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ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

Electrostatics is one of the best kept secrets in modern technology. We are not trying to hide. Rather, the term "electrostatics" is growing obsolete. For many, electrostatics conjures up images of amber rods, animal fur, lightning rods, and Van de Graaff generators. While our technology has a wonderful, colorful history, we need to shift towards imagery that will inspire a new generation of researchers and practitioners in electrostatics. Perhaps we need to consult Madison Avenue to update our image.

Other technologies have faced the same dilemma. For example, when I was a youngster, I was excited to own my first "transistor radio." Solid state physics and p-n junctions were the cutting edge technology. Now, of course, discrete transistors have gone the way of vacuum tubes. Our perception is that technology has progressed and moved on to new and exciting arenas. Organic Light Emitting Diodes (OLEDs) promise to enable a new, brighter generation of electronic displays. Printed electronics on flexible substrates look to enable such as "smart clothing;" wearing a computer on your sleeve. Think about the technological foundation of these exciting areas; solid state physics, p-n junctions and discrete transistors, perhaps made with new materials and using new processes.

What are new, emerging facets of electrostatics? From our 2007 ESA Annual Conference, here are a few examples.

- biology of charged biomacromolecules
- pharmaceutical drug delivery by electrostatic deposition
- new cancer therapies using electroporation
- electrospun nanofibers
- space exploration – electrostatic mitigation of Mars and lunar dust

The common theme in these interesting and diverse areas is the interaction between electrical charges. How can we shift the imagery of "electrostatics" away from our historical past and towards the important, emerging applications? How can we emphasize and highlight the importance of charge interactions to future application?

What are your thoughts? Should we coin a better name? Do you have a suggestion? Do you have ideas for new and better ways to teach students about interactions between charges? Perhaps we can design new demonstrations to focus attention on emerging applications. How do you think that we could do that? And, what can we learn from history? How have other technical areas shifted and adapted to technological evolution?

I invite you to share your thoughts with us. Send a paragraph or two our Newsletter Editor.

Kelly Robinson,
ESA President

Reflections on 2007 ESA Annual Meeting

Our 2007 ESA Annual Meeting was held June 12-14, 2007 on the campus of Purdue University, West Lafayette Indiana. Professor Raji Sundararajan, our Conference General Chair, and Professor Sheryl Barringer, Technical Program Chair, both did a wonderful job organizing the conference. This year, we used a new format for our meeting. Our Conference began with our first technical session starting at 1:00 PM Tuesday afternoon and concluded with our Banquet on Thursday evening. The new format worked very well.

Our Conference was held in the Stewart Center on the Purdue Campus. Registration was Tuesday morning, including a casual Welcome Reception over the lunch hour. The first of our 5 Technical sessions began Tuesday afternoon and continued with morning and afternoon sessions on Wednesday and Thursday. As is our custom, there was ample time for technical discussion during breaks.

We concluded with our Banquet on Thursday evening, including the award presentations for our Student Paper Competition. After dinner, Glenn Schmieg delighted conference participates with a talk entitled "Playing With Food."

On Friday morning, Raji arranged tours of two Purdue University facilities. First was the Envision Center where tools are developed for immersive visualization of scientific and engineering data. Second was the Birck Nanotechnology Center in Discover Park which has a 25,000 sq. ft. cleanroom with research space for nanofabrication.

Thanks to Al Seaver for the many photos of our meeting. There is a link to the photos on our website, http://www.electrostatics.org (see bottom of home page).

Kelly Robinson

Raji Sundararajan, Mark Horenstein and Sheryl Barringer prepare for the start of our technical sessions

Student Paper Competition Results

1st Place Winners

Keith M. Forward: "Tribo-electric charging in fluidized bed systems under vacuum"

Nathan Duff: "Particle dynamics simulation of tribo-electric charging in granular insulator systems"

2nd Place Winners

Jason Robison: "Development and testing of large area electro-dynamic screens for deployment on Mars missions"

Isaias Ramirez: "Improving the dispersion of nano-fillers in silicone polymers by surface treatment"

3rd Place Winners

Praveen K. Srirama: "Mars dust: real time and in-situ measurements of size and charge distributions"

Chitral J. Angammana: "Bending instability of electro-spinning and electrically forced jets applied to different electrodes arrangements"

Runners-up

Jeremy J. Diaz: "Development of a flexible electro-dynamic screen for lunar dust mitigation on EVA suits and exploration equipment"

Reshma Kotian: "Characterization of inherent electrostatic properties and particle size distribution of pharmaceutical aerosols"

Special Thanks to Mystic Tan, Inc. for the donation of $1000 towards student paper competition.

