May/June 2015 • No. 231

ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

The range of HV applications is no longer confined to the power industry; rather a wide range of other industries use high voltages and often encounter problems. This is a line taken from my curriculum vitae. What is interesting here is the link between my research and the field of electrostatics. In fact, this link has driven me to be part of our "Friendly Society" - the ESA - since 1993; a journey that has always been very progressive and memorable. Now, elected as president of the society, I am so honored and have the great responsibility to do justice to the position.

After graduating from the University of Waterloo with a Ph.D. in high voltage and electrical insulation engineering, I had the greatest opportunity to join the Applied Electrostatics group at the University of Western Ontario in London, Canada, as a junior faculty in October 1990. Here, I must mention about Prof. James Cross, my thesis supervisor; a great friend and mentor. He taught me many aspects of life along with engineering and physics. Though it was a relatively short time at Western (18 months), it had a very significant impact on my career growth because that is where I took my first steps to conducting research in the field of applied electrostatics and was first introduced to ESA. In addition, the 1993 ESA annual meeting was also held at Western.

I started working with Prof. Peter Castle on high voltage pulse application for electrostatic precipitators to capture what we then called sub-micron or ultrafine particulate contamination from flue gases (a joint project with Prof. J. S. Chang from McMaster University, Ontario, Canada and with Ontario Hydro, Toronto, one of the largest power companies in North America). Today, anything that is sub-micron is identified as nano, and am I not lucky to work in such a practical field dealing with nanomaterials in my first research project, and receiving mentorship from well-known researchers in applied electrostatics, like Castle and Chang? There was absolutely no second thought to look back; I am continuing to work in the area of applied electrostatics and high voltage engineering, whether applied to power industry or elsewhere. The projects undertaken have had both fundamental understanding of the underlying physics and practical applications.

Now I'd like to take the time to thank others from our friendly society, starting with Dr. Daniel Lacks, the outgoing president. During Dan's two terms (4yrs.) as president he has helped attract new members and add a touch of chemical engineering. Dan introduced young researchers such as Keith Forward (this year's annual meeting organizer) and Poupak Mehrani, (last year's technical program chair). This reminds me to introduce the new ESA Officers: Maciej Noras, a long term member of ESA, is our Vice President, with David Go¸ Poupak Mehrani, and Raji Sundararajan (past president) forming the Executive Council. Thank you all for agreeing to serve the society. Two more officers to thank are Steve Cooper and Mark Zaretsky, who have been carrying out the real hard tasks as Secretary/Treasurer and ESA Newsletter Editor. I also take this moment to thank Raji for agreeing to host the 2016 ESA Annual Meeting, which also happens to be a joint meeting with other electrostatic societies. As the chair for the 2007 annual meeting she did a wonderful job making the meeting so successful, and we can expect the 2016 meeting to be even more successful as Raji likes to challenge her own records.

(cont'd. p. 2)

President's Message (cont'd.)

The year's annual meeting in June at the Kellogg West Conference Center & Hotel, Cal Poly University, Pomona, California was a great success, with participants from across the globe. The on-campus housing and excellent conference venue added spirits to the technical discussions at the meeting. Each day had a keynote talk and many interesting presentations covering a wide range of topics from contact charging to electrospinning to biological and medical applications. Both Keith Forward and Peter Ireland must be commended for their excellent work in organizing the meeting and technical sessions. We must remember the support we received from Cal Poly students as it made the conference even more enjoyable. We did miss the photo taking of Al Seaver and the hospitality smiles of his wife Toni. West Lafayette is within their driving limits, and we hope to see Al and Toni resuming their activities at the 2016 meeting.

As always, there were plenty of presentations from students - close to half the number of presentations this year. This is indeed a very positive sign of our society which is filled with young people. Thanks to Trek Inc., Mystic Tan Inc., industry supporters, and Cal Poly University for the sponsorships. Special thanks go to Steve Cooper (Mystic Tan) for generously giving funds to support the student paper awards, year after year.

