Mar/Apr 2013 • No. 218

ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

Dear Colleagues,

I just returned from a pilgrimage.

The study of electrostatics is often said to begin with the Greek philosopher Thales of Miletus, around 600 BC. For example, Wikipedia calls Thales "the earliest known researcher into electricity" (*http://wikipedia.org/wiki/Electricity*), and he is said to have carried out electrostatics experiments in which he rubbed wool on amber. I discussed in the October 2012 newsletter that Thales never really did any such research, but the story remains a fun 'foundation myth' for electrostatics, along the lines of Romulus and Remus founding Rome.

Miletus is located in present-day Turkey, a few miles from the Aegean coast. Back in Thales's time, Miletus was a major port city, sitting on a bay of the Aegean Sea. Miletus remained an important city throughout the Roman period; for example, the Apostle Paul spent time at Miletus. But the Aegean coastline changed with time, and the bay that Miletus sat upon filled with river silt. When Miletus lost access to the sea, its the population dwindled, and the city was ultimately abandoned. Today all that remains in Miletus are ruins.

My family and I went on vacation to Turkey this spring. I was excited for this opportunity to make a pilgrimage to the (mythical) site of the birth of electrostatics. On day 3 of our vacation we flew to Izmir, rented a car, and drove about two hours to Miletus. Miletus is located at a beautiful site, with nothing around for miles. It was very quiet and peaceful, with only about 5 or 10 other people there besides us.

The highlight of the Miletus ruins is the impressive amphitheater, which sat over 15,000 people. It was here that we paid homage to Thales. I took the stage, and (pretended to) give a lecture on electrostatics (see picture). My daughter (under duress) performed electrostatics demonstrations, by rubbing a balloon on her hair and showing how the oppositely charged balloon and hair attract (she found this embarrassing, and I had to bribe her to do it).

I enjoyed my Miletus pilgrimage, and I recommend it to all electrostatics enthusiasts!

And I'm looking forward to the ESA meeting this June. Conference Chair Charlie Buhler and Technical Program Chair David Go have done a great job with the arrangements -- see their announcement in this newsletter for more information. Now is the time to register for the meeting, at *http://www.electrostatics.org*.

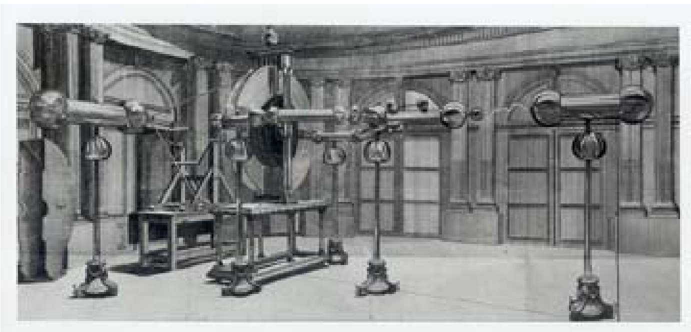
I hope to see you in Cocoa Beach in June!

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

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.

Dynamics of Electrostatics



The first plate machines appeared in the 1780's. The most powerful 18th century machine was built by John Cutheberson, an English instrument maker. This machine, with twin plates 5 feet in diameter, installed in Haarlem Holland, could produce a spark two feet long and as thick as a quill pen.

Calendar

- 12th Int'l. Conf. of Electrostatics, Electrostatics - 2013, April 2013, Budapest, Hungary, *info@electrostatics2013.org* , http://www.electrostatics2013.org/
- ESA 2013, June 11-13, 2013, Cocoa Beach, Florida, USA, Charlie Buhler, *charles.r.buhler@gmail.com* , http://electrostatics.org/conferences.html
- 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*

Election of ESA Council Members

The ESA Bylaws provide for the election of officers every two years. Members vote for a complete slate of candidates at the annual meeting, and anyone is eligible to nominate or be part of a slate.

At this time, we have one nominated slate of candidates for this years election:

Slate of ESA Officers for 2013-2015
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.

If anyone would like to nominate an alternate slate, please inform me well before the June conference so that we can prepare election materials for the business meeting. Absent an alternate slate, we will likely approve the current nominated slate by acclamation.

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

ESA Elections By-Laws - New Council Slates Are Sought

Based on Article 4 of the ESA Constitution, the term of the present ESA Council ends on June 30, 2013 and the new Council term of office begins on July 1, 2013. It is now time for the Secretary (address found on back page of this ESA Newsletter) to receive slates of nominees for the upcoming (7/1/13 - 6/30/15) term.

