Jan/Feb 2012 • No. 211

ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

Dear ESA Colleagues,

I hope you all had a great holiday break.

It's time to start making your plans for the 2012 Joint Electrostatics Meeting. Every 3 years the ESA acts as the primary sponsor of the Joint Electrostatics Meeting, which is co-sponsored with the IEEE Industry Applications Society, the Electrostatics Institute of Japan, La Societé Francaise d'Electrostatique and the International Electrostatic Assembly. The Joint Meetings bring more people than our usual ESA meetings, and colleagues we don't see as often. The previous Joint Meeting was held in 2009 at Boston University, hosted by Mark Horenstein.

The 2012 Joint Electrostatics Meeting will be held in Cambridge, Ontario (Canada), hosted by Shesha Jayaram from nearby University of Waterloo. The meeting officially begins with morning sessions on Tuesday June 12, but there will be an informal reception the evening before. We will have 3 days of technical sessions, and the conference concludes with the banquet in the evening of Thursday June 14. But you should consider staying an extra day, as Shesha is arranging a trip on Friday to Niagara Falls and local wineries – Niagara Falls is, of course, one of the most impressive waterfalls in the world.

Now is the time to submit your abstract -- the deadline for abstract submission is March 1. Abstracts can be submitted online at *http://www.electrostatics.org/conferences.html*. The Joint Electrostatics Meeting is a great opportunity to present your work to a broader audience, due to the attendance of members of the co-sponsoring societies. Maciej Noras, from the University of North Carolina at Charlotte, is the Technical Program Chair for the meeting -- you can email him at *mnoras@uncc.edu* if you have questions about abstract submission.

In addition to the regular technical sessions, we will have an evening session addressing electrostatics demonstrations for educational purposes. This session is being led by Tom Jones from the University of Rochester. We will have 10 presentations, with contributors coming from as far away as Europe and Asia. This session will include a light dinner, so it will be an enjoyable evening.

We're looking forward to a great meeting, and I hope to see you in Ontario in June!

Dan Lacks,
President, ESA
daniel.lacks@case.edu

ESA 2012: Electrostatic Demonstrations Workshop

The 2012 ESA Meeting in Waterloo, Ontario, Canada is little more than four months away now and I am pleased to tell you that plans for the electrostatics demonstration session are falling into place. Eight presenters, including Europe, Japan, and Britain, have confirmed their intentions to participate. This event will take place in the early evening of Tuesday, 12 June 2012. The room will be set up as for a poster session with tables around the walls to accommodate the presenters. Pizza, snacks, and beverages will be provided. The idea is for attendees to move from table to table during the session. The presenters will show and then periodically repeat mini-demonstrations running about ten minutes each. It may be bedlam but it will be fun. After all, this is the ESA! Shesha Jayaram at University of Waterloo is going to invite high school science teachers from Waterloo area schools to attend. We hope to lure students, too, but will face stiff competition, namely, their need to study for final exams. If you are interested in contributing to this special session but have not yet contacted me, please do so immediately by email: jones@ece.rochester.edu

Tom Jones
Department of Electrical and Computer Engineering
University of Rochester
Rochester, NY 14627 (USA)
phone: 1-585-275-5233
email: *jones@ece.rochester.edu*

Calendar

- ESA-2012, Joint ESA/IEJ/IAS/SFE Meeting, June 12-14, 2012, Univ. of Waterloo, Waterloo, Ontario, Canada, Contact: Shesha Jayaram, *jayaram@uwaterloo.ca,* website: http://www.electrostatics.org
- 8th Conf. of the French Society of Electrostatics (SFE), July 3-5, 2012, Cherbourg, France, Contact: Jean-Michel Reboul, Ph: (33) 2 33 01 42 04, *jean-michel.reboul@unicaen.fr,* website: http://www.chbg.unicaen.fr/sfe/?lang=en (titles due Jan. 15, abstracts due Feb. 13, 2012)
- ICAES-2012, 7th Int'l. Conf. on Applied Electrostatics, Sept. 17-19, 2012, Dalian Univ. of Tech., Dalian, China, Contact: Secretariat Office, Ph: +86 411 84708576-604, *ICAES2012@163.com,* website: http://www.icaes-2012.org/windows/index.htm (abstracts due Apr. 30, 2012)
- 12th Int'l. Conf. of Electrostatics, Electrostatics - 2013, April 2013, Budapest, Hungary, Contact: *info@electrostatics2013.org* website: http://www.electrostatics2013.org/ (abstracts due Mar. 19, 2012)

