH), separately: 55°C at 0 % RH and 30°C at 75 % RH. Similar to previous studies, the physical and chemical degradation of the filled coatings were monitored at

weekly intervals using a combination of laser scanning confocal microscopy (LSCM) and attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR). Progression of degradation on the coating surfaces was characterized by LSCM in terms of changes in surface roughness and morphology, pigment agglomerate size, and the occurrence of pits or holes in the coatings. The observed physical changes were correlated to the chemical changes measured by ATR FTIR as a function of UV exposure time. The results from these techniques will be discussed for the new exposure conditions used in this study and will be compared with previous degradation results.

Towson University

Raman Imaging of Graphene
Joshua Giltinan

Graphene, a one-layer sheet of hexagonally bonded carbon atoms, is currently one of the most promising materials in physics and electronics. Originally thought only to exist in theory, graphene was experimentally discovered in 2004 by Novoselov et al. Graphene's properties, such as high electron mobility and intrinsic strength make it appealing to research and industry. One method of creating graphene is mechanical exfoliation and placement onto a silicon substrate with an oxide layer for optical detection. This method typically creates small (< 10 microns) flakes of graphene, as well as some multi-layered pieces.

Raman Spectroscopy is a powerful, non-destructive technique uniquely suited to study graphene. It allows for the characterization of graphene's electrical and structural properties, and can differentiate single-layer graphene from multilayer graphite. We used the Raman peak positions and lineshape on the graph plotting intensity vs. energy shift to characterize graphene samples. The typical Raman spectra contains three main features, the *D,* the *G*, and the *G'* band. The feature named the *D*-band appears at ~1350 cm^{-1} and is indicative of the presence of defects and/or edges. The *G* band for "graphite" is observed near ~1580 cm^{-1} and is characteristic of the in-plane vibration of the atoms. The *G'* band at ~ 2700 cm^{-1} provides a unique fingerprint with which to identify the number of graphene layers, making it an authoritative tool in graphene research. The determination is based on fitting the peak to Lorentzian line shapes, and if a single peak is the best fit, then single-layer graphene is present. Of note, if four Lorentzians best fit the observed line shape, then a bi-layer of graphene is within the ~ 1 micron spot size of the laser. The laser used in our Raman experiments was 514.5 nm.

Graphene displays different properties when suspended over a substrate rather than when in direct contact with the substrate. The substrate can potentially alter the charges in the sample so that charge carriers scatter more on a substrate compared to a free-standing or suspended sample. For comparison, Raman spectroscopy was used on graphene samples suspended over trenches in the substrate and compared to the spectra of samples on the substrate. To suspend the sample, mechanically exfoliated graphene was placed onto a silicon dioxide/silicon substrate where trenches were pre-etched into it.

Another carbon nanostructure that was studied was the carbon nanotube, a rolled-up, single-layer of graphene. Electrical measurements were performed to determine if carbon nanotube

transistors would fail under high bias. It was found that the nanotube transistors did not exhibit the conventional behavior of decreased noise as the number of charge carriers increased.

This work was collaborative with other laboratories, especially EEEL and CNST.

University of Connecticut

Growth of Epitaxial Graphene on SiC Using an Induction-Heating Furnace
Joshua Leibowitz

Graphene, a material consisting of only one-atomic plane of carbon atoms, has many unique electronic properties. These properties, which include a remarkably high electron mobility, make graphene a potential candidate for next-generation transistors, but only when the graphene is produced onto a semiconducting or insulating surface. Our project focused on the epitaxial growth of graphene onto the semiconducting substrate of SiC.

The growth of graphene on SiC requires many processing steps. The first step involves the "polishing" of the SiC surface with a hydrogen-etch via a tube furnace. This process creates a stepped SiC surface, which provides a flat template on which the graphene can grow. The next step requires the heating of the SiC substrate up to a high temperature to grow graphene. This step involves placing the sample into a custom-built induction furnace, designed specifically for high temperature annealing in pressure ranges between atmosphere and ultra-high vacuum. As the temperature of the SiC is increased above 1200 °C, silicon sublimates from the surface leaving behind graphene layers. The final step of the process involves characterizing the samples with Raman Spectroscopy and Atomic Force Microscopy (AFM), both of which offer information to quality of the graphene films.

University of Cumberlands

Effects of Heat Transfer in Determining Absorbed Dose
Lola Embree

NIST currently provides primary standards for radiation dosimetry in the U.S. One of the dosimetry group's goals is to develop, maintain and disseminate national measurement standards for absorbed dose to water from Co-60 gamma beams. The water calorimetry work at NIST over the past twenty years has resulted in primary standards for absorbed dose to water for the U.S., and formed the basis for all the currently existing water calorimeters in other national metrology laboratories where primary standards are maintained. Current water calorimeters are made with small thermistors (temperature-sensitive resistors) which are placed inside a small vessel of distilled water, which in turn is placed inside a large phantom of distilled water. The radiation beam is directed toward the calorimeter and the change in temperature registered by the thermistor. This change then corresponds to the absorbed dose.

For this project, we are interested in assessing effects due to heat transport inside the small vessel of water. In order to study this, a complete artificial environment was created with the objective of determining how heat conduction and convection are affected by geometry and working

temperature. Two vessels of differing size were placed inside a water bath so that the change in temperature could be controlled. A third thermistor was placed in the bath to measure the control setting. The bath was then set to oscillate between an initial temperature and 0.1K above that initial temperature. The initial temperatures ranged from 2 to 25 degrees Centigrade. By studying the spectral characteristics of the waveform of thermistor temperature readings, we are able to characterize the thermal frequency response of the calorimeter. In this way, we hope to predict the effects of conduction and convection inside any sized vessel for any period of oscillation of a thermal stimulus, including external radiation beams for which the present device is intended. This would be beneficial to the dosimetry group because the effects of heat transport could then be taken into account in the process of determining absorbed dose.

University of Delaware

Bioconjugation to 4H-SiC Thin Films for Biosensor Applications
Peter Bocchini

Silicon Carbide (SiC) has been shown to be a promising material for use in bio-sensor based applications due to its biocompatibility and non-toxicity. This study investigates the functionalization of SiC thin films for the development and fabrication of biosensors. . We have developed a bioconjugation technique and compared the efficiency of protein attachment between the (0001) (Si-face) and (000$\underline{1}$) (C-face) of 4H-SiC surfaces.

The SiC samples were first prepared using an RCA clean to remove the native oxide and any organic contaminants from the surface. Oxygen plasma cleaning was performed to further clean the surface as well as to form a thin silicon oxide needed for bioconjugation. The SiC surfaces were then functionalized with 3-aminopropyltriethoxysilane for durations of 5 minutes, 1 hour, or 16 hours. The APTES functionalized SiC samples were immersed in biotin, followed by streptavidin. Streptavidin is a fluorescent protein molecule which binds readily to biotin. Using a fluorescence microscope, one can measure the uniformity and amount of streptavidin protein attachment by the intensity of luminescence from the surface. Spectroscopic ellipsometry analyses were performed to measure the thicknesses of the oxide, APTES, and biotin/streptavidin layers. AFM was used to measure the surface topography and further compare the thicknesses of the different layers. The data demonstrates that APTES functionalization is highly dependent on immersion time and that as the APTES thickness increases, the layer of biotin/streptavidin also increases. The developed SiC functionalization protocol is useful for the design and fabrication of SiC-base biosensors.

University of District of Columbia

Microwave-Assisted Acid-Catalyzed Esterification of Benzoid Acid with Ethanol
Amine Lambarqui

The application of microwave energy in organic chemistry is increasing rapidly. Microwave-assisted synthesis, for example, has proven to enhance many chemical processes in term of reaction rate and energy consumption. Microwave radiation in the electromagnetic region

corresponds to wavelengths of 1 cm to 1 m (frequencies of 30 GHz to 300 GHz respectively).When exposed to microwave frequencies; the dipoles of the sample align themselves with in the applied electric field. As the field oscillates the dipole field attempts to realigns itself with the alternating electric field and, in the process, energy in the form of heat is lost through molecular friction and dielectric loss causing the well known thermal effect of microwaves. In the past few years however, there have been a mentioning of other microwave effects such "specific" and "non-thermal" that some think may contribute to the overall enhancement observed in microwave-assisted chemical synthesis or processes. Such effects have been claimed when the outcome of a synthesis preformed under microwave condition was different from the outcome of the same reaction performed under conventional conditions at the same measured reaction temperature. These claims have created a lot of controversy as to whether athermal- non Arrhenius effects do in fact occur under microwave conditions.

This experiment aims to use microwave irradiation (8-18 GHz, 50 W) to assist the esterification of benzoic acid with ethanol under reflux conditions. This reaction is carried by using a catalyst (sulfuric acid) and a heat source to keep the reaction at temperatures between 70 and 80 ° C. Ethyl benzoate and water are the products of this type of esterification. Our experimental set up includes a sophisticated microwave oven and a (50 W) amplifier with a waveguide used to deliver microwave energy to glass tubing inserted into an opening on the waveguide. A thermocouple of type T (copper/Constantine) is used to provide temperature feed-back from the sample in the glass tubing to a computer programmed to control the power of the microwave generator.

The goal of this study is to compare the esterification reaction rate when carried out under microwave and conventional conditions at the same measured reaction time and temperature. The control experiment will be set up to heat the reaction conventionally (water bath) under reflux conditions. The effect of microwave energy absorption on the reaction rate of ethanol and benzoic acid will be measured as a function of frequency and power level.

University of Iowa

Human Assessment Evaluation for the NIST 2009 Metrics for Machine Translation Challenge (Metrics MATR)

Grady Payson

Machine Translation (MT) is a translation done by computers from one natural language to another. The desire for Machine Translation systems which could produce translations on par with those done by humans has been around nearly as long as there have been computers. One of the significant hurdles faced by the MT community has been the difficulty of developing standardized automated metrics. To date, the accepted measure for evaluating MT has been human assessment. This method, however, is often prohibitively expensive and time consuming to the point that it serves to bottleneck development.

In 2002, the development of BLEU [2002, Papineni et al.], a new automatic metric for MT, sparked increased interest in the field. Despite today's widespread use of BLEU, it is not without its shortcomings [2006 Callison-Burch et al.] and a considerable amount of research

continues in the field of MT metrology. However, individual metrics continue to be implemented and used in isolation of each other, giving rise to difficulties assessing the relative progress of any given new metric with respect to the rest of the field. To address this situation, the ITL's Multimodal Information Group, in 2008, started an annual Metrics for MAchine TRanslation Challenge (Metrics MATR), in which research groups were invited to have their metrics run on a set of machine translations. All metrics are then evaluated on the basis of the correlation between the generated scores and the human assessments of the same data's quality.

As the 2008 Metrics MATR challenge was the first in what will be an ongoing series of evaluations, its results have suggested a number of additions and modifications to be made to subsequent year's challenges. For example, one of the findings of Metrics MATR 2008 was that the human assessments against which the MT metrics are correlated must themselves be improved in order for us to more accurately evaluate the MT metrics. This has been the primary focus of my involvement with Metrics MATR 2009. In particular, I have had two main tasks. The first was to identify areas of disagreement between human judges assessing the same MT data. Since the large volume and discrete structure of the data being assessed serves to preclude a simple analysis using only the data files themselves, it was desirable to construct a tool to better visualize incongruity within the human assessment scores. To accomplish this, a GUI was developed to display the MT data on a sentence by sentence level, along with the human assessment scores associated with each sentence. This in turn facilitated the second task, analyzing the areas of disagreement. With the use of the GUI, we were able to clearly display those sentences which had a high level of disagreement and thus pinpoint common factors which gave rise to these disagreements between judges. For example, one of the factors we took into account was whether or not linguistic constructions such as ambiguity or the use of idiomatic expressions lead to high levels of disagreement amongst judges. Through this analysis, we hope to identify ways in which we can refine the human assessment process for use in future Metrics MATR challenges.

University of Maryland Baltimore

Exploring Surgical Lighting for Enhanced Color Contrast

Benjamin Ecker

During surgeries and endoscopic medical diagnosis procedures, doctors look for minute variations in color and brightness to distinguish between a tissue of interest and the surrounding tissues. Often times, a doctor decides whether to biopsy or not based on a piece of tissue looking a bit too red. If doctors had some tool or technique that could increase the discrimination between tissues of interest and the surrounding tissue, it could improve the objectivity of many medical decisions, allow for more rapid and reliable diagnosis, and reduce the number of unneeded invasive procedure and biopsies.

In most diagnostic and surgical suites, simple plain white lighting is being used for illumination. The only control available to the practitioner is the luminance level—ability to control the amount of light impinging on the tissue. We are exploring the use of a “custom” light generated by a spectrally tunable light source as a means to increase tissue discrimination. This is being

considered because what we perceive as color depends as much upon the spectral distribution of the light source as the spectral reflectance distribution of the sample.

In order to produce this "custom" light source, hyperspectral data is collected with a monochrome CCD camera equipped with a tunable filter. The image processing and reproduction is done in ENVI, an advanced environmental hyperspectral image analysis software program. A light source's spectral distribution is then generated that will take advantage of spectral reflectance differences between the region of interest and the surrounding tissues. Preliminary results will be presented. Other topics to be discussed in the talk will be color reproduction, hyperspectral data, and potential barriers.

Chem-BLAST: The 21st Century Tool for Structural Databases
Neeti Goel

Developed in part by NIST in 2000, the PDB (Protein Data Bank) is the world's largest repository of biological macromolecular structural data, containing more than 50,000 structures of various proteins and nucleic acids. The PDB serves as a valuable resource that's uses stretch across a wide range of disciplines, including agriculture, biofuels, chemical industries, and drug design. In fact, it holds the distinction of being the highest cited paper published in NIST in the last 20 years. Unfortunately, unlike the data it holds the PDB itself is not very structured, the molecules are organized numerically by their PDB IDs.

It was vital to create a user-friendly organizational method that allowed for advanced query capabilities and efficient navigation and usage of the data; thus Chem-BLAST (Chemical Block Layered Alignment of Substructure Technique) was developed. Chem-BLAST organizes the molecules into a chemical taxonomy that relates them by structural similarity and function. In order to achieve this Chem-BLAST dissects the chemical compounds into common scaffolds and renames them using InChI and vocabulary based names; this method of identification proves much more effective than PDB IDs. Then it reorganizes the scaffolds into an ontological tree that helps users both identify the relationship between them and compare them structurally. Furthermore Chem-BLAST is currently in the process of updating its 2D structural representations into 3D images, providing users further insight into the molecular structure. The Chem-BLAST method is being used to update HIVSDB (HIV Structural Database) and The Ligand Gateway for PDB.

Designing a Complete Safety System for the FANUC M-16iB Robot Arm as a Standard for Industrial Use
Justin Jones

"What I really have in mind is something much more contemporary: the emergence of the robotics industry, which is developing in much the same way that the computer business did 30 years ago," says the leader of the Personal Computer Industry Bill Gates. It's true; robots have the potential to become the next big thing in the world. However, what problems face the industry in making this a successful economic boom? One of the biggest problems facing full mainstream use of robots is whether they can be used 100% safely. Our goal here at the National

Institute of Standards and Technology (NIST) this summer was to develop a successful safety system for a manufacturing Robot Arm that can be integrated as a standard for industrial use.

