Sept/Oct 2008 • No. 193

ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

Let Us Make It Better!!!

(with details from "Better: A Surgeon's Notes on Performance" by Atul Gawande [1])

Dear All:

Two case studies (in medicine):
1) Each year, two million Americans acquire an infection while they are in the hospital in the US and 90,000 die from it - according to the CDC [1]. The hardest part of the infection-control teams' job is not the variety of contagions that are encountered, or the panic that occurs sometimes among patients and staff, but getting clinicians – both doctors and nurses, to wash their hands. By washing hands, 80% of the disease could be contained, but it is not done [1]. Embarrassingly, this has been the status quo since 1847 [1]. One can wonder what does it take to make the clinicians wash their hands? No part of the human skin is spared from bacteria. Bacterial counts on the hands range from 5,000 to 5 million colony-forming units/cm2 [1]. On the hand, deep skin crevices trap 10 to 20% of the flora, making removal difficult, even with scrubbing and sterilization. The worst place is under fingernails - thus recent CDC guidelines require hospital personnel to keep their nails trimmed to less than one quarter of an inch and to remove artificial nails. Making sure every clinical person washes their hands seems to be as or more difficult than a difficult diagnosis.

2) What is more likely to save a 29 year old cystic fibrosis (CF) patient when the life expectancy of CF patients is just 33 years – investment in laboratory science or in efforts to improve how existing medical care performs? Most people would opt for investment in laboratory science - the search for a cure. In 1989, when scientists discovered the gene for CF, a cure was believed to be at the doorstep - just a few years away. However, dramatic progress didn't occur. This is also true for many other diseases. Hence, the better alternative is to improve and transform existing clinical performance. Of all the work done, this would save more lives. Of course, we need innovations to expand our knowledge and therapies, whether for CF or any other countless ways the human body fails. However, we must also effectively utilize existing capabilities. Simple techniques (e.g. hand washing) have saved thousands of lives. Scientific efforts to improve performance in medicine, or any other field for that matter, gets only a miniscule portion of the total budget.

Consider breast cancer, the most common cancer for women. Rates of death from breast cancer have fallen about 25% in industrialized countries since 1990 [1]. It is reported by the US breast cancer registry that at least one quarter of the decline, and likely more than half, was due simply to increased use of screening mammography. Mammography has saved more lives than any other major medicine. The key to its working is that women must get it once a year. Less often leaves too much time in between for a breast cancer to form, grow, and spread undetected. So, how many women get their yearly mammograms? Over a five year period, one in seven; over a ten year period, just one in 16 [1]. There are a number of reasons - women themselves are often blamed - but the important underlying factors include: 1) getting a mammogram is a time-consuming, uncomfortable, and difficult process, 2) the inconvenience of getting to a facility, 3) the expense for those without medical coverage, and 4) the lack of yearly reminders [1]. The US government and private foundations spend billions of dollars on breast cancer research for discovery of new treatments, but little on innovations to improve the ease, access and cost of mammography screening, though the latter has saved more lives than the new medicines. Studies consistently show that more regular use of this one technology alone would reduce deaths by one third [1].

These are just two examples of what improving performance a little better could achieve. This doesn't mean that all research needs to be stopped, however, it has been proven many times that improving/raising performance of exist-

(cont'd. on page 3)

ELECTROSTATIC PROCESSES COMMITTEE

CALL FOR PAPERS

2009 JOINT CONFERENCE ESA / IEJ / IEEE-EPC / SFE

June 16-19, 2009

Boston University, MA, USA

The Electrostatic Society of America (ESA), Institute of Electrostatic Japan (IEJ), Industry Applications Society (IEEE-IAS) Electrostatic Processes Committee, and La Societé Francaise d'Electrostatic (SFE) will hold their 2009 Joint Conference on the campus of Boston University. Please join us for possibly the largest, most diversified, international gathering on electrostatics in North America including technical papers, a student paper competition, poster sessions, informal discussions, and electrostatic demonstrations.

