

# ESA Newsletter

Electrostatics Society of America - The Friendly Society

## President's Message

Dear ESA Colleagues,

I am writing this message on a Sunday afternoon at the airport in Riga, Latvia. The reason I'm here stems from the ESA. My family and I were on vacation in Italy last week, and this coming week I have a conference in the Netherlands. I had a couple of days free between my family's return to the US on Friday, and the start of my conference on Monday. My first thought was to use this time to travel by train from Italy to the Netherlands. But since there are many discount airlines that fly all over Europe, I came up with a better idea...

I saw that one of these discount airlines, Air Baltic, has flights to Turku, Finland. And I remembered that ESA member Matti Murtomaa is at the University of Turku. So I contacted Matti -- Matti said he would be available and he invited me to visit his lab and to see Turku.

I am now at the Air Baltic hub in Riga. I just left Turku this morning and I'm awaiting my connecting flight to the Netherlands. Matti was a great host for my visit -- he even lent me a coat since I foolishly assumed the weather in Finland would be as warm as in Italy and the Netherlands! I visited Matti's lab, and his students Maija Nyström and Jorma Roine demonstrated their electrospraying experiments; I knew Maija and Jorma from the 2010 ESA meeting in Charlotte. Their exciting work exploits electrospraying techniques to control crystallinity and create core-shell composites in pharmaceutical powder systems. I learned a lot about electrospraying from this visit, something outside my primary areas of expertise. The facilities at the University of Turku are impressive -- for example, they have four x-ray diffraction machines across the hall from the electrostatics lab. And this was the first academic department I ever visited that has its own sauna! We all had lunch and toured the impressive Turku cathedral, which dates to the 13th century (and, I found out, is where Matti got married). The Turku visit worked out great -- it is a beautiful city and there is excellent electrostatics work being done there!

This isn't the first time that my ESA connections led me to an interesting part of the world. As I described in my message a couple of issues ago, my interactions with ESA member Rufus Akande led to several trips to Botswana. The Botswana trips took me to the most southern place on earth that I ever visited, and the Finland trip took me to the second most northern place (Turku is not as far north as my record of Reykjavik, Iceland, but it did beat my former second-place city of Juneau, Alaska).

I wonder what will be the next exotic destination that my ESA connections will lead me to?

I also want to point out a couple of deadlines on May 15 -- this is the last day you can register for the Annual Meeting at the reduced rate, and this is also the last day for submitting nominations for ESA Awards. More details on the Annual Meeting and the nominating procedure for the awards are given in this newsletter.

I hope to see you in June!

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

# ESA 2012: Electrostatic Demonstrations Workshop

Below is the final program for the Electrostatics Demonstration Session scheduled to take place in the evening of Tuesday, 12 June 2012. We are very fortunate to have presenters coming from Japan, Sweden, and the UK, as well as the USA. This session will be quite informal with the emphasis on learning and fun. And there will be pizza, snacks, and beverages provided!

## **The beginnings of electrostatics - demonstration of the high school Van de Graaff**

Mr. Shethar Davis

## **Electrostatic demonstrations with the electrophorus**

Prof. Thomas B. Jones

## **Static discharges caused by cleanup after spills**

Mr. Shonosuke Kamachi

## **Storing Charge in Wound Rolls**

Dr. Kelly S. Robinson

## **How easy it is to generate ESD**

Dr. Jeremy M. Smallwood

## **Liquid charging during filtration operation**

Mr. Anders Thulin

## **Electrostatic measurements on webs**

Mr. William Vosteen

## **The first Xerox copier**

Mr. William H. Wayman

I hope all ESA members will look forward to this unique ESA event.

Tom Jones

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## 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).

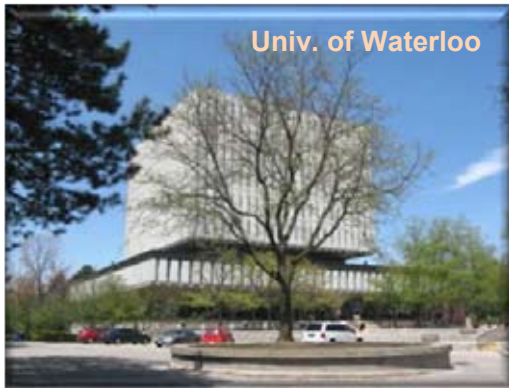
The **Student of the Year Award** recognizes middle or high school students who demonstrate outstanding achievement in Electrostatics, as showcased in laboratory projects, papers or presentations.