The specific safety issues that must be addressed include: (1) If a part is launched from the Robot Arm and becomes a projectile, will every human in the surrounding area be safe?, (2) If a human enters the Robot's work volume how can this be detected to immediately shut down the Robot?, (3) How will humans and Robot Operators be able to tell whether the robot arm has power, whether the safety system is working properly, and if there is a disruption in the safety system?, (4) If the Robot Operator notices a problem, can he/she immediately shut down power to the Robot?, (5) If a human enters through one if the two non-material transporting gates in the fence design, can power to the Robot be immediately shut down without human intervention?, and (6) How can an Automated Ground Vehicle (AGV) carrying materials for the Robot, pass through the material transporting gate in the fence design, allow the Robot to continue working, and will shut down the Robot's power if a human passes through this same gate?

If solutions can be designed and installed to solve each of these safety problems, the Robot can safely perform its tasks, and this safety system can serve as a basis for industrial use.

Visual Analysis of Fire Spread Rate on Flexible Polyurethane Foam

Patrick Macatangga

Polyurethane is a broad term that describes various polymers having a urethane bond at its basis. One use for these polymers is in the composition of flexible foams. For example, household items such as padded chairs to beddings are typically created with polyurethane. Polyurethane foam's airy composition leads to comfortable seating, but unfortunately it is also highly flammable. These foams are a contributing factor in rapid fire spread and growth in many household fires.

Numerous experiments were conducted to become familiar with the flame spread rate on 1.2 m x 1.2 m square slabs of polyurethane foam. Heat flux at the foam's surface and four thermocouples of various heights placed within the foam were used to characterize the flame spread behavior. A number of experimental variables were considered, including foam thickness (ranging from 1"-8") and burning angle (ranging from ±25°). In some cases, both bare and fabric (polypropylene and rayon) samples were burned. Each experiment was video recorded by three cameras located at the north, south, and east edges of the foam. Prior to each experiment, a gridded template on the foam was recorded.

After superimposing the gridded template onto these three camera angles, the times were recorded for when the flame front edge reaches each grid mark. By comparing these times with measurements provided by data from the heat flux gauges and thermocouples an analysis of the fire spread rate was performed. With this approach, it is possible to validate the NIST Fire Dynamics Simulator and obtain patterns of fire spread and regression rates of flexible polyurethane foam as a function of time.

Combinatorial Software Testing
Menal Modha

Software developers frequently encounter failures that occur only as the result of an interaction between two or more components or variables. Testers often use pair wise testing – all pairs of parameter values – to detect such interactions. But many errors are triggered by a combination of three or more parameters. If all faults in a system can be triggered by a combination of *n* or fewer parameters, then testing all *n*-way combinations of parameters can provide high confidence that nearly all faults have been discovered.

Our research group received error logs of spacecraft testing from a research laboratory (undisclosed because of proprietary reasons). One of my tasks was to analyze the reports and figure what combination of factors caused failures in the spacecraft software. The data was then entered onto a spreadsheet and certain conclusions were drawn from it.

I also worked on extending the fault isolation program. The program counts how many times a combination in a failing test also occurs in the set of passing tests. The code already existed for 2 way to 4 way combination testing. I extended the code to work for 5 way and 6 way combination testing.

An Algorithm for Mapping Alpha Helices to 1D Protein Sequence to Help Predict the 3D Structure
Nadezhda Serova

Although many proteins have known 1-dimensional amino acid sequences, determining their 3-dimensional structure is not trivial. Numerous experimental methods provide only partial information about the 3D structure. We examine an approach to connect known information about the proteins to the experimental data. We can obtain the lengths of the alpha helices present in a particular protein, along with prediction data for each amino acid in the sequence corresponding to the probability of an alpha helix. The goal of our method is to efficiently map the alpha helices to the protein's sequence while maximizing the probability values. There exists such an algorithm already, but we are attempting to improve the results by increasing the chances of finding the answer through introducing randomness. We use a greedy algorithm to first find an ordering of the helices, and then a dynamic algorithm to find specific placement on the sequence for the ordered helices. Randomness is introduced in different stages of the algorithm in order to examine several orderings that are likely to be close to the answer. In addition, the algorithm can produce numerous likely orderings as opposed to only the optimal one. This aspect is very useful, since we have found that the optimal solution of the problem often does not correspond to the physical answer. We used already solved proteins to test the algorithm while varying several parameters.

The Borate Fusion of Silicon Carbide
Robert Temple

X-Ray fluorescence spectrometry is a popular and effective tool for quantitative elemental analysis. The preferred approach at NIST is borate fusion of the samples to form homogeneous

glass beads. Fusion allows the creation of customized calibration standards from the highest quality starting materials to reduce and eliminate contamination. If the samples can be fused, the typical end result is a set of precise and accurate results that surpass the quality of the results from liquid cells and pressing briquettes. The goal of this project is to successfully fuse silicon carbide candidate SRM 112c into a glass bead. The silicon carbide must be oxidized because if hot Silicon carbide comes into contact with the platinum crucible used for fusion, the crucible will be damaged and may even develop a hole. There are a number of ways of going about this, but the most straightforward method is oxidizing the silicon carbide and turning it into silicon dioxide. Several methods have been tried from simply placing a certain amount of silicon carbide in a box furnace at 1000 ºC to mixing the silicon carbide with various chemicals, lithium borate fluxes and oxidizers to try to make this reaction happen. One method works fairly well and forms a decent glass. This method consists of a mixture of vanadium pentoxide and the silicon carbide inside a quantity of lithium borate flux. This talk will show the process and briefly summarize preliminary XRF results.

Dynamics of Mixed Bose-Einstein Condensates in a Double Well
Marcus Thomas

We discuss the tunneling dynamics, in a double well potential, of Bose-Einstein Condensates described by the two mode nonlinear Gross-Pitaevskii equation. Beginning with the simpler case of a single species, we analyzed oscillations of two weakly coupled condensates which exhibit BJJ, or Boson Josephson Junction, dynamics. We then analyzed the 3 species condensates as well as Spinor Condensates.

3D Polymer Scaffolds
Julia Wittkamper

We have developed a combinatorial method for screening cell response to polymer scaffolds for tissue engineering applications. Scaffolds are porous, degradable templates that support cell adhesion and proliferation in 3D for tissue regeneration. Cells are exquisitely sensitive to the wide parameter space of scaffold material properties: surface energy, topology, pore size, chemistry, bioactivity, filler composition, etc. Thus, it is advantageous to use combinatorial methods to accelerate screening of cell response to scaffold properties to identify optimal formulations. Though, it has been shown that cells cultured in a 3D environment are more analogous to cells in vivo than cells cultured on a 2D plate, most combinatorial methods for screening cell-material interactions utilize 2D flat substrates. In this work, we demonstrate a new method for screening cell-material interactions where the material is presented to cells in a more relevant, 3D scaffold format.

Hydroxyapatite (HA) is the most abundant inorganic material found in bone and HA composite materials can enhance osteogenesis. Thus, we have used an HA scaffold system to test the combinatorial approach. Scaffold libraries with varying HA compositions were fabricated and used to determine the amount of HA required to optimize osteoblast function. Osteoblasts were seeded on the scaffold libraries, cultured for various times, and assayed for adhesion, proliferation and differentiation. Osteoblasts results will be presented and discussed in terms of the advantages and disadvantages of the combinatorial approach.

Efficient Algorithms for Elliptic Curve Cryptology
Lauren Won

The Cryptographic Algorithm Validation Program at NIST created and maintains the Cryptographic Algorithm Validation System (CAVS) Program for the use of checking the validity of cryptographic implementations. Every single implementation of cryptography used by the U.S. Federal Government for non-classified data must pass the tests generated by CAVS. This includes the crypto functions of every major operating system and web browser as well as smart cards and many other applications. This summer we improved the performance of the Elliptic Curve Cryptology (ECC) Digital Signature Algorithm in CAVS. We created multiple object classes in order to implement new algorithms for ECC.

ECC is a public key cryptography scheme with predefined constants. In this case, the public key is a point on the curve, the private key is a random number, and the predefined constants are the domain parameters, which include a generator point G, curve parameters 'a' and 'b', and a few others, depending on the type of field the curve lies on. Specifically, we worked with curve parameters defined over binary finite fields.

Within ECC, the point multiplication is the most computationally costly operation. Currently, the CAVS program takes about 10 seconds to compute a public-private key pair for the B-571 curve, the largest curve currently tested on the CAVS program. This means that the number of test values must be kept small in order for the testing to be conducted in a reasonable amount of time. After we implemented new and faster algorithms, we tested the results of point multiplication for the B-571 curve with results on the order of 10 milliseconds.

University of Maryland College Park

Aggregation of α-Chymotrypsinogen A in Aqueous Solutions
Aaron Aziz

Studying the aggregation of proteins is a vital step in understanding their effects in a variety of bio-processing and biological operations. The presence of aggregates in pharmaceutical drugs can decrease the effectiveness of these drugs, have adverse side-effects on patients, and cause unwanted reactions. The aggregation of nonnative proteins has also been attributed to cytotoxicity and a variety of debilitating diseases like Alzheimer's and Huntington's disease. Studying the aggregation behavior of proteins and determining the driving forces behind such aggregation will lead to better drugs and safer, more effective means to treat diseases. In our study, aggregation of α-chymotrypsinogen A in acidic solutions was characterized by a combination of dynamic light scattering, microscopy, small-angle neutron scattering and circular dichroism. According to dynamic light scattering and microscopy, results show that the high molecular weight aggregates are linear polymer chains. Small-angle neutron scattering confirmed that preexisting monomer resided in aqueous solution after aggregation. Further testing must be done to examine this monomer and verify its nature. Circular dichroism was used to determine the activity of proteins before, during, and after aggregation. Results seem to imply that the aggregate might be a nonnative protein, and shows that the aggregation behavior seems

to be the rate-determining step. Aggregation only seems to begin after a certain period of preparation, however once the environment is ready, the actual aggregation seems to be accelerated.

Diagnosing Device Failure in Crystalline Single Electron Transistors
Jeffrey Birenbaum

Single electron tunneling transistors (SETs) rely on quantum tunneling to produce current one electron at a time. This behavior can be controlled to produce a single electron pump. SETs are also the world's most sensitive charge detectors and can be used to develop current and capacitance standards.

In an SET electrons must tunnel from a source lead through a tunnel barrier onto a metal island. Once on the island the electrons tunnel through another tunnel barrier onto a drain lead. Standard SETs consist of layered Al-AlO_x-Al deposited via double-angle deposition, a process which produces SETs with amorphous aluminum oxide as the tunnel barrier. These SETs, however, experience a phenomenon known as charge offset drift, which randomly shifts the control curves of these devices over a period of a few hours. This prevents Al-AlO_x-Al SETs from being used over periods longer than a few hours without recalibration, preventing their integration into more complicated circuits. Most researchers believe the charge offset drift is caused by motion of charges in the amorphous insulator changing the polarization of the island. Our goal is to produce an SET with crystalline aluminum oxide (Al_2O_3) and thereby greatly reduce the charge offset drift (the improved mechanical stability of the crystal translates to improved electrical stability).

The standard technique of double-angle deposition does not work for crystalline devices, so instead we developed a negative patterning technique using a focused ion beam in combination with standard photolithography and ion milling. This technique was applied to an Al-AlO_x-Al tri-layer wafer (future work will be done on Re-Al_2O_3-Al wafers). We continued work performed last summer on these devices, focusing now on diagnosing and correcting device failure occurring during the last step of the manufacturing process. The main characteristic of the device failure was shorting between the source and drain leads. We studied the electrical characteristics of various tunnel junction structures in an attempt to identify the source of the short, but as of this writing the cause and solution remain unknown (but Ga+ ion implantation and/or redeposition are likely).

Acoustically Forcing a Natural Gas Pool Fire
Nikolaj Birman

A pool fire is a fire in which the fuel is oriented horizontally and the fuel has little to no initial momentum, for example an offshore fire fueled by an oil spill. Not much is known about the dynamics and properties of pool fires and it is important to understand the behavior of pool fires in order to understand how to contain and extinguish them. When the behavior of pool fires is better understood, it will become possible to develop better models and more efficient techniques to control them, reducing the threat that these types of fires pose.

In order to get more accurate readings, we acoustically force a natural gas flame into a steadily oscillating state. Acoustically forcing the fuel flow into the fire matches the natural frequency of the fire, setting up a regular oscillation. Using a speaker, the flame was forced at a variety of different frequencies and different amplitudes to determine the ideal forcing function to reduce the repeatability problem associated with turbulent burning.

In the Building and Fire Research Lab, we conducted experiments on a small scale to record the temperature at different heights within the fire. The burner was 30 cm in diameter with a 30 cm speaker contained inside the burner, below the fuel surface, in order to acoustically force the flame. We used thermocouples to measure the temperature profile above the burner in order to provide resolved, repeatable data for modeling of the pool fire. Additionally, each burn was recorded and digitized in order to gather qualitative data to facilitate visualization of the dynamics of pool fires.

Data Visualization for Industrial Irradition Simulations
Dustin Biser

Designers of industrial irradiators use a Monte Carlo approach to simulate dose amounts throughout product containers. These simulations can create a vast amount of data that is both hard to visualize and hard to spot trends such as locations of large changes in dosage. My work this summer involved taking the simulated data and producing useful visualizations that will allow one to located variances in the dose distribution. Specifically a three dimensional gradient field was produced using an iterative nearest neighbor technique, which increases in accuracy with more passes. This application allows for the easy determination of changes in dose distribution and their locations throughout a container's volume.

Characterization of Magnetic Nanoparticles with Potential Applications in Cancer Hyperthermia
Jeffrey Camp

Hyperthermia has been investigated as an alternative or supplement to traditional cancer treatments such as chemotherapy. Magnetic nanoparticles (MNPs) heat in the presence of an externally applied alternating magnetic field, offering a means to localize hyperthermia treatment to cancerous cells within the body. The rate of heat generation in MNPs depends on particle size, level of aggregation in solution, and magnetic properties such as the anisotropy, coercivity, and remnant magnetization. Consequently, physical and magnetic characterization methods are important assays of the potential efficacy of MNPs for hyperthermia.

Three candidate iron oxide nanoparticles systems were characterized magnetically and physically. Torque measurements were taken on dilution series of the MNPs using a vector vibrating sample magnetometer (VSM), yielding the unidirectional and uniaxial anisotropy energies after model fitting in MATLAB. The uniaxial anisotropy energies did not scale linearly with concentration, a strong indication of the presence of iterations between the nanoparticles. A series of hysteresis loops were taken at temperatures ranging from 10 – 300K using a SQUID VSM, yielding the saturation magnetization after fitting to a Langevin function and

normalization to mass. There was notable deviation from the Langevin function at the turning points in the hysteresis curves, a secondary confirmation of interparticle interactions.

Achieving Sub-Diffraction Resolution Imaging of a Latent Image of Chemically Amplified Resist Utilizing Inverse Stochastic Optical Reconstruction Microscopy (iSTORM)

Suehyun Cho

In lithography, the chemistry that occurs during the resist exposure determines the resolution and contrast of the pattern. Although we can make measurements of the aerial images and the developed features, the details of what happens in the resist are unknown. The goal of this research is to devise a new method, iSTORM (Inverse Stochastic Optical Reconstruction Microscopy), to obtain and examine images that reveal the chemical process occurring in the resist.

iSTORM applies the concept of Stochastic Optical Reconstruction Microscopy (STORM) which achieves a sub-diffraction limit resolution by turning on a few fluorophores at a time and determining their precise locations by Gaussian fitting their emission distribution. With iSTORM we introduce a chemical process which involves embedding a novel fluorophore (Rhodamine Amide) in a traditional chemically amplified resist. During the exposure process, fluorophores will be activated where the UV light has struck, and the fluorescent pattern will correspond to the latent image in the resist. Unlike STORM, iSTORM bleaches the fluorescent pattern and re-activates the previously unaffected areas and thus obtains the negative image of the fluorescent pattern, enabling a precise map of the latent image chemistry to be obtained.