TECHNICAL PROGRAM: We invite papers in all scientific and technical areas involving electrostatics. Contributions can range from fundamental investigations of electrostatic phenomena to studies of the implications, mitigation, or utilization of electrostatic phenomena in diverse settings. Technical topics include:

• Atmospheric and space applications	• Flows, forces, and fields	• Particle control and charging
• Biological and medical applications	• Materials behavior and processing	• Safety and hazards
• Breakdown and discharge	• Measurement and instrumentation	

ABSTRACT SUBMISSION: Abstracts should be submitted online, at http://www.electrostatics.org

STUDENT PAPER COMPETITION: Undergraduate and graduate student authors and co-authors presenting their work are eligible. The Conference Registration Fee is waived for participants in our Student Paper Competition.

IMPORTANT DATES	February, 2009	Detailed conference information available at http://www.electrostatics.org
	March 2, 2009	Abstract submission deadline
	March 18, 2009	Notification of paper acceptance
	April 17, 2009	Final manuscripts due

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President's Message (cont'd.)

ing techniques will save more lives than spending most of the dollars only on new research.

I think the same is applicable to the electrostatics field too. Improving the performance of existing electrostatic spraying or other techniques might go a long way until the next efficient technique is invented and implemented. Changing the electrode geometry, material, size - everything that will lead to an improvement is to be explored and implemented. I am exploring ways to enhance our service to all of you members too; how to do a "better" job. Please join me and give me your support and suggestions (I am sure you have plenty). I know we have to keep looking for and finding opportunities to do better. That reminds me to tell you with pleasure that days are nearing to submit your abstract for 2009 ESA in Boston. It will be a joint meeting with the IEEE Industrial Applications Society - Electrostatic Processes Committee (IAS-EPC), the Societe Francaise d'Electrostatic (SFE), and the Institute of Electrostatic Japan (IEJ).

Thank you very much.
Have a "better" time.

Yours for the Friendly Society,
Raji Sundararajan,
ESA President

Calendar

- ISEHD2009. March 25-28, 2009, Universiti Malaysia Sarawak, Sarawak, Malaysia, Contact: ISEHD2009 Secretariat, Tel: 006-082-58-3326, *isehd2009@feng.unimas.my* or *aigit@feng.unimas.my* , website: *http://www.feng.unimas.my/ISEHD2009/* (abstracts due Oct. 31, 2008)
- 11th Int'l. Conf. of Electrostatics. May 27-29, 2009, Valencia, Spain, Contact: Dr. Pedro Segovia, Tel: (+34) 96 136 66 70, *pedro.llovera@ite.es*, website: http://electrostatics.ite.es (abstracts due Feb. 29, 2008)
- ESA-2009, June 16-19, 2009, Boston, MA Contact: Mark Horenstein, Tel: 617-353-5437, *mnh@bu.edu,* website: http://www.electrostatics.org
- ESA-2010, June, 2010, Charlotte, NC Contact: Maciej Noras, Tel: 704-687-3735, *mnoras@uncc.edu,* website: http://www.electrostatics.org

ESA08 Conference Follow-up

ESA08 Photos

The photos of ESA-2008 (taken by Dave Swenson, Luz Marina Calle and Al Seaver) can be accessed by going to the ESA home page at *http://www.electrostatics.org* and clicking on the Conference Photos link found under ESA2008 Conference. This will bring you to the instruction page describing how to view and download any pictures you want. There were almost 800 pictures taken at ESA-2008, and due to this large number the photos are grouped according to activity. The table below will be a useful guide to finding the activity of interest. Several people sent in pictures, so you may find multiple pictures of a person scattered throughout an activity. Each page below contains nine pictures.

