Sept/Oct 2007 • No. 187

ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

I had the great pleasure to attend the 2007 IEEE Industry Applications Society Annual Meeting in New Orleans, Louisiana held the last week in September. The conference had 68 technical sessions with 7 organized by the Electrostatic Processes Committee.

- Micro-, Nano-, and Molecular Electrostatics
- Electrostatic Measurements and Materials
- Industrial Electrostatics
- Electrical Discharges
- Non-Thermal Plasma Reactors
- Pollution Control Methods and Devices
- Electrostatic Hazards

I was keenly interested in presentations on emerging technologies and applications. Here are a few examples:

- Prof. Wamadeva (Bala) Balachandran, Brunel University, UK, presented an overview of the micro-fluidic "Doctor-on-a-Chip" technology being developed at Brunel University (see http://www.brunel.ac.uk/about/acad/sed/sedres/si/esrg/members/azimi/) for human DNA extraction, purification and detection.
- Prof. Jamal Seyed-Yagoobi, Illinois Institute of Technology, Chicago, Illinois, presented work on using EHD pumping to circulate fluid with the goal of equalizing the temperature in spherical reservoirs for satellite and space exploration applications (see http://www.mmae.iit.edu/research/heat_transfer_lab.html)
- Praveen Srirama, University of Arkansas at Little Rock, Arkansas, reviewed ESPART Analyzer technology adapted for measuring dust particle size and charge on the surface of Mars and Earth's moon.
- Prof. Bruce Locke, Florida State University, Tallahassee, discussed the effect of pressure on electrical discharges in liquid phase chemical reactors looking towards using electrical discharges to drive chemical reactions in supercritical water and other fluids.
- Prof. Bill Greason, University of Western Ontario, London, analyzed the spatial scaling of induced charge on MEMS devices finding that static problems from induced charge becomes more severe as these devices become smaller.

Well, after 4 days, my head was spinning. Electrostatics science and technology is at the foundation of so many emerging applications. And, I am impressed by the thoughtful and creative electrostatics related research being done. I agree with Prof. Balachandran's comment. "I wish I were 20 years younger … !" It is very satisfying to see a new generation of scientists and engineers so excited to work on these new projects and perhaps be able to watch their work grow, evolve and reach fruition.

I appreciate the hard work by our teachers and professional educators that teach, encourage and inspire these young people to do such fine work.

Kelly Robinson,
ESA President

Electrostatics Society of America

CALL FOR PAPERS

2008 ANNUAL MEETING OF THE ELECTROSTATICS SOCIETY OF AMERICA

The 2008 Annual Meeting of the Electrostatics Society of America will be held June 17-19, 2008. The venue is the Ramada Mall of America in Minneapolis, MN, USA.

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 sessions will include:

I. Atmospheric and space applications
II. Biological and medical applications
III. Breakdown and discharge
IV. Flows, forces, and fields
V. Materials behavior and processing
VI. Measurement and instrumentation
VII. Particle control and charging
VIII. Safety and hazards

Abstract submission: Abstracts should be submitted online, at http://www.electrostatics.org

Student paper competition: Presentations by students (undergraduate and graduate) are eligible; please indicate if a student will present when submitting abstract.

Important dates

February, 2008	Detailed conference information available at http://ww.electrostatics.org
March 1, 2008	Abstract submission deadline
March 17, 2008	Notification of paper acceptance
April 18, 2008	Final manuscripts due
June 17, 2008	Reception and late registration, 11 AM. Conference begins, 1 PM
June 19, 2008	Conference ends after evening banquet (Banquet: 7 PM – 10 PM)

Contact information

For questions about the technical program and abstract submission, contact the Technical Chair:
Prof. Daniel Lacks, Dept. of Chemical Engineering, Case Western Reserve University
daniel.lacks@case.edu, (216)368-4238

For other questions, contact the General Chair:
Dr. Albert Seaver, aseaver@electrostatics.us , (651)735-6760

ESA-2008 Annual Meeting

ESA-2008 Annual Meeting: Minneapolis, MN USA; June 17-19, 2008 – Mark your calendar.