High Standards: New Designs for High-Resistance Hamon Transfer Devices

Andrew Dupree

Resistance Metrology is the precise measurement and calibration of resistors. The scientists in this field strive to create increasingly accurate methods of defining the value of a resistance, build highly accurate and stable resistors (called standards), calibrate other resistors to these standards, and improve dissemination of resistance to commercial calibration labs. High Resistance Metrology is a particular branch of resistance metrology concerned with accomplishing these tasks with resistors in the range of 10 MΩ to 100 TΩ.

Current designs for high-resistance standards have reached a plateau in precision. Lengthy settling times have made direct scaling from the Quantum Hall Resistance challenging, and leakage current due to insufficient implementations of guard circuitry and resistor connections has been a source of error. To circumvent these obstacles, several new design features have been implemented in the construction of a new set of standard resistors and Hamon transfer standards. First, film type resistors are being used instead of the traditional wire-wound variety, due to the improved stability of modern films and lack of inductive properties. Second, an internal guard network has been carefully simulated for maximum reduction of leakage current between the main circuit and ground. Also, to decrease leakage at resistor terminals, new glass-to-metal seals have replaced older metal-PTFE connectors. These new seals do not suffer from charge accumulation to the same extent as did their predecessors.

Many further tests and measurements are necessary prior to reaching a firm conclusion, but initial calibrations with NIST's Dual Source Bridge show promising results. The settling time of the device is similar to previous film-type implementations, and the resistors hold quite stable across multiple measurements. After all improvements are completed, it is projected that the new standards will outperform their predecessors.

Micro-Robot Design and Control
John Garvey

I designed and implemented a modification to the control procedures that direct movement of currently operable microscopic (micrometer (10^{-6} meter) dimensions) robots in the Microelectromechanical Systems (MEMS) Laboratory. In addition, I created a modification to the microfluidic deposition system used to mark these micro-robots with a fluorescent solution, which increases their optical detectability. The micro-robots consist of two polysilicon components – an untethered scratch drive actuator (USDA) and a curved, cantilevered steering arm. These components respond to dynamic control signals by interacting with their operation substrate through a capacitive coupling. The grid of metal electrodes on the top layer of the substrate directly receives the control signals from a signal generator as two distinct, amplified voltage waveforms. These signals direct the micro-robots to move forward through the flexing and relaxing of the USDA, or turn in one direction by lowering the steering arm and then flexing and relaxing the USDA. Using an application programming interface (API) found at the National Instruments (NI) website, I designed and wrote source code programmed with NI's LabVIEW software which interacts with a Nintendo Wiimote and with a multifunction signal generator through Bluetooth and USB connections, respectively, to enable an external, remote-controlled method of teleoperation of the micro-robots. This method of operation is easier and more efficient than the previously used computer-controlled operation. The microfluidic deposition system presented produces a controlled, filtrated transfer of the fluorescent solution used to track the micro-robots during operation. This design provides more control in droplet deposition volume than the previously used system, and is reusable. With the previous system, an entirely new apparatus had to be fabricated each time the micropipette at the end of the system broke. Possible future plans in the Microscopic Robotics Project to increase robot capability include the addition of a second steering arm to allow bidirectional turns. Applications of this specific type of electrostatically-controlled micro-robots are in the field of micromachining: to construct precise micrometer- or nanometer-scale devices by manipulating individual molecules or atoms in exacting routines.

Polymer Solar Cells: Influence of Substrate on Crystallization Kinetics in Polythiophene/Fullerene Bulk Heterojunctions
Christine He

Organic solar cells hold the promise of lighter and cheaper photovoltaic devices compared to traditional silicon solar cells. Polymer solar cells utilize an active layer composed of an electron donor and acceptor (in this case, a polythiophene and fullerene) blended together in a bulk heterojunction (BHJ).

One method for maximizing solar cell efficiency is thermal treatment. However, annealing also causes fullerene to crystallize out of the blend. These microscopic crystals lower device performance, but the formation of large crystals minimizes interfacial energy and represents a stable, equilibrium state. Therefore, optimization strategies must be developed to control the effects of this crystallization.

This investigation explores how the crystallization kinetics of a BHJ vary with the substrate upon which it is cast. The primary focus is the difference between crystallization kinetics of polymer/PCBM (donor/acceptor) systems on an oxide substrate (used in materials studies) versus a polymer substrate (PEDOT-PSS, used in devices). Annealing was performed in situ on a heated optical microscope stage.

Experimentation showed that crystallization kinetics were strongly influenced by the free energy of the substrate. Microscopic crystals appeared with a much higher nucleation density at significantly lower temperatures for films cast on oxide than those on PEDOT-PSS. This observation can be attributed to the presence of a PCBM seed layer on the oxide substrate that facilitates crystal growth. Data analysis revealed that on oxide, crystal growth is diffusion-limited, i.e. crystal area is proportional to time, while on PEDOT-PSS, crystal growth is reaction-limited. Crystal growth on PEDOT-PSS is also independent of the type of polymer used, since all systems yielded similar results under the same time and temperature conditions.

Electronic Measurements of Novel Magnetic Sensors
Daniel Hemmer

A “dipper” for cooling novel magnetic sensors down to liquid helium temperatures was constructed so that the superconducting niobium lead wires eliminate negative resistance errors. The dipper enables us to perform resistance, current-voltage (I-V), and magnetoresistance (MR) measurements at liquid helium temperatures. Negative resistance errors arise in crossed wire devices when the resistance of the magnetic tunnel junction (MTJ) is comparable to the lateral square resistance of the lead wires. The MTJ consists of: a ferromagnetic wire deposited on a silicon chip; a layer of aluminum deposited everywhere and exposed to oxygen plasma to create an insulating layer of aluminum oxide; another ferromagnetic wire deposited on top and perpendicular to the first wire. The MTJ is formed at the junction where the wires intersect. A solenoid constructed of copper-clad niobium wire is attached to the end of the dipper enabling MR measurements with magnetic fields of up to 1500 G.

Qualitative Biofunctionalization of Gold Nanoparticles
Karam Hijji

Gold nanoparticles (AuNP) have become a focus in nanotechnology due to their unique stability, uniformity, and optical properties. As a result of their versatility, AuNP’s are being increasingly used in conjunction with biological materials such as proteins. Such examples can be found in cancer therapeutics in which drug proteins are attached to the suface of AuNP’s. Therefore measuring the activity of the proteins post-binding is critical to ensuring batch-to-batch quality control. In this research study, the enzyme was covalently bonded to the nanoparticles via an amide bond to a thiol molecule known as 3-mercaptopropionic acid (MPA). Using a direct self

assembly process, we stoichiometricly varied the number of thiol groups that are attached to the nanoparticle surface by adjusting the concentration of thiols respective to the NP concentration. We focused on the quantitative attachment of a well known model system enzyme, Calf Intestinal Alkaline Phophatase (CIAP), chosen for its catalyzing a reaction with para-nitrophenyl phosphate that yields a photoactive product. From this, we are able to see a color change which is measured by UV-Vis spectroscopy. This measurement allows us to determine the rate of product formed by the reaction, and then ascertain how much enzyme on the nanoparticle surface was still active post-binding. We concluded that we did retain activity of the enzymes, and using dynamic light scattering and the atomic force microscope, we could resolve the increased size of the nanoparticles from the protein shell.

Optimizing mRNA Capture and Reverse Transcription for Microscale Linear Amplification

Marc Howell

The overall aim of this project is to amplify small samples of messenger RNA (mRNA) for use in gene expression studies using a variation of the Eberwine process.[1] In this study, we sought to find both biochemical and procedural modifications to existing processes to optimize the ability of the beads to capture and reverse transcribe mRNA. In theory, the concentrations of mRNA and enzymes can be effectively increased on the microscale to allow more efficient processing than traditional benchtop methods. Specifically, the capture and RT steps are particularly inefficient on the benchtop, which poses challenges for small samples where material losses significantly skew gene expression profiles.

The addition of magnesium salt (3 mM $MgCl_2$) to the binding buffer improved the efficiency of the capture and RT process approximately 10 fold. The magnesium ion in solution has been shown to stabilize the biotin-streptavidin interaction that holds the primers on the beads[2] and may also stabilize binding of the cDNA primer and the mRNA. Both of these effects likely contribute to the increased efficiency in capture and RT, as determined from qPCR of the housekeeping gene beta actin (ACTB) on benchtop experiments.

Using this, we applied the changes to the microfluidic system and varied the on-chip capture flowrate and temperature and RT flowrate. Pulsed flow (or stopped flow) appeared to improve overall capture and RT efficiency compared with constant flow, especially at RT temperature (42 °C), also determined by qPCR. This may be due to a slow enzymatic binding step at elevated temperatures. A colder mRNA capture temperature (10 °C) is also effective, and may improve the RT enzyme binding rate, thereby facilitating RT once the temperature is raised to 42 °C.

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IEEE p1451.2 Communication Standard
Alvin Hua

The Institute of Electrical and Electronics Engineers (IEEE) has developed the 1451 family of standards. The 1451 sets communication standards between microprocessor-based transducer modules and network capable devices. This talk will be an overview of the communication structure defined by the IEEE 1451.0 standard, and will focus on communication using the IEEE 1451.2 standard between a Transducer Interface Module (TIM) that contains sensors and a Network Capable Application Processor (NCAP). These new standards will promote more efficient communication among devices as well as better compatibility. The updated IEEE 1451.2 standard includes multiple serial communication methods, such as the Recommended Standard 232 (RS232), Universal Asynchronous Receiver/Transmitter (UART), Serial Peripheral Interface (SPI), and the now commonly used Universal Serial Bus (USB). The compatibility of the IEEE 1451.0 and IEEE 1451.2 standards is studied and demonstrated using a network capable laptop as the NCAP and the Wolf BL2600 single board computer module as a TIM. Command and reply messages defined by the IEEE 1451.0 standard are implemented, and communication between the TIM and NCAP according to the IEEE 1451.2 protocol is established using the RS232 and USB interfaces. Sensor data as well as device information stored as Transducer Electronic Data Sheets can be transferred from the TIM to the NCAP. The standards facilitate interoperability between sensor devices and network systems, but still have more room for improvement and expansion in the future.

Micro- and Nano-Fiber Waveguide Simulations
Daniel Jaskot

In the field of photonics, dielectric optical waveguides with widths from micrometers to millimeters are already in widespread use. Micro- and nano- optical fiber waveguide with air-cladding have a great potential for use in future miniaturized and high performance photonic devices.

In this project, we studied the wave propagation in micro- and nano- fibers. We developed several Mathematica programs and also used commercial software to calculate the effective refractive index and dispersion of light inside the optical fibers. The results are consistent with published results. We further investigated a type of third order nonlinear interaction in the fiber, namely Four-wave mixing, which basically converts two photons from the pump light into two photons of different colors, one is redder and the other one is bluer as compared to the pump. This process is constrained by both the energy conservation and what is known as the phase matching condition. We found that Four-wave mixing can efficiently occur only at appropriate combinations of the pump wavelength and fiber diameter.

Performance Metrics and Standards for Respirator Masks
Chad Kriebel

Fires are dangerous places to be, and firefighters' protective equipment must be able to shield them from those hot and hazardous conditions. One of the weakest areas of their ensemble is the face piece of their self-contained breathing apparatus (SCBAs). The SCBAs are standardized

under NFPA 1981, but the face piece portion of the SCBA is tested mostly to keep the integrity of the viewing area, not focusing as much on the fire resistance of the face piece and protection of the wearer. This project aims to develop the performance metrics and testing protocols for the face pieces.

In fires, heat is transferred three ways, conduction, convection, and radiation. Early in the fire, radiation provides the greatest amount of heat, therefore, the greatest heat flux. Using a radiant panel to simulate the heat source, the masks are tested at a variety of fluxes to simulate different situations in a fire, from entering the building to being in the room with the fire. The tests included fluxes from 1 to 10 KW/m^2, but fires can have a much greater flux, sometimes close to 200 KW/m^2.During the test, temperatures of the mask and the wearer will be recorded, as well as any physical changes that the mask undergoes as a result of the flux.

Fingerprinting Proanthocyanidins in Botanicals

Kevin Krueger

Antioxidants found in a variety of foods are believed to have numerous health benefits including the ability to slow aging and prevent cancer due to the ability to neutralize free radicals. Proanthocyanidins (PACs), polymers formed from catechin and epicatechin monomers, are a type of antioxidant found in vacinium berries, green tea, wine, chocolate, and other foods. Since the polymers can contain catechin and epicatechin flavanoids, and have two types of linkages, the variety of PACs increases exponentially with the addition of each monomer. PACs are considered to be much more powerful at neutralizing free radicals than many other antioxidants such as Vitamins C and E. It has also been claimed that the larger polymer PACs have cardiac protective effects and increased abilities to fight bacterial infections. Based on the variety of polymers and differing claims about their health benefits, analytical separation is necessary.

A method for analyzing PACs in cocoa beans has recently been developed. The goal of this project was to optimize this method and create chromatographic fingerprints of these PACs in berries. Normal phase liquid chromatography was used for the separation of the different polymers, which were then detected by fluorescence and confirmed with mass spectrometry. The improved separation and detection can be used to differentiate sources of PACs and may be used to clarify the clinical importance of these molecules.

Understanding and Optimizing the Crystal Orientation of Polymer Semiconductors for Organic Electronics

Hilary Lane

Polymer semiconductors are being developed for applications such as displays, sensors, lighting, and photovoltaics. The advantage of polymer semiconductors is that they are solution processible and can be deposited by low-cost methods such as screen printing and ink jet printing on flexible substrates. These methods allow for a newspaper-like roll-to-roll production line and high-volume, low-cost production. This market is expected to rapidly expand into a multi-billion dollar industry by 2012. The growth of the market is largely limited by materials properties such as the performance and reliability. Our work focuses on relating the materials performance of

polymer semiconductors to the method of materials deposition and the resulting film microstructure.

We have fabricated and studied films of poly(bithiophene-thienothiophene) (pBTTT), the current record holding polymer semiconductor for device performance, that were deposited by a method called flow coating. Flow coating uses a blade to spread the polymer solution across the substrate and results in a directional drying front. We have previously shown that flow coating results in films where the molecules tend to orient along the flow direction. This is advantageous because polymer semiconductor crystals are highly anisotropic and preferential alignment provides an opportunity for performance improvement. This project has studied the effect of flow coating parameters and heating conditions to optimize the resulting crystal alignment, increase the reproducibility of the method, and to understand the alignment process. We have also used *insitu* temperature polarized microscopy and x-ray diffraction measurements to monitor the orientation process as it occurs during the thermal processing.

We have found the key parameters for increasing the film orientation to be the blade height and the composition of the solvent mixture. Reducing the blade height increased the film orientation by a factor of 2. We have also determined that the orientation process takes place during the thermal anneal. The results are consistent with a model where crystals that only partially melt serve as seed crystals during the recrystallization on cooling.