Pages 1 - 36 Banquet

Pages 36 - 51 Boat ride down the Mississippi

Pages 52 - 81 Conference

Page 81 Governing Board

Pages 82 - 87 Hospitality Suite

Pages 87 - 88 Spouses Activities

ESA08 Presentations - Where are they?

This has turned out to be a bigger project than I originally estimated. I apologize for the delay, but I have to separate the audio from the video, then compress each separately (to date I have the videos compressed, but not all the audios). Next I will have to attach and sync everything back together. As of today I hope to have the talks ready for announcement in the Nov/Dec ESA Newsletter.

Al Seaver
Past ESA President

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Current Events

Solid-state cooling device harnesses corona discharge

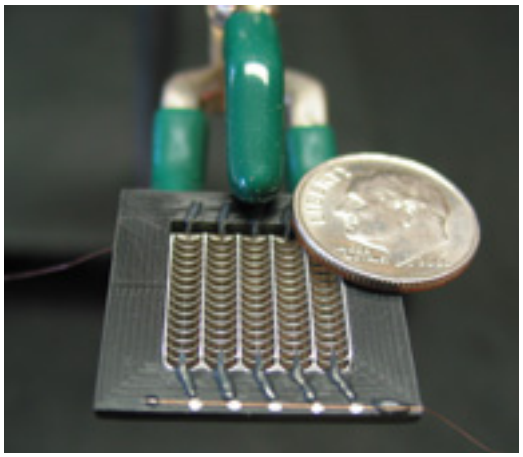
Matthew Miller, Editor in Chief, EDN.com – EDN, 5/1/2008

http://www.edn.com/article/CA6553636.html?industryid=47042&nid=2432&rid=1258757318

Thorrn Micro Technologies has demonstrated a small, silent, no-moving-parts cooling device that generates more airflow than mechanical fans four times its size while consuming less power and space. The 15×15×2-mm RSD5 creates a breeze of 2.4m/sec, outperforming the 1.7m/sec that a mechanical fan measuring 40×40×10 mm can produce, according to the company.

The product of six years of National Science Foundation-funded research, the technology nestles live wires within half-cylinder beds that the company carves into a non-conducting plate. Application of a voltage through the wires causes a corona discharge, creating a microscale plasma. Free ions in the plasma then migrate from the wires to the plate, displacing air molecules as they go and generating a sustained wind.

Thorrn's innovation lies in the structure that channels the airflow effectively enough to cool a 25W chip with a device smaller than 1 cm3 without risk of sparks or arcing. In the company's current design, the contoured plate resides atop a heat sink, but plans call for integrating the technology directly onto ICs.



Scientist Sells the Electric Sail for Space Propulsion

Barry E. DiGregorio

A Finnish invention known as an electric sail has been designed to propel a space probe through the solar system by repelling the protons contained in the solar wind. If successful, the electric sail would reduce the cost of launching deep-space probes that must carry heavy fuel tanks.

Invented by Pekka Janhunen, a research fellow at the Finnish Meteorological Institute, the electric sail produces thrust from the solar wind, comprising high-energy electrons and protons streaming from the sun. The electric sail is similar in some ways to the more conventional solar-sail idea. The solar sail requires an ultrathin aluminized Mylar sail 250 meters in diameter to catch the solar wind, which blows out from the sun at speeds between 400 and 800 kilometers per second. However, no one has ever deployed and tested the solar sail in space, and because of its extreme size, the sail presents a number of engineering problems. But, says Janhunen, the electric sail has many advantages over the solar sail—notably, not having to deploy a gigantic sheet of Mylar in space.

Instead, the electric sail uses 50 to 100 wire tethers, each 20 to 30 km long, that are unreeled in space like a fishing line and kept taut using centrifugal force, by spinning them on a central axis. Each tether is composed of four wires, 20 micrometers in diameter, that are interconnected by other smaller wires. The tethers are kept at a 20-kilovolt potential relative to solar protons. This voltage is achieved by an electron gun, which draws off the electrons from the tethers and fires them into space. The positively charged tethers repel the solar wind protons, thereby extracting momentum from them and producing thrust for the spacecraft.