If you ever thought about combining a family vacation with an ESA conference, next year's meeting may be the one for you. Why? Because ESA-2008 will offer you an excuse to hear great technical talks while the rest of your family gets to see the famous Mall of America and, if they want, other sites located in and around the Twin Cities area. Yes, sometimes you do find a win-win situation that fits the whole family and your budget. Do you have young children, or teenagers, or maybe grandchildren who would like a very memorable experience? Want a special hotel conference rate for your family ($89 flat rate – up to 4 people) at a pleasant hotel with a beautiful Native American decor? Want to arrive up to 2 days before the conference or leave up to 2 days after the conference and still get that special conference rate? Want your vacation to include discount coupons for a variety of happenings? Want to fly and then get free transportation to the hotel as well as to the Mall of America? Then you need look no further; ESA-2008 is calling you. The ESA-2008 Annual Meeting will be June 17 – 19, 2008 and will be held at the Ramada Mall of America hotel *http://www.ramadamoa.com* in Bloomington, Minnesota. Bloomington is sometimes called the Third City of the Twin Cities, sometimes referred to as a suburb of Minneapolis, but always referred to as the home of the Mall of America (MOA). The MOA *http://www.mallofamerica.com* is the United States' largest, as well as the world's most-visited, shopping center. Bloomington is also the home of the HHH airport from where most international flights arrive and depart as well as the MSP (a.k.a. Charles Lindbergh) airport. Do you hate driving in a strange city? Don't worry; you will have no need for a car. Just go the MOA and hop on the new light rail transit system *http://www.metrotransit.org/rail* and you and your family can travel into downtown Minneapolis. Mark your calendar now. Most ESA conferences are memorable, but this time do something different and make ESA-2008 memorable for the whole family.

Current Events

ENew technology has dramatic chip-cooling potential for future computers

Emil Venere, Purdue University

Researchers have demonstrated a new technology using tiny "ionic wind engines" that might dramatically improve computer chip cooling, possibly addressing a looming threat to future advances in computers and electronics.

The Purdue University researchers, in work funded by Intel Corp., have shown that the technology increased the "heat-transfer coefficient," which describes the cooling rate, by as much as 250 percent.

When used in combination with a conventional fan, the experimental device enhanced the fan's effectiveness by increasing airflow to the surface of a mock computer chip. The new technology could help engineers design thinner laptop computers that run cooler than today's machines.

Findings are detailed in a research paper that has been accepted for publication in the Journal of Applied Physics and is tentatively scheduled to appear in the Sept. 1 issue. The paper was authored by mechanical engineering doctoral student David Go, Garimella, associate professor of mechanical engineering Timothy Fisher and Intel research engineer Rajiv Mongia.

The experimental cooling device, which was fabricated on top of a mock computer chip, works by generating ions - or electrically charged atoms - using electrodes placed near one another. The device contained a positively charged wire, or anode, and negatively charged electrodes, called cathodes. The anode was positioned about 10 millimeters above the cathodes. When voltage was passed through the device, the negatively charged electrodes discharged electrons toward the positively charged anode. Along the way, the electrons collided with air molecules, producing positively charged ions, which were then attracted back toward the negatively charged electrodes, creating an "ionic wind." This breeze increased the airflow on the surface of the experimental chip.

Conventional cooling technologies are limited by a principle called the "no-slip" effect - as air flows over an object, the air molecules nearest the surface remain stationary. The molecules farther away from the surface move progressively faster. This phenomenon hinders computer cooling because it restricts airflow where it is most needed, directly on the chip's hot surface.

The new approach potentially solves this problem by using the ionic wind effect in combination with a conventional fan to create airflow immediately adjacent to the chip's surface, Fisher said.

The device was created at Purdue's Birck Nanotechnology Center in the university's Discovery Park. The researchers quantified the cooling effect with infrared imaging, which showed the technology reduced heating from about 60 degrees Celsius - or 140 degrees Fahrenheit - to about 35 degrees C, or 95 F.

(for more info go to *http://news.uns.purdue.edu/x/2007b/070813GarimellaIonic.html*)

Current Events (cont'd.)

Electric fields have potential as a cancer treatment: Low-intensity alternating fields can hinder or destroy dividing cells and slow the growth of brain tumors in cancer patients.