Three Dimensional Shape Retrieval Using Scale Invariant Feature Transform and Spatial Restrictions

Lydia Lei

This summer, this project did 3-dimensional shape retrieval. 3D shape retrieval is a fairly new concept being studied. It is important because it can be applied to multiple disciplines in society, including: computer vision, CAD models, computer graphics, molecular biology, etc. For the project, 907 2D models from the Princeton Benchmark were rendered as depth images from 20 views. The models featured 92 different classes, ranging from humans to houses. David Lowe's Scale Invariant Feature Transform (SIFT) algorithm was used in this project to normalize the images, find 'key points' on each of the views, and created a specific feature vector to describe its respective key point. A comparison of these 907 objects was done by finding similarity between key points and their feature vectors on each of the objects' corresponding views. After using the SIFT algorithm, the results were further filtered using spatial restrictions. By adding the spatial restrictions, it prevented the code from matching a hand to a foot; this is because the x, y, and z coordinates of the feature vectors would not be in the same general 'spatial area'. Lastly, a formula was written to calculate the overall similarity of the objects. The different objects were then ordered based on similarity and stored in a 'distance matrix'. The accuracy of the code and the results were evaluated by comparing the distance matrix results to the results yielded from other shape descriptors (not SIFT) using the PSB base classification.

Nano-Calorimetry on a Thermal Conductivity Gauge

Song Wei Li

A commercially available thermal conductivity gauge is capable of being used as a thin-film nanocalorimeter and can achieve high heating and cooling rates. The temperature of the sample can either be obtained by the voltage output of a thermopile on the membrane or by monitoring the resistance of the heater (i.e. using the heater as a RTD). In these devices, the thermal connection between the heater and thermopile is mostly through the sample, which creates a great deal of uncertainty when using the thermopile to measure sample temperatures; the heater resistance was found to be a more reproducibly indicator of sample temperature in these devices. After the heater resistance-temperature relationship is established, an experiment is performed by applying an arbitrary voltage waveform using a custom LabVIEW virtual instrument (VI), which also records the current and voltage at the heater and calculates the applied power and sample temperature. With the flexibility of programming a custom VI, the system can detect transitional temperatures in materials such as the melting point of a lipid bilayer, and can be used to measure the heat capacity of the thin films.

Designing an Electrostatic Comb Drive Actuator for a MEMS Nanopositioner

Matthew McMahon

The goal of this project is to develop an electrostatic comb drive actuator for a micro-electro-mechanical systems (MEMS) nanopositioner. Thermal actuators are currently being used; however, they offer a limited range of frequencies in which they can operate. The goal is to be able to drive the nanopositioners with a maximum displacement of 12 micrometers at a frequency of at least 1000 Hz. A comb drive operates by applying a voltage bias between two interdigitated combs with a certain number of fingers on each comb. The electrostatic force generated depends on several variables including the voltage applied, the gap between fingers, and the number of fingers.

An initial literature study was conducted on MEMS actuators to understand the parameters of the project. The dimensions of the actuator were then designed based on the required force. This force was determined by multiplying the effective stiffness of the nanopositioner by the desired displacement. Computer aided design (CAD) drawings were generated using SolidWorks, which were converted into lithography drawings using a mask fabrication software package called IntelliMask Pro. This mask will be used to fabricate a prototype that will be used for testing and optimization of the actuator.

To determine the effective stiffness of the nanopositioner, a separate experiment was conducted using an atomic force microscope (AFM). A micro-bead was bonded to the end of the AFM cantilever, which was used to exert a force on the stage of the nanopositioner. By measuring the force and the displacement of the stage, the effective stiffness was determined. This information was then used to determine the required maximum force to be generated by the electrostatic actuator.

A Robust Photoresist Developer Process
Gregory Meyer

The process of pattern transfer through photolithography plays a central role in the development of highly complex integrated circuits that are used in computers and other machines. As such, it is important that the transfer of patterns from a photomask to a substrate is as exact as possible. The step in the pattern transfer process in which the highest amount of error is likely to occur is photoresist development. This error occurs because developer that strips away in exposed sections on a positive resist (unexposed on negative resists) will also strip away the unexposed areas at a slower rate. This problem is apparent in the current development process used at NIST, in which exposed resists are placed in beakers filled with developers and stirred. The motion of the developer at the edges of the beaker cause the resist there to be more developed than at the center, ruining the pattern. To overcome this problem, a repeatable process for uniform development is necessary.

I have been repairing and refurbishing a tool that will allow such a process to be created. The machine is automated and programmable allowing the process to be repeated easily. Its function is similar to the resist spinners that create the thin, uniform layers of photoresist used in photolithography, so it will allow for a uniform development process, reducing error.

Mathematical Approaches in Analysis of Crystal Structures
Richard Moss

A matrix approach is used to analyze symmetry within a crystal lattice cell. Among other things, the matrices are used in the determination of group-subgroup relationships. This can often be fairly simple in systems with a small number of matrices and integer entries in the matrices. Systems that comprise a much higher number of matrices, as well as matrices containing non-integer data, can be much more difficult to analyze by hand. Thus, a computer program was developed in the Java programming language that better analyzes these large, non-integer matrix systems.

Experiments and Simulations of Cable Tray Fires in Nuclear Power Plants
Michael Price

Power, instrument, and control cables are all susceptible to fire damage. When cable jacket and insulation materials melt and burn, conductors can fuse together causing hot-shorts that can cause control systems to behave unpredictably. In the case of Nuclear Power Plants (NPPs), such hot-shorts are a serious potential safety concern. In this series of experiments, NPP cables were loaded into trays in various arrangements and burned in the NIST Large Fire Lab to obtain data on the Heat Release Rates (HRRs) and flame spread of the cables in two configurations The first was a single tray under a Radiant Panel Apparatus that was used to evenly heat and ignite an entire tray of cables in order to get the HRR and HRR per unit area of a single, fully involved tray. The second configuration involved multiple trays ranging from 1 to 7 that were ignited from beneath the lowest tray with a gas burner. For these experiments, the HRR was taken as well as video footage. Video analysis was done on the footage, referenced with the HRR data, in

order to determine the average HRR per unit area of each experiment as well as gain a qualitative analysis for the spread phenomena.

The primary objective of the project is to use this data to make a numerical model for cable tray fires. Using Matlab, a 2-dimensional simplified model for flame spread across a multiple tray setup was created based off a geometric approximation for flame. The simulation plots a chart of the HRR over time that is comparable to charts produced by the actual experiments. In future, a full model will be made for the Fire Dynamics Simulator to more rigorously simulate cable tray fires.

Intrinsically Disordered Proteins and Heterogeneous Complexes
Sindhushree Raghunandan

The link between protein structure and function has been a prominent theme in the study of proteins since their discovery. To understand a protein's function, we must be able to determine or model its structure. Primary methods used to determine protein structure include x-ray crystallography, NMR spectroscopy, and electron microscopy. While all of these methods have been effective in elucidating protein structure, most have been unable to determine the structure of intrinsically disordered proteins. Approximately one-third of all proteins have large regions of unstructured amino acids. These regions may be characterized using low-resolution methods such as, small-angle neutron scattering (SANS) combined with molecular modeling. The growth in biological SANS research on intrinsically disordered proteins has motivated the development of SASSIE, a conformational Monte Carlo program which generates multiple protein conformations by varying the dihedral angles in flexible linkers and filters out structures with physically unreasonable potential energies. SANS profiles from the computed structures are then compared with the experimental data and density plots of the best-fit conformations are generated.

SASSIE has primarily been used to explore the monomeric Gag protein, which plays a key role in viral assembly of the Human Immunodeficiency Virus (HIV). With current efforts to extend the capabilities of SASSIE, we hope to be able to more efficiently study not only more complicated systems of proteins such as Gag-dimers and MCM helicase proteins (12-mers), but also branch out to heterogeneous systems looking at the role of nucleic acids in protein structure and function. The development of algorithms and software to enable the study of intrinsically disordered proteins and heterogeneous systems by SANS provides a key tool for biological research problems that have a wide applications from basic research to medicine.

A Comparison of the 2D Response of EBT2 Radiochromic Film with the 3D Response of the PRESAGE™ Dosimeter
Scott Robertson

Although ionizing radiation has many applications in modern society, none would be practical without dosimeters that accurately detect the amount of radiation present in a system. Two recently developed dosimeters are the focus of this project. First, GAFCHROMIC® EBT2 radiochromic film is a two-dimensional dosimeter which undergoes a color change relative to the amount of radiation it receives. Samples of this film were irradiated to varying doses between

0.03 and 100 Gy. The response of each sample was measured using a document scanner, and the net optical density was plotted as a function of the dose of radiation to create a calibration curve for the EBT2 film. Secondly, the PRESAGE™ dosimeter is a three-dimensional plastic material that also changes color in response to radiation. Cuvettes containing samples of this plastic were irradiated to varying doses between 5 and 200 Gy. The optical density was measured for each sample using a laser scanner, and a calibration was performed similar to the EBT2 analysis.

Using these calibrations, we plan to compare the 2D response of the film to the 3D response of the plastic. A cylindrical PRESAGE™ sample will be irradiated along its axis to obtain the depth-dose profile of a ^{60}Co radiation field. A laser scanner will be used to measure the response of this sample at different axial heights. Then, several films will be irradiated in water at various distances in the same field, corresponding to the measurements made in the plastic. By determining the agreement between these measurements, we hope to characterize the effectiveness of PRESAGE™ as a three dimensional dosimeter.

United States Measurement System Office at NIST – Web Presence and Functionality

Robert Seng

The United States Measurement System (USMS) includes the nation's solution providers and users. The USMS Office at NIST promotes innovation and industrial competitiveness in developing and deploying technological measurement solutions. In order to do this, the public web presence of the USMS Office strives to efficiently present accurate information that the USMS community requires. The USMS website contains over seven hundred authenticated measurement needs (MNs) submitted by industry researchers; several concepts are being implemented to aid accessibility of this data. Using creative SQL (Structured Query Language) queries, Javascript, and Adobe's ColdFusion to implement advanced searching and suggestion tools as well as making USMS data available in XML (Extensible Markup Language) format, the NIST USMS website embraces many Web 2.0 concepts.

A large number of measurement needs contain metadata in the form of tags; it is possible to search for these based on their tags in an advanced searching function. This search function also now allows one to find an MN that applies to a specific sector or area where the measurement barrier appears as well as searching by an author's name. The search box automatically suggests words as the user types from the most common terms in the USMS MN database; in addition, there is a wordcloud function on the advanced search page that suggests popular terms a user might want to add to their query to be able to find the right information more quickly. Moreover, as part of the goal of increasing knowledge of these measurement needs US industry faces today, we have made available the hundreds of measurement needs in the shared XML data specification: a ColdFusion script takes our database information and renders it on-the-fly into XML. This allows other websites and programs to easily handle, present, and transfer our measurement need data. These modifications have positively affected the already rich environment the USMS website provides for the entire body of workers that comprise the US Measurement System.

Refitting e-FITS
Noorulain Siddiqi

e-FITS is a web-based application for generating tables, graphs, and random numbers for numerous statistical distributions. Individuals can also fit user-supplied data to these distributions.

Scientists and engineers mainly use e-FITS to do distributional modeling of data, which coupled with simulation (i.e random numbers) are common problems in statistical applications. e-FITS strives to refine and improve this issue. Universities could potentially use this application in the future, as most introductory statistics courses discuss continuous and discrete distributions.

My job this summer was to convert a subset of e-FITS, which had been programmed in Fortran 77, to Java. I also helped streamline the interface and provide additional functionality to previously written Java code. Translating the code into Java is necessary for broad-based usage, since Dataplot and other statistical software require e-FITS to be run on the server machine. Java allows a user to run it on his or her own computer, reducing the load on the server.

The Effects of Material Surface Properties on Cell Response
Kathy Tang

A better understanding of cell-material interaction is needed for improved clinical application of existing biomaterials and to realize the promise of material-directed cell response for regenerative medicine. The objective of this study is to evaluate the effects of critical material properties, such as surface functionality, roughness, and rigidity, on cell response. A representative and relevant system was selected to examine each material property of interest individually. Material properties were characterized, and the resulting cell response was quantified.

Dimethacrylate-based composites, comparable to typical dental restoratives, were fabricated to contain varying surface roughness, and MC3T3-E1 pre-osteoblasts and RAW264.7 macrophages were cultured on them for 24 h to evaluate the effect of roughness on cell response. A10 smooth muscle cells were cultured on polydimethylsiloxane substrates of increasing stiffness to determine the effect of substrate rigidity on cell morphology. Dimethacrylate based-polymers containing varying amounts of quaternary ammonium, incorporated to impart antimicrobial properties, were utilized to study the effects of substrate chemistry on cell viability of RAW264.7 macrophages. After fixing and staining the cells, cell responses, including cell spreading, density, and viability, were quantified using epifluorescence microscopy and image analysis.

Preliminary results show that all three material properties significantly affected the cell response. Utilizing well-controlled, well-characterized materials allows for improved interpretation of the cell response data. Results from these studies contribute toward a mechanistic understanding of cell-material interactions, which will enable rational design of new biomaterials to guide targeted and specific cell responses.

Open Source Voting Systems
Tobin Valenstein

The Help America Vote Act, passed in 2000, has meant an increase in the number of voting machines used in American elections, and has given NIST the important roles of proposing standards for voting machines and advising the Election Assistance Commission. NIST researches security of components used in voting systems, ways to detect and prevent fraud, voter privacy protection, and human interaction with voting machines, especially for the disabled. Open source voting systems have not been well researched, however.

Open source software is software that is completely public; it is free, and anyone can conceivably work on the project, or help the main developers. The main systems available are Punchscan and Scantegrity, the Open Voting Consortium system, and Votebox. Many others exist as well but are not as developed, or interest in them has declined.

Experimentation with different open source voting programs led to the conclusion that the probability that said systems could be used for public elections on a wide scale is slim. Many of the systems were very strong in one specific area, such as, usability, security, privacy, or verifiability. This, however, means the systems are weak in all other areas, which is not desirable. Open source voting projects may not have the resources to produce a system that could stand up to professional products, but they do provide a chance for new ideas to flourish and grow. These ideas could some day change the way America votes drastically for the better.

Effect of Laboratory Conditioning on Asphalt Film Thickness
Emma Weaver

In the laboratory, short-term field ageing of asphalt mixtures are simulated through oven conditioning. For mixtures with non-absorptive aggregates the accepted conditioning time is 4h to simulate the correct field conditions for mechanical testing. Absorptive aggregates, on the other hand, have many different properties from non-absorptive aggregates that could possibly make this conditioning time inappropriate. Mixtures with absorptive aggregates are likely to fail in permanent deformation due to little absorption, and in fatigue due to excess absorption and thus small film thickness of asphalt. It is imperative to find the correct balance in the laboratory to minimize to failure and produce the ideal material for the field. The purpose of this study is to find the appropriate conditioning time for asphalt mixtures with absorptive aggregates that mimics field conditions the best and minimizes both permanent deformation and fatigue failure.

One way to compare the differences between different conditioning times is to look at film thickness and the amount of asphalt absorbed into aggregates using X-ray micro tomography. My project analyzes the image slices generated using X-ray micro tomography from mixtures of different aggregate types, conditioned for different durations. This information can then be combined with information gained from mechanical testing to determine the correct laboratory conditioning time for mixtures with absorptive aggregates.

