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ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

Dear ESA Members:

It is amazing what electrostatics does in our body. Protein-protein interactions, charges and their interactions contributing to cytotoxicity –all governed by electrostatic interactions of various ions and charges in our cells, tissues, and organs [1, 2]. It is exciting to know that our biological cell plasma membrane surface charge has a significant impact on cell signaling, a significant part of cancer biology [3]. Changes in the membrane electrostatic potential could modify cell-signaling behavior. Modifying the net charge and altering the membrane surface charge itself could regulate the surface charge effect. One can hope that charged cancer drugs such as Bleomycin work in this manner. When combined with an electric field, such as in electroporation or electropermeabilization, one could imagine a redistribution of charge and inhibition of proliferation thereby leading to a greatly enhanced cell death process compared to a drug only treatment, as observed by various researchers [4]. Neutralization of the existing negative charges using positive charges will effectively reduce the electrostatic interaction between the given protein domain and the plasma membrane, and hence reduce the toxicity associated with charge [5]. Abundant primary, secondary, and tertiary amine groups contribute to significant cell toxicity due to their charge density on the polymer surface. Preventing electrostatic interactions with cellular membranes seems to be a necessary step towards minimizing the toxicity of delivery vehicles to the cells. Parameters such as molecular weight, structure topology (whether linear or branched), degree of branching, and charge density may further aggravate cytotoxic effect. Modification of membrane surface charge is thus a major issue for fighting cancer and electrostatics plays again a major role, in addition to its role played in DNA and RNA as discussed in the Apr 2009 ESA Newsletter.

Cytotoxicity limits the potential of high molecular weight cationic polymers in gene delivery. About 100 years ago in the western world, realization of this limitation led to a focus on the study of bio-chemical interactions; a major change in the prevailing paradigm used to explain cellular functions and disease progression [6]. The pharmaceutical industry subsequently became very successful in using this model to develop a series of drugs and transformed medicine into a huge multibillion business using drug therapies. All the research dollars and effort were mostly directed towards understanding the chemistry of the body and developing drugs to alter that chemistry. Yet many biological questions remain unanswered and it is no wonder that only 10% of the people respond to 90% of the drug or 90% of the drugs work only for 10% of the people.

Thus all the questions of the body cannot be answered by chemistry (and hence by drugs) alone due to the fact that bio-chemical processes fail to explain the role of electricity and electrostatic forces and interactions in cell regulation and hence in deadly diseases such as cancer. Our cells possess electrical mechanisms and use charges and electricity to regulate and control the transduction of chemical energy and life processes. Hence, we can all be proud to be in the exciting field of electrostatics and contribute to its success in various applications.

(cont'd. p.2)

President's Message (cont'd.)

I am sure we will see more bio-electrostatics in the upcoming 2011 ESA annual meeting at Case Western Reserve University in June. As always I look forward to hearing from you and I am very happy to mention that I heard very positively about our last ESA Newsletter from one of our very esteemed members. I am very grateful to him for that.

Thank you very much and have a very productive and pleasant time.

Yours for the friendly Society,

Raji Sundararajan,
ESA President

References:

1) P.H. Wen and K.M. Blumenthal, Role of electrostatic interactions in defining the potency of neurotoxin B-IV from Cerebratulus lacteus, The J of Biological Chemistry, Vol. 271, No. 47, Nov 22, 1996, pp. 29752-29758.
2) N. Sinha and S.J. Smith-Gill, Electrostatics in protein binding, Curr Protein Pept Sci. 2002 Dec;3(6):601-14.
3) N.M. Goldenberg and B.E. Steinberg, Surface charge: a key determinant of protein localization and function (review), Cancer Res; 70(4) Feb 15 2010.
4) Luca Campana, et al., "Bleomycin-based electrochemotherapy: clinical outcome from a single Institution's experience with 52 patients", Annals of Surgical Oncology, 16:191-99, 2009
5) A. Pathank, S. Patnaik, and K.C. Gupta, Recent trends in non-viral vector-mediated gene delivery (Review), Biotechnol. J. 2009, 4, 1559-1572
6) Steve Haltiwanger, The Electrical Properties of cancer Cells, *http://www.royalrife.com/haltiwanger1.pdf*., July 2010.

