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ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

Thinking ahead to the 2017 ESA meeting, I have a thought to include a technical tour to CanmetENERGY, Canada's leading research and technology organization in the field of clean energy within National Resources Canada in Ottawa (if possible for hosts, and pending the approval of security clearance). A question was raised, would this be something of interest to our ESA community? This question has prompted me to write about electrostatic precipitation and clean energy. As is well known for a long time, it would not be possible to achieve the level of emission control with 99% particulate collection efficiency without the use of electrostatic precipitators.

Although there are numerous practical applications based on electrostatic principles, precipitation is critical considering its importance in protecting our environment from pollution. The first electrostatic precipitator (ESP) was developed by Frederick Cottrell in 1906 and the basics of that early design are still used in today's precipitators. In brief, line commutated rectifiers energize the discharge electrodes, commonly with a negative potential, producing the required ionization. Particulate matter entering the electrical field region develops a negative charge, as the negative ions tend to attach to particles in the gas flow, and is driven by electric fields away from the discharge electrodes and towards the collecting plates. Migration and collection of charged particles depend upon the particulate resistivity, chemistry of the flue gas and the electrical field between the two electrodes, as well as the gas flow profile. Particulate matter precipitated on collection plates is periodically removed by mechanical rapping and collecting in hoppers for further disposal. Modern day precipitators use highly controllable power supplies, scrubbers, and fabric filters installed downstream of ESPs to enhance the effectiveness of emission control. Although this summary briefly describes the use and development of ESPs and their ability to perform well, there are many additional challenges to alleviating contamination from coal burnt power plants.

Many countries rely on fossil fuels; coal plays a vital role in electricity generation worldwide. Coal-fired power plants currently fuel approximately 40% of global electricity and, in some countries, the percentage is much higher. For example, in China 70% of power generation utilizes coal. It is not clear how effectively China, a single country with coal consumption equal to the rest of the world, has implemented regulations for emission control to protect the environment. Elsewhere, increased use of natural gas in power plants has resulted in the reduction of the percentage of CO_2 emission and particulate matters, as compared to the use of coal alone, but the level of CO_2 emission by use of natural gas has surpassed coal burning due to increased demand for power. This indicates the pollution level in the environment is still a concern. Alternative sources used in power generation, such as biomass, add new challenges to precipitation as the chemistry of after-burnt products are significantly different. In addition, many ESPs have been in operation for 30-50 years, using older technologies and performing with lower efficiency, hence requiring upgrades and retrofitting. Awareness of health issues arising from respirable-sized particles, stringent regulations by governments and attempts to extend precipitation to control gaseous pollutants have further increased the complexity of ESP design and operation.

Papers related to electrostatic precipitators were presented every year at annual ESA meetings but we have not seen presentations in this important area in the past few years, aside from a few presentations during our joint meetings. Does this mean there are no problems associated with air pol-

(cont'd. p. 2)

President's Message (cont'd.)

lution from coal burning, or there is no longer much interest in this field of research? Nonetheless, the International Society for Electrostatic Precipitation (ISESP) aims to share ESP knowledge and technology through organizing international conferences like the International Conference on Electrostatic Precipitation (ICESP) since 1981, and ESP schools as part of the conference for providing basic knowledge and advancements in the field of electrostatic precipitators and fabric filters since 2013. The next, XIV ICESP, will be held in Wroclaw, Poland in 2016. Let us hope that some of these authors will join ESA through our annual meetings in the future.

As always. I would like to invite you to get involved with ESA, and share your vision through e-mails, newsletter articles, the website, conferences, and special events like the demos.

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

ESA Officers

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Maciej Noras, Univ. of North Carolina
Executive Council:
David Go, Univ. of Notre Dame
Poupak Mehrani, Univ. of Ottawa
Rajeswari Sundararajan, Purdue Univ.