Predicting Neutron Scattering Off of Nanoscale Magnetic Elements
Nathaniel Wright

One of the primary uses for neutron scattering is the analysis of material properties of layered nanoscale elements that cannot be seen with instruments like microscopes that can only see the surface. To "see" the insides of these tiny, layered elements, neutrons can be shot into a specimen in a process called neutron reflectometry. Neutrons are particularly useful for this analysis of certain magnetized elements for a number of reasons: unlike x-rays, neutrons are primarily scattered by very short-range nuclear forces rather than the electrons that scatter x-rays, which makes neutrons especially penetrating. The most important feature of neutrons for my work is their magnetic moment combined with their lack of charge. This unique combination of properties allows for neutrons to be used to analyze the magnetic moments of these nanoscale elements without being scattered by the charged electrons of the specimen being analyzed. My project this summer is to design and use a program to calculate the lowest-energy state for magnetic elements or arrays of elements. Then using this information and the unique scattering properties of neutrons, write another program to predict the magnetic scattering for neutrons. Ideally, a seamless progression could be made starting with a modeling software like K3D to design an element, then to the OOMMF program to find the element's magnetic moment configuration, and finally to a program in Python to determine the magnetic neutron scattering off of the nanoscale magnetic element. In terms of broader impact, the results from this work could be used in the future to design ever more space-efficient devices for storing information on hard drives and in other electronic devices.

Digital Data Preservation Strategy and Implementation
Tso Hsuan (Jason) Young

For the SURF 2009 project, a team of three students worked together to prototype and strategize digital data preservation framework and tools. The project consists of two phases: (a) Because of the portable devices (cell phones, personal digital assistants, etc.) play a vital role in our society today and the future to come, the team had strategized and implemented a set of cell phones (Apple's iPhone, RIM's Blackberry, and Google's Android) players to access the preserved ISO/IEC 23000-3 images content which provides ISO/IEC MPEG-7 metadata descriptions and the rich ISO/IEC MPEG-4 file format standard technologies; (b) Apply the lesson learned from phase (a) to strategize what generic infrastructure framework to handle multimedia content (images, audio, video, text). A set of digital data preservation tools has been investigated and developed for the generic framework.

Specifically, my responsibility for the Digital Data Preservation was to:
A) Design and implement a client for the BlackBerry Bold.
B) Brainstorm with Mr. Chang to create the initial generic framework.
C) Work with teammates to setup a prototype implementation of the generic framework.
D) Make the BlackBerry client compliant with the generic framework.

See Also: William Killian and Scott Albertine

University of Massachusetts Amherst

Spin Torque and Spin Current in Magnetic Multilayers with an Anti-Ferromagnetic Layer

Kathik Prakhya

The aim of this theoretical project is to understand the nature of spin currents and spin torque in magnetic multi-layers – structures consisting of two magnetic layers separated by a non-magnetic spacer layer. In these systems, spin transfer torque is a mechanism responsible for current-induced magnetization dynamics. These current-induced magnetization dynamics caused by spin transfer torque may be utilized in future current-controlled microwave oscillators, and enable the switching of memory elements in magnetic random access memory. Spin transfer torques can be understood as a result of spin currents. Considering the small sizes of these magnetic multilayers, conduction of charge or spin current is best understood using the Landauer formalism. In this approach, the current across a conductor is related to the transmission probability that a charged particle will transmit from one end of the conductor to the other. The information about the reflection and transmission probabilities for a scattering interface is contained in a scattering matrix for that interface, called the S-matrix. The S matrices describing individual interfaces in the multilayer can be combined to get the S-matrix for the entire multilayer. This approach was used to simplify the numerical computer calculation for the spin currents in magnetic multi-layers by allowing each interface between spacer layer and a magnetic layer to be dealt with separately rather than as one whole system. After calculating spin currents in this manner, the spin transfer torque can be calculated by considering the net change of spin current before and after the interaction between conducting electrons and the magnetic layer. We used this approach to understand the nature of the spin transfer torque in a magnetic multi-layer when one of the magnetic layers is an anti-ferromagnetic layer and the other is a ferromagnetic layer.

Development of Silicon Nanocrystals as a Standard Reference Material via UV-Assisted Hydrosilylation

Geoffrey Purdum

Silicon nanocrystals have unique size dependent physicochemical properties. Unlike bulk silicon, which is an inefficient light emitter, silicon nanostructures under five nanometers in diameter acquire bright photo and electro luminescence due to quantum effects. These recently discovered properties make them viable for possible applications in sensing, photovoltaics, solid state lighting, and catalysis. In particular, Si nanocrystals are much less toxic than metal chalcogenide-based quantum dots, thus they can be utilized as biotags for in-vivo bioassays. However, a significant amount of research is still needed to control nanoparticle size, surface chemistry, and concentration. Therefore it is critical to reproducibly prepare Si nanocrystals with narrow size distribution and determine their physicochemical properties.

We produce Si nanocrystals using a top-down procedure by corroding a silicon wafer in a mixture of hydrofluoric acid, hydrochloric acid, and a strong oxidizing agent such as iron (III) chloride hexahydrate. These particles are then dispersed in toluene and their surface is alkylated by a UV assisted hydrosilylation. The reaction also facilitates breaking apart large nanocrystal

agglomerates and could be used for particle size control. As nanocrystal size is gradually reduced during this reaction, the nanoparticle photoluminescence experiences a blue shift.

The resulting nanocrystals are analyzed using several techniques. First, the size distribution of the particles is determined by dynamic light scattering based particle sizer. UV/vis absorption and photoluminescence are measured to gage the optical properties. Finally, a quartz crystal microbalance is used to determine the mass concentration and molar extinction coefficient is calculated as a function of particle diameter.

University of Puerto Rico

Simulation of Dielectrophoretic Field-Flow Fractionation for the Separation of Single-Walled Carbon Nanotubes

Milena Bobea Rodriguez

Single-walled carbon nanotubes (SWCNTs) are a distinctive class of molecules that display unique characteristics. Consisting of a one-atom thick graphite sheet rolled into a tube, these carbon allotropes are known to be excellent thermal conductors, stable at very high temperatures, elastic, and exceptionally strong. The way SWCNTs are wrapped can be represented as a pair of indices (n-m), called the chiral vector, which dramatically determines different electric and physical properties. More importantly, chirality allows the classification of SWCNTs as metallic or semiconducting. These special features make them effective candidates for a vast number of applications in a wide variety of scientific disciplines including energy, sensing, multifunctional materials, biomedicine and future nanoscale electronics. The main impediment to nanotube-based electronic devices is the difficulty of separation according to tube length, diameter and electronic type. Since all current synthesizing methods produce polydisperse mixtures, separation of SWCNTs has become an actively researched field.

Field-flow fractionation (FFF) is a chromatography-like separation and sizing technique based on elution through a thin channel, where separation is induced by interactions of particles in a field that acts perpendicular to the throughput flow. Classical flow-FFF has proven to be a successful approach for nanotube separation by size. Electric field-FFF, in which an electric field is also imposed on the system, can be used to sort nanotubes by type. For this particular project, we have used a Brownian dynamics method to simulate the separation of SWCNTs in a flow chamber with an applied non-uniform electric field, where the dielectrophoretic (DEP) force allows type separation under normal mode conditions by means of frequency-dependent polarizability. The behavior of metallic and semiconducting SWCNTs in a flow-DEP device is analyzed. Results on sorting performance and other observations are discussed.

Simulation of a Microfluidic Mixer for Polymer Melts

Greichaly Cabrera Cruz

Microfluidic platforms have been important for developing mixing devices and techniques. There are a number of types of mixers that can be developed in the context of microfluidics, including flow separation, chaotic advection and splitting and recombination mixing. In this work, we are modeling the behavior of a novel Split and Recombine (SAR) mixer for polymer

melts that has been developed by Moon and Migler. This passive mixer consists of units of splitting and recombination channels which are connected in series. The units are formed by stacking three stainless steel shims on a microfluidic platform. The device generates 2^n layers per unit and produces mixing by reducing layer thickness to the molecular level with resorting to large scale extruders and die structures. The device can also be used to produce multi-layer laminates.

Flow in the mixer is analyzed using two techniques. First, numerical simulation of the Navier–Stokes equations using the finite element method (FEM) is combined with multi-species particle tracking to produce Poincare diagrams of the mixing in the outflow cross-sections of each serial unit. In a second technique, multiphase flow equations based on a Cahn-Hilliard type free energy model are solved. Results for the two techniques are compared with experimental results and suggestions for future work are discussed.

Development of Verification Scripts and Complex Geometry Methods for the Fire Dynamics Simulator

Clara Cruz

The Fire Dynamic Simulator (FDS) is a computational fluid dynamics model for fire developed by members of the Building and Fire Research Laboratory (BFRL) at the National Institute of Standards and Technology (NIST). It has evolved through the years and today it is used in different parts of the world as a design, teaching, and research tool, mainly for solving fire protection engineering problems and for studying fundamental fire dynamics. This growth has pushed FDS to its limits, posing the challenge of solving more difficult problems that require more accuracy. Though FDS code is written in FORTRAN, we have been using MATLAB to work on a smaller scale model involving flow past solid objects in an effort to solve fundamental numerical issues related to complex geometry in FDS. Currently, FDS uses a first-order immersed boundary method to treat geometry, but this method presents difficulties when simulating flow around non-rectangular objects. We have experimented with several methods to achieve a second-order implementation in the MATLAB code, showing the possibility for future modification of the corresponding FDS code.

We have also created scripts, using MATLAB, to standardize the manipulation of the data files and graphs for the verification and validation guides. These guides are a collection of cases developed by the Fire Modeling Group at BFRL to test the performance and reliability of FDS. The new scripts facilitate the processing of data files for the guides, allowing for expansion and maintenance to be a faster, and more standardized process.

Chemical Metrology of Trace Explosives Detection

Melissa Davila Morris

The NIST Surface and Microanalysis Science Division is working to build a chemical metrology program to support the widespread operational deployment and effective utilization of explosive trace detectors (ETD's) currently deployed throughout the United States in support of security screening for homeland security. One objective of our research is to optimize the detection of trace explosives by manipulating the analysis conditions in the ETD's, to increase the overall

sensitivity of detection. There are many types of ETD's currently deployed but the most common systems are based on ion mobility spectrometry (IMS). In a typical screening implementation, personnel wipe the surface of luggage, packages, cargo etc. with a "trap" composed of cloth, paper or Teflon coated materials. Traps are then introduced into the IMS instrument where the explosive particles are vaporized by rapid heating in a thermal desoorber. The explosive vapor is then introduced into the ion source region where it ionized using Beta emission from a 63Ni source. After ionization, the analyte ions are injected into a drift tube where their atmospheric gas phase mobility is determined by their time of flight in a weak electric field. Ions travel through the drift tube at different rates depending on their size, shape and charge and the measured drift time is compared to a reference library of known explosives for identification. Typically, ETD's thermal desorbers are set to a relatively high temperature of 230-280°C. This temperature range allows the best chance of detection for a wide range of explosives (and narcotics). In this work, we have conducted a series of experiments to optimize the desorber temperature for several common explosives. By modifying the desorber temperature, order of magnitude increases in sensitivity have been obtained for several high explosives. Optimal temperatures (giving the highest sensitivity) were 60°C for TNT, 100°C for PETN, 140°C for RDX and 200°C for HMX. This data will be discussed in the context of developing optimized conditions for screening applications. We will also present additional experiments designed to provide insights into the possible mechanisms of the observed sensitivity enhancements. Ongoing research is focused on more complex explosives such as plastic bonded explosives and ammonium nitrate fuel oil.

Certification of SRM 2461 Standard Casing Through Confocal Microscopy

Stephanie Montalvo Delgado

When a spent cartridge casing is recovered from a crime scene, the evidence is entered into a nationwide database using the IBIS (Integrated Ballistic Identification System) system. This system uses image capture and image analysis technology to generate a signature. Examiners from various laboratories around the nation use the IBIS system to compare firearm related evidence. When a new signature is entered in one of the laboratories, the system searches the existing database for a match. Currently, each labs use their own quality assurance casing to verify system functionality. These casings do not exhibit the traceability required by the American Society of Crime Laboratory Directors (ASCLD). Therefore, it is essential to establish one traceable measurement standard for all the labs to use.

The National Institute of Standards and Technology (NIST), with the collaboration of the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), have developed Standard Reference Material SRM2461 casings to be used as a reference standard for instrument calibration at IBIS labs across the nation. The SRM2461 casings are produced through electro formation using a fired master casing at the ATF. The 3D topography of the replicated casings are generated using the Nanofocus Confocal Microscope. To quantify the difference between replicated casings, NIST uses the maximum cross correlation function (CCF_{max}) as well as a proposed parameter called topography difference (D_s). Using these parameters, NIST can certify the SRM2461 standard casing for use in IBIS labs.

Currently 173 of the 256 standard casings have been produced and measured to obtain their signatures. The regions of interest are the firing pin and the breech face impressions. Any low scoring casings are carefully analyzed for a cause. Low scores are usually the result of damages incurred during the manufacturing process. These damaged casings were rejected as SRMs and new ones will be made to replace them.

Implementation of PLAID Protocol in PIV Cards
Eliezer Ferra

Smartcards are used by companies and the government as a form of ID. These cards have an integrated circuit chip where all the information needed from the holder, such as their name, facial picture, biometrics and other important information, is stored and can be accessed. To protect the integrity of transactions and the privacy of the user, there has to be some security protection. Security protocols have been created to ensure the security of the information in the card and also that of the communication between card and terminal.

The Protocol for Lightweight Authentication of ID (PLAID) was created by Centrelink a part of the Australian Government. This protocol is stronger than other protocols because it does mutual authentication. This means that both the terminal and the card are authenticated before sharing any important data. Other protocols only do one way authentication where the card alone is authenticated. The mutual authentication also allows a secure session to give more privacy for contactless applications.

My project was to create a terminal program that will authenticate PIV cards using the PLAID protocol. I also created the commands that would do the mutual authentication in the card. In this presentation I will discuss the differences between the PLAID implementation code and the PIV code and also the difficulties presented before and during the PLAID implementation. At the end I'll give a demo of the PLAID implementation in the PIV cards.

Interfacial Rheology and Mass Transfer in Two Phase Microchannel Flows
Britzy Rivera

Emulsion characterization is an important subject to study, especially using drop-based microfluidic devices. These devices provide tools to study the interfacial dynamics and mass transfer of two phases under flow at a reduced length scale that is typical of many processing applications. The main application from our experimentation is to improve the industry production techniques for emulsion systems such as food, cosmetics, paints and all processes involving droplet systems. In our project, we study the mass transfer of a surfactant in droplet flows and measure the internal droplet flow behavior in quantitative detail through the use of particle tracers. When surfactants are present, Marangoni effects can alter the coupling between the interfacial tension and the two-phase flow. These Marangoni effects are difficult to observe and measure directly. Using silicone oil as a continuous phase and an aqueous surfactant solution as the drop phase, we created aqueous droplet flows in a microchannel and measured the time-dependant interfacial tension, as well as the detailed internal circulation patterns of the droplets. By observing the droplet circulation in detail, we were able to directly measure Marangoni effects, i.e., interfacial immobilization. With this process we demonstrate a

microfluidic approach to measure the interrelated phenomena of dynamic interfacial tension, surfactant mass transfer, Marangoni effect, interfacial retardation, and the overall droplet behavior that employs a droplet flow within a microchannel with constrictions and expansions.