2007 ESA Student Paper Competition winners

Current Events

Electrostatics & Experimental Verification of the General Theory of Relativity

For the past three years a satellite has circled the Earth, collecting data to determine whether two predictions of Albert Einstein's general theory of relativity are correct. The GP-B satellite was launched in April 2004. It collected more than a year's worth of data that the Stanford GP-B science team has been poring over for the past 18 months. The satellite was designed as a pristine, space-borne laboratory, whose sole task was to use four ultra-precise gyroscopes to measure directly two effects predicted by general relativity. One is the geodetic effect—the amount by which the mass of the Earth warps the local space-time in which it resides.

The other effect, called frame-dragging, is the amount by which the rotating Earth drags local space-time around with it. According to Einstein's theory, over the course of a year, the geodetic warping of Earth's local space-time causes the spin axes of each gyroscope to shift from its initial alignment by a minuscule angle of 6.606 arc-seconds (0.0018 degrees) in the plane of the spacecraft's orbit. Likewise, the twisting of Earth's local space-time causes the spin axis to shift by an even smaller angle of 0.039 arc-seconds (0.000011 degrees)—about the width of a human hair viewed from a quarter mile away—in the plane of the Earth's equator.

Two important discoveries were made while analyzing the gyroscope data from the spacecraft: one, the "polhode" motion of the gyroscopes dampens over time; two, the spin axes of the gyroscopes were affected by small classical torques. Both of these discoveries are symptoms of a single underlying cause: electrostatic patches on the surface of the rotor and housing. Patch effects in metal surfaces are well known in physics and were carefully studied by the GP-B team during the design of the experiment to limit their effects. Though previously understood to be microscopic surface phenomena that would average to zero, the GP-B rotors show patches of sufficient size to measurably affect the gyroscopes' spins.

The gyroscope's polhode motion is akin to the common "wobble" seen on a poorly thrown American football, though it shows up in a much different form for the ultra-spherical GP-B gyroscopes. While it was expected that this wobble would exhibit a constant pattern over the mission, it was found to slowly change due to minute energy dissipation from interactions of the rotor and housing electrostatic patches. The polhode wobble complicates the measurement of the relativity effects by putting a time-varying wobble signal into the data.

The electrostatic patches also cause small torques on the gyroscopes, particularly when the space vehicle axis of symmetry is not aligned with the gyroscope spin axes. Torques cause the spin axes of the gyroscopes to change orientation, and in certain circumstances, this effect can look like the relativity signal GP-B measures. Fortunately, the drifts due to these torques have a precise geometrical relationship to the misalignment of the gyro spin/vehicle symmetry axis and can be removed from the data without directly affecting the relativity measurement.

(excerpted from an article appearing at

http://www.sciencedaily.com/releases/2007/04/070416164604.htm)

DNA Sieve: Nanoscale Pores Can Be Tiny Analysis Labs

Imagine being able to rapidly identify tiny biological molecules such as DNA and toxins using less than a drop of salt water in a system that can fit on a microchip. It's closer than you might believe, say a team of researchers at the National Institute of Standards and Technology (NIST), Brazil's Universidade Federal de Pernambuco, and Wright State University in Dayton, Ohio.

In a paper appearing next week in the Proceedings of the National Academy of Sciences,* the team proves for the first time that a single nanometer-scale pore in a thin membrane can be used to accurately detect and sort different-sized polymer chains (a model for biomolecules) that pass through or block the channel.

Traditionally, unknown molecules are measured and identified using mass spectrometry, a process that involves ionizing and disintegrating large numbers of a target molecule, then analyzing the masses of the resulting molecules to produce a "molecular fingerprint" for the original sample. This equipment can cover a good-sized desk. By contrast, the "single-molecule mass spectrometry" system described in the PNAS paper is a non-destructive technique that in principle can measure one molecule at a time in a space small enough to fit on a single microchip device.

The technique involves creating a lipid bilayer membrane similar to those in living cells, and "drilling" a pore in it with a protein (alpha-hemolysin) produced by the Staphyloccoccus aureus bacteria specifically to penetrate cell membranes. Charged molecules (such as single-stranded DNA) are forced one-at-a-time into the nanopore, which is only 1.5 nanometers (the diameter of a human hair is about 10,000 nanometers) at its smallest point, by an applied electric current.