Calendar

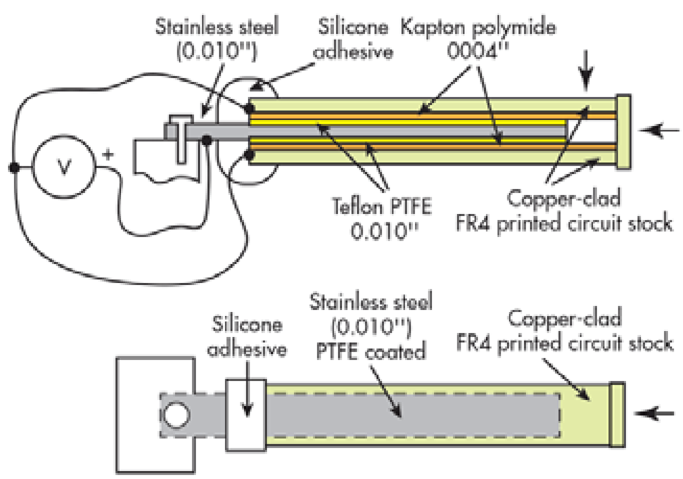
- XIV Int'l. Conf. on Electrostatic Precipitation (ICESP 2016), Sept. 19-23, 2016, Wroclaw, Poland, *http://www.icesp2016.pwr.edu.pl* Contact: Arkadiusz Świerczok, *icesp2016@pwr.edu.pl*
- CEIDP, Conf. on Elec. Insul. & Diel. Phen., Oct. 16-19, 2016, Toronto, Canada, *http://sites.ieee.org/ceidp/2016-ceidp-info/* Contact: Resi Zarb, *rzarb@irispower.com*
- Electrostatics 2017, April 10-13, 2017, Frankfurt/Main, Germany, *http://www.dechema.de/en/electrostatics2017.html* Contact: Nadja Strein, *strein@dechema.de*
- ESA 2017 Annual Meeting, June 13-15, 2017, University of Ottawa, Ottawa, Ontario, Canada *http://www.electrostatics.org* Contact: Poupak Mehrani, *poupak.mehrani@uottawa.ca*

Current Events

Simple, Novel Switch Exploits Triboelectric Effect

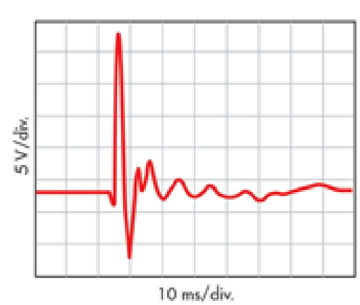
Dev Gualtieri

The triboelectric effect can be used in a simple switch (Fig. 1). A metal tine wrapped with Teflon tape is sandwiched between pieces of copper-clad epoxy circuit board stock and covered with Kapton tape (a polyimide film developed by DuPont in the late 1960s that remains stable across an extremely wide temperature range, from −270 to +400°C). The surfaces are in tight contact with each other, and are joined by a blob of silicone adhesive. In this case, Teflon and Kapton are used as the triboelectric couple, but other materials can be used.



1. Construction of the triboelectric switch shows the layered implementation, which allows for rubbing and thus generation of high voltages.

The silicone adhesive allows a rubbing notion when the assembly is tapped from above or on end, as shown by the arrows. The generated charges are collected by the metal tine and the copper surfaces of the circuit board. When discharged into a large resistance, impressively high voltages can be generated (Fig. 2). (The author's demonstration switch was four inches long and ¾-inch wide, but smaller switches are possible.)



2. The peak voltage of the pulse obtained by tapping the switch depends on the force and speed of the finger tap, and the loading resistance (the probe impedance was 10 MΩ).

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2017 Annual Meeting of the Electrostatics Society of America

University of Ottawa, Ontario, Canada
June 13-15, 2017

The Electrostatic Society of America (ESA) invites papers in all scientific and technical areas involving electrostatics for the 2017 Annual Meeting of the ESA. Contributions range from fundamental physics and new developments in electrostatics to applications in industry, atmospheric and space sciences, medicine, energy, and other fields.