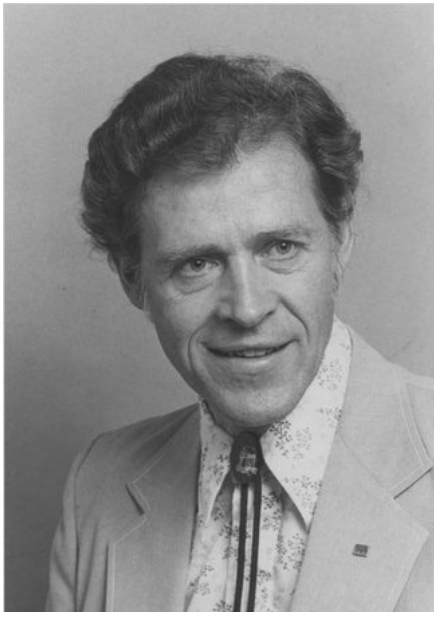
ESA OFFICERS

Calendar

- IEEE-IAS 2010 Annual Meeting, Electrostatic Processes Committee, Oct. 3-7, 2010, Houston, Texas, website: http://www.ewh.ieee.org/soc/ias/2010/home.htm
- IEEE-DEIS CEIDP 2010, Oct. 17-20, 2010, Purdue University, West Lafayette, Indiana, Contact: Rajeswari Sundararajan, Tel: +1 765 494 6912, *rsundara@purdue.edu,* website: http://ewh.ieee.org/soc/dei/ceidp/ceidp2010.htm
- Electrostatics 2011, 13th Int'l. Conf. on Electrostatics, April 10-14, 2011, Bangor University, Wales, UK, Contact: Dawn Stewart, Tel: +44 (0)20 7470 4800, *dawn.stewart@iop.org*, website: http://www.electrostatics2011.org
- 12th Int'l. Conf. of Electrostatic Precipitation (ICESP XII), Maritim Hotel, Nuremberg, Germany, May 9-13, 2011, Contact: Norbert Grass, *norbert.gross@ohm-hochschule.de* website: *http://www.icespxi.org*
- ESA-2011, June 14-16, 2011, Case Western Univ., Cleveland, OH Contact: Dan Lacks, *daniel.lacks@case.edu,* website: http://www.electrostatics.org

In Memoriam - Bob Gundlach

ESA founding member, top Xerox scientist and first-rate inventor dies at 84



Robert W. Gundlach, a founding member of the Electrostatics Society of America (ESA) and a prolific inventor, died Wednesday August 18, 2010 of aspiration pneumonia at The Shore Winds nursing home in Charlotte, New York. He was 84. He is survived by his wife of 50 years, Audrey; and sons Eric of Maryland, Kurt of Massachusetts and Greg of Vermont.

Bob was born Sept. 7, 1926 in Buffalo, New York. He earned a bachelor's degree in physics in 1949 from the University at Buffalo, where he did additional graduate studies in physics. He started with the Haloid Co. in 1952, where he worked with Chester Carlson, the inventor of xerography. The Haloid Co. later became the Xerox Corporation. Bob was one of Xerox Corp.'s most creative inventors and a pioneer in the science behind photocopying.

During his career at Xerox, Bob received 155 US patents, with the technology he developed making possible advances such as desktop copiers. When he retired in 1995, he had 12 patent applications pending and he received his 155th in 2002. He received an additional eight U.S. patents outside of Xerox for inventions including a water-based heat pump system and a type of backpack.

Xerox made Bob one of its first four principal scientists in 1963. Three years later, he was named its first research fellow, at the time the highest non-managerial post available for a company scientist. In 1978, he was named senior research fellow.