We were so worried about missing Glenn Schmieg's banquet presentations but Mark Horenstein did not disappoint us. Mark made this year's talk equally enjoyable and memorable. I never thought the "quiet person" (as described by Bill Vosteen, 2003 ESA Newsletter) could create something that was so hilarious, yet meaningful. Throughout the conference he had quietly followed everyone, taking pictures and using them to make an animated slide show of us, relating cartoon-like pictures to our personality. In addition to the fun part, he also provided scientific demonstrations that have left us thinking about how science works.

In the coming months I would like to share my plans to serve the society and at the same time, I like to hear your ideas and/or comments about improving our society's profile. Please do share your vision by sending an e-mail to me or to any of our executives.

For the Friendly Society
Shesha Jayaram, *shesha.jayaram@uwaterloo.ca*
President, Electrostatics Society of America

ESA Officers

President:
Shesha Jayaram, Univ. of Waterloo
Vice President and Awards Chair:
Maciej Noras, Univ. of North Carolina
Executive Council:
David Go, Univ. of Notre Dame
Poupak Mehrani, Univ. of Ottowa
Rajeswari Sundararajan, Purdue Univ.

Calendar

- 3rd ISNPEDADM, Oct. 25-30, 2015, Le Recif Hotel, Saint Gilles les Bains, Reunion, *http://isnpedadm2015.conference.univ-poitiers.fr/* Contact: Gerard Touchard, *gerard.touchard@univ-poitiers.fr*
- Electrospinning: Principles, Practices and Possibilities 2015 Conf., Hallam Conf. Centre,, London, UK, *http://electro15.iopconfs.org/* Contact: Dawn Stewart, *dawn.stewart@iop.org (abstracts due by Sept. 30, 2015)*
- ESA 2016, June, 2016, Purdue University, West Lafayette, IN, USA, *http://www.electrostatics.org/conferences.html* Contact: Raji Sundararajan, *rsundara@purdue.edu*

Electrospinning Conf.

Electrospinning: Principles, Practice and Possibilities 2015 Conference
3 - 4 December 2015
Hallam Conference Centre, London, UK
Organised by IOP Dielectrics and Electrostatics Group
Co-sponsored by IOP Polymer Physics Group
http://electro15.iopconfs.org/

The Electrospinning, Principles, Possibilities and Practice 2015 conference will reflect the multidisciplinary nature of the science involved with and supported by electrospinning. The meeting will attract scientists from all disciplines, medical and physical sciences, engineering and application technologists.

This two-day conference is the fourth in the series of conference on all aspects of electrospinning.

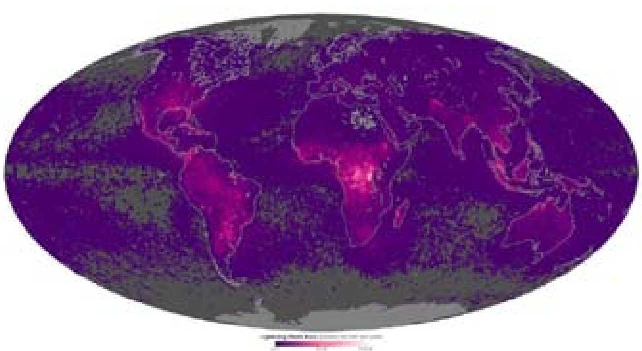
Confirmed speakers:
- **Greg Rutledge**, MIT, USA
- **Paul Dalton**, Univ. of Wurzburg, Germany
- **Suwan Jayasinghe**, Univ. College London, UK
- **Nick Tucker**, Univ. of Lincoln, UK

Current Events

Think Lightning Strikes Most Frequently in Florida? Think Again

Sean Breslin

Studies have shown that Florida is the state where you're most likely to get struck by lightning, but there are places elsewhere in the world where lightning flashes even more often. NASA's Earth Observatory recently released a map showing the frequency of lightning on the planet by using data collected by multiple satellites from 1995 to 2013. The two areas that see more lightning than anywhere else, according to the data, are northwestern Venezuela and the far east of the Democratic Republic of Congo.



