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ESA Newsletter

Electrostatics Society of America - The Friendly Society

President's Message

Electrostatic precipitators and clean energy

Dear All:

In coal power plants, the coal does not burn completely. It depends on whether it is anthracite (almost carbon, the best quality), bituminous coal with >80% carbon, or lignite with hardly 60% carbon. The smoke indicates the unburned or incompletely burned coal residuals, some falling to the bottom of the boiler and cleared away, and some carried off as flue gas. Electrostatic precipitators (ESP) are used to remove the particulates [1, 2, 3]. The particles are negatively charged and collected by a positively charged electrode. The resulting fly ash accumulates on the electrodes and is disposed of regularly. In this manner, the majority of the particles can be removed from the flue gas using ESPs. In addition, in-line scrubbers remove the sulfur dioxide [4]. However, ESPs have issues such as "sneakage", and "back corona" that reduce collection efficiency. ESPs and scrubbers on new coal plants still release massive quantities of pollution into air, and generate millions of tons of heavy metal-laden coal ash.

Nationwide, coal power plants account for 67% of all sulfur dioxide, 22% of all nitrogen dioxide, nearly 40% of carbon dioxide, and a 33% of all mercury emissions. Coal plants release some sixty varieties of "hazardous air pollutants" per EPA, including known toxins, such as lead (176,000 pounds), chromium (161,000 pounds), arsenic (100,000 pounds), and mercury (96,000 pounds) [4]. And that's just what goes into the air. In addition, each year coal plants produce about 130 million tons of solid waste - about three times as much as all the municipal garbage in the nation. These by-products of the combustion process (waste-fly ash, bottom ash, scrubber sludge) is laced with heavy metals and other potentially toxic compounds and is routinely pumped into abandoned mines or impoundment ponds where, if not handled correctly, they can leach into aquifers and water supplies. According to EPA, half of all Americans live in areas where air pollution levels exceed national health standards. For example, in the Northeast the level of small-particle pollution (tiny bits of soot, acid droplets, and toxic metals that have been linked to a number of deadly health effects, cancers, and heart attacks) has remained about the same over the past several years. Ozone levels (created when nitrogen oxides released from coal plants react in the presence of sunshine and other heat sources with other pollutants) remain a serious problem in many regions of the country, especially during hot summer months. In 2004, 29 million children (aged 14 and under) lived in counties with unhealthful ozone levels. Additionally, researchers have recently found that particulate matter is damaging not only our lungs, but also our hearts and even perhaps our brains. Long term exposure to low-level pollution can be as dangerous as short-term exposure to high levels, especially for the young, old, and those with diabetes and heart problems are more vulnerable. There are also unexpected long term effects, like children who grow up in areas with high ozone levels have smaller, weaker lungs and mercury from coal to water to fish to our dinner makes more damages than most could realize [4]. Since mercury is a neurotoxin, it is particularly harmful to the still-forming brains and nervous systems of fetuses and young children. Mercury exposure is different from other pollutants exposure-it comes through eating fish, meaning, that mercury emitted from a coal plant in Illinois can end up on the dinner plate of a pregnant women in New Mexico, so it is untraceable. Mercury is the most harmful to the unborn; its subtle effects may play out over a life time. EPA had issued advisories in 44 states to avoid or limit their consumption of certain kinds of fish [4].

Further damage is done by smaller particles, known as "ultrafines", which are roughly 0.1 micron in diameter, and hence could pass through our lungs' natural defenses and enter directly into our bloodstreams, often carrying whatever metals or acids attached to them [4].

(cont'd. on page 2)

President's Message (cont'd.)

We are hooked on the wire by the electrons generated by the coal for the past 100+ years [4]. We send robots to Mars, but when it comes to generating electricity we rely on a system that pollutes the environment, causes fishes to die, children to suffer, pollutes the water and air, and causes cancers and kills people?

Until we find alternative energies and reduce the coal burning (which is here to stay for another several decades), we need to come up with electrostatic precipitators and scrubbers that collect these ultrafines and capture mercury as much as possible. I hope one of us comes up with such a device, a nano-ESP, in the near future. Until then, we can reduce our energy consumption [5], reduce the waste of energy that we do knowingly as well as unknowingly. May be some of us can submit abstracts and papers on this very important topic of the planet in our next annual meet during June 22-24, 2010 at University of North Carolina. Our general conference chair, Maciej Noras is busy negotiating excellent deals for us. You will hear from Technical Program Chair, Dan Lacks about the due dates for abstract submission and paper submission dates (which could be similar to last year's).

