May/Jun 2013 • No. 219

ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

Dear Colleagues,

I just returned from the ESA annual meeting in Cocoa Beach. I really enjoyed the meeting and I heard rave reviews from everyone I spoke with. The Technical Program Chair, David Go, brought new faces to the meeting, and I heard many compliments on the quality and variety of the talks. The Conference Chair, Charlie Buhler, arranged for a great venue right on the Atlantic Ocean, set up social events every evening and arranged a tour of the NASA Kennedy Space Center. And Glenn Schmieg again gave a very entertaining banquet talk. We will have a more detailed recap of the meeting in our next newsletter.

Perhaps my favorite aspect of being ESA President is the opportunity to present the ESA Awards at our banquet. Angela Antoniu received the 2013 Distinguished Service Award in deep appreciation for her dedicated service to the profession of electrostatics. Carlos Calle received the 2013 Lifetime Achievement Award. As his nomination letter said, "Dr. Calle is world recognized as NASA's premier electrostatics expert…The successful implementation of his studies have saved the program millions of dollars and prevented loss of life and equipment". And Ed Law received the 2013 Honorary Life Member Award for his many contributions exploiting electrostatics in agricultural processes, in combination with his many years of leadership in the ESA. His nomination letter pointed out in particular his development of "water-based electrostatic sprays for food, fiber and ornamental crops … resulting in substantial cost savings to producers as well as 50% reduction in environmental loading of toxic pesticides".

We also finalized plans for the 2014 and 2015 ESA meetings. The 2014 meeting will be held at the University of Notre Dame. The Conference Chair is David Go (Notre Dame) and the Technical Program Chair is Poupak Mehrani (University of Ottawa). You will enjoy seeing Notre Dame's beautiful campus, and its famous sites such as "Touchdown Jesus".

In 2015 -- for the first time in 10 years -- we will hold our meeting significantly west of the Mississippi River (while our 2008 meeting in Minneapolis was west of the Mississippi, it was west by only 2 miles). The meeting will be held at Cal Poly Pomona, and will be hosted by Keith Forward, who joined their faculty in 2012. Cal Poly Pomona was built on the ranch where W. K. Kellogg (founder of the Kellogg cereal company) bred Arabian horses; Kellogg's legacy lives on through the Arabian Horse Center on campus and Keith will arrange a tour of this center during the conference.

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

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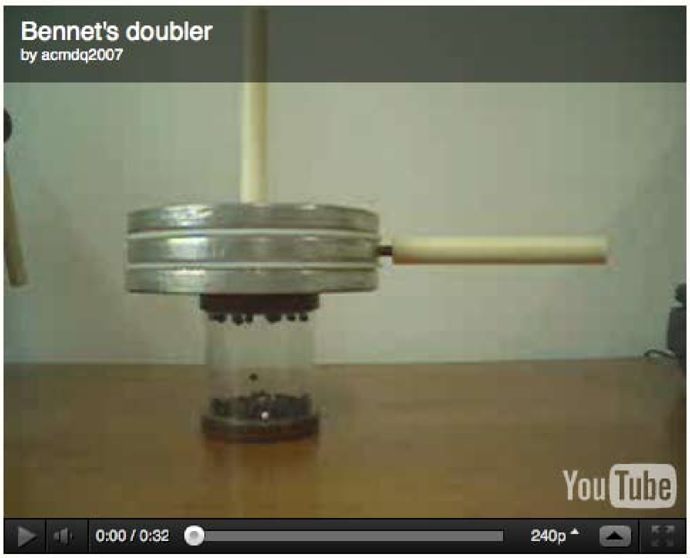
Dynamics of Electrostatics



Bennet's doubler: Using the principle of charge induction a fascinating demonstration of charge amplification is produced. Use the link to view the video: *http://lateralscience.blogspot.com/2012/11/bennets-doubler.html*