This map shows the frequency of lightning, measured by the number of flashes per square kilometer per year. (NASA's Earth Observatory)

The map has several fascinating revelations about the interactions between severe weather and our planet. For one, lightning is far more likely to flash over land than water. This find, "makes sense because solid earth absorbs sunlight and heats up faster than water; this means there is stronger convection and greater atmospheric instability, leading to the formation of thunder and lightning producing storms," NASA noted.

You'll also see that the most frequent lightning occurs near the equator, which is to be expected, as temperatures are consistently warm and convection allows thunderstorms to build year-round.

In the United States alone, lightning kills about 100 people every year, according to the University Corporation for Atmospheric Research.

(excerpted from *http://www.weather.com/safety/thunderstorms/news/lightning-strikes-around-the-world*)

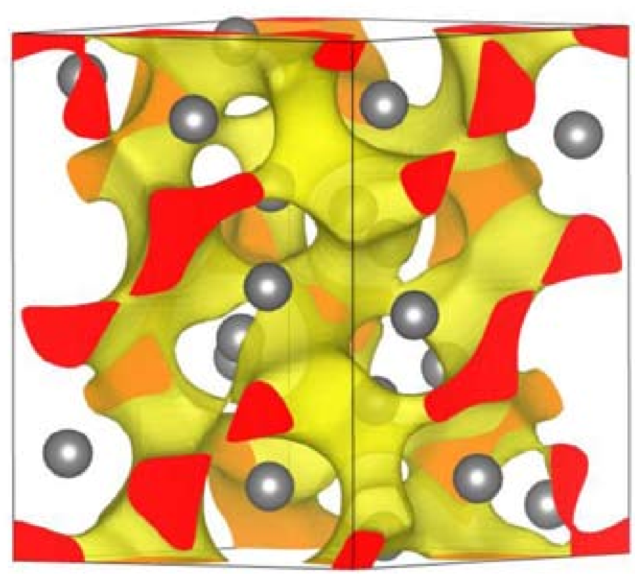
From metal to insulator and back again

New work from Carnegie's Russell Hemley and Ivan Naumov hones in on the physics underlying the recently discovered fact that some metals stop being metallic under pressure. Their work is published in Physical Review Letters.

Metals are compounds that are capable of conducting the flow of electrons that make up an electric current. Other materials, called insulators, are not capable of conducting an electric current. At low temperatures, all materials can be classified as either insulators or metals.

Insulators can be pushed across the divide from insulator to metal by tuning their surrounding conditions, particularly by placing them under pressure. It was long believed that once such a material was converted into a metal under pressure, it would stay that way forever as the pressure was increased. This idea goes back to the birth of quantum mechanics in the early decades of the last century. But it was recently discovered that certain groups of metals become insulating under pressure–a remarkable finding that was not previously thought possible.

For example, lithium goes from being a metallic conductor to a somewhat resistant semiconductor under around 790,000 times normal atmospheric pressure (80 gigapascals) and then becomes fully metallic again under around 1.2 million times normal atmospheric



View of the localized electrons in the unusual insulating state of lithium under pressure, courtesy of Russell Hemley and Ivan Naumov.

pressure (120 gigapascals). Sodium enters an insulating state at pressures of around 1.8 million times normal atmospheric pressure (180 gigapascals). Calcium and nickel are predicted to have similar insulating states before reverting to being metallic.

Hemley and Naumov wanted to determine the unifying physics framework underlying these unexpected metal-to-insulator-to-metal transitions. "The principles we developed will allow for predictions of when metals will become insulators under pressure, as well as the reverse, the when-insulators-can-become-metals transition," Naumov said.