Since the Council shall be nominated as a full slate, the presenter of that slate is responsible for checking with all the members of that slate to insure each nominee is willing to serve. A slate consists of five members: the President, the Vice-President and three Council Members.

If more than one slate is presented to the Secretary, a ballot will be mailed out about April 30 (or as soon as reasonably possible) with the deadline for receipt of the ballots by the Secretary being May 31, 2013. If only one slate is presented (then as tradition has held) no ballots will be mailed, and the Membership present at the ESA Annual Meeting will be asked to vote on the slate. If no slates are presented, then, as Article 4b states, "If extraordinary circumstances prevent the election of a new Council, the existing Council shall continue in office, year by year, until an election can be held."

2013 Annual Meeting of the Electrostatics Society of America
Cocoa Beach, FL, June 11-13, 2013

The Electrostatic Society of America (ESA) will host its 2013 Annual Meeting of the ESA from June 11-13, 2013 in Cocoa Beach, FL. This annual conference gathers experts across a wide range of fields to present new developments in electrostatics, including fundamentals and applications. Full information and the program can be found at http://www.electrostatics.org; highlights of the 2013 program include:

Keynote Speakers:
- Prof. Mounir Laroussi, Old Dominion University
- Prof. Bruce R. Locke, Florida State University
- Prof. Tatsushi Matsuyama, Soka University
- Prof. Poupak Mehrani, University of Ottawa

Invited Speakers:
- Prof. Weidong Zhu, St. Peter's University
- Dr. Bilge Baytekin, Northwestern University
- Dr. H. Tarik Baytekin, Northwestern University

Special Session: Electrostatic Developments at NASA

Technical Sessions: Contact Charging and Triboelectrics, Materials Synthesis Processing and Behavior, Electrically-Induced Flows and Electrokinetics, Gas Discharges and Microplasmas, Measurements, Instrumentation, Safety and Hazards, Breakdown Phenomenon and Discharges

Special Events:
- June 10 (evening): Informal Welcome Gathering at Fishlips Waterfront Bar & Grill in Cape Canaveral
- June 12 (evening): Annual ESA banquet, including student awards and recognition
- June 13# (afternoon): Tour of NASA Kennedy Space Center and Facilities

 # If you are interested in attending this tour, you must contact Dr. Charles Buhler no later than April 30, 2013. Full information can be found on the conference website at http://www.electrostatics.org/conferencetour.html

Registration: Registration is now open at http://www.electrostatics.org/conferences.html

	Before May 10	After May 10
Member*	$295	$350
Non-Member**	$315	$370
Student**	$50	$90

** Full registration (ESA Member or Non-Member) includes a guest ticket for banquet*
*** Non-member and student registration fees include 1-year membership to the ESA*

Housing and Travel Information:
The conference will be located at **DoubleTree by Hilton Cocoa Beach Oceanfront,** 2080 N. Atlantic Ave. Cocoa Beach, FL 32931. Special conference rates are $109/night for standard room and $149/night for Oceanfront. Reservations can be made at http://www.cocoabeachdoubletree.com; be sure to mention "2013 Electrostatic Society Conference" to get the conference rate.

The best way to get to the venue is to fly into the Orlando Airport (MCO). The DoubleTree offers a shuttle to/from the airport for a fee and details can be found on the conference website.

Contact Information

General Chair
Dr. Charles Buhler (charles.r.buhler@gmail.com)
CRB High Field LLC

Technical Chair
Prof. David B. Go (dgo@nd.edu)
University of Notre Dame

ESA Award Nominations

The ESA is accepting nominations for the following awards:

The **ESA Distinguished Service Award** recognizes outstanding service to the ESA over an extended period of time, with a demonstrated long-term commitment to the growth and continued well-being of the Society (requirement: 10 years as ESA member).

The **ESA Lifetime Achievement Award** recognizes outstanding contributions to the field of Electrostatics, as shown by the pervasiveness of the contributions in understanding certain problems or important practical benefits resulting from the work (requirement: 10 years working in field of Electrostatics).

The **ESA Honorary Life Member Award** recognizes exceptional contributions to both the ESA and to the field of Electrostatics, sustained over much of a career (requirements: 10 years as ESA member, 20 years working in field of Electrostatics).