Johanna Miller, phyicstoday.org

Healthy cells have regulating mechanisms that generally limit how rapidly they can divide. Skin cells, for example, normally divide about once every 30 days, but they can divide faster in response to a wound that needs healing. Cancer, however, is characterized by cell division that has gone out of control. In cancer cells, the mechanisms that regulate division break down, and the cells spend less time in the quiescent state and more time dividing.

Many chemotherapy drugs work by interfering with the cell-division cycle. The drugs reach healthy cells and cancer cells alike, but they do most of their damage to the cancer cells. Unfortunately, some types of healthy cells divide as rapidly as cancer cells and are badly damaged as well. Such cells are found in bone marrow, the lining of the digestive tract, and hair follicles, so chemotherapy patients often lose their hair and are susceptible to infection. The damage to healthy cells limits the drug dose that a patient can tolerate and therefore limits the treatment's effectiveness.

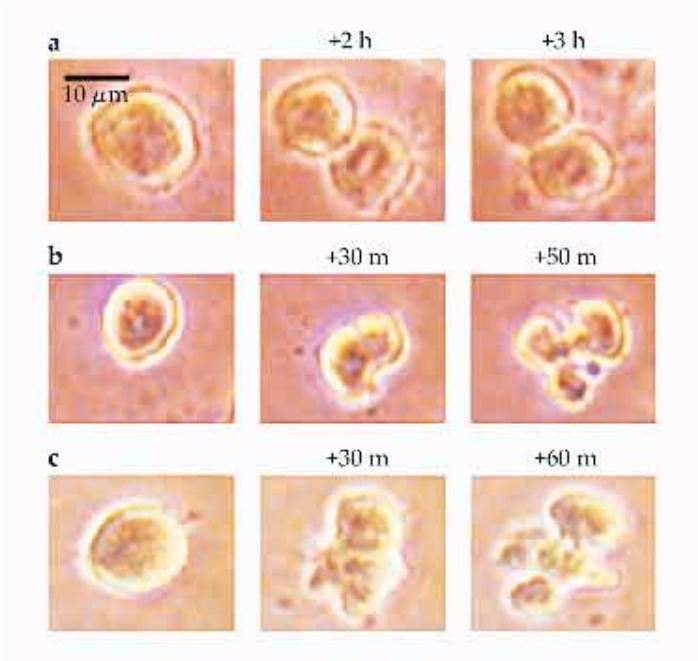
Yoram Palti, of the Technion–Israel Institute of Technology in Haifa, and his colleagues have demonstrated another way to disrupt cell division: alternating electric fields with intensities of just 1–2 V/cm. The fields they use, with frequencies in the hundreds of kilohertz, were previously thought to do nothing significant to living cells other than heating them. But Palti and colleagues have conducted a small clinical trial showing that the fields have an effect in slowing the growth of tumors.1

In studies of tumor cells in vitro, Palti and colleagues observed two distinct effects, both of which depend on the direction of cell division with respect to the applied field. First, they found that cells in the electric field take longer than usual to divide, as shown in figure 1a. Second, they found that dividing cells sometimes disintegrate just before the division process is complete, as shown in figure 1, panels b and c. They offer an explanation for each effect.

The researchers suggest that cell division is slowed because the electric field hinders the formation and function of the mitotic spindle, the structure that guides the newly replicated chromosomes as they separate into the two daughter cells. The mitotic spindle is made up of microtubules, formed by the polymerization of dimers of the protein tubulin. (Microtubules and other cellular structures are illustrated in PHYSICS TODAY, September 2006, page 80.) The tubulin dimers and polymers have large dipole moments, so they are affected by the electric field. But most other biochemical processes also involve polar molecules and structures, and small oscillating electric forces don't appear to have much of an effect on them. The difference, says Palti, is that when the tubulin dimers assemble into the mitotic spindle, they all line up in the same direction. If that direction happens to be orthogonal to the direction of the electric field, the microtubules are less likely to function normally.