Anticipated Technical Session Topics

- Breakdown phenomena and discharges
- Electrically-induced flows and electrokinetics
- Contact charging and triboelectric effects
- Gas discharges and microplasmas
- Atmospheric and space applications
- Biological and medical applications
- Materials synthesis, processing, and behavior
- Measurements and instrumentation
- Safety and hazards

Conference information, including, registration and lodging, will be updated and available at http://www.electrostatics.org

Student Presentation Competition

Presentations by undergraduate and graduate students are eligible for the Student Presentation Competition. Please indicate student presenter when submitting abstract.

Important Dates

January 1, 2017	*Abstract submission open*
March 1, 2017	*Abstract submission deadline*
March 17, 2017	*Notification of abstract acceptance*
May 1, 2017	*Early registration deadline*
May 15, 2014	*Final manuscript deadline*

Abstract Submission

Online submission at http://www.electrostatics.org

Contact Information

General Chair

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Technical Chair

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Rhodes College, USA

About University of Ottawa: Located in Ottawa, Canada's capital city, within walking distance of Canada's Parliament Hill, uOttawa is the largest bilingual (English-French) university in the world. uOttawa has a student population of over 40,000 and has more than 450 programs in 10 faculties.

2016 Electrostatics Joint Conference

The 2016 Electrostatics Joint Conference was held on the beautiful campus of Purdue University, West Lafayette, Indiana, USA (again, it was first held in 2007) during June 13-16 (with a Chicago trip on 17th), 2016. This time it was a joint meeting of the Electrostatics Society of America, ESA (USA), Institute of Electrostatics Japan, IEJ (Japan), La Societe Francaise d'Electrostatique, SFE (France), and IEEE Industrial Applications Society Electrostatics Process Committee (IAS-EPC). About 100 electrostatic experts and enthusiasts from 16 different countries attended and made it a great success. The various represented countries were: USA, Japan, France, Canada, Finland, United Kingdom, India, Brazil, Russia, New Zealand, South Korea, China, Czech Republic, Germany, Spain and Turkey.

General Chair, Prof. Raji Sundararajan of Purdue University and Technical Chair, Prof. Keith Forward of California State Polytechnic University, Pomona organized the meeting.

Raji Sundararajan and Shesha Jayaram

Keith Forward

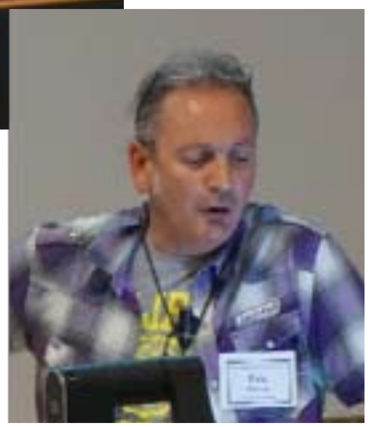
The technical program consisted of 76 oral presentations organized into 19 sessions. There were 6 eminent keynote speakers who delivered interesting keynote lectures on the topics listed below:

1. Heinrich Jaeger (University of Chicago) Contact Charging in single component systems.
2. N.K. Kishore (Indian Institute of Technology, Kharagpur, India) Experimental investigation on the electrohydrodynamic motion and shape deformation of a sedimenting drop under uniform alternating electric field.
3. George Chase (University of Akron) Applications of electrical fields in chemical processes.
4. Eric Moreau (University of Poitiers) Electrohydrodynamic phenomena in atmospheric discharges: application to airflow control by plasma actuators.
5. Tomoyuki Kuroki (Osaka Oreferture University) Nanoparticle removal and exhaust gas cleaning using a gas-liquid interfacial nonthermal plasma.
6. Lazunori Takashima (Toyohashi University of Technology) Application of atmospheric pressure plasma in environmental remediation and medicine.

In addition, we had a poster session with 18 poster presentations that were very well attended. We also had 3 very well received demonstrations by Kelly Robinson, Bill Vosteen, and Mark Horenstein. Many thanks to Kelly for arranging this demo session.