Again, I had the great pleasure of hearing from one of our esteemed members in response to last newsletter (Thank you so much). As always, I look forward to hearing from more of you.

Thank you.

Have a pleasant & productive time.
Yours for the Friendly Society,

Raji Sundararajan,
ESA President

References:

[1] J.H. Turner, P.A. Lawless, T. Yamamoto, and D.W. Coy, G.P. Greiner, and J.D. McKenna, W.M. Vatavuk, Electrostatic Precipitators, Chapter 6, Dec. 1995.

[2] Herek L. Clack, Mercury capture within coal-fired power plant electrostatic precipitators: model evaluation, Environ. Sci. Technol. 2009, 43, 1460-1466.

[3] Virtual Power Plant Tour: Electrostatic Precipitator, *http://corporate.evonik.com/resources/sites/powerplant/precipitator.html*

[4] Jeff Goodell, Big Coal - The dirty secret behind America's Energy future, A Mariner Book, Houghton Mifflin Company, Boston, 2007.

[5] Kim McKay and Jenny Bonnin, True green - 100 everyday ways you can contribute to a healthier planet, National Geographic, Washington DC, 2006.

Acknowledgement: I am very grateful to Dr. Rod Handy, Purdue University, for introducing me to "Big Coal".

Sources and Sinks

Request for Input: Electrostatics and Drilling

Stuart A. Hoenig

Does anyone know about the electrostatic effect when a metal drill contacts a rock? It seems that there is a current of electrons (100 microamps) from the drill-contact point that flows to ground via the cooling water. If the current is stopped by applying an external counter current the drill penetration goes up by about 90% and the drill wear goes down by about 70%.

Anyone interested in this might contact me.

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Calendar

- ESA-2010, June 22-24, 2010, Univ. of North Carolina, Charlotte, NC Contact: Maciej Noras, Tel: 704-687-3735, *mnoras@uncc.edu,* website: http://www.electrostatics.org
- SFE 2010, Aug 30 - Sept 1, 2010, Montpellier, France, Contact: SFE2010 Organizing Committee, Tel: +33 4 67 14 34 85, *sfe2010@univ-montp2.fr,* website: http://www.electrostatics.org (abstracts due by Dec 31, 2009)
- 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

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2010 Annual Meeting of the Electrostatics Society of America

University of North Carolina, Charlotte. June 22-24, 2010

CALL FOR PAPERS

We invite papers in all scientific and technical areas involving electrostatics. Contributions can range from fundamental investigations of electrostatic phenomena to studies of the implications, mitigation, or utilization of electrostatic phenomena in diverse settings. Technical sessions include:

I. Atmospheric and space applications
II. Biological and medical applications
III. Breakdown and discharge
IV. Flows, forces, and fields
V. Materials behavior and processing
VI. Measurement and instrumentation
VII. Particle control and charging
VIII. Safety and hazards

Abstract submission: Abstracts should be submitted online, at http://www.electrostatics.org

Student paper competition: Presentations by students (undergraduate and graduate) are eligible; indicate participation when submitting abstract.

Registration and housing information: Will be posted online, at http://www.electrostatics.org

Important dates

March 1, 2010	Abstract submission deadline
March 17, 2010	Notification of paper acceptance
May 15, 2010	Final manuscripts due
June 22, 2010	Conference begins (1 PM)
June 24, 2010	Conference ends after evening banquet (Banquet: 7 PM – 10 PM)

Contact information

For questions regarding the technical program and abstract submission, contact the Technical Chair:
Prof. Daniel Lacks, Case Western Reserve University, daniel.lacks@case.edu, (216) 368-4238

For all other questions, contact the General Chair:
Prof. Maciej Noras, University of North Carolina-Charlotte, mnoras@uncc.edu, (704) 687-3735

Current Events

Physicist may have solved a 40-year-old lunar riddle

John Johnson Jr.
http://articles.latimes.com/2009/apr/23/science/sci-moon-dust23

One of the biggest problems facing America's space agency as it prepares to return to the moon is how to manage lunar dust. It gets into everything. Worse, it's sticky, adhering to spacesuits and posing a potentially serious health hazard to future colonists. Now, a scientist who has been studying the problem off and on over four decades thinks he may have untangled the mystery of why that dust is so sticky. Brian O'Brien, an Australian physicist who worked on the Apollo program in the 1960s, said the sun's ultraviolet and X-ray radiation gives a positive charge to the dust, making it stick to surfaces such as spacesuits. This doesn't happen on Earth because our atmosphere screens out much of the sun's harmful radiation. The moon's atmosphere is so thin that the rays easily reach the surface.