The proposed mechanism for the destruction of dividing cells stems from the distribution of the electric field in each cell. The cell membrane, a lipid bilayer, acts as a capacitor with high impedance at the frequencies used, so the electric field doesn't readily penetrate the cell membrane. In a quiescent cell, the electric field inside the cell (shown in figure 2a) is much smaller than the field outside the cell and is largely uniform. But in the late stages of cell division, a higher-field region forms at the bottleneck point, or furrow, between the two newly forming cells, as shown in figure 2b. The nonuniform electric field generates a so-called dielectrophoretic force that draws polarizable molecules and structures in the direction of the higher-field region. The researchers calculate that the force, which can be as large as 60 pN, is enough to cause the organelles to pile up at the furrow within a few minutes.

Just how that pileup destroys the cell is still largely a matter of speculation, but Palti and his colleagues have a few ideas. "The organelles are attached to a cytoskeleton," Palti says. "They're not just floating around in the cytoplasm," so maybe the dielectrophoretic force rips them



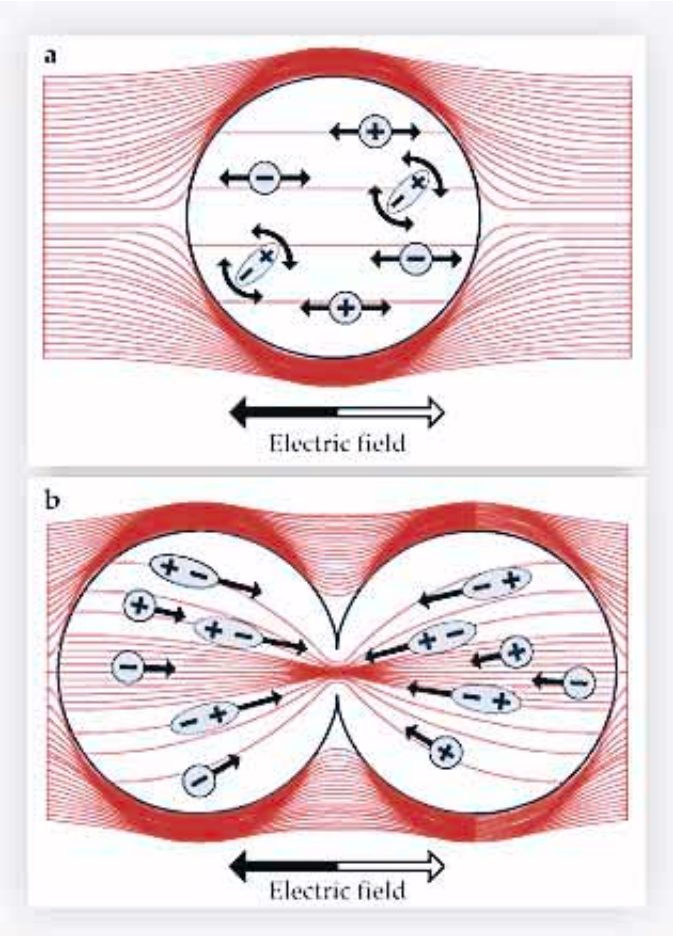
Current Events (cont'd.)

from that connective structure and kills the cell. Also, the pinching-off mechanism, by which the furrow closes and one cell becomes two, is a sensitive process that could be disrupted by the presence of molecules and organelles that are supposed to be elsewhere in the cell.

Palti's 100-kHz fields are not the only form of electrical stimulation that can hinder cell division. Luca Cucullo, Damir Janigro, and their colleagues at the Cleveland Clinic have found that low-intensity alternating current with a much lower frequency—about 50 Hz—can keep some types of cells from dividing. They don't yet know exactly how the process works, but their experiments suggest that the mechanism involves a particular protein that forms pores in the cell membrane to transport potassium ions into the cell. Cells whose division was halted by electric current contained more than the usual amount of the protein. And when the stimulated cells were exposed to cesium or barium, which block the potassium-transport pores, they divided at the same rate as unstimulated cells.

(for more info. go to

http://ptonline.aip.org/journals/doc/PHTOAD-ft/vol_60/iss_8/19_1.shtml?type=PTALERT)



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CALENDAR

- 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 17-19, 2008, Minneapolis, MN, USA Contact: Al Seaver, Tel: 651-735-6760, *aseaver@electrostatics.us*, or Daniel Lacks, Tel: 216-368-4238, daniel.lacks@case.edu, website: http://www.electrostatics.org
- 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
- 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

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