The onsets of these transitions can be determined by the positions of electrons within the basic structure of the material. Insulators typically become metallic by a reduction in the spacing between atoms in the material. Hemley and Naumov demonstrated that for a metal to become an insulator, these reduced-spacing overlaps must be organized in a specific kind of asymmetry that was not previously recognized. Under these conditions, electrons localize between the atoms and do not freely flow as they do in the metallic form.

"This is yet another example of how extreme pressure is an important tool for advancing our understanding principles of the nature of materials at a fundamental level. The work will have implications for the search for new energy materials." Hemley said.

(excerpted from *https://carnegiescience.edu/news/metal-insulator-and-back-again?*)

Towards High Performance Electrodeless Electric Propulsion in Space

A part of the performance degradation mechanism of the advanced, electrodeless, helicon plasma thruster with a magnetic nozzle, has been revealed by the research group of Dr. Kazunori Takahashi and Prof. Akira Ando at Tohoku University's Department of Electrical Engineering.

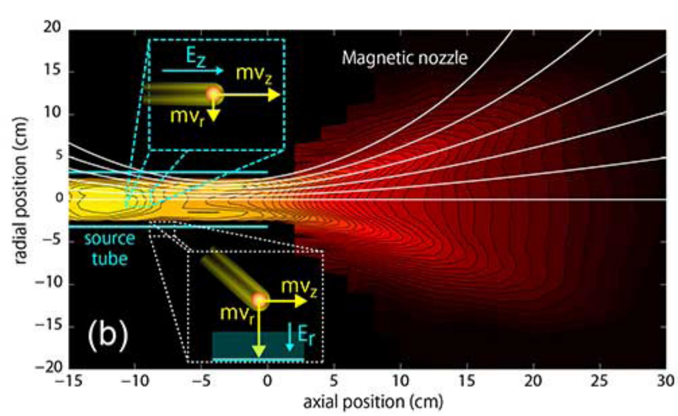
An electric propulsion device is a main engine, and a key piece of technology for space development and exploration. Charged particles are produced by electric discharge and accelerated, i.e. momentum is transferred to them via electromagnetic fields. The thrust force is equivalent to the momentum exhausted by the device, and the spacecraft can thus be propelled into space.

Mature electric propulsion devices such as ion engines, hall thrusters and magnetoplasmadynamic thrusters have electrodes exposed to the plasmas. Ion sputtering and erosion damage these exposed electrodes over time. For propulsion systems that are used over a long period, electrodeless propulsion devices have been suggested and rigorously researched as an alternative option. These are represented by the Variable Specific Impulse Magneto-plasma Rocket (VASIMR) and the helicon plasma thruster.

In the helicon plasma thruster concept, the charged particles in a high density helicon plasma source is guided to the open source exit and accelerated by the magnetic nozzle via a magnetic expansion process. Various gain and loss processes of the particle momentum occur in the thruster, significantly affecting the propulsive performance, where the thrust force is equivalent to the momentum exhausted from the system.

It has been considered that the major momentum loss occurs at the source lateral wall, where the "radial" momentum is transferred to the wall via an electrostatic ion acceleration in the plasma sheath. This might be true. Although the loss of the axial momentum there has been treated as negligible, data from experiments clearly show the presence of the "axial" momentum lost to the lateral wall, which is transferred by the radially lost ions.

This significant axial momentum loss seems to have originated from the internal axial electric field in the plasma core, which appears to be more enhanced by the highly ionized plasmas for the future high power



The measured plasma pressure profile and the particle dynamics relating to the loss of axial momentum loss.

operation of the helicon plasma thruster. More detailed understanding of the plasma dynamics will hopefully lead to further development of the advanced high power and electrodeless electric propulsion device.

(excerpted from *http://www.tohoku.ac.jp/en/news/research/news20150513_1.html*)

Whoa, scientists have captured the first ever picture of thunder

Fiona MacDonald

When it comes to thunderstorms, lightning tends to steal the show, dazzling everyone with its spectacular displays, and overshadowing the powerful long-distance rumbles that accompany the atmospheric energy release.