Nominations should be submitted electronically to the ESA Award Chair, Prof. Raji Sundararajan at [rsundara@purdue.edu](mailto:rsundara@purdue.edu), by May 15 of each year. 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.

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: (I) advancement of the fundamental knowledge of Electrostatics; (II) promotion of interest in the field of Electrostatics; (III) innovations using Electrostatics technology in industry. Nominations should be submitted electronically to the ESA Award Chair, Prof. Raji Sundararajan at [rsundara@purdue.edu](mailto:rsundara@purdue.edu), by May 15 of each year. 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.



INTERNATIONAL  
ELECTROSTATIC  
ASSEMBLY  
(IEA)



## 2012 Electrostatics Joint Conference

Cambridge-Hespeler Galt Holiday Inn

Cambridge, Ontario, Canada, June 12-14, 2012

<http://www.electrostatics.org/conferences.html>

June 12: Conference begins (8AM)

June 12 (evening): Electrostatics Demonstrations Session and UW campus tours

June 13: Conference continues, evening poster session

June 14: Conference ends after evening banquet

June 15: Optional Niagara Falls Day Trip

(details at [http://www.electrostatics.org/images/Niagara\\_Trip.pdf](http://www.electrostatics.org/images/Niagara_Trip.pdf))

**University of Waterloo Research Labs:** In addition to the electrostatics demonstrations described on the previous page, visits to other world class laboratories on UW campus are arranged. The visit will include the High Voltage Engineering Laboratory (HVLE), the Institute for Quantum Computing (IQC), and Waterloo Advanced Technology Laboratory (WatLab). HVLE is a leading research and teaching laboratory in the field of insulation, applied electrostatics, nanodielectrics, pulse power applications, and power electronics. In IQC's state-of-the-art laboratories, researchers explore quantum information through experiments in optics, nanoelectronics, nuclear magnetic resonance, quantum sensors and more. This research has created a wealth of new knowledge, and is already spawning the first wave of practical quantum technologies. WatLab consists of two fully operational state-of-the-art materials analytical systems: an ultrahigh resolution scanning electron microscope and a multi-technique imaging ESCA micro-probe system.

**Local Attractions:** During your visit several sightseeing attractions can be enjoyed in the Waterloo Region. For those who are interested in nature, Niagara Falls is the best choice with views of one of the greatest waterfalls in the world. Historical and cultural sights include the Royal Ontario Museum (ROM) and CN Tower in Toronto, Dundrun Castle in Hamilton, University of Guelph Arboretum in Guelph, Covered Bridge in Waterloo and the Elora Gorge Conservation Area.

**Conference Hotel:** The Cambridge-Hespeler Galt Holiday Inn (200 Holiday Inn Dr., Cambridge, Ontario) is located right on the Macdonald-Cartier Freeway (highway 401). If you are flying into the Pearson International Airport, please make your reservation through "Airways Transit". If you have a reservation, it is their responsibility to bring you to the hotel, and safely take you back to meet your flight timings. You can make the reservation from the conference webpage or using the following link:

<http://www.holidayinn.com/hotels/us/en/cambridge/ycmca/hoteldetail?groupCode=ESA>.

Contact Information:

Technical Chair: Prof. Maciej A. Noras, University of North Carolina at Charlotte, [mnoras@uncc.edu](mailto:mnoras@uncc.edu), (704) 687-3735

General Chair: Prof. Shesha Jayaram, University of Waterloo, [jayaram@uwaterloo.ca](mailto:jayaram@uwaterloo.ca) (519) 888-4567 ext.: 35337

## Current Events

### IBM captures first-ever image of single-molecule charge distribution

IBM scientists were recently able to measure for the first time how charge is distributed within a single molecule. This breakthrough should enable fundamental scientific insights into single-molecule switching and bond formation between atoms and molecules. The ability to image the charge distribution within functional molecular structures holds great promise for future applications such as solar photoconversion, energy storage, or molecular scale computing devices.