The **Teacher of the Year Award** recognizes outstanding teachers who use Electrostatics to stimulate learning, inspire students, or otherwise encourage and energize the learning process in a formal educational setting in grades K-12 (requirement: 3 years teaching Electrostatics).

The **Student of the Year Award** recognizes middle or high school students who demonstrate outstanding achievement in Electrostatics, as showcased in laboratory projects, papers or presentations.

The ESA is also accepting nominations for induction to the Electrostatic Hall of Fame. This honor recognizes and records for posterity those individuals who have made extraordinary contributions to the field of Electrostatics. Nominees do not need to be still living. The Hall of Fame has three categories: (1) advancement of the fundamental knowledge of Electrostatics; (2) promotion of interest in the field of Electrostatics; (3) innovations using Electrostatics technology in industry.

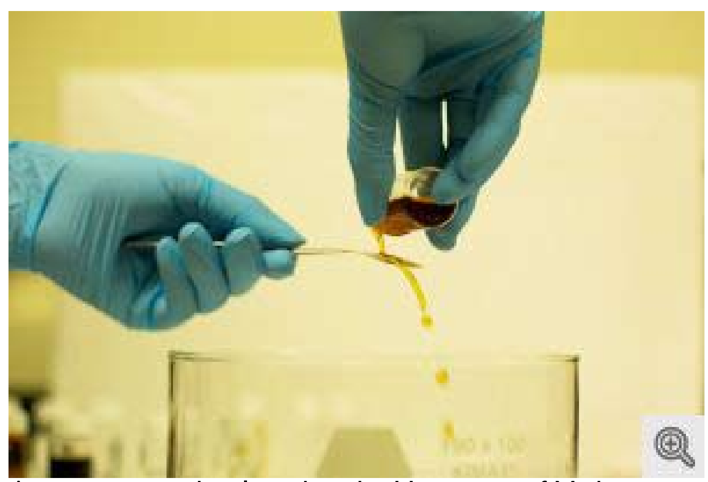
Nominations should be submitted electronically to the ESA Award Chair, , Prof. Raji Sundararajan at *rsundara@purdue.edu*, by April 30. The nomination should be in the form of a letter from an ESA member that includes a description of how the accomplishments of the nominee satisfy the award requirements (including citations of publications or patents when relevant), the contact information of the nominator and nominee, and the names and contact information of 3 other ESA members who endorse the nomination. For the Teacher and Student awards, endorsements from two faculty members of the nominee's should substitute for the ESA member endorsements.

Current Events

A material that most liquids won't wet

A nanoscale coating that's at least 95 percent air repels the broadest range of liquids of any material in its class, causing them to bounce off the treated surface, according to the University of Michigan engineering researchers who developed it. In addition to super stain-resistant clothes, the coating could lead to breathable garments to protect soldiers and scientists from chemicals, and advanced waterproof paints that dramatically reduce drag on ships.

Droplets of solutions that would normally damage either your shirt or your skin recoil when they touch the new "superomniphobic surface." "Virtually any liquid you throw on it bounces right off without wetting it. For many of the other similar coatings, very low surface tension liquids such as oils, alcohols, organic acids, organic bases and solvents stick to them and they could start to diffuse through and that's not what you want," said Anish Tuteja, assistant professor of materials science and engineering, chemical engineering and macromolecular science and engineering. Tuteja is the corresponding author of a paper on the coating published in the current issue of the Journal of the American Chemical Society.



A new coating developed at the University of Michigan can repel virtually any liquid and could lead to breathable protective wear for soldiers and scientists, as well as stain-proof garments. In this demonstration, it repels coffee. Image credit: Joseph Xu, Michigan Engineering Communications & Marketing

He and his colleagues tested more than 100 liquids and found only two that were able to penetrate the coating. They were chlorofluorocarbons—chemicals used in refrigerators and air conditioners. In Tuteja's lab, in a demonstration, the surface repelled coffee, soy sauce and vegetable oil, as well as toxic hydrochloric and sulfuric acids that could burn skin. Tuteja says it's also resistant to gasoline and various alcohols.

To apply the coating, the researchers use a technique called electrospinning that uses an electric charge to create fine particles of solid from a liquid solution. So far, they've coated small tiles of screen and postage-stamp-sized swaths of fabric.

The coating is a mixture of rubbery plastic particles of "polydimethylsiloxane," or PDMS, and liquid-resisting nanoscale cubes developed by the Air Force that contain carbon, fluorine, silicon and oxygen. The material's chemistry is important, but so is its texture. It hugs the pore structure of whatever surface it's being applied to, and it also creates a finer web within those pores. This structure means that between 95 and 99 percent of the coating is actually air pockets, so any liquid that comes in contact with the coating is barely touching a solid surface.