(cont'd. on next page)

Current Events (cont'd.)

DNA Sieve: Nanoscale Pores Can Be Tiny Analysis Labs (cont'd.)

As the molecules pass through the channel, the current flow is reduced in proportion to the size of each individual chain, allowing its mass to be easily derived.

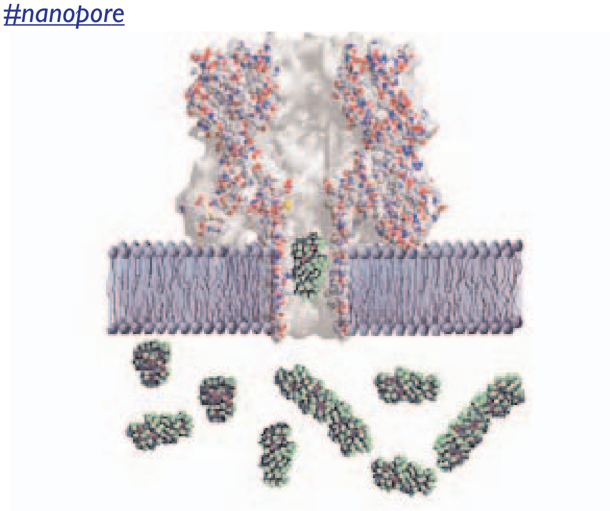
In this experiment, various-sized chains in solution of the uncharged polymer polyethylene glycol (PEG) were substituted for biomolecules. Each type of PEG molecule reduced the nanopore's electrical conductance differently as it moved through, allowing the researchers to distinguish one size of PEG chain from another.

As a control, a solution of a highly purified PEG of a specific size was characterized with the nanopore. The resulting "fingerprint" closely matched the one identifying samples of the same size polymer in the mixed chain solution.

Further enhancement of the data from both the experimental and control tests yielded mass measurements and identifications of the different PEG chains that correlate with those made by traditional mass spectrometry.

Because the dimensions of the lipid bilayer and the alpha-hemolysin pore, as well as the required amount of electrical current, are at the nanoscale level, the "single-molecule mass spectrometry" technology may one day be incorporated into "lab-on-a-chip" molecular analyzers and single-strand DNA sequencers.

source:
http://www.nist.gov/public_affairs/techbeat/tb2007_0510.htm#nanopore



Graphic showing a lipid bilayer membrane (blue) with an alpha-hemolysin nanopore. A polyethylene glycol molecule (green globular structure) is transiting the pore; others are in solution on one side of the membrane. The colored spheres represent individual atoms, and are approximately 0.5 nanometers in diameter.

Doctors Warn of Injuries From Lightning Strikes While Using IPods, Electronic Devices

Listen to an iPod during a storm and you may get more than electrifying tunes. A Canadian jogger suffered wishbone-shaped chest and neck burns, ruptured eardrums and a broken jaw when lightning traveled through his music player's wires. Last summer, a Colorado teen ended up with similar injuries when lightning struck nearby as he was listening to his iPod while mowing the lawn.

Emergency physicians report treating other patients with burns from freak accidents while using personal electronic devices such as beepers, Walkman players and laptop computers outdoors during storms.

Michael Utley, a former stockbroker from West Yarmouth, Massachusetts, who survived being struck by lightning while golfing, has tracked 13 cases since 2004 of people hit while talking on cell phones. They are described on his lightning safety Web site, *http://www.struckbylightning.org*.

Contrary to some urban legends and media reports, electronic devices do not attract lightning the way a tall tree or a lightning rod does. "It's going to hit where it's going to hit, but once it contacts metal, the metal conducts the electricity," said Dr. Mary Ann Cooper of the American College of Emergency Physicians and an ER doctor at University of Illinois Medical Center at Chicago.

When lightning jumps from a nearby object to a person, it often flashes over the skin. But metal in electronic devices -- or metal jewelry or coins in a pocket -- can cause contact burns and exacerbate the damage.

Lightning strikes can occur even if a storm is many miles away, so lightning safety experts have been pushing the slogan "When thunder roars, go indoors," said Cooper.