As the "friendly society," the ESA continues to encourage student presenters to participate at the meeting. This year we had 38 student presenters from almost all of the 16 countries mentioned above. The conference provided them with a welcoming opportunity to present their latest research. Generous first, second, and third

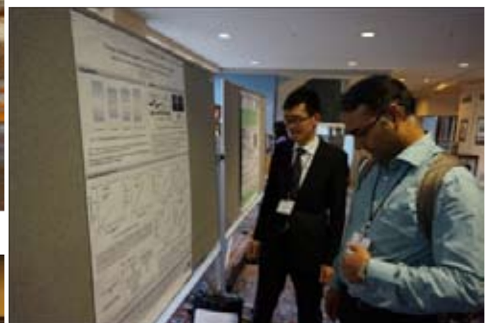
Keynote & other Speakers

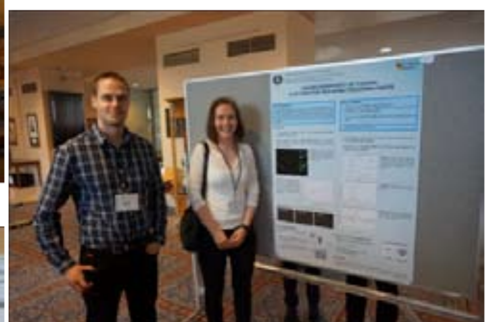


Reception & Breaks

2016 Electrostatics Joint Conference

Poster Session





Demos

Banquet

Flute Recital

Students w/Awards

place awards were given out to these students by a panel of judges.

In addition to student awards, special honors and recognitions were given at the banquet. This included the Lifetime Achievement Award to Prof. Kaz Adamiak from the University of Western Ontario, London, Canada, for his contributions in the field of Computational Electromagnetics. President's appreciation award plaques were awarded to 2016 and 2015 General chairs (Profs. Raji Sundararajan and Keith Forward) and Technical Program chairs (Profs. Keith Forward and Peter Ireland).

We had a nice banquet with a wonderful flute recital by Mr. Shakti Prasad from the Indian Institute of Science (IISc), India, and the traditional ESA entertaining and educational banquet talk. Professor Horenstein gave a wonderful presentation entitled "Things that you can break: A to Z". Everyone had fun breaking the wooden ruler in one stroke, many succeeded too in breaking it as specified.

Special thanks are due to our sponsors, Mystic Tan and Trek, who have been continuously and generously supporting us for many years now.

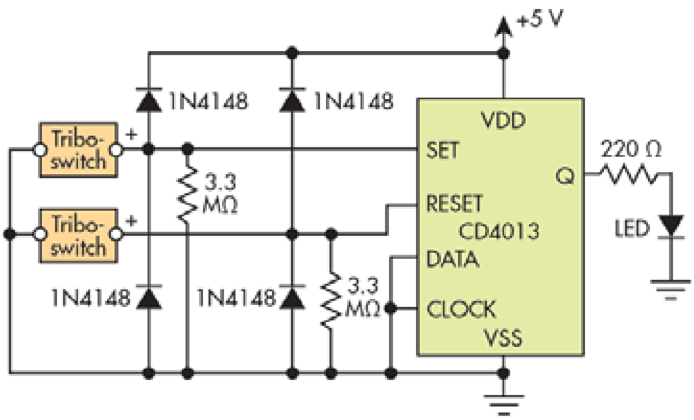
The organizers would like to thank the staff of the Purdue Conference Services, under the auspices of Mrs. Pam Walker-Stokes, for their great services and efforts to ensure that the meeting ran smoothly, students Mr. Vishveswaran Jothi and Tejasvi Parupudi and visiting professor Rajnish from India for all their help with organizing the conference including registration, distribution of badges, AV of the conference and the photo shoots and uploading of same.

Sample photos are included for your kind views and more can be found at *http://electrostatics.us/esa/2016/page_01.htm*.