For the past two years, scientists from the space research department at the Finnish Meteorological Institute, in Helsinki, have been conducting computer simulations, hoping to get their electric-sail concept accepted and funded by the European Space Agency (ESA). Janhunen and two other researchers, Giovanni Mengali and Alessandro A. Quarta, from the University of Pisa, in Italy, reported a performance analysis of the electric sail in the January–February 2008 issue of the Journal of Spacecraft and Rockets. According to their analysis, an electric sail would allow a spacecraft to travel just about anywhere in the solar system without having to carry large stores of liquid or solid rocket fuel. Their analysis shows that the electric sail could accelerate small 10- to 100-kilogram payloads to substantial speeds, even faster than is possible with conventional propulsion systems.

At first glance it might seem that the sail can only propel a craft in a straight line out from the sun. But Janhunen's simulations show that by tilting the plane of the sail as much as 30 degrees the system allows for attitude course-correction adjustments, which are required to

reach most objects in the solar system. "This thrust vectoring allows one to spiral inward or outward in the solar system," he says. "It is not clear how this would be done with a solar sail."

"Even with the baseline electric sail, one could ferry a multimetric-ton payload from a near-Earth asteroid to Earth orbit in a timescale of a few years," said Janhunen.

For the electric sail to accelerate, the electron gun has to fire constantly. "If one stops the gun, the tethers become neutralized by solar-wind electrons in a timescale of about half a minute," says Janhunen. "This, however, turns out not to be bad, since it provides us with an interesting electric throttling capability. For example, we can turn off and restart propulsion an unlimited number of times." (He points out, though, that shutting down the power does not actually slow down the craft.) For Janhunen and his team, this is another selling point of the electric sail compared with the traditional solar sail, which cannot be turned off once it has been opened in space.

Ralph McNutt, project scientist for the NASA Messenger mission to Mercury, says that both the solar-sail and electric-sail concepts should be explored but adds that both have weaknesses. For one, they are both quite large and need to be deployed, even in a test version, rather far out in space. Because Earth's magnetic field shields easily accessible low Earth orbits from the solar wind, sails would have to be launched into a high, and consequently expensive, orbit. "By the time a launch vehicle is added, I think one is easily talking tens of millions of dollars," says McNutt. "Without an immediate need for development, [the money] will be the biggest stumbling block to even demonstrating that the technology will work."

Janhunen's cost estimates are lower—on the order of 5 million euros [US $7.7 million]—provided that his team could freely select where they purchase the parts. "If we get this amount of funding, we estimate that we can fly a test mission three years from now," he says.

(for more info. see *http://www.spectrum.ieee.org/may08/6240*)

Scientists Find Trigger for Northern Lights

Kenneth Chang

http://www.nytimes.com/2008/07/25/science/space/25aurora.html?_r=2&oref=slogin&oref=slogin

Researchers working on a NASA mission to understand the interplay of magnetic fields and charged particles blown outward from the Sun have identified the trigger for the colorful electrical storms in the polar regions. They hope this is a step in developing reliable forecasts of geomagnetic storms that can disrupt satellites in orbit and power grids on the ground. The findings appeared in an article published Thursday on the Web site of the journal Science.

Scientists have long known that the dancing auroras of color known as the northern and southern lights are generated by charged particles flying from the Sun and interacting with the Earth's magnetic field, which is then pulled into a windsock shape by the solar wind. Turbulent storms on the Sun generate extremely bright auroral displays, but even in quieter times, smaller events known as substorms still generate the lights.

"They happen every three or four hours," said Vassilis Angelopoulos, a professor of earth and space sciences at

University of California, Los Angeles, and principal investigator of a NASA mission called Themis, short for Time, History of Events and Macroscale Interactions during Substorms. "The Earth's environment stores energy. Then all of a sudden it releases it."