University of San Diego

The Electronic Kilogram Experiment
Emmett Perl

The kilogram is currently defined by the mass of the International Prototype Kilogram (IPK), making it the only SI unit derived from a physical artifact instead of fundamental properties of nature. We now believe that the mass of the IPK is drifting slowly over time. Because of this inconsistency, scientists are scrambling to find a new definition for the kilogram that will not change over time. The electronic kilogram experiment hopes to redefine the mass standard based on Planck's constant (h), an unchanging fundamental constant. If we were to fix Plank's constant to an exact value, the kilogram would be tied to the second through this number and other constants. The electronic kilogram at NIST currently has the best measurement of Planck's constant in the world ($6.62606889 * 10^{-34}$ J s) with an uncertainty of only 36×10^{-9}, making our approach the leading candidate for the redefinition.

The electronic kilogram is a complicated system that compares electrical power (UI) to mechanical power (mgv). To do this, we use a two step procedure. First, an induction coil is suspended in a magnetic field which produces an electromagnetic force exactly opposed to the gravitational force of the mass (mg=ILB). The coil is then moved through the magnetic field, inducing a voltage (U=BLv). We can combine these two equations to get our final formula (mgv=UI). By using our knowledge of the Josephson effect and the Quantum Hall effect, we are able to find a value for Planck's constant.

Over the course of the summer I worked on three concurrent projects. 1) The computer program for our Josephson Voltage standard was many years old and needed to be replaced. I integrated a new program based on LabVIEW that runs more efficiently and is better coupled with our main program. 2) I also wrote a LabVIEW program that drives high precision piezo motors to control the tilt of the induction coil. When the coil is tilted, a cosine term is introduced into the equation, leading to possible errors and making our calculations more difficult. With the use of these motors, we can greatly reduce this potential source of error. 3) We also needed to synchronize many of our instruments to a standard frequency. I built a transmitter/receiver circuit that brought a 10 MHz signal from our GPS standard to our instruments in another room upstairs. With these improvements and further progress, we hope to reduce our uncertainty for Planck's constant, and ultimately form the basis of a new kilogram standard.

University of South Florida

Dual-Frequency MOPA Setup for Laser-Cooling Lithium
Jason Bylsma

In order to create a focused-ion beam of lithium atoms for use in a lithium-based ion microscope, the thermal beam of lithium atoms must first be laser cooled. To produce the light for laser cooling, we use laser diodes with a wavelength near 671nm, which is the wavelength of the D2 lithium transition. All frequencies needed for operation of the magneto-optical trap will ultimately be superposed and injected into a tapered amplifier, hence the name "master-oscillator power amplifier" or MOPA.

To begin, we assembled the laser amplifier system, which provides electrical connections and thermal management for the tapered amplifier chip. Next, we seeded the amplifier with the light from the master oscillator diode and coupled the output into fiber optic cables. Analysis included characterizing the coupling of the seed laser to the amplifier as well as examining the relationship between the seed spectra and the corresponding amplifier spectra.

The motivation for using a dual-frequency MOPA setup stems from the need for main laser cooling light and repumping light, which are separated by about 800 MHz in a single laser beam. Lithium is conveniently cooled by a single laser.

Ultimately, this dual frequency MOPA setup should provide a few hundred milliwatts of power from only a few milliwatts input. This laser power will then be used to trap and cool the thermal beam of lithium atoms. An ion microscope based on lithium instead of the traditional gallium liquid metal ion source has many advantages. Lithium is much lighter than gallium and will not destroy the surface of the sample. Erbium is among many other laser-coolable ions, including Na, K, Rb, Cs, Fr, Mg, Ca, Sr, He, Ne, Ar, Kr, Xe, Al, Ag, Cr and Yb. In theory, this setup could be extended to other light ions for microscopy and heavy ions for milling as well.

Uniersity of Southern Mississippi

Wavelength-Dependent Photodegradation Study of Pure Nano ZnO-Containing Polyurethane Coatings
Brooks Abel

Accelerated photodegradation studies of polymeric coatings allow for service life prediction of outdoor coatings without the need for time consuming and irreproducible outdoor degradation experiments. Photodegradation studies conducted using the NIST SPHERE (Simulated Photodegradation by High Energy Radiant Exposure) can be used to relate indoor accelerated studies to outdoor real time performances. In this study, pure polyurethane (PU) and nano ZnO-containing polyurethane (PU/ZnO) films were exposed to four specific wavelengths of light (306 nm, 326 nm, 354 nm, and 450 nm) at constant temperature and relative humidity (45 °C, 75% RH) using the ***NIST SPHERE***. Chemical changes in the PU and PU/ZnO films were monitored by Fourier Transform Infrared (FTIR) spectroscopy and ultraviolet-visual (UV-vis) spectroscopy and related to dosage, the total amount of light absorbed by the films. Confocal microscopy and

atomic force microscopy (AFM) were used to monitor surface morphological changes throughout the degradation study. Ultimately, the resulting chemical and structural changes resulting from the four specific wavelengths will be used in predicting long-term outdoor behavior by the same PU and PU/ZnO systems.

Biomimetic Lipid Membranes for the Study of Membrane Protein Structure
Emily Hoff

Membrane proteins play vital roles in the functions of the human body. Some transmembrane proteins act as ion channels which control the transportation of ions across a membrane, or lipid bilayer, and have become important targets for new drugs. Despite the importance of membrane proteins, little is known about how they function at a molecular level.

This research is geared toward preparing model oriented lipid bilayers with incorporated proteins to be studied with x-ray and neutron diffraction. Various lipids were explored for optimal orientation and incorporation of a membrane protein. The lipids used in this research vary in the type of charge their head-groups have (anionic, cationic, and zwitterionic) and the degree of un-saturation in their hydrocarbon chains. X-ray diffraction results reveal that the sample alignment and subsequently, the diffraction signal quality depends strongly on lipid type and sample composition. The antibacterial peptide, Gramicidin A, was incorporated into the lipid bilayers, for studies with X-ray and neutron diffraction. Methods to enhance the diffraction signal from oriented lipid multilayers with incorporated peptide will be explored. Samples will be prepared in the presence of a lanthanide-phospholipid chelate complex (DMPC-DTPA/Tm3+) which will orient in a magnetic field for improved lipid membrane alignment. Neutron diffraction experiments will be used to investigate the structure, hydration, and interaction of the peptide with the lipid membranes.

University of the Sciences Philadelphia

Polyelectrolyte Brushes as Nanoscale Confinement for Novel Electronic Materials
Timothy Enright

Organic materials offer novel and rich electronic functionalities not readily available in inorganic devices. This has opened a venue for active research in the field of flexible electronics, organic field-effect transistors, and polymeric solar cells. Electroconductive polymers are expected to play important role in these and others applications. One of the electroconductive polymers of particular interest is poly(3,4-ethylenedioxythiophene) (PEDOT). In-situ synthesis of PEDOT in nanoscale confinement will allow us to control charge transport in polymeric electrodes. The confinement is to be designed with the aim of ultrathin covalently grafted polymer chains (polymer brushes) miscible with the monomer, EDOT.

We first fabricated bottom-contact electrodes made with platinum onto a silicon/silicon oxide substrate. Next, we grew the polymer brush of poly(acrylamide-co-acrylic acid) (PAM-co-AA)) via “grafting through” technique following the procedure recently developed by Dr. A. Sidorenko, USP. The brush layer of 10~15 nm in thickness is capable of swelling in EDOT aquatic solutions thus forming nanoscale reactors for further EDOT polymerization. The top gold

contact was made on the surface on the brush using the stencil mask technique developed in the group of Dr. N. Zhitenev, NIST. The active working area of brush sandwiched by bottom and top contacts is in the range of 200 nm x 200 nm. This top contact served as a semi-penetrable membrane providing nanoscale confinement for EDOT polymerization. Polymerization of EDOT initiated by ammonium persulfate resulted in conversion of EDOT monomer solubilized by polymer brush. We observed a unique and novel morphology of PEDOT clusters dispersed in polymer brush by Atomic Force Microscopy. The charge transport measurements are also planned.

University of Tulsa

Simulated Silicon: Perfection of Single Crystal Silicon Line Width Reference Features
Matthew Walker

The production of standard reference material calibrated width reference features on the nanometer scale is useful in both research and industry for the calibration of instruments such as atomic force microscopes and other nanoscale metrology instruments. Currently NIST is attempting to reduce the uncertainty on the width of these reference materials to less than 1nm. This is a large undertaking which poses significant challenges.

On the cutting edge of research we currently employ single crystal silicon with a nitride mask patterned with focused electron beam technology followed by a wet etching process. We then image and post process the chips in a variety of ways. Over the past summer months I have looked principally at modeling the wet etching process with an atomistic kinetic Monte Carlo simulator. Variables looked at in simulation include temperature, etch time, and reference feature geometry. Results from these simulations were then taken to the lab bench for further physical study and for validation / calibration of the model.

University of Wisconsin Madison

JMONSEL: Improvements
Jarrod Feight

SEMs (Scanning Electron Microscopes) have been one of the most demanded tools for precise measurements in the semiconductor industry. As technologies in the semiconductor industry have enabled the production of a smaller and smaller Critical Dimension (CD)/Gate Width, the methods used by the SEM to measure CDs have become outdated and have too large of an error in measurements. CD line width measurement uses the measurements between the bright edges of an image, but recent studies have shown that the model used to obtain a measurement has inherent errors. To create a better model for CD measurement Dr. John Villarrubia of the NIST Precision Engineering Division has written simulation software (JMONSEL). This model interfaces with previous SEM simulation software (MONSEL) to create a new model by which measurements of CDs can be more accurately obtained via SEM line width methods. New physical models have been obtained through these simulations, but the simulations have been limited by user interface abilities and limited materials to be simulated. Future goals of this

project include improving its 3-D sample rendering and to expand its user interface capabilities to obtain even more accurate measurements for the multi-billion dollar semiconductor industry.

University of Wisconsin Stout

Low Energy Ar+ Plasma Etching of CoPd Multilayers
Aaron Cochran

We developed new sample preparation techniques which use low energy Ar+ plasma etching to clean delicate CoPd multilayer structures in order to image their magnetic nanostructure using Scanning Electron Microscopy with Polarization Analysis (SEMPA). CoPd multilayers, which consist of alternating ultrathin layers of Co (0.4 nm) and Pd (0.6 nm) exhibit perpendicular (out-of-plane) magnetic anisotropy and a complex nanoscale magnetic structure which is useful for high-density magnetic storage media and magneto-electronics. We used SEMPA to image this magnetic nanostructure. SEMPA is a high resolution (10 nm) technique that can fully resolve the in-plane and out-of-plane magnetic structure by measuring electron spins; however SEMPA is surface sensitive and requires an atomically clean magnetic surface for imaging. Conventionally, in situ sputtering using high-energy (1keV or more) Ar+ ions is used to remove the native oxides, hydrocarbons, and non-magnetic coatings from the sample surface. This high-energy Ar+ bombardment can mix the CoPd multilayers, which reduces the perpendicular anisotropy and alters the magnetic structure. We investigated using plasma-generated, low-energy (50 eV) Ar+ ions to clean the sample surfaces. Etch rates and magnetic domain structure damage were measured and compared with high-energy Ar+ etching using 1 keV ions. Initial results were promising, showing that the 50 eV ions can effectively remove hydrocarbons, oxides, and coatings from the thin-film samples with little to no damage to the magnetic domains.

Toxicity Measurements of Fire Effluents for Cables Used in Nuclear Power Plants
Heather Schrader

The majority of fire related deaths are due to smoke inhalation. This is because of the toxic gases produced during combustion. Carbon dioxide (CO_2), carbon monoxide (CO), hydrogen chloride (HCl) and hydrogen cyanide (HCN) are four of the most frequent gases produced and a reliable method for measuring their yields is desirable. One potential method to measure yields of toxic gases is the IST/TO 19700 Tube Furnace. The first part of this study was designed to determine how accurate the ISO Tube Furnace is when slight changes are made in the test conditions. Changes were made to the feed rate, tube furnace temperature, mass loading, and sample configuration and concentrations of CO_2 CO, HCl and O_2 were measured. The largest variation was seen for polymethylmethacrylate (PMMA) when the primary airflow was reduced. The yield of CO_2 increased by a factor of three from the base and the CO yield increased one and a half times.

The second part used cables supplied by the Nuclear Regulatory Committee to determine what gases would be produced if the cables were ignited, the concentrations, and what effects these gases would have on the opperators. In tests done thus far it has been found that the CO yields range from 0.7 g/g to 1.0 g/g and the HCl yields range from 4 mg/g to 110 mg/g.

Valparaiso University

A Measurement of the Reflectivity of Neutrons in a Silicon Crystal
Ansel Hillmer

It has been proposed to measure the neutron's magnetic dipole moment utilizing the Schwinger interaction of neutrons with a silicon crystal during Bragg scattering. This method, however, requires many successive Bragg reflections to produce a significant signal. It is therefore important to measure the reflectivity of neutrons off the crystal to determine if sufficient numbers of neutrons remain after these successive reflections. To obtain this reflectivity value, we have designed an experiment and have carried out initial measurements. In this talk, we report the setup, experimental method, and preliminary results of our experiment.

Complications of Silicon Crystal Reflectivity Measurements
Timothy Olson

The electrically neutral neutron is known to posses a magnetic dipole moment (nMDM). A proposed method of measuring the nMDM may lead to an eventual attempt to measure the neutron electric dipole moment (nEDM). The proposed method employs Bragg reflection from perfect single crystal. Many sequential reflections will be required to enhance precision, and the crystal reflectivity must be well known to accurately estimate the final neutron count after these reflections. Although measuring the reflectivity is conceptually straightforward, there are many issues that must be monitored and controlled, including crystal structure variations, beam divergence and attenuation, wavelength acceptance, internal reflections, and Pendellösung interference. This talk highlights these issues in pursuit of a successful neutron reflectivity measurement.

Analytical and Finite Element Structural Modeling of Nanomechanical Resonators
Rebecca Van Aartsen

Accelerometers for vehicle air bag deployment, microphones for cell phone communication, and nozzles for inkjet printing are examples of successful commercial applications of microelectromechanical systems (MEMS). More recently, improved nanofabrication techniques have enabled the development of even smaller devices, nanoelectromechanical systems (NEMS), whose dimensions range from several thousand nanometers to a few nanometers.

Of particular interest to this project are resonant NEMS devices, which have applications in atomic force microscopy, mass sensing, and chemical detection. Typically operated at their first resonant frequency, which is on the order of MHz, the nanoscale size of these devices permits force and mass measurement sensitivities as small as attonewtons and zeptograms, respectively. Shorter devices result in desirable higher resonant frequencies but also increased stiffness values, which then limit the sensitivity. Thus a design geometry that compromises between high resonant frequency and the optimal stiffness range is essential in resonant NEMS design. However, when calculating the resonant frequency and stiffness of a NEMS beam, the discrepancy between analytically calculated results and experimentally measured results are sometimes greater than 50%. The large error may be partially due to the analytical assumption

that beam supports are perfectly fixed, while in reality the beams are restrained incompletely and only from the bottom. Other possible sources of these errors stem from nanofabrication tolerances and differences in material properties at the nano- and macroscales.

To better understand the design of nanomechanical resonators and the parametric discrepancies described above, a comparison of analytical and finite element structural analyses was performed on cantilever and doubly clamped beams over a range of sizes. In one condition, the beams are modeled with fixed constraints on both the top and bottom of the supports to match the boundary conditions of the analytical equations. For comparison, the same beams are analyzed with fixed constraints on only the bottom of the support to replicate the actual geometry of nanomechanical resonators. A third condition, with an undercut in the bottom of the beam support, imitates the nanofabrication limitations in the release of the beam using isotropic etching.

