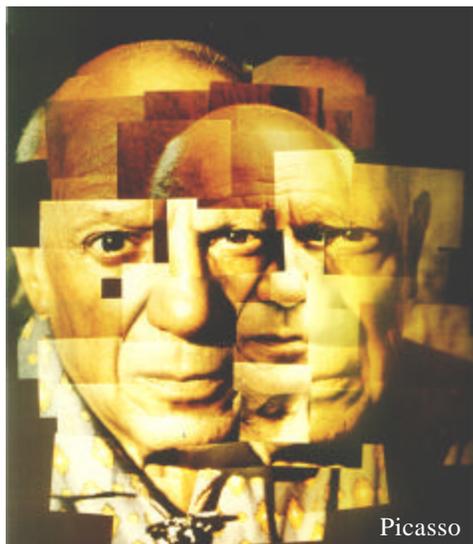
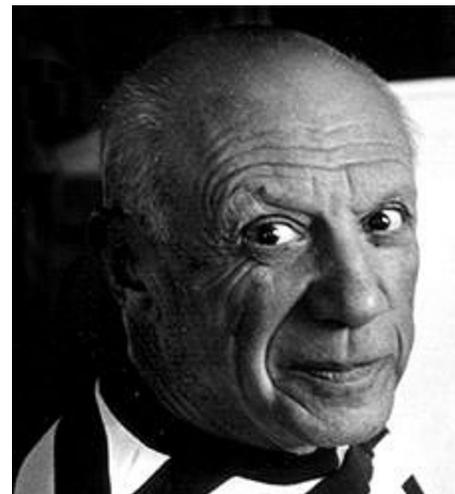


AES Newsletter



Picasso



Inside this issue:

Meeting Moments	2
Ask the Experts thread	3-4
New Councilor Biosketches	4

It will all come together for you once you join or renew your AES membership at www.aesociety.org

Many thanks to our Sponsors for contributions funding the 2006 meeting.

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Our traditionally strong meetings, with sessions strengthened by invited plenary speakers discussing state-of-the-art topics, would simply not be possible without help from sponsors. Their donations are greatly appreciated.

We also thank NIH for travel grant support.

Call for Papers from our 2007 Meeting Organizers!

The 2007 meeting will be held November 4-9 in a location of great beauty: Salt Lake City, Utah. The meeting has taken shape nicely as you can from the table below. However, we still need co-chairs for some sessions. Please email if you are interested or have suggestions.

2007 Session	Chair	Co-Chair
AES Plenary	Biernacki	
BioMEMS and Microfluidics: Biomedical Diagnostics	Biernacki	Gale
BioMEMS & Microfluidics: Sensing, Detection, and Integration	Lu	
Advances in Electrokinetics & Electrophoresis	Minerick	Poesner
Advances in Proteomics: New Technologies I	Patton	Lim
Advances in Proteomics: New Technologies II	Ge	
AES Poster Session	Biernacki	Kendrick
Advances in CE and Microdevice Tech. for Genomic Analysis	Bowser	
BioMEMS and Microfluidics - Novel Applications	Murthy	Radisic
Advances in Electrokinetics & Electrophoresis - DNAApps	Ugaz	
BioMEMS and Microfluidics: Proteome Analysis	Oyanader	
BioMEMS and Microfluidics: Cell and Biomolecule Analysis	Srivastava	
Advances in Electrokinetics & Electrophoresis - Fundamentals	Arce	
AES Field Trip to the University of Utah	Gale	Crews



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2006 Meeting Moments:



San Francisco Union Square



Hilton Lobby



Pedro Arce, Eva Cortez, Mario Oyander



Neil Ivory



Nancy and Earle Stellwagen



Gerald Prbyzylski
Stanford Court Dinner Speaker



Bin Cao receives 2nd Place Award from Judge Sharon Sauer



Adrienne Minerick addresses Expense Grant Awardees
See AES web site (www.aesociety.org) for Awardee list

Winners of the 2006 Poster Competition

- 1st Place: *Bryan Fonslow, University of Minnesota*
- 2nd Place: *Bin Cao, National University of Singapore*
- 3rd Place: *Chris Fredlake, Northwestern University*
- Honorable Mention: *Prashant Daggolu, Mississippi State University*
- Honorable Mention: *Diana Hou, University of Notre Dame*

Ask the Experts: Electroosmotic Flow

I have a question to ask the experts. A student asked me this question after class today. Even though it seems like a very basic question I found that I was not able to come up with an answer that was satisfying to me. So I'm hoping that you can help. Here goes...