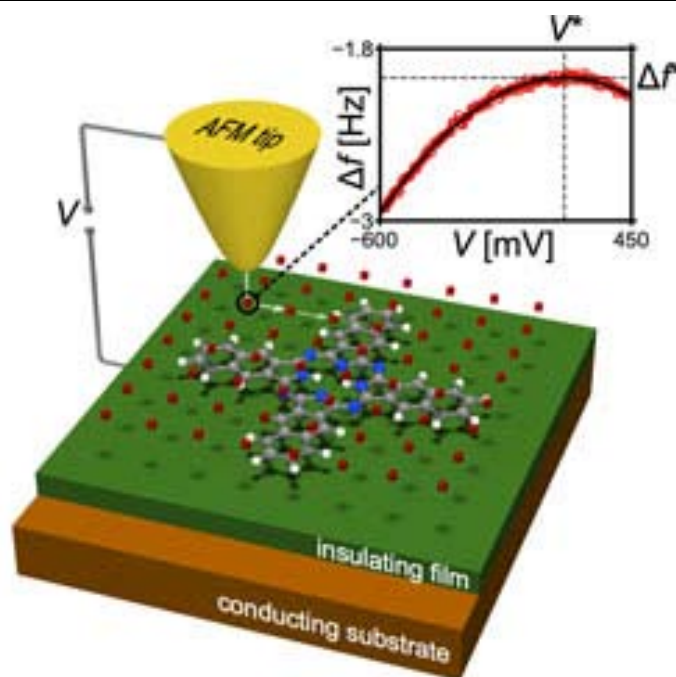
As reported recently in the journal *Nature Nanotechnology*, scientists Fabian Mohn, Leo Gross, Nikolaj Moll and Gerhard Meyer of IBM Research succeeded in imaging the charge distribution within a single molecule by using a special kind of atomic force microscopy called Kelvin probe force microscopy at low temperatures and in ultrahigh vacuum.

"This work demonstrates an important new capability of being able to directly measure how charge arranges itself within an individual molecule," states Michael Crommie, professor in the Department of Physics at the University of California, Berkeley. "Understanding this kind of charge distribution is critical for understanding how molecules work in different environments. I expect this technique to have an especially important future impact on the many areas where physics, chemistry, and biology intersect."

The new technique provides complementary information about the molecule, showing different properties of interest. This is reminiscent of medical imaging techniques such as X-ray, MRI, or ultrasonography, which yield complementary information about a person's anatomy and health condition.

The discovery could be used to study charge separation and charge transport in so-called charge-transfer complexes. These consist of two or more molecules and hold tremendous promise for applications such as computing, energy storage or photovoltaics. In particular, the technique could contribute to the design of molecular-sized transistors that enable more energy efficient computing devices ranging from sensors to mobile phones to supercomputers.

"This technique provides another channel of information that will further our understanding of nanoscale physics. It will now be possible to investigate at the single-molecule level how charge is redistributed when individual chemical bonds are formed between atoms and molecules on surfaces," explains Fabian Mohn of the Physics of Nanoscale Systems group at IBM Research – Zurich. "This is essen-



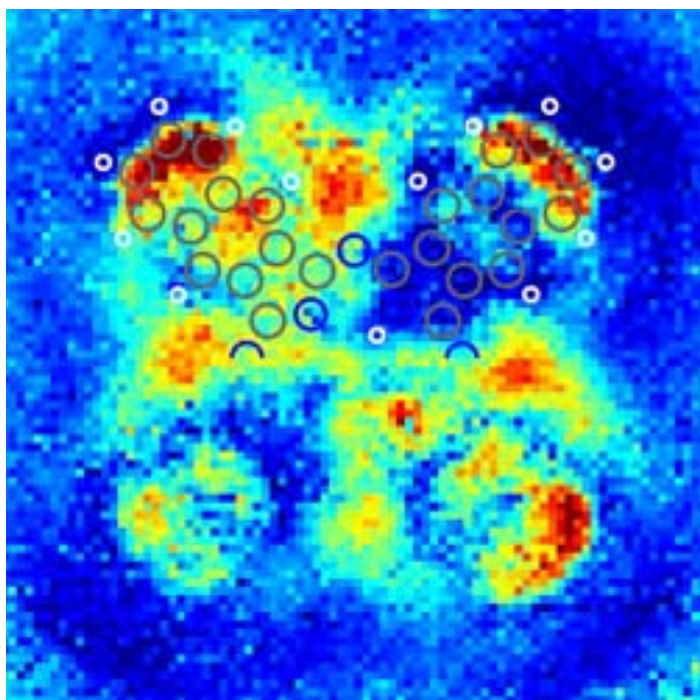
Schematic of the measurement principle. At each tip position, the frequency shift is recorded as a function of the sample bias voltage (inset, red circles). The maximum of the fitted parabola (inset, solid black line) yields the KPFM signal  $V^*$  for that position. Image courtesy of IBM Research - Zurich

tial as we seek to build atomic and molecular scale devices."

Gerhard Meyer, a senior IBM scientist who leads the scanning tunneling microscopy (STM) and atomic force microscopy (AFM) research activities at IBM Research – Zurich adds, "The present work marks an important step in our long term effort on controlling and exploring molecular systems at the atomic scale with scanning probe microscopy." For his outstanding work in the field, Meyer recently received a European Research Council Advanced Grant. These prestigious grants support "the very best researchers working at the frontiers of knowledge" in Europe.