ESA Officers

President:
Dan Lacks, Case Western Reserve Univ.
Vice President
Shesha Jayaram, Univ. of Waterloo
Executive Council
Sheryl Barringer, Ohio State Univ.
Kelly Robinson, Electrostatic Answers, LLC
Rajeswari Sundararajan, Purdue Univ.

2012 Electrostatics Joint Conference

Cambridge, Ontario, Canada, June 12 – 14, 2012

CALL FOR PAPERS

The Electrostatic Society of America (ESA), Institute of Electrostatic Japan (IEJ), International Electrostatic Assembly (IEA), Industry Applications Society (IEEE-IAS) Electrostatic Processes Committee, and La Societé Francaise d'Electrostatique (SFE) invite papers in all scientific and technical areas involving electrostatics. The scope of the conference ranges from the fundamental physics underlying electrostatics to applications in industry, atmospheric and space sciences, medicine, energy, and other fields.

Technical sessions 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

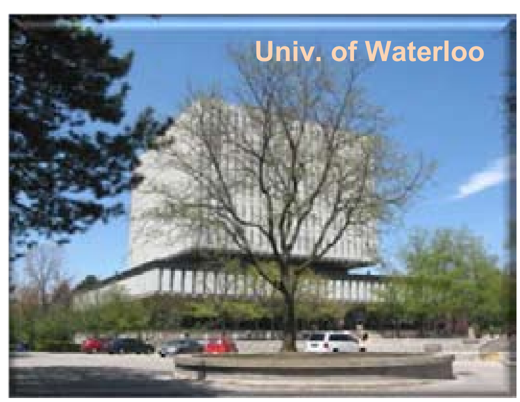
Abstract submission: Abstracts should be submitted online, at http://www.electrostatics.org

Student paper competition: Presentations by students (undergraduate and graduate) are eligible; please indicate participation when submitting abstract.

Registration and housing information: Will be posted online, at http://www.electrostatics.org

Important dates:

March 1, 2012 Abstract submission deadline
March 17, 2012 Notification of paper acceptance
May 15, 2012 Final manuscripts due
June 12, 2012 Conference begins (8 AM)
June 14, 2012 Conference ends after evening banquet
(Banquet: 7 PM – 10 PM)



Contact information:

For questions regarding the technical program and abstract submission, contact the Technical Chair:
Prof. Maciej A. Noras, University of North Carolina at Charlotte, mnoras@uncc.edu, (704) 687-3735
For all other questions, contact the General Chair:
Prof. Shesha Jayaram, University of Waterloo, jayaram@uwaterloo.ca, (519) 888-4567 ext.: 35337

Researchers Do Precise Gene Therapy Without A Needle

Pam Frost Gorder

For the first time, researchers have found a way to inject a precise dose of a gene therapy agent directly into a single living cell without a needle. The technique uses electricity to "shoot" bits of therapeutic biomolecules through a tiny channel and into a cell in a fraction of a second.

L. James Lee and his colleagues at Ohio State University describe the technique in the online edition of the journal Nature Nanotechnology, where they report successfully inserting specific doses of an anti-cancer gene into individual leukemia cells to kill them. They have dubbed the method "nanochannel electroporation," or NEP.

"NEP allows us to investigate how drugs and other biomolecules affect cell biology and genetic pathways at a level not achievable by any existing techniques," said Lee, who is the Helen C. Kurtz Professor of Chemical and Biomolecular Engineering and director of the NSF Nanoscale Science and Engineering Center for Affordable Nanoengineering of Polymeric Biomedical Devices at Ohio State.