I was discussing electroosmotic flow in capillaries and presented the basic picture in terms of the negative surface charge at the capillary wall and the formation of an electrostatic double layer of positive counterions from the electrolyte solution. And that when a potential is applied, this hydrated counterion sheath effectively pulls the adjacent water molecules along with it generating a bulk flow. I can also understand how one can derive the thickness of the double layer (Debye length) and all that.

So here's the question: If there is this zone near the wall where the concentration of positive ions is higher than in the bulk, then wouldn't that leave a corresponding excess of negative ions elsewhere within the bulk (away from the wall)? And if that's the case, wouldn't those ions experience a net migration opposite to that of the counterion sheath near the wall? Then the two effects would cancel out and there would be no net flow.

Seems like a straightforward question, and it must be because it's assumed that the net charge in the diffuse layer quickly drops to zero as you move away from the wall in the books or papers I've looked at this afternoon. But wouldn't that leave unbalanced charges elsewhere? What do you think experts? Thanks in advance!!

Victor Ugaz, Texas A&M University

Victor has raised an interesting question. I do not know that the concentration of positive ions is higher near the wall than in the bulk. I think that the problem arises because the negative charges in the wall are stationary, while the cations are free to move. Hence, there is a net migration of the cations toward the cathode. In the bulk, both the cations and anions are free to move, resulting in little or no migration of the buffer ions toward the electrodes. Similar electroosmotic effects are observed with agarose gels, where the fibers are negatively charged, but immobile. It is well known that the pH in the cathodic electrode chamber can become highly acidic during extended electrophoresis experiments, while the pH in the anodic electrode chamber becomes only slightly more basic than the pH of the buffer (due to electrolysis). These pH changes in the buffer chambers do not occur with polyacrylamide gels, which have uncharged fibers. The EOF in agarose gels can easily be measured by putting a colored, uncharged marker in one of the lanes and watching it move toward the cathode when the field is applied. I will be interested to hear other ideas on this subject.

Nancy Stellwagen, University Iowa

The counter ions near the wall most certainly move. Fresh ions are brought in to replace the ones that have moved on through action of the field. It is the shell of water around the counter

ions that creates the EOF flow. The sizes of the hydrated ions depend on the ions. **Dave Garfin, AES President**

Hi Nancy and Dave,

Thanks for your thoughts. So it sounds like you're saying that the counter ions near the wall that balance the negative surface charge are not mobile, thus the concentration of mobile counterions would remain constant. Does the relative size of the counterions have anything to do with the EOF maybe? Like if the positive ionic species are bigger or smaller than the negative ones, for example? I don't have a feel for what those sizes would be for the components in typical buffer solutions.

Victor

If I've properly followed the emails, the issue is conservation of ions with regards to the bulk and the charged layer near the wall. My understanding is as follows: If x co-ions exist and x -counterions exist, a highly charged wall will pull y counterions out of the bulk. The bulk now contains x co-ions and $x-y$ counterions. The y counterions near the wall are VERY densely packed (length scale from the wall of <100 nm) and will pull the "shell of water" (Dave's words) with them toward the proper electrode. The student asked if the excess co-ions left in the bulk move opposite the electroosmotic flow, thus canceling the movement of the fluid. While the co-ions do move, they do not counter EOF because the excess co-ions in the bulk are widely dispersed (across tens or hundreds of microns) - the effective shell of water that they move is significantly less than the water mobilized in the highly charged Debye layer near the wall. This does bring up a point that I've pondered. It is possible that EOF flow is not truly a "flat velocity profile" but instead an inverted parabolic velocity profile. See the article by Terrance Conlisk, *Electrophoresis* 2005, 26, 1896-12, for derivations.