Virginia Polytechnic Institute & State University

A High-Resolution Interferometer for Nanmechanical Measurements

Cadence Martin

The Ceramics Division at NIST is building a Precision Indentation Platform (PNP) to measure the mechanical properties of materials accurately on the nanometer scale and to certify standard reference materials (SRMs) that will be used to verify the performance of commercial nanoindentation instruments. The research described here focused on the optical-fiber interferometer systems that will be used to measure the displacement of an indentation probe tip directly, and to measure the force on the probe tip indirectly by determining the elastic deflection of a spring suspension incorporated into the load head of the PNP. Prototype interferometers for these applications were constructed and their performance was evaluated.

The interferometer functions by forming a Fabry-Perot (FP) cavity between the end of an optical fiber and a parallel reflective surface; polished glass wedges were used in this experiment. Light from an infrared laser is guided to the FP cavity through an optical fiber. Reflections from the end of the fiber and from the wedge surface interfere due to the difference in path length, which is equal to twice the length of the gap between the surfaces. This reflected light is converted to a voltage by a photodetector and amplifier; changes in voltage can then be correlated to changes in gap length using the calculated sensitivity of the interferometer. Displacement resolution was determined to be significantly less than the radius of an atom; such high resolution has many useful applications in addition to the PNP.

Vulnerability Assessment of Steel Frame Structures to Progressive Collapse

Sara Sidhom

Progressive collapse, also known as disproportionate collapse, is the spread of an initial local failure resulting in the collapse of the entire structure or a disproportionately large part of it. Currently, there exists a need to quantify the robustness, or collapse resistance, of structural systems. Two potential metrics of structural robustness investigated in this project involve assessment of: (1) the redistribution of strain energy in the structure under column removal scenarios and (2) the reserve capacity in the structure under gradually increasing gravity loads

through a "push-down" analysis. While ongoing NIST research makes use of advanced finite element modeling approaches to simulate and study collapse, this project explores the applicability of relatively simple finite element software available in a typical design office. The modeling approach used consists of defining frame elements to model the beams and columns of steel frame structures and introducing plastic hinges to model yielding in the members. Nonlinear static analyses are performed, which include material and geometric nonlinearities to account for large displacements and rotations in the structure.

An important part of this research was to validate the simplified modeling approach used against experimental data. This has been achieved through comparison with previous testing by NIST of a steel frame structure with reduced beam section connections under a column removal scenario. The validated models are then used to asses and compare the robustness of different steel frame structures using the two robustness metrics described above.

Washington University St. Louis

Building an External Feedback Loop to Perform FM Scanning Kelvin Force Microscopy

Nathan Shemonski

Scanning Kelvin Force Microscopy (SKFM) is an imaging technique which can be used to determine the work function of a sample. Simple methods of SKFM can be performed using the boxed equipment and software that are purchased with the AFM. It becomes more difficult, though, to perform more advanced scanning techniques such as Frequency Modulated SKFM (FM SKFM) due to a lack of access to internal signals.

Performing FM SKFM is very desirable for many reasons. First, it can give a quantitative value of the work function. Using the boxed equipment alone, one cannot reliably determine quantitative values for work functions without tedious calibration. With small changes in parameters, the measured work function can change drastically. Second, FM SKFM relies on the phase of the vibrating cantilever which is much more sensitive to forces and thus higher spatial resolution can be achieved. Finally, FM SKFM is performed using a single pass which can conceivably double the speed of imaging since two scans over the same line are required when using the boxed scanning techniques.

To implement FM SKFM, multiple external feedback loops were implemented. The main piece of these feedback loops is a cheap digital signal processor (DSP). Success in this project would be exciting since it would mean higher resolution images for a small amount of money.

Wellesley College

Measurements of Wavelength Standards for Calibration of Spectrometers on Extremely Large (Astronomical) Telescopes

Yomay Shyur

Extremely large telescopes (ELTs), the next generation of astronomical telescopes, will enable scientists to study distant redshift galaxies and dust obscured objects. ELTs make use of adaptive

optics which are wavelength dependent and optimized for the near infrared, a region very important to astronomical study in the next few decades. Currently there are few sources for wavelength calibration in the near infrared. A preliminary study identified several potential calibration sources for these ELTs, and commercial titanium hollow cathode lamps were chosen for a more comprehensive study. The 2-m Fourier transform spectrometer at NIST was used to measure the spectral lines in the near infrared of these titanium lamps. Using titanium spectra taken in the visible and near infrared from high current hollow cathode lamps, the lines in the commercial titanium lamp were calibrated to produce a list of recommended wavelength standards. This project is a collaboration between NIST and the European Southern Observatory.

Western New England College

Enhancing a User Interface and Underlying Knowledge Base for a Robot Classification System for Urban Search and Rescue

Elizabeth Avondo

Robotic technology is rapidly evolving and is even finding its way into emergency response. Using robots as a tool in disaster response provides emergency professionals with critical information about disaster sites dangerous or inaccessible to humans. Urban Search and Rescue (US&R) robots are a recent development, therefore a set of standardized test methods is necessary to regulate and optimize the performance of machines executing critical and life saving tasks.

The Urban Search and Rescue Robot Performance Standards project at NIST brings together first responders, robot vendors, and members of the scientific community, as it is funded by the Department of Homeland Security (DHS) Science and Technology (S&T) Directorate and the Federal Emergency Management Association (FEMA). The purpose of the project is to establish and quantify standard performance metrics that exemplify and regulate robot attributes important to effective behavior in the field, as determined by focus groups with first responders. An ontology stores and meaningfully represents the data collected from these tests, along with other information captured in robot spec sheets, which presents first responders with a need for a method of finding and viewing the data.

Since not every first responder is a robotics expert, an intuitive graphical user interface (GUI) was developed in Java to take user input, search the ontology, and present a list of the best robots to use during an emergency. When facing a disaster, first responders assess the situation rationally and make note of the tasks that need to be done. The GUI was developed to emulate this logical process and allows the user to input limiting factors based on the purpose of the robot's mission and the challenges it will face. As the Urban Search and Rescue Robot Performance Standards project is an ongoing project, the GUI was written in Java to comfortably incorporate future developments.

Whitman College

Phosphate Ion Preadsorption Slows Nonspecific Protein Adsorption to Borosilicate Glass and Enhances Short-term Adhesion of Osteoblasts

Jackson Cahn

A key property of any biomaterial is the degree to which it adheres to tissues. Colloid-probe atomic force microscopy (AFM) provides a powerful tool for investigating these interactions because of its sensitivity, versatility, and ability to measure adhesive interactions with individual cells. By attaching a microsphere of the test material to the AFM cantilever, a number of materials can be rapidly characterized in relation to a variety of cells. We have been attempting to characterize the interactions of various glasses with osteoblastic cells, primarily for drug-delivery applications. Our results have shown that under some conditions, the measured adhesive force is found to decrease hyperbolically with use, suggesting a fouling of the probe with biomolecules. Previously the larger initial forces have been disregarded and the mechanism behind this decay has not been investigated.

In this study we have investigated the effect of pretreatments of the glass with various cell-culture media to either eliminate or elongate this decay phenomenon in order to develop and understand of the underlying mechanism. When no pretreatment (or pretreatment with DI water) is used, the decay is extremely rapid. When the glass is pretreated with a protein containing cell-culture media, there is no measurable decay in adhesion, implying that the glass is already fully coated with biomolecules. Interestingly, pretreatment with protein-free phosphate-containing buffers such as minimum essential media (α-MEM) or phosphate-buffered saline (PBS) slows the decay of adhesion. Because the only compositional difference between cell-culture media and the α-MEM is protein content, this implies that the serum proteins are responsible for the adhesive decay. This result is consistent with recent work by Wei *et al*. and others showing that phosphate ions absorb in competition with negatively-charged proteins.

We have also used fluorescence microscopy to examine specific and nonspecific protein adsorption both from solution and from cell contact under a variety of conditions, as well as to rule out lipid membrane as a source of contamination. These results will be discussed along with avenues for future study.

Worcester Polytechnic Institute

Hold Old Is It? – Nuclear Forensic Chronology Reference Materials

Christopher Horgan

Nuclear forensics makes attempts to analyze the nature of nuclear materials, either retrieved from post-detonation debris or secured before an incident. Through this analysis and the determination of such qualities as material age, impurity content, and ratios of radioisotopes, one hopes to determine the origin of the material in question. From there, it may be possible to identify those involved and take proper steps to ensure national security and prevent malicious use. However, to determine information such as the amount of time that has passed since the material's last purification, a reliable standard is required.

Pu-241 is almost always present in Uranium- and Plutonium-based nuclear weapons, which pose the greatest threat to our safety. The in-growth of Americium-241 due to the decay of Plutonium-241 gives us an excellent chronometer to tell us the age of the material. It is apparent then that Pu-241 is needed to serve as a reliable standard.

This research endeavors to verify the stability and certification of a 23 year old Pu-241 Standard Reference Material (SRM4340) through alpha-gamma anticoincidence counting. Furthermore, by separating out each radionuclide through radiochemistry and applying alpha spectroscopy, actinide impurities in the original material will also be quantified. The work done here will be important to provide the nuclear forensics community with a standard that could be used to validate their measurement capability, as a basis for between-laboratory comparability, and as material for verifying laboratory performance.

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APPENDIX A. QUICK CROSS-REFERENCE – SURF 2009

2009

SURF STUDENTS

BY UNIVERSITY

STUDENT	UNIVERSITY	TITLE OF TALK	OU
Flynn, William	American University	Development of Single Magnon Cross-Section/Spinwave Dispersion Software	NCNR
Pope, Nicholas	Appalachian State University	Development of an Ion Capture and Transport System for Atomic Spectroscopy	PL
Romantseva, Eugenia	Boston University	High-Throughput Measurement of Cellular Oxygen Consumption	CSTL
Okita, Alyssa	Bucknell University	Toward Estimating the Harvestable Energy from Human Motion	ITL
Kitchaev, Danil	California Institute of Technology	The Structural and Magnetic Purity of Sub-Nanometer Co | Ni Multilayers	NCNR
Vu, Kennedy	California State University Fresno	Aggregation of Titanium Dioxide Nanoparticles – The Role of Surface Chemistry	CSTL
Jia, David	Carnegie Mellon University	Immobilization of Tissue Cells Using Positive Dielectrophoresis and Polyelectrolyte Multilayers	EEEL
Tworkoski, Ellen	Carnegie Mellon University	Effects of Molecular Weight on the Viscoelastic Properties of Polystyrene Thin Films Utilizing Thermal Wrinkling	MSEL
Albertine, Scott	Centre College	Digital Data Preservation Strategy and Implementation	ITL
Callo, Catherine	City College of New York Hunter	Energy Transfer Between Conjugated Quantum Dots	PL
Clark, Alexander	College of New Jersey	The Influence of Growth Conditions on Surface Properties of Bacillus Spores	CSTL
Krizan, Jason	College of New Jersey	Phase Equilibrium Relations in the Ceramic SrO-Y_2O_3-TiO_2 and SrO-Y_2O_3-ZrO_2 Systems	MSEL
Ames, William	College of William and Mary	Lead Resistance Measurements of Cryostat for Graphene Device Contact Resistance Tests	EEEL
Richards, Brian	College of William and Mary	Characterization of Standard Reference Materials Through High Resolution X-Ray Diffractometry (HRXRD) and X-Ray Reflectometry (XRR)	MSEL
Meier, Amanda	Colorado School of Mines	Development of 6/d Spectral Reflectance Calibration Service for Colored Samples	PL
Rose, John	Colorado School of Mines	Spectral Irradiance to Spectral Radiance Transfer Using a Plaque and Monochromator	PL
Huang, Eric	Cornell University	Design and Construction of a Simple Magneto-Optical Trap	PL
Strauss, Benjamin	Cornell University	Unsupervised Part of Speech Tagging of Blog Data Using Map-Reduce	ITL
Howarth, Timothy	Eastern Kentucky University	Analysis of Stairwell Movement in High-Rise Office Buildings	BFRL
Roberts, Jillian	Eastern Kentucky University	Analysis of Stairwell Movement in High-Rise Office Buildings	BFRL
Van Norman, Craig	Eastern Kentucky University	Multi-Phase Study on Firefighter Safety and the Deployment of Resources	BFRL

STUDENT	UNIVERSITY	TITLE OF TALK	OU
Nowak, Stephen	Franciscan University Steubenville	System Dynamics Modeling of the Corn Ethanol Industry	MEL
Atkins, Michael	George Mason University	Phase-Field and Atomistic Modeling of Grain Boundaries in Copper	MSEL
Ackun, Marian	George Washington University	Bias-Induced Changes in the Vibrational Spectra of Next-Generation Organic Electronic Materials	EEEL
Aslani, Marjan	George Washington University	Multijunction Thermal Converters for Precision AC Voltage and Current Metrology	EEEL
Bever, Sarah	George Washington University	Using the Anodic Dissolution of Tungsten in Determining the Mass of Nanoparticles	MEL
Messier, Nicole	George Washington University	Wetting Properties of Superhydrophobic Surfaces	CNST
Kuhn, Christine	Gettysburg College	Automated CHARM: Retroreflector Measurements and LED Traffic Signal Distributions	PL
Smith, Glenn	Hamilton College	aCORN: Measuring the Electron Antineutrino Angular Correlationin Neutron Decay	PL
Perrault, Maryette Haggerty	Hampshire College	Building AvailTechs to Commercialize NIST-Developed Inventions and Technologies	TS
Hoyt, Robert	Harvey Mudd College	Real-Time Laser Calibration and Environmental Isolation of Nanophotonic Device Characterization Setups	CNST
Keller, Benjamin	Harvey Mudd College	Testing Power MOSFET Reliability: A Novel Aproach	EEEL
Howard, Joseph	Haverford College	Software Validation and Verification on SOP 4	TS
Dolly, Kendall	Hood College	Heat of Hydration Prediction for Portland Cement	ITL
Levine, Mara	Hood College	Packing of Polydisperse Systems and High Packing Fraction	NCNR
Nyman, Julie	Hood College	Surface vs. Bulk Degradation of P3HT:PCBM Blend Films for Organic Photovoltaic Cells	MSEL
Stauffer, Hilary	Hood College	Tethered Bilayer Lipid Membranes for Protein Characterization	CSTL
Kaspercyzk, Mark	Illinois Wesleyan University	Terahertz Spectroscopy of Polypeptides	PL
Welch, Elizabeth	Iowa State University	Development of a Nanoindenter with Optical Microscopy and Raman Spectroscopy Capabilities	MSEL
Joress, Howard	Johns Hopkins University	Combinatorial Methodology Applied to the Exploration of Novel Materials for Advanced Metal Oxide-Semiconductor (MOS) Gate Stacks	MSEL
Richter, Ian	Johns Hopkins University	Size Matters: Difficulties in Profiling Large-Diameter Optical Flats	MEL
Chinnapongse, Stephanie	Johns HopkinsUniversity	Silver Nanoparticle Stability and Speciation in Aquatic Environments	MSEL