There have long been ways to insert random amounts of biomaterial into bulk quantities of cells for gene therapy. And fine needles can inject specific amounts of material into large cells. But most human cells are too small for even the smallest needles to be of any use.

NEP gets around the problem by suspending a cell inside an electronic device with a reservoir of therapeutic agent nearby. Electrical pulses push the agent out of the reservoir and through a nanometer- (billionth of a meter) scale channel in the device, through the cell wall, and into the cell. Researchers control the dose by adjusting the number of pulses and the width of the channel.

In Nature Nanotechnology, they explain how they constructed prototype devices using polymer stamps. They used individual strands of DNA as templates for the nanometer-sized channels.

Lee invented the technique for uncoiling strands of DNA and forming them into precise patterns so that they could work as wires in biologically based electronics and medical devices. But for this study, gold-coated DNA strands were stretched between two reservoirs and then etched away, in order to leave behind a nano-channel of precise dimensions connecting the reservoirs within the polymeric device.

Electrodes in the channels turn the device into a tiny circuit, and electrical pulses of a few hundred volts travel from the reservoir with the therapeutic agent through the nano-channel and into a second reservoir with the cell. This creates a strong electric field at the outlet of the nano-channel, which interacts with the cell's natural electric charge to force open a hole in the cell membrane – one large enough to deliver the agent, but small enough not to kill the cell. In tests, they were able to insert agents into cells in as little as a few milliseconds, or thousandths of a second.

First, they tagged bits of synthetic DNA with fluorescent molecules, and used NEP to insert them into human immune cells. After a single 5-millisecond pulse, they began see spots of fluorescence scattered within the cells. They tested different pulse lengths up to 60 milliseconds – which filled the cells with fluorescence.

To test whether NEP could deliver active therapeutic agents, they inserted bits of therapeutic RNA into leukemia cells. Pulses as short as 5 milliseconds delivered enough RNA to kill some of the cells. Longer pulses – approaching 10 milliseconds – killed almost all of them. They also inserted some harmless RNA into other leukemia cells for comparison, and those cells lived.

At the moment, the process is best suited for laboratory research, Lee said, because it only works on one cell or several cells at a time. But he and his team are working on ways to inject many cells simultaneously. They are currently developing a mechanical cell-loading system that would inject up to 100,000 cells at once.

(excerpted from *http://researchnews.osu.edu/archive/electropore.htm*)

Using ionized plasmas as cheap sterilizers for developing world

Robert Sanders

University of California, Berkeley, scientists have shown that ionized plasmas like those in neon lights and plasma TVs not only can sterilize water, but make it antimicrobial – able to kill bacteria – for as long as a week after treatment.

"We know plasmas will kill bacteria in water, but there are so many other possible applications, such as sterilizing medical instruments or enhancing wound healing," said chemical engineer David Graves, the Lam Research Distinguished Professor in Semiconductor Processing at UC Berkeley. "We could come up with a device to use in the home or in remote areas to replace bleach or surgical antibiotics."

Low-temperature plasmas as disinfectants are "an extraordinary innovation with tremendous potential to improve health treatments in developing and disaster-stricken regions," said Phillip Denny, chief administrative officer of UC Berkeley's Blum Center for Developing Economies, which helped fund Graves' research and has a mission of addressing the needs of the poor worldwide. "One of the most difficult problems associated with medical facilities in low-resource countries is infection control," added Graves. "It is estimated that infections in these countries are a factor of three-to-five times more widespread than in the developed world."

Graves and his UC Berkeley colleagues published a paper in the November issue of the Journal of Physics D: Applied Physics, reporting that water treated with plasma killed essentially all the E. coli bacteria dumped in within a few hours of treatment and still killed 99.9 percent of bacteria added after it sat for seven days. Mutant strains of E. coli have caused outbreaks of intestinal upset and even death when they have contaminated meat, cheese and vegetables.