Adrienne Minerick, Mississippi State University

Victor: I felt I knew the answer to this, but wanted to check it with the acknowledged expert, Milan Bier. I'm pleased to share his answer with everyone.

Scott Rodkey, University of Texas, Houston

Dear Scott,

It is fun to try to clarify this issue, as it reminded me of one of my very first reviews, published in 1952. A benefit of old age—and there are very few of such benefits.

The electrical potential is generated at the surface of a solid by immobilized charges, either due to dissociation of fixed ionizable groups or adsorption of ions from the medium. This potential decays as we move from the surface of the solid—going to zero at sufficient distance thereof. The countercharges are however not immobilized, but are ions, usually small ions or products of water dissociation, flirting around by Brownian motion. So, there is not a fixed counterion zone, but only a statistical preponderance of certain ions as we move away from the solid surface. By definition, also, the water molecules in contact with the solid are also immobilized, but as we move away they become freer to flow. Thus, there is a frictional boundary established between stationary water and the flowing one, actually at

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Electrophoresis
past, present
and future

some distance from the physical solid/liquid boundary. The shape of the potential decay from surface to far removed (where by definition the potential is zero) is dependent on many factors, ion concentration, charge, etc. The grandfather of this field was Smoluchowski, with many later workers including Peter Debye. The famous zeta potential defining electroosmotic flow is the electrical potential at the frictional boundary between the immobilized and flowing medium. It is usually of the opposite polarity of the fixed charges at the solid surface, but can under certain circumstances be also of the same polarity, as suggested by the student. Basically, two essential rules: at sufficient distance, the potential is zero, electrical neutrality dominates everywhere.

Milan Bier, Professor Emeritus, University of Arizona

Thanks everyone for your help. I think I have a better picture of what's going on now (at least enough to explain the basic idea). I will have a look at the Conlisk article and think about the velocity profile. **Thanks again Experts!! Victor Ugaz**



Submit an article to the new journal **Biomicrofluidics**.
Contact Adrienne Minnerick minerick@che.msstate.edu
for more information. See also: <http://bmf.aip.org>

New Councilor Biosketches

Two new councilors, Dr. Sharon Sauer and Dr. Joe Biernacki were formally approved by the AES board at the 2006 November meeting.

Sharon Sauer is currently an Assistant Professor in the Dept of Chemical Engineering at Rose-Hulman Institute of Technology. She obtained a B.S. degree in chemical engineering from Florida State University in 1993, worked at Shell Oil Company from 93-96, and in 2001 received her PhD in Chemical Engineering from Rice University under Walter Chapman. She joined the faculty at RHIT in January, 2002. Sharon's interest in electrophoretic systems began as an undergraduate student where she was awarded the Shell Foundation Summer Research Scholarship to work on the analysis of electrophoretic protein separations in a packed bed system under the direction of Pedro Arce and Bruce Locke. She continued this theme in her undergraduate thesis where she analyzed a rectangular channel with 2-D applied electric fields. Her PhD work was in thermophysical property prediction methods with applications to biochemical systems. At RHIT, Sharon has introduced students to the mathematical analytical techniques used in her undergraduate thesis and continues to pursue mathematical analysis of electrophoretic separations as an area of research with collaborations both in the US and abroad.

Joe Biernacki is currently a Professor in the Dept of Chemical Engineering at Tennessee Tech. He received his B.S. degree in Chemical Engineering from Case Western Reserve University in 1980 and a Ph.D. in Chemical Engineering from Cleveland State University in 1988.

Research Interest: The primary emphasis of my research group is to develop fundamental kinetic and thermophysical data for materials synthesis. Materials in this case are primarily ceramics, but may include composites of ceramics, metals and polymers. While my specific focus changes from project to project, there are several themes: hydration stoichiometry and kinetics of waste and by-product materials in Portland cement and characterization of the microstructure and transport processes in cement-based materials; kinetics and associated transport processes for electronic materials; and kinetics of designed organic and inorganic materials for high temperature applications.



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