Each substorm generates a current of about one million to two million amps over one to two hours, or a total energy equivalent to a magnitude-5 or magnitude-6 earthquake, Dr. Angelopoulos said. Scientists knew two events that occur in the tail of the magnetic field during substorms, but did not know which event acted as the trigger for the auroras.

Over the past 30 years, some scientists have believed that a disruption in the current of charged particles — similar to the blowing of an electric fuse, the scientists said — about one-sixth of the distance from the Earth to the Moon's orbit was responsible. Others believed it was a snapping of magnetic field lines farther out, about one-third of the distance to the Moon.

To answer the question, the Themis mission launched five identical satellites, each about the size of a washing machine, to measure the electric and magnetic fields as well as the particles passing by at different locations around Earth. Coupled with ground observations, scientists were able to deduce the order of events in a substorm in February.

The snapping of magnetic fields occurred first, followed by a burst of auroras. Surprisingly, the disruption in the charged particle current occurred after the aurora. Proponents of that hypothesis had thought that the magnetic snapping caused the change in electric current and that, in turn, led to the auroras.

"This defies our old paradigms," Dr. Angelopoulos said. Next, Dr. Angelopoulos said, scientists will try to figure out exactly why the magnetic field lines snap. With a better understanding of substorms, scientists would like to understand what happens during the larger storms. They hope to have better prediction methods working by the time the next peak of solar storms arrives between 2010 and 2012.

Simulations help explain fast water transport in nanotubes

James E. Kloeppel, Physical Sciences Editor, 217-244-1073; kloeppel@illinois.edu

http://www.news.uiuc.edu/news/08/0916water.html

By discovering the physical mechanism behind the rapid transport of water in carbon nanotubes, scientists at the University of Illinois have moved a step closer to ultra-efficient, next-generation nanofluidic devices for drug delivery, water purification and nano-manufacturing.

"Extraordinarily fast transport of water in carbon nanotubes has generally been attributed to the smoothness of the nanotube walls and their hydrophobic, or water-hating surfaces," said Narayana R. Aluru, a Willett Faculty Scholar and a professor of mechanical science and engineering at the U. of I.

"We can now show that the fast transport can be enhanced by orienting water molecules in a nanotube," Aluru said. "Orientation can give rise to a coupling between the water molecules' rotational and translational motions, resulting in a helical, screw-type motion through the nanotube," Aluru said.

Using molecular dynamics simulations, Aluru and graduate student Sony Joseph examined the physical mechanism behind orientation-driven rapid transport. For the simulations, the system consisted of water molecules in a 9.83 nanometer long nanotube, connected to a bath at each end. Nanotubes of two diameters (0.78 nanometers and 1.25 nanometers) were used. Aluru and Joseph reported their findings in the journal Physical Review Letters.

For very small nanotubes, water molecules fill the nanotube in single-file fashion, and orient in one direction as a result of confinement effects. This orientation produces water transport in one direction. However, the water molecules can flip their orientations collectively at intervals, reversing the flow and resulting in no net transport.

In bigger nanotubes, water molecules are not oriented in any particular direction, again resulting in no transport.

Water is a polar molecule consisting of two hydrogen atoms and one oxygen atom. Although its net charge is zero, the molecule has a positive side (hydrogen) and a negative side (oxygen). This polarity causes the molecule to orient in a particular direction when in the presence of an electric field.

Creating and maintaining that orientation, either by directly applying an electric field or by attaching chemical functional groups at the ends of the nanotubes, produces rapid transport, the researchers report.

"The molecular mechanism governing the relationship between orientation and flow had not been known," Aluru said. "The coupling occurs between the rotation of one molecule and the translation of its neighboring molecules. This coupling moves water through the nanotube in a helical, screw-like fashion."

In addition to explaining recent experimental results obtained by other groups, the researchers' findings also describe a physical mechanism that could be used to pump water through nanotube membranes in next-generation nanofluidic devices.