Jason Bunch, 18, says it was not even raining last July, but there was a storm off in the distance. Lightning struck a nearby tree, shot off and hit him. Bunch, who was listening to Metallica while mowing the grass at his home in Castle Rock, Colorado, still has mild hearing damage in both ears, despite two reconstructive surgeries to repair ruptured eardrums. He had burns from the earphone wires on the sides of his face, a nasty burn on his hip where the iPod had been in a pocket and "a bad line up the side of my body," even though the iPod cord was outside his shirt. "It was a real miracle" he survived, said his mother, Kelly Risheill.

The Canadian jogger suffered worse injuries, according to a report in Thursday's New England Journal of Medicine.

Current Events (cont'd.)

The man, a 39-year-old dentist from the Vancouver area, was listening to an iPod while jogging in a thunderstorm when, according to witnesses, lightning hit a tree a couple of feet away and jumped to his body. The strike threw the man about eight feet (2.5 meters) and caused second-degree burns on his chest and left leg.

The electric current left red burn lines running from where the iPod had been strapped to his chest up the sides of his neck. It ruptured both ear drums, dislocated tiny ear bones that transmit sound waves, and broke the man's jaw in four places, said Dr. Eric Heffernan, an imaging specialist at Vancouver General Hospital.

The injury happened two summers ago and despite treatment, the man still has less than 50 percent of normal hearing on each side, must wear hearing aids and can't hear high-pitched sounds.

"He's a part-time musician, so that's kind of messed up his hobby as well," Heffernan said.

Like the Colorado teen, the Canadian patient, who declined to be interviewed or identified, has no memory of the lightning strike.

In another case a few years ago, electric current from a lightning strike ran through a man's pager, burning both him and his girlfriend who was leaning against him, said Dr. Vince Mosesso, an emergency doctor at University of Pittsburgh Medical Center.

Eardrum ruptures are considered the most common ear injury in lightning-strike victims, occurring in 5 percent to 50 percent of patients, according to various estimates -- whether or not an electronic device is involved. A broken jaw is rare, doctors say.

(from *http://www.foxnews.com/story/0,2933,289023,00.html*)

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CALENDAR

- Electrostatics Science and Technology Workshop, Aug. 16-23, 2007, Tahiti, Contact: Gérard Touchard, Tel: 33 (0)5 49 49 69 32, Fax : 33 (0)5 49 49 69 68 email: *gerard.touchard@lea.univ-poitiers.fr*
- 5th Asian Aerosol Conf., Aug. 26-29, 2007, Kaohsiung, Taiwan, info at *http://www.aac2007.org*
- 29th Annual EOS/ESD Symp., Sept. 16-21, 2007, Anaheim, California, Contact: ESD Assoc., Tel: 315-339-6937, *info@esda.org* or *http://www.esda.org* ,
- Elect. Insul. Conf., Sept. 24-26, 2007, Nashville, Tennessee, Contact: Mr. Art Lemm, Tel: 262-835-3368, Fax: 262-835-1515, *alemm@cooperpower.com* , info at *http://www.deis.nrc.ca/eic2007/eic2007.htm* (abstracts due Feb. 15, 2007)
- 2007 IEEE Conf. on Elec. Insul. & Diel. Phen., Oct. 14-17, 2007, Vancouver, British Columbia, Canada, info at *ceidp@ieee.org* or *http://www.ewh.ieee.org/soc/dei/ceidp*
- ESA 2008, June, 2008, Minneapolis/St. Paul, Minnesota, Contact: Al Seaver, Tel: 651-735-6760, *aseaver@electrostatics.us*, or Daniel Lacks, Tel: 216-368-4238, daniel.lacks@case.edu
- 16th Int'l. Conf. on Diel. Liquids, June 30-July 4, 2008, Poitiers, France, Contact: H. Romat, Tel: 33-(0)5-49-49-69-31, *icdl2008@lea.univ-poitiers.fr*, (abstracts due Oct. 15, 2008), info at *http://lea.sp2mi.univ-poitiers.fr/icdl/*
- 6th Conf. of the French Electrostatic Society, July 7-9, 2008, Gif-Sur Yvette, France, Contact: Philippe Molinie, Tel: 33-(0) 1-69-85-15-25, *sfe2008@sup-elec.fr*, (title due Dec. 15, 2007), website under construction
- ESA 2009, June 16-19, 2009, Boston, MA Contact: Mark Horenstein, Tel: 617-353-5437, *mnh@bu.edu*

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Details Forthcoming