STUDENT	UNIVERSITY	TITLE OF TALK	OU
Olson, Scott	Lehigh University	Evolution of Surface Roughening in Relation to Grain Orientation in 6022 T4 Aluminum	MSEL
Hochlowski, Natasha	Loyola College of Maryland	Detection and Differentation of Bacterial Endospores Through Fluorescence Spectroscopy	CSTL
Schneider, Lisa	Loyola College of Maryland	Performance Evaluation of External Calibration of a Camera and Laser Range Finder	MEL
Bratton, Ryan	Miami University Ohio	Determining the Synthesis Mechanism of Ultra-Small Ligand-Capped Gold Nanoparticles	CSTL
Marshall, Megan	Miami University Ohio	Phase and Amplitude Modulation with a Spatial Light Modulator and Its Applications	PL
Riley, Grant	Miami University Ohio	Neutron Tomography of Alkaline and Lithium Primary Cells	PL
Killian, William	Millersville University of Pennsylvania	Digital Data Preservation Strategy and Implementation	ITL
Dillon, Andrew	Montgomery College	Interaction Mechanisms of Gold Nanoparticles with DNA	CSTL
Geronimo, Carly	Mount Saint Mary's University	Anti-Body Mediated Self-Limiting Self-Assembly of Gold Nanoparticles	MSEL
Wroge, Christine	Mount Saint Mary's University	Characterization of Organic Molecular Electronic Junctions by Transition Voltage Spectroscopy	CSTL
Abusomwan, Uyiosa	New Jersey Institute of Technology	Quantitative Evaluation of the Quality of Robot-Generated Maps	MEL
Fabara, Fatima	New Jersey Institute of Technology	Cell/Substrate Modulus Interaction. Polymer Characterization	MSEL
Sharpnack, Michael	New York University	A Mathematical Analysis of the Switch-Like and Oscillatory Behaviors of the Tumor Protein 53 Feedback Loop	ITL
Weinman, Nathaniel	New York University	USARSim 1.8 Upgrading Robotic Simulation	MEL
Marley, Daniel	North Carolina State University	Design and Development of a Muon Veto System for an Ultra-Cold Neutron Lifetime Experiment	PL
Taylor, Courtney	North Carolina State University	Millikelvin Temperature Rise in Water – Ultrasound Thermometry for Therapy-Level Radiation Dosimetry	PL
Richards, Reyniak	Oakwood University	Near-IR/Raman Spectroscopy for Biodiesel Characterization	CSTL
Lorek, Michael	Ohio University	Circuit Design for Charge-Based Capacitance Measurement of Sub-Femto-Farad-Level Capacitances	EEEL
Kim, Eric	Oklahoma State University	Evaluation of Concrete Degradation Through the Use of X-ray Fluorescence	CSTL
Kim, Rhan	Olin College of Enginering	Virtualization within NIST Security Protocol	ITL
Blumenfeld, David	Pennsylvania College of Technology	Machining a Calibration Artifact Using a Non-Orthogonal 5 Axis Machine Tool	MEL

STUDENT	UNIVERSITY	TITLE OF TALK	OU
Cox, Matthew	Pennsylvania College of Technology	Three Dimensional Printing: An Exploration of Capabilities Using a Commercially Available Printing Solution	MEL
Hong, Christopher	Pennsylvania State University	Nannoplasmonic Fabry-Perot Resonators for Ultrasensitive Biosensing	CNST
Alexander, Sarah	Purdue University	Moiré Deflectometry Applications and Programming	CSTL
Nitta, Naoki	Rice University	Interference from Decomposition in the Measurement of Diffusion Coefficients of Hydrocarbons	CSTL
Nunnally, Steven (DHS Intern)	Roanoke College	Hearing Victims in USARSim: Adding Acoustic Sensors to the Robotic Simualtion	MEL
Miller, Matthew	Saint Mary's College of Maryland	Solvent Vapor Wrinkling of Physically Confined Polymer Thin Films	NCNR
Mooney, Martin	Saint Mary's College of Maryland	Validation of the Fire Dynamics Simulator	BFRL
Chiu, Wesley	State University of New York Binghamton	Developing a Standard for Through Barrier Radar	EEEL
Hasapis, Gregory	State University of New York Binghamton	Visual Analysis of Fire Spread Rate on Flexible Polyurethane Foam	BFRL
Steinmann, Andrew	State University of New York Binghamton	An Automated Software Tool for High Voltage Dielectric Stress Test Bed	EEEL
Winterstein, Eylon	State University of New York Binghamton	Imaging the Adsorption of Methane and Hydrogen in Corncob Carbon	NCNR
Hatlee, Timothy	Syracuse University	Mechanisms of Adhesion Loss at and Above a Critical Relative Humidity Range	BFRL
Weaver, Jordan	Temple University	Validating Hydrogen Embrittlement Testing Using Electrochemical Techniques	MSEL
Johnson, Azurae	Tennessee Technological University	Characterization of the UV Degradation of Photocatalytic Nanoparticle-filled Polymers	BFRL
Turley, Kimberly (DHS Intern)	The George Washington University	RDID-Sensor Integration from Standardization to Application	MEL
Giltinan, Joshua	Towson University	Raman Imaging of Graphene	PL
Leibowitz, Joshua	University of Connecticut	Growth of Epitaxial Graphene on SiC Using an Induction-Heating Furnace	CNST
Embree, Lola	University of Cumberlands	Effects of Heat Transfer in Determining Absorbed Dose	PL
Bocchini, Peter	University of Delaware	Bioconjugation to 4H-SiC Thin Films for Biosensor Applications	MSEL
Lambarqui, Amine	University of District of Columbia	Microwave-Assisted Acid-Catalyzed Esterification of Benzoid Acid with Ethanol	EEEL
Payson, Grady	University of Iowa	Human Assessment Evaluation for the NIST 2009 Metrics for Machine Translation Challenge (Metrics MATR)	ITL
Ecker, Benjamin	University of Maryland Baltimore	Exploring Surgical Lighting for Enhanced Color Contrast	PL

STUDENT	UNIVERSITY	TITLE OF TALK	OU
Goel, Neeti	University of Maryland Baltimore	Chem-BLAST: The 21st Century Tool for Structural Databases	CSTL
Jones, Justin	University of Maryland Baltimore	Designing a Complete Safety System for the FANUC M-16iB Robot Arm as a Standard for Industrial Use	MEL
Macatangga, Patrick	University of Maryland Baltimore	Visual Analysis of Fire Spread Rate on Flexible Polyurethane Foam	BFRL
Modha, Menal	University of Maryland Baltimore	Combinatorial Software Testing	ITL
Serova, Nadezhda	University of Maryland Baltimore	An Algorithm for Mapping Alpha Helices to 1D Protein Sequence to Help Predict the 3D Structure	ITL
Temple, Robert	University of Maryland Baltimore	The Borate Fusion of Silicon Carbide	CSTL
Thomas, Marcus	University of Maryland Baltimore	Dynamics of Mixed Bose-Einstein Condensates in a Double Well	PL
Wittkamper, Julia	University of Maryland Baltimore	3D Polymer Scaffolds	MSEL
Won, Lauren	University of Maryland Baltimore	Efficient Algorithms for Elliptic Curve Cryptology	ITL
Aziz, Aaron	University of Maryland College Park	Aggregation of α-Chymotrypsinogen A in Aqueous Solutions	NCNR
Birenbaum, Jeffrey	University of Maryland College Park	Diagnosing Device Failure in Crystalline Single Electron Transistors	PL
Birman, Nikolaj	University of Maryland College Park	Acoustically Forcing a Natural Gas Pool Fire	BFRL
Biser, Dustin	University of Maryland College Park	Data Visualization for Industrial Irradiation Simulations	PL
Camp, Jeffrey	University of Maryland College Park	Characterization of Magnetic Nanoparticles with Potential Applications in Cancer Hyperthermia	MSEL
Cho, Suehyun	University of Maryland College Park	Achieving Sub-Diffraction Resolution Imaging of a Latent Image of Chemically Amplified Resist utilizing Inverse Stochastic Optical Reconstruction Microscopy (iSTORM)	CNST
Dupree, Andrew	University of Maryland College Park	High Standards: New Designs for High-Resistance Hamon Transfer Devices	EEEL
Garvey, John	University of Maryland College Park	Micro-Robot Design and Control	EEEL
Guiterrez, Teresa (DHS Intern)	University of Maryland College Park	The Development of Standard Test Methods in Homeland Security Applications	MEL
He, Christine	University of Maryland College Park	Polymer Solar Cells: Influence of Substrate on Crystallization Kinetics in Polythiophene/Fullerene Bulk Heterojunctions	CSTL
Hemmer, Daniel	University of Maryland College Park	Electronic Measurements of Novel Magnetic Sensors	PL
Hijji, Karam	University of Maryland College Park	Qualitative Biofunctionalization of Gold Nanoparticles	MSEL
Howell, Marc	University of Maryland College Park	Optimizing mRNA Capture and Reverse Transcription for Microscale Linear Amplification	CSTL

STUDENT	UNIVERSITY	TITLE OF TALK	OU
Hua, Alvin	University of Maryland College Park	IEEE p1451.2 Communication Standards	MEL
Jaskot, Daniel	University of Maryland College Park	Micro- and Nano-Fiber Waveguide Simulations	PL
Kriebel, Chad	University of Maryland College Park	Performance Metrics and Standards for Respirator (SCBA) Masks	BFRL
Krueger, Kevin	University of Maryland College Park	Fingerprinting Proanthocyanidins in Botanicals	CSTL
Lane, Hilary	University of Maryland College Park	Understanding and Optimizing the Crystal Orientation of Polymer Semiconductors for Organic Electronics	MSEL
Lei, Lydia	University of Maryland College Park	Three Dimensional Shape Retrieval Using Scale Invariant Feature Transform and Spatial Restrictions	ITL
Li, Song Wei	University of Maryland College Park	Nano-Calorimetry on a Thermal Conductivity Gauge	MSEL
McMahon, Matthew	University of Maryland College Park	Designing an Electrostatic Comb Drive Actuator for a MEMS Nanopositioner	MEL
Meyer, Gregory	University of Maryland College Park	A Robust Photoresist Developer Process	CNST
Moss, Richard	University of Maryland College Park	Mathematical Approaches in Analysis of Crystal Structures	MSEL
Price, Michael	University of Maryland College Park	Experiments and Simulations of Cable Tray Fires in Nuclear Power Plants	BFRL
Raghunandan, Sindhushree	University of Maryland College Park	Intrinsically Disordered Proteins and Heterogeneous Complexes	MSEL
Robertson, Scott	University of Maryland College Park	A Comparison of the 2D Response of EBT2 Radiochromic Film with the 3D Response of the PRESAGE^{TM} Dosimeter	PL
Seng, Robert	University of Maryland College Park	United States Measurement System Office at NIST – Web Presence and Functionality	TS
Siddiqi, Noorulain	University of Maryland College Park	Refitting e-FITS	ITL
Tang, Kathy	University of Maryland College Park	The Effects of Material Surface Properties on Cell Response	MSEL
Valenstein, Tobin	University of Maryland College Park	Open Source Voting Systems	ITL
Weaver, Emma	University of Maryland College Park	Effect of Laboratory Conditioning on Asphalt Film Thickness	BFRL
Wright, Nathaniel	University of Maryland College Park	Predicting Neutron Scattering Off of Nanoscale Magnetic Elements	NCNR
Young, Tso-Hsuan (Jason)	University of Maryland College Park	Digital Data Preservation Strategy and Implementation	ITL
Prakhya, Karthik	University of Massachusetts Amherst	Spin Torque and Spin Current in Magnetic Multilayers with an Anti-Ferromagnetic Layer	CNST
Purdum, Geoffrey	University of Massachusetts Amherst	Development of Silicon Nanocrystals as a Standard Reference Matereial via UV-Assisted Hydrosilylation	CSTL

STUDENT	UNIVERSITY	TITLE OF TALK	OU
Schniebs, Kathleen	University of North Texas & Texas Women's University	Silicon Substrate Temperature Sensor	EEEL
Bobea Rodriguez, Milena	University of Puerto Rico	Simulation of Dielectrophoretic Field-Flow Fractionation for the Separation of Single-Walled Carbo Nanotubes	MSEL
Cabrera Cruz, Greichaly	University of Puerto Rico	Simulation of a Microfluidic Mixer for Polymer Melts	MSEL
Cruz, Clara	University of Puerto Rico	Development of Verification Scripts and Complex Geometry Methods for the Fire Dynamics Simulator	BFRL
Davila Morris, Melissa	University of Puerto Rico	Chemical Metrology of Trace Explosives Detection	CSTL
Delgado, Stephanie Montalvo	University of Puerto Rico	Certification of SRM2461 Standard Casing through Confocal Microscopy	MEL
Ferrá, Eliezer	University of Puerto Rico	Implementation of PLAID Protocol in PIV Cards	ITL
Rivera, Britzy	University of Puerto Rico grant (Pontifical Catholic University of Puerto Rico)	Interfacial Rheology and Mass Transfer in Two Phase Microchannel Flows	MSEL
Perl, Emmett	University of San Diego	The Electronic Kilogram Experiment	EEEL
Bylsma, Jason	University of South Florida	Dual-frequency MOPA Setup for Laser-cooling Lithium	CNST
Abel, Brooks	University of Southern Mississippi	Wavelength-Dependent Photodegradation Study of Pure and Nano ZnO-Containing Polyurethane Coatings	BFRL
Hoff, Emily	University of Southern Mississippi	Biomimetic Lipid Membranes for the Study of Membrane Protein Structure	NCNR
Enright, Timothy	University of the Sciences Philadelphia	Polyelectrolyte Brushes as Nanoscale Confinement for Novel Electronic Materials	CNST
Walker, Matthew	University of Tulsa	Simulated Silicon: Perfection of Single Crystal Silicon Line Width Reference Features	EEEL
Feight, Jarrod	University of Wisconsin Madison	JMONSEL: Improvements	MEL
Cochran, Aaron	University of Wisconsin Stout	Low Energy Ar+ Plasma Etching of CoPd Multilayers	CNST
Schrader, Heather	University of Wisconsin Stout	Toxicity Measurements of Fire Effluents for Cables Used in Nuclear Power Plants	BFRL
Hillmer, Ansel	Valparaiso University	A Measurement of the Reflectivity of Neutrons in a Silicon Crystal	PL
Olson, Timothy	Valparaiso University	Complications of Silicon Crystal Reflectivity Measurements	PL
Van Aartsen, Rebecca	Valparaiso University	Analytical and Finite Element Structural Modeling of Nanomechanical Resonators	MEL
Martin, Cadence	Virginia Polytechnic Institute & State University	A High-Resolution Interferometer for Nanomechanical Measurements	MSEL

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Sidhom, Sara	Virginia Polytechnic Institute & State University	Vulnerability Assessment of Steel Frame Structures to Progressive Collapse	BFRL
Shemonski, Nathan	Washington University St. Louis	Building an External Feedback Loop to Perform FM Scanning Kelvin Force Microscopy	EEEL
Shyur, Yomay	Wellesley College	Measurements of Wavelength Standards for Calibration of Spectrometers on Extremely Large (Astronomical) Telescopes	PL
Avondo, Elizabeth	Western New England College	Enhancing a User Interface and Underlying Knowledge Base for a Robot Classification System for Urban Search and Rescue	MEL
Cahn, Jackson	Whitman College	Phosphate Ion Preadsorption Slows Nonspecific Protein Adsorption to Borosilicate Glass and Enhances Short-Term Adhesion of Osteoblasts	MSEL
Horgan, Christopher	Worcester Polytechnic Institute	How Old Is It? – Nuclear Forensic Chronology Reference Materials	PL

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