The 2017 ESA annual meeting will be held at University of Ottawa, Ottawa, ON, Canada from June 13-15th. Professor Poupak Mehrani of University of Ottawa will serve as General Chair and Professor Shubho Banerjee of Rhodes College, Memphis, USA, will serve as technical chair. We look forward to seeing you all there too.

Raji Sundararajan, General Chair

Banquet Attendees



3. The demonstration circuit uses the switch to activate a simple LED; standard 1N4148 diodes are used as clamps to prevent high-voltage spikes from damaging the flip-flop IC.

You can use such switches to activate CMOS digital circuitry (Fig. 3), where two triboelectric switches control a set-reset flip-flop and control an LED. The diodes prevent high voltages from damaging the input transistors of the CD4013 integrated circuit.

(excerpted from *http://electronicdesign.com/analog/simple-novel-switch-exploits-triboelectric-effect*)

This New Fiber Can Shock Like an Electric Eel

Hilary Brueck

Electric eels may be the most shocking animals on earth, but don't be too quick to disregard the slimy creatures. Someday their self-defense mechanism may be the basis for a new way to power everything from your headphones to your Fitbit. According to research published earlier this month in the journal Advanced Materials, scientists at Fudan University in Shanghai have engineered a new fiber based on an electric eel's ability to stun almost anything that approaches it. Woven from conductive thread built on microscopic carbon nanotube sheets, this fiber could one day help power human-sized electronic wearables and high-performance solar cells.

But to understand how it works, you first need to know the science behind the eel's electrical system, which is made up of low-voltage electric plates that are each capable of driving .15 volts of charge. When eels stack thousands of the organ plates in a row, their bodies can produce much higher voltages. For instance, the electrically charged abs on a full-size, 6-foot-7-inch long eel can produce up to 600 volts of electricity. That's the equivalent of five household outlets, and enough voltage to handily stun prey lurking in the muddy waters of the Amazon River basin into submission.

In the Chinese group's lab tests, researchers used the eel-inspired fibers on a wristband that could power the watch it holds—no battery required. The team also sewed rows of the fibers, which look like gauzy thread, into the body of a T-shirt so that it could light up a string of 50 embedded LEDs.

In these human-sized examples of eel-like electronics, tiny conductive nanotubes were spun onto an elastic fiber that works like the eel plates to make high voltage threads out of tiny, low voltage material. By stretching the fibers nearly 40 feet long, the new material produced up to 1,000 volts of electric current.

For now, the fibers can only store energy, not generate it. So unlike an eel, you'd still have to charge your wearables before slithering around in the new threads. But the tech is just one of a number of new electrically conducting fibers that Fudan professor Huisheng Peng's lab is developing..

(excerpted from *http://fortune.com/2016/01/26/electric-eel-charge-fiber/*)

In the war against dust, a new tool inspired by geckos

William Weir

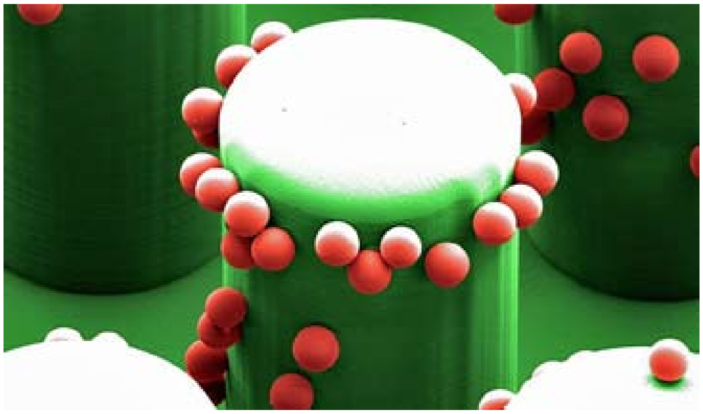
Drawing from the forces of static cling and the science behind gecko feet, the lab of Yale School of Engineering & Applied Science Dean T. Kyle Vanderlick has developed a promising tool in the war on dust. The results appear in the journal ACS Applied Materials and Interfaces. Hadi Izadi, a postdoctoral associate, is the paper's lead author. The lab worked with a number of Yale art conservators in developing the technology. Cindy Schwarz, assistant conservator of painting at the Yale University Art Gallery, said dust is particularly a problem for her when it comes to modern paintings that feature acrylic paint. "Acrylic paints are incredibly porous, so anything you're putting on the surface could get into the pores, and then work from the insides of the pores to soften the paints," Schwarz said, adding that the new technology has the potential to solve this long-standing problem.