Based on other experiments, Graves and colleagues at the University of Maryland in College Park reported Oct. 31 at the annual meeting of the American Vacuum Society that plasma can also "kill" dangerous proteins and lipids – including prions, the infectious agents that cause mad cow disease – that standard sterilization processes leave behind. In 2009, one of Graves' collaborators from the Max Planck Institute for Extraterrestrial Physics built a device capable of safely disinfecting human skin within seconds, killing even drug-resistant bacteria. "The field of low-temperature plasmas is booming, and this is not just hype. It's real!" Graves said.

In the study published this month, Graves and his UC Berkeley colleagues showed that plasmas generated by brief sparks in air next to a container of water turned the water about as acidic as vinegar and created a cocktail of highly reactive, ionized molecules – molecules that have lost one or more electrons and thus are eager to react with other molecules. They identified the reactive molecules as hydrogen peroxide and various nitrates and nitrites, all well-known antimicrobials. Nitrates and nitrites have been used for millennia to cure meat, for example.

Graves was puzzled to see, however, that the water was still antimicrobial a week later, even though the peroxide and nitrite concentrations had dropped to nil. This indicated that some other reactive chemical – perhaps a nitrate – remained in the water to kill microbes, he said.

Plasma discharges have been used since the late 1800s to generate ozone for water purification, and some hospitals use low-pressure plasmas to generate hydrogen peroxide to decontaminate surgical instruments. Plasma devices also are used as surgical instruments to remove tissue or coagulate blood. Only recently, however, have low-temperature plasmas been used as disinfectants and for direct medical therapy, said Graves, who recently focused on medical applications of plasmas after working for more than 20 years on low-temperature plasmas of the kind used to etch semiconductors.

(excerpted from http://newscenter.berkeley.edu/2011/11/14/using-plasmas-to-sterilize-water/)

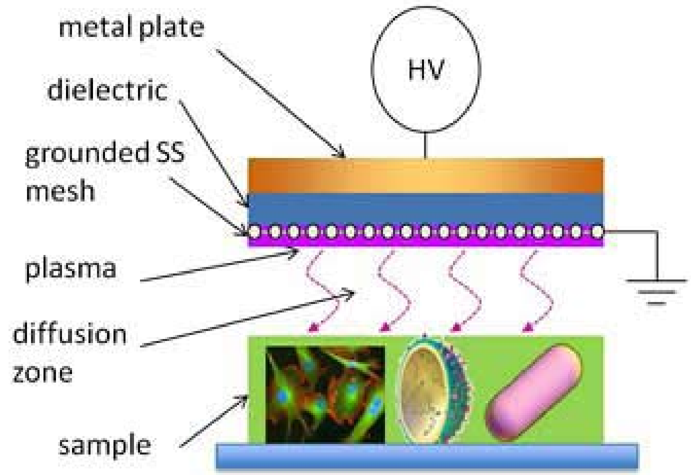


Diagram of dielectric barrier discharge, which generates a plasma (pink) that diffuses into a nearby liquid and kills bacterial contaminants.

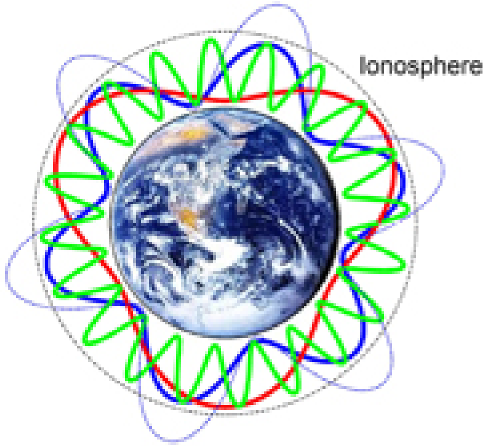
Lightning-made Waves in Earth's Atmosphere Leak into Space

Karen C. Fox

At any given moment about 2,000 thunderstorms roll over Earth, producing some 50 flashes of lightning every second. Each lightning burst creates electromagnetic waves that begin to circle around Earth captured between Earth's surface and a boundary about 60 miles up. Some of the waves -- if they have just the right wavelength -- combine, increasing in strength, to create a repeating atmospheric heartbeat known as Schumann resonance. This resonance provides a useful tool to analyze Earth's weather, its electric environment, and to even help determine what types of atoms and molecules exist in Earth's atmosphere, but until now they have only ever been observed from below.