Because the liquid touches mere filaments of the solid surface, as opposed to a greater area, the developed coating can dramatically reduce the intermolecular forces that normally draw the two states of matter together. These Van der Waals interaction forces are kept at a minimum.

"Normally, when the two materials get close, they imbue a small positive or negative charge on each other, and as soon as the liquid comes in contact with the solid surface it will start to spread," Tuteja said. "We've drastically reduced the interaction between the surface and the droplet." With almost no incentive to spread, the droplets stay intact, interacting only with molecules of themselves, maintaining a spherical shape, and literally bouncing off the coating.

One classification of liquid that this coating repels is the so-called non-Newtonian category, which includes shampoos, custards, blood, paints, clays and printer inks, for example. These are liquids that change their viscosity depending on the forces applied to them. They differ from the Newtonians, such as water and most other liquids, whose viscosity stays the same no matter the force applied. Viscosity is a measure of a liquid's resistance to flow on the application of force, and it's sometimes thought of as its thickness. "No one's ever demonstrated the bouncing of low surface tension non-Newtonian liquids," Tuteja said.

(excerpted from *http://141.211.145.190/new/multimedia/videos/21099-a-material-that-most-liquids-won-t-wet*)

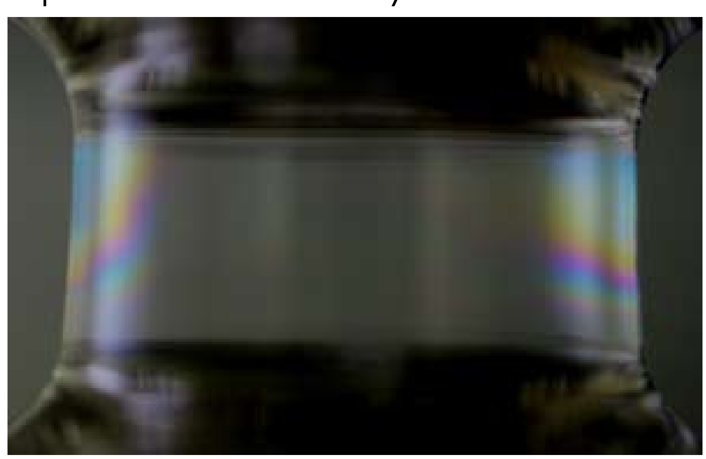
Focus: Tuning the Flow through a Soap Film of Charged Particles in Complex Media

Michael Schirber

An electric field can drive fluid through a narrow pipe by pulling on ions in the liquid. Now researchers show in Physical Review Letters that an electric field can also pull fluid through a soap film, which is essentially a narrow channel with deformable walls. They also found that the film thickness increases with the electric field strength, which could be useful in controlling the flow of tiny fluid volumes in future labs-on-a-chip.

The emerging fields of microfluidics and nanofluidics offer the possibility of replacing a lab full of beakers with a single chip that can manipulate drops of fluid. These miniature chemistry labs can move fluid using electric fields that act on ions in the fluid. The ions are normally an equal mixture of positive and negative charges, but an excess of one type typically collects along the surface of the channel because the walls are charged. When these surface ions are pulled by an electric field, they drag fluid along with them, including all of the fluid from the interior (or "bulk") of the channel. This flow—called electroosmosis—is dominant in micro- and nanochannels, where the surface-to-volume ratio is high. But little research has considered what might happen if this ratio were free to change, as in a soft-walled channel.

A soap film is a deformable channel made of two sheets of "surfactant" (soaplike) molecules that enclose a layer of water. Anne-Laure Biance and her colleagues from the University of Lyon in France investigated the effect of electric fields on soap films. They set up two horizontal plate electrodes, with one roughly half a centimeter above the other. The team wetted them with a soapy solution consisting of water, a surfactant, and potassium chloride to provide free ions. A vertical cylindrical film of the solu-



Narrow escape. Voltage applied across this cylindrical soap film causes fluid to flow up against gravity in the roughly 100-nanometer-thick film. If the voltage is turned higher, the film thickens, and the flow rate increases significantly tion naturally formed between the electrodes. The channel walls in this case were two concentric cylindrical sheets of surfactant that allowed water and ions to flow up and down in the space between. The positively charged surfactant molecules attracted negatively charged chloride ions along the inner and outer walls.