But now a team of scientists working at the Southwest Research Institute in the US has captured the world's first detailed image of thunder, and it looks even more incredible than we ever imagined.

The image was created using acoustic wave maps, which were based on recordings from a range of microphones positioned around an artificially generated lightning strike.

Because sound waves from higher elevations take longer to travel to the microphones, these recordings allowed the scientists to visualise how the claps and rumbles emitted during a storm move in space.

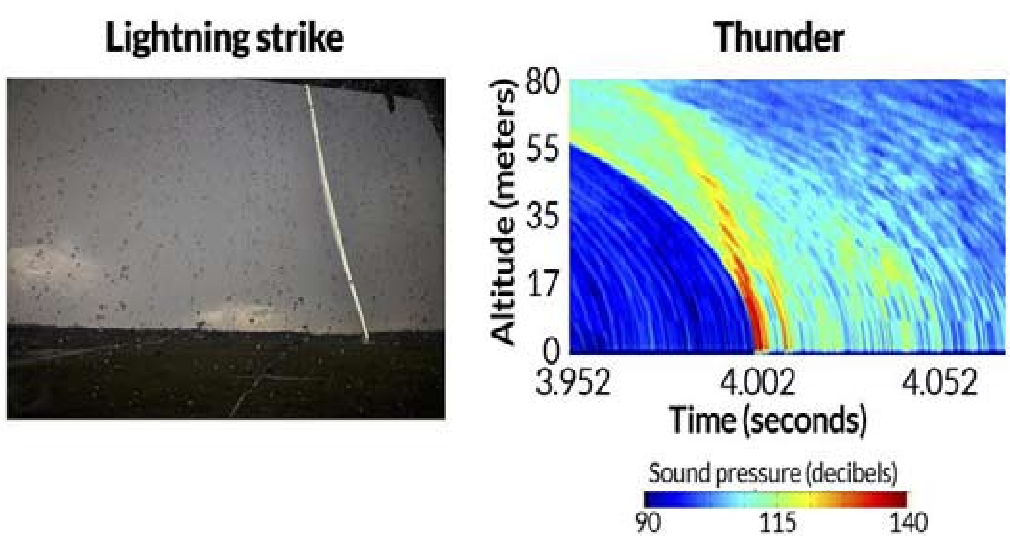
To understand how thunder works, you first need to understand lightning, which is created by electrical charges moving either within a cloud, or between the cloud and the surface of the Earth. As this charge

travels, it heats up the surrounding air, triggering the dramatic release of energy, which causes thunder.

To map the process, the researchers shot a long, Kevlar-coated copper wire into an electrically charged cloud, as you can see in the Science News photo above (and video on webpage). The result is an impressive lighting strike and resulting thunder, captured by 15 ultra-sensitive microphones positioned 95 metres from the strike point.

The researchers found that the thunder was louder when more current flowed through the lightning, a discovery that could one day help scientists use thunder to work out how much energy is being conducted through lightning. This could potentially be useful if we work out how to harness the energy from lightning.

(excerpted from *http://www.sciencealert.com/whoa-scientists-have-captured-the-first-ever-picture-of-thunder*)



ESA Information

ESA Home Page: *http://www.electrostatics.org*

Shesha Jayaram
ESA President
Dep't. of Elect. & Comp. Eng.
Univ. of Waterloo
Waterloo, Ontario
CANADA N2L 3G1
(519)888-4567, x35337
shesha.jayaram@uwaterloo.ca

Steve Cooper
Secretary/Treasurer
540 Morton Rd.
Athens, GA 30605
(706)255-5518
steve@mt-ind.com

Mark Zaretsky
Newsletter Editor
30 Shalimar Drive
Rochester, NY 14618
(585)588-6351
mark.zaretsky@kodak.com

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Purdue University
West Lafayette, IN, USA