O'Brien's most important finding, at least for NASA's purposes in planning for a return to the moon by 2020, is that the angle of the sun's rays influences the stickiness. The more direct the sunlight, he said, the stickier the dust. O'Brien's interest in lunar dust dates to 1965, when he was at Houston's Rice University, where he was selected as the lead scientist for seven lunar experiments designed for the Apollo program. He began worrying that lunar dust could clog his devices and ruin the experiments. Lunar dust is "a bloody nuisance," O'Brien said in a statement.

In 1970, he published a paper showing that lunar dust kicked up by the Apollo 11 lunar module that carried Neil Armstrong and Buzz Aldrin back to space coated the surface of a seismometer left behind on the moon's surface. The ground motion sensor overheated and failed after three years.

More than three decades later, in 2006, O'Brien's fascination with lunar dust was rekindled when he learned that NASA had misplaced the original tapes from his dust-detecting experiments, he said in an e-mail from his home outside Perth, Australia. O'Brien dug up his own collection of 173 tapes and set about trying to understand the behavior of the dust once more.

Now 75 and retired, he traced his desire to unravel the 40-year-old problem to "old-fashioned enduring interest and, I suppose, curiosity." Over two years of painstaking research, O'Brien tracked the dust accumulating on two solar cells, one horizontal and one vertical, over the course of two lunar days. That may not sound like much time, but a lunar day equals nearly 30 days on Earth.

He found that little dust collected on the horizontal cell in the lunar morning, when the sun's rays were slanted, while more dust adhered to the vertical cell, which more directly faced the rising sun. The weaker the sun's rays, he found, the weaker the electrostatic forces causing the dust particles to stick, until the dust fell off.

Some scientists believe that one of the greatest challenges for future lunar colonists will be keeping their lungs free of the particles, each thinner than a human hair but sharp as a razor.

Based on his research, which is to be published in the journal Geophysical Research Letters, O'Brien thinks colonists will be able to combat the dust problem with a practical, Earth-tested solution: old-fashioned sunscreen. There might be other approaches, O'Brien said, but "I leave that stuff to the engineers responsible for the safety of the astronauts."

NASA's Johnson Space Center in Houston, the home of the manned spaceflight program, is working on the dust problem too. Several scientists there have been in contact with O'Brien, according to the center's press office. Officials didn't challenge O'Brien's findings nor did they endorse them. "There are several models that predict how lunar dust behaves on the moon and very little evidence to validate those models," said Josh Byerly, a public affairs officer at Johnson. "We probably will not know its true behavior until we return."

Ohio Engineers "Ink" New E-Paper

Rosaleen Ortiz, IEEE Spectrum
(excerpted from http://spectrum.ieee.org/semiconductors/materials/ohio-engineers-ink-new-electronic-paper-technology)
A new technology that uses ambient light and pigments used in commercial printing promises to make thin electronic displays that are as bright and vibrant as the pages of a glossy magazine, Researchers at the University of Cincinnati's Novel Devices Laboratory have developed what they call electrofluidic display technology over the past two years in collaboration with color experts from ink and pigments manufacturer Sun Chemical Corp. Sun Chemical also funded the work and has applied for a patent on the technology with the university.

An electrofluidic display is built from two sheets of plastic. Onto one sheet, mesa-like polymer structures are printed to form pixels. For each pixel, a hole taking up 5 to 10 percent of the pixel area (about 50 micrometers) is formed in the polymer and filled with a droplet of pigmented fluid. Surrounding the pixel is a trench cut into

Current Events (cont'd.)

the polymer that contains air or oil. The pixels are topped by another sheet of plastic—this one containing a transparent electrode—leaving a 3-µm gap between it and the polymer pixel.