To measure the charge distribution, IBM scientists used an offspring of AFM called Kelvin probe force microscopy (KPFM). When a scanning probe tip is placed above a conductive sample, an electric field is generated due to the different electrical potentials of the tip and the sample. With KPFM this potential difference can be measured by applying a voltage such that the electric field is compensated. Therefore, KPFM does not measure the electric charge in the molecule directly, but rather the electric field generated by this charge. The field is stronger above areas of the molecule that are charged, leading to a greater KPFM signal. Furthermore, oppositely charged areas

## Current Events (cont'd.)



Enhanced resolution in the Kelvin probe force microscopy images by tip functionalization with a carbon monoxide molecule. When a scanning probe tip is placed above a conductive sample, an electric field is generated due to the different electrical potentials of the tip and the sample. With Kelvin force probe microscopy this potential difference can be measured by applying a voltage such that the electric field is compensated. Therefore, KPFM does not measure the electric charge in the molecule directly, but rather the electric field generated by this charge. The field is stronger above areas of the molecule that are charged, leading to a greater KPFM signal. Furthermore, oppositely charged areas yield a different contrast because the direction of the electric field is reversed. This leads to the light and dark areas in the micrograph. Image courtesy of IBM Research - Zurich

yield a different contrast because the direction of the electric field is reversed. This leads to the light and dark areas in the micrograph (or red and blue areas in colored ones).

Naphthalocyanine, a cross-shaped symmetric organic molecule which was also used in IBM's single-molecule logic switch, was found to be an ideal candidate for this study. It features two hydrogen atoms opposing each other in the center of a molecule measuring only two nanometers in size. The hydrogen atoms can be switched controllably between two different configurations by applying a voltage pulse. This so-called tautomerization affects the charge distribution in the molecule, which redistributes itself between opposing legs of the molecules as the hydrogen atoms switch their locations.

Using KPFM, the scientists managed to image the different charge distributions for the two states. To achieve submolecular resolution, a high degree of thermal and mechanical stability and atomic precision of the instrument was required over the course of the experiment, which lasted several days.

Moreover, adding just a single carbon monoxide molecule to the apex of the tip enhanced the resolution greatly. In 2009, the team has already shown that this modification of the tip allowed them to resolve the chemical structures of molecules with AFM. The present experimental findings were corroborated by first-principle density functional theory calculations done by Fabian Mohn together with Nikolaj Moll of the Computational Sciences group at IBM Research – Zurich.

(from <file:///Users/dad/Documents/esa/esa%20newsletter/future%20articles/IBM%20captures%20first-ever%20image%20of%20single%20molecule%20charge%20distribution%20%7C%20R&D%20Mag.webarchive>)

## 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.

## Calendar

- ✦ ESA-2012, Joint ESA/IEJ/IAS/SFE Meeting, June 12-14, 2012, Univ. of Waterloo, Waterloo, Ontario, Canada, Contact: Shesha Jayaram, [jayaram@uwaterloo.ca](mailto:jayaram@uwaterloo.ca), website: <http://www.electrostatics.org>
- ✦ 8th Conf. of the French Society of Electrostatics (SFE), July 3-5, 2012, Cherbourg, France, Contact: Jean-Michel Reboul, Ph: (33) 2 33 01 42 04, [jean-michel.reboul@unicaen.fr](mailto:jean-michel.reboul@unicaen.fr), website: <http://www.chbg.unicaen.fr/sfe/?lang=en>
- ✦ ICAES-2012, 7th Int'l. Conf. on Applied Electrostatics, Sept. 17-19, 2012, Dalian Univ. of Tech., Dalian, China, Contact: Secretariat Office, Ph: +86 411 84708576-604, [ICAES2012@163.com](mailto:ICAES2012@163.com), website: <http://www.icaes-2012.org/windows/index.htm> (abstracts due Apr. 30, 2012)
- ✦ 12th Int'l. Conf. of Electrostatics, Electrostatics - 2013, April 2013, Budapest, Hungary, Contact: [info@electrostatics2013.org](mailto:info@electrostatics2013.org) website: <http://www.electrostatics2013.org/> (abstracts due Apr. 19, 2012)

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Society of America**



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**ESA-2012 Annual Joint Meeting**

**ESA/IEJ/IEEE-IAS EPC/SFE**

**June 12-14, 2012**

**University of Waterloo, Waterloo, Ontario, Canada**