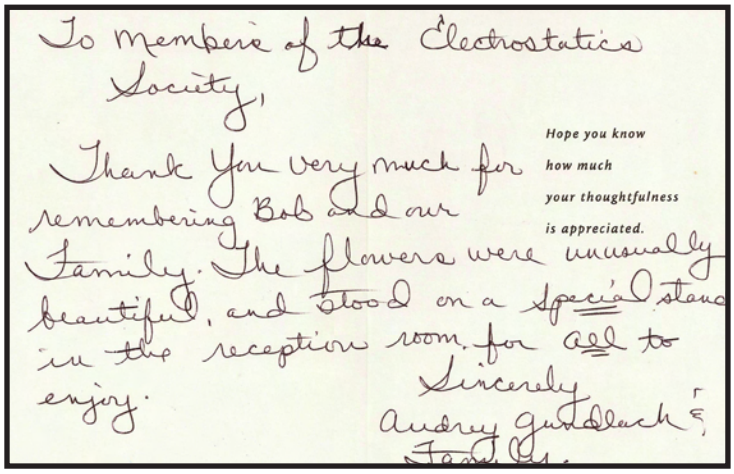
He was elected to the National Academy of Engineering in 1994. On his retirement, he received Xerox's President's Award for outstanding career achievement. Bob was very active in the ESA and served on the Executive Committee (1971-73). In 1997, he received the Electrostatics ESA's Lifetime Achievement Award.

His work, according to the National Inventors Hall of Fame, "made photocopying technology more practical, flexible and affordable."

Bob had an uncanny ability to listen to an ESA presentation and then suggest several applications of the technology that might be patentable. Most ESA members would agree that his mind was exceptionally creative and innovative.

Bob was an avid cross-country skier, hiker, jogger and birder who had integrity, congeniality and honor in everything he did. His presence at ESA meetings helped mold the ESA into the Friendly Society. The ESA has lost one of its greatest members, and he will always be fondly remembered.

(Thanks to Al Seaver and http://www.nytimes.com/2010/08/23/business/23gundlach.html?_r=2&ref=obituaries for providing these words.)



To Members of the Electrostatics Society,

Thank You very much for remembering Bob and our family. The flowers were unusually beautiful, and stood on a special stand in the reception room for all to enjoy.

Sincerely
Audrey Gundlach

Hope you know how much your thoughtfulness is appreciated.

Thank you note from the Gundlach family in appreciation of the ESA flower donation to the memorial service.

Current Events

Lunar polar craters may be electrified

As the solar wind flows over natural obstructions on the moon, it may charge polar lunar craters to hundreds of volts, according to new calculations by NASA's Lunar Science Institute team. Polar lunar craters are of interest because of resources, including water ice, which exist there. The moon's orientation to the sun keeps the bottoms of polar craters in permanent shadow, allowing temperatures there to plunge below minus 400°F, cold enough to store volatile material like water for billions of years. "However, our research suggests that, in addition to the wicked cold, explorers and robots at the bottoms of polar lunar craters may have to contend with a complex electrical environment as well, which can affect surface chemistry, static discharge, and dust cling," said William Farrell of NASA's Goddard Space Flight Center, Greenbelt, Md. Farrell is lead author of a paper on this research published March 24 in the Journal of Geophysical Research. The research is part of the Lunar Science Institute's Dynamic Response of the Environment at the moon (DREAM) project.

The researchers created computer simulations to discover what happens when the solar wind flows over the rims of polar craters. They discovered that in some ways, the solar wind behaves like wind on Earth -- flowing into deep polar valleys and crater floors. Unlike wind on Earth, the dual electron-ion composition of the solar wind may create an unusual electric charge on the side of the mountain or crater wall; that is, on the inside of the rim directly below the solar wind flow. Since electrons are over 1,000 times lighter than ions, the lighter electrons in the solar wind rush into a lunar crater or valley ahead of the heavy ions, creating a negatively charged region inside the crater. The ions eventually catch up, but rain into the crater at consistently lower concentrations than that of the electrons. This imbalance in the crater makes the inside walls and floor acquire a negative electric charge. The calculations reveal that the electron/ion separation effect is most extreme on a crater's leeward edge – along the inside crater wall and at the crater floor nearest the solar wind flow. Along this inner edge, the heavy ions have the greatest difficulty getting to the surface. Compared to the electrons, they act like a tractor-trailer struggling to follow a motorcycle; they just can't make as sharp a turn over the mountain top as the electrons. "The electrons build up an electron cloud on this leeward edge of the crater wall and floor, which can create an unusually large negative charge of a few hundred Volts relative to the dense solar wind flowing over the top," says Farrell.