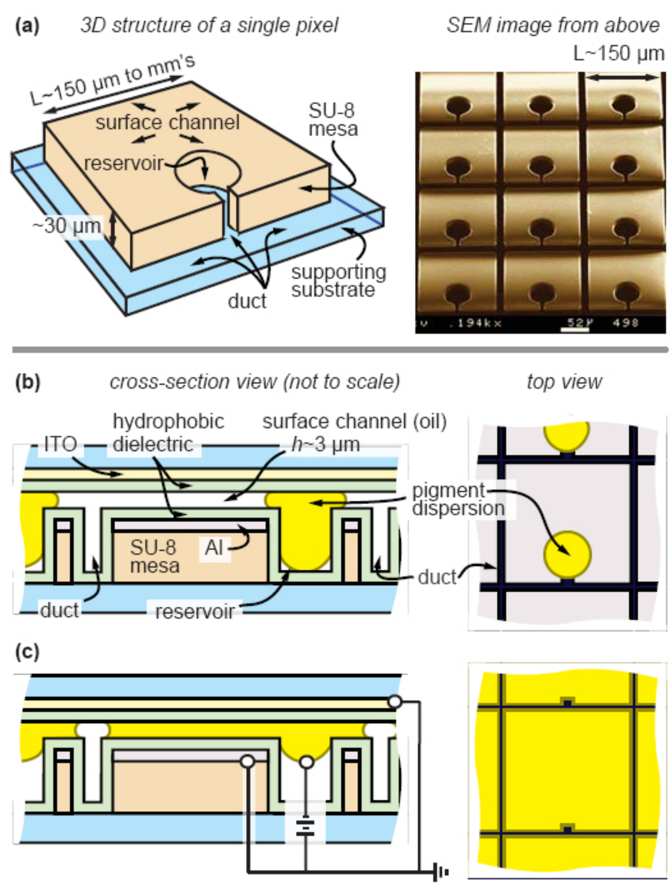
When there is no voltage between the plastic sheets, the pigment will stay inside the hole, essentially invisible to the naked eye. But when a voltage is applied, the pigment is pulled out of the hole and spread out along the glass, revealing its rich color to the viewer. The air or oil surrounding the pixel prevents the pigment in one pixel from spilling into another. Switching off the power lets the pigment recoil back into the hole.

Jason Heikenfeld, who led the research and is director of the Novel Devices Laboratory, says electronic paper would be only one of many possible applications. There is also potential for rollable displays, adaptive camouflage, and even cellphone cases that can change color on the fly, he says. Heikenfeld says the reason this design works so well is that there is nothing between the viewer and the pigments except a pane of glass. "You basically get to see the pigment without any losses, any polarizing filters. You actually get to look straight at the pigment," he says.

Heikenfeld and some partners have formed a start-up company, Gamma-Dynamics, in Cincinnati, to develop electrofluidic technology. Prototypes may roll out in about three years, he says, followed by the commercialization of some of the simpler applications.

(*from http://www.ece.uc.edu/devices/NDL_Research.html*)

The basic electrofluidic structure (Figure a) contains several important geometrical features. First there is a reservoir, which will hold an aqueous pigment dispersion in less than 5-10% of the visible area. Secondly, there is a surface channel of 80-95% of the visible area, and which can receive the pigment dispersion from the reservoir when a suitable stimulus is applied. Third, there is a duct surrounding the device which enables counter-flow of a non-polar fluid (oil or gas) as the pigment dispersion leaves the reservoir. It is important to note, that all of these features are inexpensively formed by a single photolithographic or microreplication step. Turning attention to Figure b, several additional coatings and a top substrate are added. First, the surface channel is bound by two electrowetting plates consisting of an electrode and hydrophobic dielectric. The top electrowetting plate utilizes a transparent $In_2O_3:SnO_2$ electrode (ITO) such that the surface channel is viewable by the naked eye. The bottom electrowetting plate utilizes a highly reflective electrode such as aluminum. With the device structure described, we now begin a general discussion of device operation. With no applied voltage, a net Young-Laplace pressure causes the pigment dispersion to occupy the cavity that imparts a larger radius of curvature on the pigment dispersion. Therefore at equilibrium, the pigment dispersion occupies the reservoir and is largely hidden from view. This is analogous to connecting two soap bubbles by a straw; the larger bubble has a larger radius of curvature, a lower Young-Laplace Pressure, and will therefore consume the smaller bubble. Next, as shown in the figure a voltage is applied between the two electrowetting plates and the pigment dispersion. This induces an electromechanical pressure that exceeds the net Young-Laplace pressure and the pigment dispersion is pulled into the surface channel. If the volume of the pigment dispersion is slightly greater than the volume of the surface channel, then the pigment will be simultaneously viewable in both the reservoir and the surface channel, and nearly the entire device area will exhibit the coloration of the pigment. If the voltage is removed the pigment dispersion rapidly (1's to 10's ms) recoils into the reservoir. Thus a switchable device is created that can hide the pigment, or reveal the pigment with visual brilliance that is similar to pigment printed on paper. Videos of this device in operation can be found on the videos page of this website: http://www.ece.uc.edu/devices/NDL_Research.html



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Call for Papers Inside