The team applied different voltages to the electrodes and measured the current produced by moving ions. Using some preliminary measurements, the researchers were able to separate the surface ion contributions to this current from that of bulk ions. The surface current, as predicted, dragged fluid up through the soap film against the force of gravity. However, when the team increased the voltage, they noticed that the bulk current increased faster than expected. They deduced that the film was thickening, allowing more bulk current. They estimated that the thickness varied from less than 100 nanometers to several hundred nanometers. A wider channel allowed greater fluid flow, which they could verify by observing the rate of growth in the film's upper meniscus.

To measure how the flow rate changed with voltage, the team drew on some previous theoretical work that describes how a vertical plate lifted out of a liquid bath can—through viscous forces—pull up, or entrain, a film of fluid. The surface layer of ionic current is like a moving plate that drags fluid up inside the soap film. Using this analogy, the team calculated that the flow rate should increase as the 5/3 power of the applied field, which agreed with their experimental data.

The researchers suggest that this steep dependence of flow rate on voltage could be used to build a fluidic device analogous to a common electronic component. It would essentially restrict fluid flow to zero until a certain threshold voltage was applied (similar to the "off/on" features of an electronic gate). "The interest is that this device would be low cost, with its properties mainly due to the deformability of the channel," Biance says. The team is also interested in seeing if electric fields could be used to stabilize foams, which tend to collapse when water drains out of them due to gravity.

"[This work] breaks new ground by removing the solid walls that usually define the geometry of a nanofluidic system and control many of its important characteristics," says Derek Stein of Brown University in Providence, Rhode Island. He says that soap films could help researchers investigate lingering questions about motion at the fluid-wall interface. "By simply changing the soap used to make the bubble, it should also be possible to tune the surface charge density, the surface tension, or other important physical parameters."

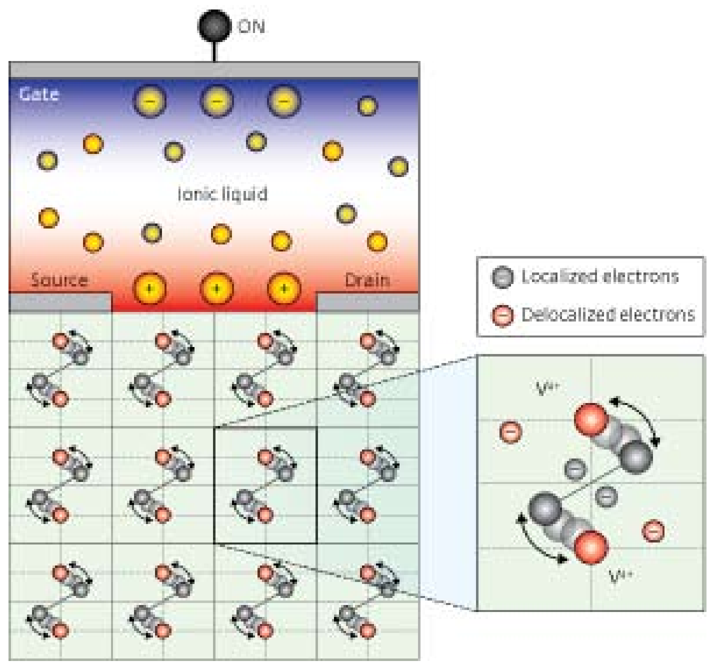
(from *http://physics.aps.org/articles/v6/12*)

Oxide flips from open to closed

The transistor is the ultimate on-off switch. When a voltage is applied to the surface of a semiconductor, current flows; when the voltage is reversed, current is blocked. Researchers have tried for decades to replicate these effects in transition metal oxides by using a voltage to convert the material from an insulator to a metal, but the induced change only occurs within a few atomic layers of the surface.

Now, Masaki Nakano and colleagues at the RIKEN Advanced Science Institute in Wako have discovered that applying a voltage to a vanadium dioxide (VO2) film several tens of nanometers thick converts the entire film from an insulator to a metal1. The findings point to the specific material properties needed to make such devices work. They may also lead to new types of 'smart' technology.