Calendar

- EOS/ESD 35th Annual Symposium, Sept. 8-13, 2013, Las Vegas, Nevada, USA, Lisa Pimpinella, *info@esda.org, http://www.esda.org/*
- 13th Int'l Conf on Electrostatic Precipitation (XIII ICESP), Sept. 16-21, 2013, Bangalore, India, S. Seetharamu, *icesp2013@gmail.com, http://icesp2013.in*
- IEEE-IAS Annual Mtg., Oct. 6-11, 2013, Orlando, Florida, Lucian Dascalescu, *lucian.dascalescu@univ-poitiers.fr, http://ewh.ieee.org/soc/ias/2013/*
- 2013 IEEE CEIDP, Oct. 20-23, 2013, Shenzhen, P.R. China, *Mahmoud.Abou-Dakka@nrc-cnrc.gc.ca.,* http://www.ewh.ieee.org/soc/dei/ceidp/ceidp2013.htm *(abstract deadline Feb. 15)*
- ESA 2014, June 17-19, 2014, Univ. of Notre Dame, South Bend, Indiana, USA, David Go, *dgo@nd.edu*
- ESA 2015, June, 2015, Cal Poly Pomona, Pomona, CA, USA, Keith Forward, *kmforward@csupomona.edu*

Current Events

Electric-Field Gesture Interface Gets Users' Hands Off Their Gadgets

Willie D. Jones

Touch screens are de rigueur on yesterday's high-end mobile devices, but the next revolution in interface technology will get users' hands off their machines' displays. And according to Microchip Technology of Chandler, Ariz., this interface is on the way. Today, the company introduced GestIC, a configurable 3-D gesture controller that it says will allow users of smartphones, tablets, and laptops to dial, open apps, manipulate documents, scroll through phone directories and music playlists, and perform a host of other tasks, without touching these gadgets at all.

GestIC identifies gestures by generating an electric field and sensing how a user's hand movements change it. The chip does this using a set of up to six electrodes. One electrode emits an electric field, which hops around among frequencies in the 70- to 130-kilohertz range in order to minimize interference from things like fluorescent lights and AC chargers. The remaining electrodes act as receivers, measuring the change in the field 200 times a second and allowing the chip to interpret a hand's position in three dimensions. Microchip says the system works as long as the user's hand is within 15 centimeters of the electrodes, which can be incorporated below a portable device's housing or even in its touch screen.

The system features a dedicated chip that does onboard 32-bit digital signal processing (DSP). Using an on-chip library of hand swipes, circular motions, and other gestures, the DSP can do the initial recognition of movements without using any of the phone's or laptop's native number-crunching resources.

Fanie Duvenhage, director of Microchip's human-machine interface division, says that preventing unintended recognition of movements within the electric field—as in the case of pocket dialing—is simple. A phone or tablet can be programmed to start taking commands after a specific gesture—essentially, a gesture password—that is unlikely to be replicated randomly inside a pocket or purse. That's important, because another basic characteristic the company is trumpeting is that the system's miserly use of power (it draws as little as 150 microwatts) will allow always-on gesturing, even in small gadgets, where energy is at a premium.

Low power consumption isn't the only advantage of electric-field gesture recognition. It could also potentially extend the abilities of other gesture interfaces. For example, camera-based gesture controllers, such as Microsoft's Kinect, work better at longer distances but suffer from blind spots at close range. An e-field sensor could fill in the gap, Duvenhage says. Electric fields also sidestep cameras' susceptibility to the effects of ambient light and ultrasonic sensors' sensitivity to noise.

GestIC may not be alone in the electric-field-based gesture interface race. Last November, Plessey Semiconductors detailed its Electric Potential Integrated Circuit, or EPIC, which the company described as essentially a very sensitive, contactless digital voltmeter capable of measuring millivolt changes in electric fields. The gadget, shown in a video taking electrocardiogram readings through a patient's sweater, will be used in consumer devices such as hands-free gaming controllers, Plessey says, once some refinements have been made.

Alan Colman, director of the EPIC product line, says the company is working on a gesture interface for small electronics that it wants to show off to manufacturers at CES in January. It is also developing a version of the sensor to be embedded in car seats for monitoring whether the driver is drowsy. However, Coleman would not set a timetable for either of these to be commercialized.