New Electrostatic-based DNA Microarray Technique Could Revolutionize Medical Diagnostics

ScienceDaily (July 1, 2008)

(excerpted from *http://www.sciencedaily.com/releases/2008/06/080630130134.htm*)

The dream of personalized medicine - in which diagnostics, risk predictions and treatment decisions are based on a patient's genetic profile — may be on the verge of being expanded beyond the wealthiest of nations with state-of-the-art clinics. A team of researchers with the U.S. Department of Energy's Lawrence Berkeley National Laboratory (Berkeley Lab) has invented a technique in which DNA or RNA assays — the key to genetic profiling and disease detection — can be read and evaluated without the need of elaborate chemical labeling or sophisticated instrumentation. Based on electrostatic repulsion — in which objects with the same electrical charge repel one another — the technique is relatively simple and inexpensive to implement, and can be carried out in a matter of minutes.

"One of the most amazing things about our electrostatic detection method is that it requires nothing more than the naked eye to read out results that currently require chemical labeling and confocal laser scanners," said Jay Groves, a chemist with joint appointments at Berkeley Lab's Physical Biosciences Division and the Chemistry Department of the University of California (UC) at Berkeley, who led this research. Groves, who is also a Howard Hughes Medical Institute (HHMI) investigator, and members of his research group Nathan Clack and Khalid Salaita, have published a paper on their technique in the journal Nature Biotechnology, which is now available online. The paper is entitled "Electrostatic readout of DNA microarrays with charged microspheres."

In their paper, Groves, Clack, and Salaita describe how dispersing a fluid containing thousands of electrically-charged microscopic beads or spheres made of silica (glass) across the surface of a DNA microarray and then observing the Brownian motion of the spheres provides measurements of the electrical charges of the DNA molecules. These measurements can in turn be used to interrogate millions of DNA sequences at a time. What's more, these measurements can be observed and recorded with a simple hand-held imaging device — even a cell phone camera will do.

"The assumption has been that no detection technique could be more sensitive than fluorescent labeling, but this is completely untrue, as our results have plainly demonstrated," said Groves. "We've shown that changes in surface charge density as a result of specific DNA hybridization can be detected and quantified with 50-picometer sensitivity, single base-pair mismatch selectivity, and in the presence of complex backgrounds. Furthermore, our electrostatic detection technique should render DNA and RNA microarrays sufficiently cost effective for broad world-health applications, as well as research."

"We have demonstrated parallel sampling of a microarray surface with micron-scale resolutions over centimeter-scale lengths," said Groves. "This is four orders of magnitude larger than what has been achieved to date with conventional scanning-electrostatic-force microscopy."

In a typical experiment, a microarray is prepared and mounted in a well chamber and the DNA is hybridized (a standard technique in which complementary single strands of DNA bind to form double-stranded DNA "hybrids"). A suspension of negatively-charged silica microspheres is then dispersed through gravitational sedimentation over the microarray surface, a process which takes about 20 minutes. Because the substrate or background surface of the microassay is positively charged, the silica microspheres will spread across the entire surface and adhere to it. However, on surface areas containing double-stranded DNA, which is highly negatively charged, and on areas containing single-stranded DNA, also negatively charged but to a lesser degree than double-stranded DNA, the microspheres will levitate above the substrate surface, stacking up in "equilibrium heights" that are dictated by a balance between gravitational and electrostatic forces.

These electrostatic interactions on the microarray surface result in charge-density contrasts that are readily observed. Surface areas containing DNA segments take on a frosted or translucent appearance, and can be correlated to specific hybridizations that reveal the presence of genes, mutations and pathogens.

"Our technique is essentially a millionfold parallel version of the classic experiment used by Robert Millikan almost 100 years ago, when he determined the charge of a single electron by observing the positions of oil droplets levitated above a charged plate," said Groves.

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