The electronic properties of transition metal oxides can be tuned by changing their chemical composition or temperature. For example, VO2 is an insulator at room temperature, but heating it or replacing a small fraction of the vanadium atoms with tungsten (an electron donor) causes a phase transition where the vanadium ions, which are paired up at low temperature, unfasten into a different crystal structure in which electrons are mobile. In princi-



Below 47 °C, the vanadium ions in a film of VO2 pair up into a different crystal structure and the electrons no longer conduct freely. The transition can be reversed with a positive voltage, applied at the top of the film. The voltage induces electrons to move to the region near the surface, which restores the high-temperature structure and metallic behavior throughout the entire film.

ple, applying a positive voltage to the surface of an insulating VO2 film can accomplish the same effect by inducing electrons to the surface, making this region metallic.

Researchers have assumed that this charging effect would be limited to a few atomic layers just below the surface because the excess of electrons cancels out the applied electric field (an effect called screening). But Nakano and his colleagues found that the excess electrons were enough to 'trigger' the crystal structure change associated with metallic behavior (Fig. 1). "The surface lattice distortion propagates through the entire film, followed by an electronic phase transition inside the bulk region," he says. The voltage-induced transition decreases VO2's resistance by a factor of 100.

The team is actively seeking other materials like VO2, as well as technological applications. One is a heat switch. Since temperature determines whether VO2 is a metal or an insulator, it also determines the frequency of light the material absorbs. VO2-coated glass could therefore act as a 'smart window', passing or blocking infrared light depending on the temperature outside. "Normally, this switching temperature is fixed," says Nakano. "Our device adds electrical switching functionality to a smart window, which is very promising for energy-saving applications."

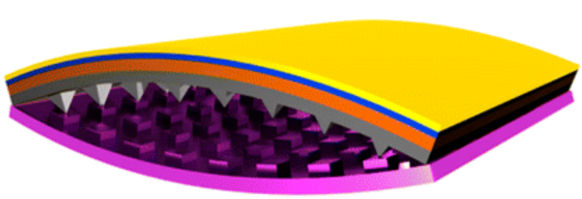
(from http://www.rikenresearch.riken.jp/eng/research/7173.html)

How Friction May Someday Charge Your Cell Phone

Katherine Bourzac

The phenomenon that causes a painful shock when you touch metal after dragging your shoes on the carpet could someday be harnessed to charge personal electronics. Researchers at Georgia Tech have created a device that takes advantage of static electricity to convert movement—like a phone bouncing around in your pocket—into enough power to charge a cell phone battery. It is the first demonstration that these kinds of materials have enough oomph to power personal electronics.

Excess energy produced when you walk, fidget, or even breathe can, in theory, be scavenged to power medical implants and other electronics. However, taking advantage of the energy in these small motions is challenging.



Zhong Lin Wang, a professor of materials science at Georgia Tech, has been working on the problem for several years, mostly focusing on piezoelectric materials that generate an electrical voltage under mechanical stress. So far, though, piezoelectric nanogenerators have not had very impressive power output.

Now Wang's group has demonstrated that a different approach may be more promising: static electricity and friction. The Georgia Tech researchers demonstrated that this static charge phenomenon can be harnessed to produce power using a type of plastic, polyethylene terephthalate, and a metal. When thin films of these materials come into contact with one another, they become charged. And when the two films are flexed, a current flows between them, which can be harnessed to charge a battery. When the two surfaces are patterned with nanoscale structures, their surface area is much greater, and so is the friction between the materials—and the power they can produce.

The Georgia Tech nanogenerator can convert 10 to 15 percent of the energy in mechanical motions into electricity, and thinner materials should be able to convert as much as 40 percent, Wang says. A fingernail-sized square of the triboelectric nanomaterial can produce eight milliwatts when flexed, enough power to run a pacemaker. A patch that's five by five centimeters can light up 600 LEDs at once, or charge a lithium-ion battery that can then power a commercial cell phone. Wang's group described these results online in the journal Nano Letters. "The choice of materials is wide, and fabricating the device is easy," says Wang. Any of about 50 common plastics, metals, and other materials can be paired to make this type of device.

Whether the new nanogenerator will work outside the lab remains to be seen. To work in the real world, an energy scavenger will have to be able to pick up on vibrational frequencies that provide the most energy. A nanogenerator that can only pick up on low-energy mechanical vibrations would take way too long to charge a cell phone, Priya notes. Wang says he is in talks with companies about developing the energy scavenger for particular applications, and envisions it being worn on an armband.

(excerpted from http://www.technologyreview.com/news/507386/how-friction-may-someday-charge-your-cell-phone/)

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NASA Tour: June 13, afternoon (sign-up by Apr. 30th)