(excerpted from *http://spectrum.ieee.org/consumer-electronics/gadgets/electricfield-gesture-interface-gets-users-hands-off-their-gadgets*)

Bumblebees Sense Electric Fields in Flowers

Matt Kaplan and Nature magazine

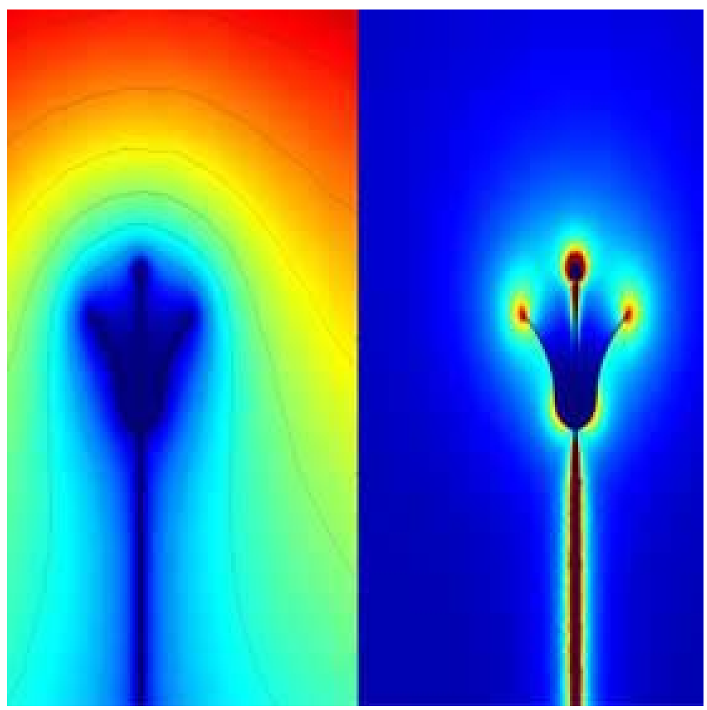
As they zero in on their sugary reward, foraging bumblebees follow an invisible clue: electric fields. Although some animals, including sharks, are known to have an electric sense, this is the first time the ability has been documented in insects. Pollinating insects take in a large number of sensory cues, from colors and fragrances to petal textures and air humidity. Being able to judge which flowers will provide the most nectar, and which have already been plundered by other pollinators, helps them to use their energy more efficiently.

It has long been known that bumblebees build up a positive electrical charge as they rapidly flap their wings; when they land on flowers, this charge helps pollen to stick to their hairs. Daniel Robert, a biologist at the University of Bristol, UK, knew that such electrical interactions would temporarily change the electrical status of the flowers — but he did not know whether bumblebees were picking up on this.

Keen to find out, he and a team of colleagues measured the net charges of individuals of Bombus terrestris, a common species of bumblebee, by using sucrose to lure them into a Faraday pail — an electrically shielded bucket that reacts to the charge of anything inside it. As expected, most bumblebees were carrying a positive charge.

Next, the team placed the insects into an arena with petunias (Petunia integrifolia) and measured the flowers' electrical potentials. Sure enough, when the bees landed, the flowers became a little more positively charged. Finally, the team released bumblebees into an arena with artificial flowers, half of which were positively charged and carried a sucrose reward, and the other half of which were grounded and carried a bitter solution. Over time, the bees increasingly visited the rewarding charged flowers.

But when the researchers turned off the electrical charge on the flowers and re-released the trained bees, the insects visited rewarding flowers only about half of the time, as they would have by random chance. That suggested that the bees were detecting the electric fields and using them to guide their activities, rather than relying on other clues such as fragrance. The team reports its results in this week's Science. "We think bumblebees are using



A flower's electric field (right, with associated electric potential on the left) helps bumblebees predict where to find the most nectar.

Image: Dominic Clarke

this ability to perceive electrical fields to determine if flowers were recently visited by other bumblebees and are therefore worth visiting," says Robert.

"We had no idea that this sense even existed," says Thomas Seeley, a behavioral biologist at Cornell University in Ithaca, New York. "Assuming we can replicate the findings, this is going to open up a whole new window on insect sensory systems for us to study."

Some experts suggest that the study has implications for insects other than bees. "If you think about it, these discoveries could also apply to hoverflies and moths," says Robert Raguso, a chemical ecologist also at Cornell. "We don't know if they can perceive charge differentials, but they burn a lot of energy while hovering around looking for pollen or nectar. So it would make sense for them to attend to such cues."

