May/June 2010 • No. 202

ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

Electrospinning and Nanofibers

Dear All:

As we all know, electrostatic phenomenon is very versatile, crossing borders of many fields of specialization, starting from DNA interactions to electrostatic precipitators to electrospinning, used for tissue engineering and smart food packaging. Electrostatic interactions and forces are the very reason for our being/living, as there are a number of interactions that must occur between DNA and proteins during the development of a life from its inception and many of these are electrostatic interactions are due to the charges of these molecules. Electrostatic precipitators are responsible for the filtering of the fine particles in the power plants and other industry. Another electrostatic application, electrospinning, has the potential to revolutionize the food industry with smart packaging, a few billion dollar industry. Electrospinning is also part of tissue engineering and fabrication of new organs and parts of body. There are several papers on electrospinning in the 2010 ESA Conference, including the one on free surface electrospinning from MIT, as well as others from various universities and industry. Electrostatics plays an important role in nanotechnology too. We also have a presentation dealing with the review of the effects of ESD in MEMS.

The golden period of electrostatics each year is our ESA Annual Meeting and this year it is being held at the scenic Charlotte, at the University of North Carolina (UNC) and we have a number of papers dealing with electrostatics applications, starting from dielectrophoretic cell separation to electrospinning to electro-molecular delivery to stem cells and cancer cells to charge transport and electrode polarization in ionic liquids to the electrical phenomena on the Moon and Mars. Our Technical Program Chair, Dan Lacks (along with his colleague Mohan Sankaran) has put up an exciting technical program including four invited talks.

As you all can imagine, General Conference Chair, Maciej Noras is putting in lot of efforts to have a great meeting.

I look forward to seeing many of you at the conference.

As usual, I look forward to hearing from you.

Thank you very much and have a very productive and pleasant time.

Yours for the friendly Society,

Raji Sundararajan,
ESA President

Current Events

Evidence for Bacterial Electrical Networks

Electrical highways between bacteria could make for better biological fuel cells

Ann Corley, IEEE Spectrum

Experimental microbial fuel cells could turn bacteria into batteries that generate electricity from biomass. The key to this technology is the ability of bacteria to transfer electrons to their surroundings—for example, to the anode of a microbial fuel cell. But if the organisms have to be in direct contact with the anode, such devices would have to have extremely large surface areas.

Researchers from Aarhus University, in Denmark, report today in the journal Nature that bacteria appear to conduct electricity while separated by several millimeters, at least a thousand times as far apart than previously demonstrated. The naturally occurring electric currents, if confirmed, would allow bacteria spaced at least 12 millimeters apart to communicate electrically. The discovery might lead to new paths to treating infection and a better understanding of microbial ecosystems. "It's exciting to realize that organisms are connected in electric networks, cooperating through them, affecting the cycling of nature," say Lars Peter Nielsen, an associate professor in the department of biological sciences at Aarhus, who led the work.

The Danish researchers made their discovery by accident when they found that mud samples from their local Aarhus Harbor started acting strangely after being left in beakers for a few weeks. According to Nielsen, his team knew oxygen wouldn't penetrate more than a millimeter into the mud. But over a centimeter down in the beakers, "there were processes going on as if oxygen were there," Nielsen says. Hydrogen sulfide—a compound that smells like rotten eggs—was disappearing at the bottom of the samples as if it were reacting with oxygen, but no oxygen was present.

They prepared more mud samples and used microsensors to measure the distribution of oxygen and hydrogen sulfide from the surface through to the bottom of the samples under different conditions over several weeks, with varying amounts of oxygen at the top layer. Their experiments confirmed that the bacteria at the bottom of the samples were interacting electrically with oxygenated mud at the top. The bugs at the bottom break down hydrogen sulfide to produce energy, but they need oxygen to do it, because it absorbs the excess electrons generated in the process. The bacteria would ordinarily use oxygen nearby, but in the Aarhus experiment, the electrons traveled nearly a centimeter to get to the oxygen to complete the reaction. By process of elimination, the researchers concluded that the mechanism for this electron transport was a network of naturally occurring nanowires.

(excerpted from http://spectrum.ieee.org/biomedical/devices/evidence-for-bacterial-electrical-networks)

NC State Research May Revolutionize Ceramics Manufacturing

Researchers from North Carolina State University have developed a new way to shape ceramics using a modest electric field, making the process significantly more energy efficient. The process should result in significant cost savings for ceramics manufacturing over traditional manufacturing methods.

At issue are crystalline defects found in crystalline materials, such as ceramics. "One of these defects is called a grain boundary, which is where crystals with atoms aligned in different directions meet in the material," says Dr. Hans Conrad, emeritus professor of materials science and engineering at NC State and co-author of the study. These boundaries have electrical charges. "We found that if we apply an electric field to a material, it interacts with the charges at the grain boundaries and makes it easier for the crystals to slide against each other along these boundaries. This makes it much easier to deform the material." In other words, the material becomes superplastic – so a ceramic can be shaped into a desirable form using a small amount of force. "We've found that you can bring the level of force needed to deform the ceramic material down to essentially zero, if a modest field is applied," Conrad says. "We're talking between 25 and 200 volts per centimeter, so the electricity from a conventional wall socket would be adequate for some applications."