The negative charge along this leeward edge won't build up indefinitely. Eventually, the attraction between the negatively charged region and positive ions in the solar wind will cause some other unusual electric current to flow. The team believes one possible source for this current could be negatively charged dust that is repelled by the negatively charged surface, gets levitated and flows away from this highly charged region. "The Apollo astronauts in the orbiting Command Module saw faint rays on the lunar horizon during sunrise that might have been scattered light from electrically lofted dust," said Farrell. "Additionally, the Apollo 17 mission landed at a site similar to a crater environment – the Taurus-Littrow valley. The Lunar Ejecta and Meteorite Experiment left by the Apollo 17 astronauts detected impacts from dust at terminator crossings where the solar wind is nearly-horizontal flowing, similar to the situation over polar craters."

(*excerpted from* [*http://www.rdmag.com/News/2010/04/General-Science-Lunar-polar-craters-may-be-electrified/*](http://www.rdmag.com/News/2010/04/General-Science-Lunar-polar-craters-may-be-electrified/) *)*

Electrical properties of glass at the nanoscale lead to a pump the size of a red blood cell

Researchers have devised a way to fabricate tiny electrodes from glass, harnessing a phenomenon by which nanoscale glass walls can be transformed from insulators to conductors and back again. At larger scales, that phenomenon, known as "dielectric breakdown," leads to excess heating and structural damage, but at the nanoscale the process appears to be harmless and reversible. Sanghyun Lee of the Pohang University of Science and Technology in South Korea and Ran An and Alan Hunt of the University of Michigan at Ann Arbor announced their finding in a paper published online May 16 in Nature Nanotechnology, along with a prototype application in what may be the smallest man-made pump in existence. (

Using lasers, the group machined glass channels just 600 nanometers wide onto a substrate. (A nanometer is one billionth of a meter.) Two electrolyte-filled channels were placed end to end, with a thin glass wall separating them. Ordinarily the wall would serve as a dam, blocking the flow of both electrolyte and electric current. But dielectric breakdown, induced by extreme electric fields, can change that, allowing current to pass through the glass wall even though the wall remains structurally intact and continues to prevent electrolyte flow. The researchers found that at such small scales, even an electric potential of 10 volts would suffice to transform the glass insulator into a conducting electrode. And the heat accompanying dielectric breakdown, which can fry larger devices, dissipates so quickly on the nanoscale that the glass structure appears to suffer no permanent damage.

(*excerpted from* [*http://www.scientificamerican.com/blog/post.cfm?id=electrical-properties-of-glass-at-t-2010-05-16*](http://www.scientificamerican.com/blog/post.cfm?id=electrical-properties-of-glass-at-t-2010-05-16)*)*

Electrostatics Society of America
2011 Annual Meeting

Case Western Reserve University • Cleveland, OH
June 14-16, 2011

The conference will cover a range of interdisciplinary topics related to electrostatics including fundamental physics and issues relevant to industry, atmospheric and space science, medicine, energy, and other fields.

Technical sessions include:

- **Atmospheric and space applications**
- **Biological and medical applications**
- **Breakdown and discharge**
- **Electrostatic forces and fields**
- **Electrostatics in flowing liquids**
- **Materials behavior and processing**
- **Measurement and instrumentation**
- **Particle control and charging**
- **Safety and hazards**

The conference will be held on the campus of Case Western Reserve University.

Conference Chairs:
Professor Daniel Lacks, Case Western Reserve University: daniel.lacks@case.edu
Professor R. Mohan Sankaran, Case Western Reserve University: mohan@case.edu

Deadline for abstracts is March 1, 2011.
Submit abstracts online at:
www.electrostatics.org/conferences.html

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