"Researchers didn't expect to observe these resonances in space," says Fernando Simoes, a scientist at NASA's Goddard Space Flight Center in Greenbelt, MD. "But it turns out that energy is leaking out and this opens up many other possibilities to study our planet from above."

Simoes is the first author on a paper about these observations that appeared online in the journal Geophysical Research Letters on November 16, 2011, and will appear



Waves created by lightning flashes -- here shown in blue, green, and red -- circle around Earth, creating something called Schumann resonance. These waves can be used to study the nature of the atmosphere they travel through. Courtesy of NASA/Simoes

in the print publication in December. He explains that the concept of resonance in general is fairly simple: adding energy at the right time will help any given phenomenon grow. Think of a swing -- if you push it back just as it hits the top of its arc, you add speed. Push it backwards in the middle of its swing, and you will slow it down. When it comes to waves, resonance doesn't occur because of a swing-like push, but because a series of overlapping waves are synchronized such that the crests line up with the other crests and the troughs line up with the other troughs. This naturally leads to a much larger wave than one where the crests and troughs cancel each other out.

The waves created by lightning do not look like the up and down waves of the ocean, but they still oscillate with regions of greater energy and lesser energy. These waves remain trapped inside an atmospheric ceiling created by the lower edge of the "ionosphere" -- a part of the atmosphere filled with charged particles, which begins about 60 miles up into the sky. In this case, the sweet spot for resonance requires the wave to be as long (or twice, three times as long, etc) as the circumference of Earth. This is an extremely low frequency wave that can be as low as 8 Hertz (Hz) -- some one hundred thousand times lower than the lowest frequency radio waves used to send signals to your AM/FM radio. As this wave flows around Earth, it hits itself again at the perfect spot such that the crests and troughs are aligned. Voila, waves acting in resonance with each other to pump up the original signal.

While they'd been predicted in 1952, Schumann resonances were first measured reliably in the early 1960s. Since then, scientists have discovered that variations in the resonances correspond to changes in the seasons, solar activity, activity in Earth's magnetic environment, in water aerosols in the atmosphere, and other Earth-bound phenomena.

"There are hundreds, maybe thousands, of studies on this phenomenon and how it holds clues to understanding Earth's atmosphere," says Goddard scientist Rob Pfaff, Principal Investigator of the VEFI instrument and an author on the GRL paper. "But they're all based on ground measurements."

C/NOFS, of course, measured them much higher -- at altitudes of 250 to 500 miles. While models suggest that the resonances should be trapped under the ionosphere, it is not unheard of that energy can leak through. So the team began looking for waves of the correct, very low frequency in the observations from VEFI – an instrument built at NASA Goddard with high enough sensitivity to spot these very faint waves. And the team was rewarded. They found the resonance showing up in almost every orbit C/NOFS made around Earth, which added up to some 10,000 examples.

Detection of these Schumann resonances in space requires, at the very least, an adjustment of the basic models to incorporate a "leaky" boundary at the bottom of the ionosphere. But detecting Schumann resonance from above also provides a tool to better understand the Earth-ionosphere cavity that surrounds Earth, says Simoes.

"Combined with ground measurements, it provides us with a better way to study lightning, thunderstorms, and the lower atmosphere," he says. "The next step is to figure out how best to use that tool from this new vantage point."

(excerpted from http://www.scientificcomputing.com/news-DS-Lightning-made-Waves-in-Earths-Atmosphere-Leak-into-Space-120111.aspx?et_cid=2354455&et_rid=41420904&linkid=http%3a%2f%2fwww.scientific-computing.com%2fnews-DS-Lightning-made-Waves-in-Earths-Atmosphere-Leak-into-Space-120111.aspx)

Bioelectrical alterations cause tadpoles to grow eye in back, tail

For the first time, scientists have altered natural bioelectrical communication among cells to directly specify the type of new organ to be created at a particular location within a vertebrate organism. Using genetic manipulation of membrane voltage in Xenopus (frog) embryos, biologists at Tufts University's School of Arts and Sciences were able to cause tadpoles to grow eyes outside of the head area.