These findings mean that manufacturers who make anything out of ceramics will be able to do so using less energy. "It will make manufacturing processes more cost-effective and decrease related pollution," Conrad says. "And these findings also hold promise for use in the development of new ceramic body armor." Conrad is planning to do additional work using this approach to fabricate ceramic body armor with better properties at a lower cost.

http://news.ncsu.edu/releases/wmsconradceramics/

Giant Natural Particle Accelerator Forms above Thunderclouds

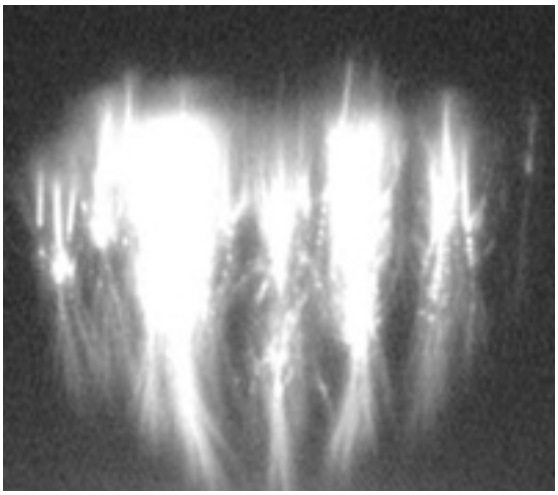
A lightning researcher has discovered that, when particularly intense lightning discharges in thunderstorms coincide with high-energy particles coming in from space (cosmic rays), nature provides the right conditions to form a giant particle accelerator above the thunderclouds, 40km above the surface of the Earth. The cosmic rays

Current Events (cont'd.)

strip off electrons from air molecules and these electrons are accelerated upward by the electric field of the lightning discharge. The free electrons and the lightning electric field then make up a natural particle accelerator. The accelerated electrons develop into a narrow particle beam which can propagate from the lowest level of the atmosphere (the troposphere), through the middle atmosphere and into near-Earth space, where the energetic electrons are trapped in the Earth's radiation belt and can eventually cause problems for orbiting satellites. These are energetic events and, for the blink of an eye, the power of the electron beam can be as large as the power of a small nuclear power plant. Martin Fullekrug, a researcher at the University of Bath, presented his new work at the RAS National Astronomy Meeting (NAM 2010) on April 14, 2010.

The trick to determining the height of one of the natural particle accelerators is to use the radio waves emitted by the particle beam, explains Fullekrug. These radio waves were predicted by his co-worker Robert Roussel-Dupré using computer simulations at the Los Alamos National Laboratory supercomputer facility. A team of European scientists, from Denmark, France, Spain and the UK helped to detect the intense lightning discharges in southern France which set up the particle accelerator. They monitored the area above thunderstorms with video cameras and reported lightning discharges that were strong enough to produce transient airglows above thunderstorms known as sprites. A small fraction of these sprites were found to coincide with the particle beams.

(from http://www.scientificcomputing.com/news-DS-Giant-Natural-Particle-Accelerator-Forms-above-Thunderclouds-041510.aspx)



A transient airglow or 'sprite' above a thunderstorm in France in September 2009. Courtesy of Serge Soula/Oscar van der Velde

ESA Annual Meeting at UNC

Maciej Noras, General Conference Chair

The 2010 Annual ESA Meeting was held on June 22-24 in Charlotte, North Carolina. The topics of presentations ranged from atmospheric and space applications through materials science, biology, medicine, electric fields and forces theory, to electrical discharge and breakdown phenomena. This year the meeting brought together participants from industry (13 companies), government agencies (NASA), and universities (21 institutions), providing great atmosphere for potential collaborations. We had an opportunity to hear 41 oral presentations, including four keynote lectures. This truly international conference attracted 57 participants, including 21 students, from 12 countries. In addition to the conference sessions, we went for a tour of the optoelectronics and motorsports laboratories at the Univ. of North Carolina at Charlotte. More details will be forthcoming in the next newsletter.

ESA OFFICERS

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Rajeswari Sundararajan, Purdue Univ.

Vice President:
John Gagliardi, Rutgers Univ.

Executive Council
Sheryl Barringer, Ohio State Univ.
Steve Cooper, Mystic Tan, Inc.
Kelly Robinson, Electrostatic Answers, LLC

Calendar

- SFE 2010, Aug 30 - Sept 1, 2010, Montpellier, France, Contact: SFE2010 Organizing Committee, Tel: +33 4 67 14 34 85, *sfe2010@univ-montp2.fr,* website: http://www.electrostatics.org
- IEEE-IAS 2010 Annual Meeting, Electrostatic Processes Committee, Oct. 3-7, 2010, Houston, Texas, website: http://www.ewh.ieee.org/soc/ias/2010/home.htm
- IEEE-DEIS CEIDP 2010, Oct. 17-20, 2010, Purdue University, West Lafayette, Indiana, Contact: Rajeswari Sundararajan, Tel: +1 765 494 6912, *rsundara@purdue.edu,* website: http://ewh.ieee.org/soc/dei/ceidp/ceidp2010.htm
- Electrostatics 2011, 13th Int'l. Conf. on Electrostatics, April 10-14, 2011, Bangor University, Wales, UK, Contact: Dawn Stewart, Tel: +44 (0)20 7470 4800, *dawn.stewart@iop.org*, website: http://www.electrostatics2011.org
- ESA-2011, June, 2011, Case Western Univ., Cleveland, OH Contact: Dan Lacks, *daniel.lacks@case.edu,* website: http://www.electrostatics.org

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ESA-2011 Annual Meeting: June, 2011
Case Western Univ., Cleveland, OH