(from *http://www.scientificamerican.com/article.cfm?id=bumblebees-sense-electric-fields-in-flowers*)

Michigan Tech Scientist's Discovery Could Lead to a Better Capacitor

A new process for growing forests of manganese dioxide nanorods may lead to the next generation of high-performance capacitors. As an energy-storage material for batteries and capacitors, manganese dioxide has a lot going for it: it's cheap, environmentally friendly and abundant. However, chemical capacitors made with manganese dioxide have lacked the power of the typical carbon-based physical capacitor. Michigan Technological University scientist Dennis Desheng Meng theorized that the situation could be improved if the manganese dioxide were made into nanorods, which are like nanotubes, only solid instead of hollow. However, a stumbling block has been making manganese dioxide nanorods with the right set of attributes. Until now, researchers have been able to grow nanorods that either have the best crystalline structure or were aligned, but not both.

Now, Meng's research group has developed a technique to grow manganese dioxide nanorods that are not only straight and tall (at least by nano-standards), but also have the optimal crystal structure, known as α-$MnO2$. This minimizes the internal resistance, allowing the capacitor to charge and discharge repeatedly without wearing out. That's a recipe for a better capacitor: it can store more energy, extract that energy more quickly, and work longer between rechargings. Plus, it can be used over and over again. Even after Meng's group recharged their capacitor more than 2,000 times, it was still able to regain over 90 percent of its original charge.

Meng's device belongs to the family of chemical, or reduction-oxidation, capacitors. They are hybrids between physical supercapacitors, which release a burst of energy and discharge quickly, and batteries, which generally store more energy and release it gradually over a longer period. Typically, chemical capacitors have more energy and less power than the physical ones. The chemical capacitors made with Meng's manganese dioxide nanorods offer the best of both worlds: they hold more energy, like a battery, plus they yield even more power than a comparable carbon-based physical capacitor.

The non-aligned manganese dioxide nanorods on the left were made using conventional methods. The aligned nanorods on the right were grown in Dennis Desheng Meng's lab using electrophoretic deposition. Photos by Sunand Santhanagopalan

His team was able to grow a nanoforest of manganese dioxide nanorods using electrophoretic deposition, a technique in which small particles are deposited on a substrate under the influence of an electric field. The process is not especially difficult. "We did it in a lab, but this is scalable manufacturing," he says. "We can continuously print it out in a roll-to-roll manner, and you can make the substrate very large if you like." Capacitors made with manganese dioxide nanorods could help hybrid and electric vehicles accelerate more quickly or could be coupled with solar cells. "The process also opens the door for many other applications, not just supercapacitors," says Meng.

(from *http://www.mtu.edu/news/stories/2013/april/story88254.html*)

UNL team's discovery yields supertough, strong nanofibers

University of Nebraska-Lincoln materials engineers have developed a structural nanofiber that is both strong and tough, a discovery that could transform everything from airplanes and bridges to body armor and bicycles. Their findings are featured on the cover of this week's April issue of the American Chemical Society's journal, ACS Nano.

"Whatever is made of composites can benefit from our nanofibers," said the team's leader, Yuris Dzenis, McBroom Professor of Mechanical and Materials Engineering and a member of UNL's Nebraska Center for Materials and Nanoscience. "Our discovery adds a new material class to the very select current family of materials with demonstrated simultaneously high strength and toughness."

In structural materials, conventional wisdom holds that strength comes at the expense of toughness. Strength refers to a material's ability to carry a load. A material's toughness is the amount of energy needed to break it; so the more a material dents, or deforms in some way, the less likely it is to break. A ceramic plate, for example, can carry dinner to the table, but shatters if dropped, because it lacks toughness. A rubber ball, on the other hand, is easily squished out of shape, but doesn't break because it's tough, not strong. Typically, strength and toughness are mutually exclusive.