If dust particles are bigger than 10 micrometers, removing them can be achieved with minimal fuss, usually with an air jet or nitrogen jet. It's a whole other world of trouble for particles less than 10 micrometers. There are plenty of methods of removal, but each has its drawbacks. Wet cleaning is limited in its ability to remove particles, and can possibly damage the object being cleaned. In recent years, the electronics industry and art conservators have turned to dry cleaning techniques, such as lasers, micro-abrasive particles, and carbon dioxide snow jets. They remove dust well, but can be just as damaging to artwork as wet cleaning methods.

The Yale researchers' solution is deceptively simple. In the lab, Izadi holds up what looks like an ordinary plastic sheet. It's actually an elastic and non-sticky polymer, polydimethylsiloxane (PDMS). Put it under a microscope, and you can see millions of tiny columns. Depending on the size of dust particles you're removing, the pillars range from 2 to 50 micrometers in diameter — bigger particles require bigger pillars.

Izadi is very familiar with fibrillar structures and micropillars. His previous research explored the mystery of how geckos effortlessly stick to walls. It turns out that a lot of it has to do with electrostatic charges and the microscopic pillars on the pads on their feet. Applying some of this science to cleaning microparticles made sense, he said. "When you're talking about dust, you're talking about electrostatic charges."

The micropillar structures used for dust cleaning, however, differ from those of geckos in that they're designed specifically not to stick. The PDMS polymer has minimal interaction with the substrate — whether it's an iPhone or a sculpture — but it produces enough electrostatic charge to detach the dust particles.



Microscopic images of silica dust particles lifted by micropillars, 50 micrometers in diameter. (Vanderlick Lab)

Once you match up a sheet with the appropriately sized pillars, cleaning is simply a matter of tapping the polymer on the surface. Particles absorbed by the polymer go around the pillars. Tests on various surfaces in the lab have shown total cleaning of silica dust particles and no damage to the surface.

(excerpted from *http://news.yale.edu/2016/04/26/war-against-dust-new-tool-inspired-geckos*)

Chocolate with less fat? Scientists make shocking discovery

Roya Sabri

Can you take the fat out of chocolate? A Temple University study published last week finds that electric currents can reduce the fat content of milk chocolate by up to 20 percent.

The group began studying how electricity can improve the viscosity of chocolate without adding extra cocoa butter in 2012 after a consulting firm working for Mars, Inc. approached Rongjia Tao, professor of physics at Temple and chief investigator of the study. That experiment led to curiosity about whether electricity can also cut the fat in chocolate and yet keep it viscous.

To achieve low-fat chocolate without using low-calorie fat substitutes that are banned in Canada and western Europe, "new technology based on new soft matter science is critically needed," write Dr. Tao and his colleagues in the study. "In this paper, we report that unconventional electrorheology (ER) provides a solution for this critical outstanding issue." "Electrorheology leads to healthier and tastier chocolate" was published by the Proceedings of the National Academy of Sciences of the United States of America.

Throughout the manufacturing process, chocolate is in a liquid state. Traditionally, cocoa butter and fat are essential for keeping the viscous combination of spherical cocoa solids, sugar, and mixed solids flowing, but Tao's findings may make the oil superfluous..

(from *http://www.csmonitor.com/Science/2016/0626/Chocolate-with-less-fat-Scientists-make-shocking-discovery*)

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