The researchers achieved most surprising results when they manipulated membrane voltage of cells in the tadpole's back and tail, well outside of where the eyes could normally form. "The hypothesis is that for every structure in the body there is a specific membrane voltage range that drives organogenesis," says Pai. "These were cells in regions that were never thought to be able to form eyes. This suggests that cells from anywhere in the body can be driven to form an eye."

To do this, they changed the voltage gradient of cells in the tadpoles' back and tail to match that of normal eye cells. The eye-specific gradient drove the cells in the back and tail—which would normally develop into other organs—to develop into eyes.

These findings break new ground in the field of biomedicine because they identify an entirely new control mechanism that can be capitalized upon to induce the formation of complex organs for transplantation or regenerative medicine applications, according to Michael Levin, PhD, professor of biology and director of the Center for Regenerative and Developmental Biology at Tufts University's School of Arts and Sciences. Levin is senior and corresponding author on the work published in Development online Dec. 7, 2011, in advance of print.

"These results reveal a new regulator of eye formation during development, and suggest novel approaches for the detection and repair of birth defects affecting the visual system," he says. "Aside from the regenerative medicine applications of this new technique for eyes, this is a first step to cracking the bioelectric code."

From the outset of their research, the Tufts' biologists wanted to understand how cells use natural electrical signals to communicate in their task of creating and placing body organs. In recent research, Tufts biologist Dany S. Adams showed that bioelectrical signals are necessary for normal face formation in the Xenopus (frog) embryos. In the current set of experiments, the Levin laboratory identified and marked hyperpolarized (more negatively charged) cell clusters located in the head region of the frog embryo.

They found that these cells expressed genes that are involved in building the eye called Eye Field Transcription Factors (EFTFs). Sectioning of the embryo through the developed eye and analyzing the eye regions under fluorescence microscopy showed that the hyperpolarized cells contributed to development of the lens and retina. The researchers hypothesized that these cells turned on genes that are necessary for building the eye.

Next, the researchers were able to show that changing the bioelectric code, or depolarizing these cells, affected normal eye formation. They injected the cells with mRNA encoding ion channels, which are a class of gating proteins embedded in the membranes of the cell. Like gates, each ion channel protein selectively allows a charged particle to pass in and out of the cell.

Using individual ion channels that allow, the researchers changed the membrane potential of these cells. This affected expression of EFTF genes, causing abnormalities to occur: Tadpoles from these experiments were normal except that they had deformed or no eyes at all.

Eye developed in midsection of tadpole.
Image: Michale Levin and Sherry Aw

Further, the Tufts biologists were also able to show that they could control the incidence of abnormal eyes by manipulating the voltage gradient in the embryo. "Abnormalities were proportional to the extent of disruptive depolarization," says Pai. "We developed techniques to raise or lower voltage potential to control gene expression."

The researchers achieved most surprising results when they manipulated membrane voltage of cells in the tadpole's back and tail, well outside of where the eyes could normally form.

"The hypothesis is that for every structure in the body there is a specific membrane voltage range that drives organogenesis," says Pai. "By using a specific membrane voltage, we were able to generate normal eyes in regions that were never thought to be able to form eyes. This suggests that cells from anywhere in the body can be driven to form an eye."

Levin and his colleagues are pursuing further research, additionally targeting the brain, spinal cord, and limbs. The findings, he said "will allow us to have much better control of tissue and organ pattern formation in general. We are developing new applications of molecular bioelectricity in limb regeneration, brain repair, and synthetic biology."

(excerpted from

http://www.rdmag.com/News/2011/12/Life-Science-Electricity-Bioelectrical-alterations-cause-tadpoles-to-grow-eye-in-back-tail/)

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