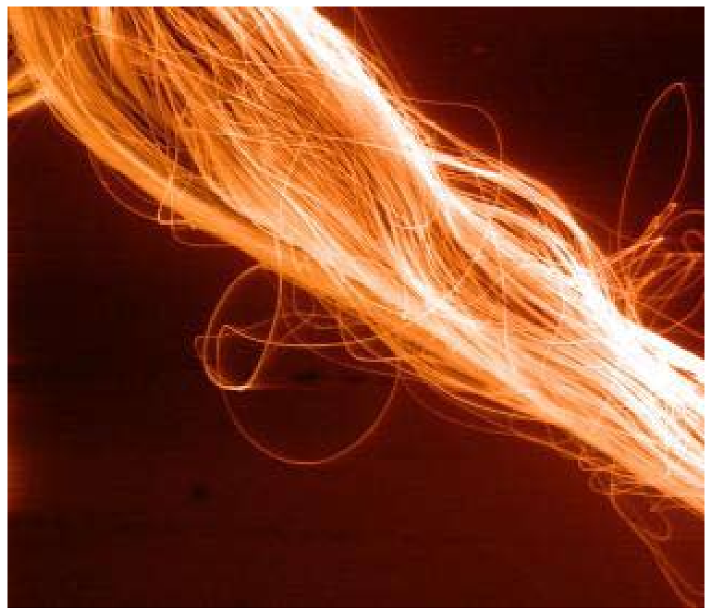
Dzenis and colleagues developed an exceptionally thin polyacrilonitrile nanofiber, a type of synthetic polymer related to acrylic, using a technique called electrospinning. The process involves applying high voltage to a polymer solution until a small jet of liquid ejects, resulting in a continuous length of nanofiber. They discovered that by making the nanofiber thinner than had been done before, it became not only stronger, as was expected, but also tougher.

Dzenis suggested that toughness comes from the nanofibers' low crystallinity. In other words, it has many areas that are structurally unorganized. These amorphous regions allow the molecular chains to slip around more, giving them the ability to absorb more energy.

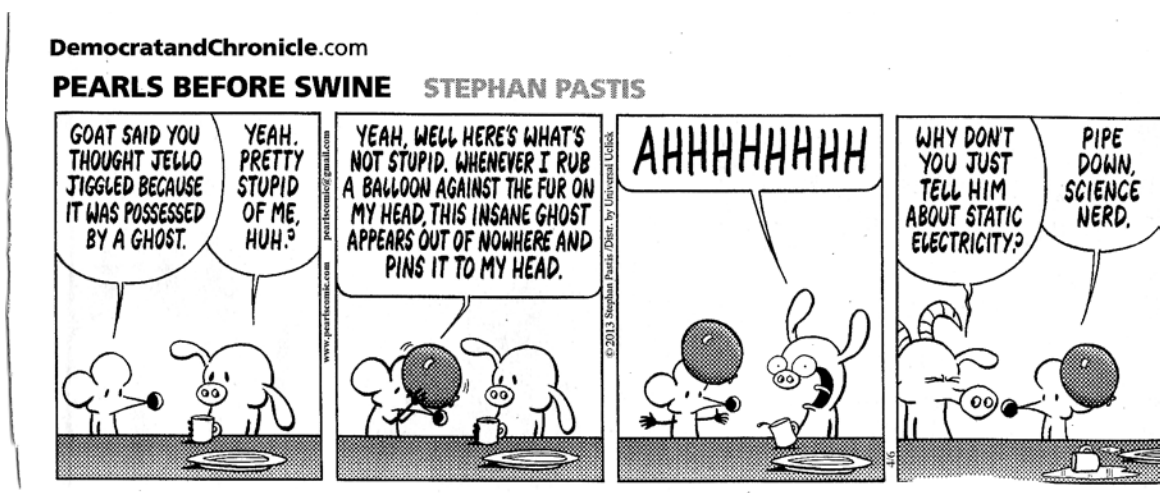
Most advanced fibers have fewer amorphous regions, so they break relatively easily. In an airplane, which uses many composite materials, an abrupt break could cause a catastrophic crash. To compensate, engineers use more material, which makes airplanes, and other products, heavier. "If structural materials were tougher, one could make products more lightweight and still be very safe," Dzenis said.

Body armor, such as bulletproof vests, also requires a material that's both strong and tough. "To stop the bullet, you need the material to be able to absorb energy before failure, and that's what our nanofibers will do," he said.

(from *http://newsroom.unl.edu/releases/2013/04/23/UNL+team%27s+discovery+yields+supertough%2C+strong+nanofibers*)



High-resolution scanning electron microscopy shows a portion of a large bundle of ultra-strong and tough continuous nanofibers developed by UNL researchers. (Photo: Joel Brehm, Dimitry Papkov, Yuris Dzenis)



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