Contact: Matt Hoelter (see p4)

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Volume 13, Issue 1

AES Newsletter

The bleak midwinter is a time to reflect and write, to be a creature of the mind. AES members generally suffer it well.

Inside this issue:

Many thanks to our Sponsors for contributions funding the 2007 meeting.

BD Diagnostics

Bio-Rad Laboratories

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GE HealthCare

Kendrick Labs

Nonlinear Dynamics

Syngene

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.

Call for Papers for the 25th Annual Meeting of the AES!

The 2008 annual meeting of the American Electrophoresis Society will be held November 16-21 in Philadelphia, the Birthplace of America, in conjunction with the American Institute of Chemical Engineers (AIChE). Please mark these dates on your calendar! This year will highlight our 25th annual meeting and the 100th anniversary of AICHE. Below is the preliminary program, including two new sessions: Nanoscale Electrokinetics and Advances in Electrophoresis Separation Media. Session descriptions are in the Topical 3 Group of the AIChE program on their website. **We are still seeking co-chairs for some sessions. Please email if you are interested.**

2008 Session (all T3000)	Chair	Co-Chair
Biomems and Microfluidics: Biomedical Diagnostics	Nimisha Srivastava	
Biomems and Microfluidics: Sensing, Detection, and Integration	Chang Lu	Saif Khan
Advances in Electrokinetics and Electrophoresis - Particles and Biomolecules	Adrienne Minerick	
Advances in Proteomics: New Technologies I	Thomas Berkelman	
Advances in Proteomics: New Technologies II	Janice Simler	
AES Poster Session	Shashi Murthy	Nancy Kendrick
Advances in CE and Microdevice Technology for Genomic Analysis	Christa Hestekin	
Biomems and Microfluidics - Novel Applications	Hang Lu	
Advances in Electrokinetics and Electrophoresis - DNA Applications	Rajiv Bharadwaj	
Biomems and Microfluidics: Proteome Analysis	Victor Ugaz	
Biomems and Microfluidics: Cell and Biomolecule Analysis	Milica Radisic	
Advances in Electrokinetics and Electrophoresis - Fundamentals	Brian Kirby	
Nanoscale Electrokinetics	Jonathan Posner	
Advances in Electrophoresis Separation Media	Mary Wirth	

2008 Meeting Co-Organizers

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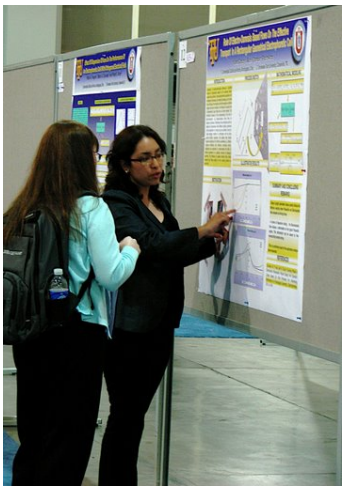
2007 Meeting Moments:

Salt Palace Convention Center
Salt Lake City, Nov 4-9, 2007



Photos from the Tues evening poster reception: top middle, top right and middle right:

Stimulating Banquet conversation at Salt Lake City's Buca di Beppo restaurant

Tim Bingaman spoke at the AES banquet about the Family History Library of the Mormon Church.

Winners of the 2007 Poster Competition

First Place: Kaela Leonard, School of Chemical Engineering, Mississippi State University, Mississippi State, MS (left above)
Second Place: Jennifer Anne Pascal, Chemical Engineering, Tennessee Tech University, Cookeville, TN (middle above)
Third Place: Yusuke Tatsumi, Kyoto Institute of Technology, Kyoto, Japan (right above)

Judges: Drs. David Garfin, Sharon Sauer and Victor Ugaz from the AES Council. All the 2007 poster abstracts will be posted soon on the AES website.

Isotachophoresis

By Huanchun Cui and Cornelius F. Ivory
Washington State University

Isotachophoresis (ITP) is a nonlinear electrophoretic technique used in the separation of a variety of ionic compounds ranging from small molecules like metal ions [1] to large molecules like proteins [2]. Unlike "linear" zone electrophoresis in which separating solute bands continually spread by diffusion or dispersion, ITP forms self-sharpening, adjacent zones of substantially pure solute whose concentrations often exceed several mgs/ml. In ITP a multianalyte sample is usually introduced between the leading electrolyte (LE, containing leading ion) and the terminating electrolyte (TE, containing terminating ion) where the leading ion, the terminating ion and the sample components must have the same charge polarity, and the sample ions must have lower electrophoretic mobilities than the leading ion but larger than the terminating ion. After application of a fixed electric current, sample components move forward behind the leading ion and in front of the terminating ion and form discrete, contiguous zones in order of their electrophoretic mobilities. Then, following a brief transient period where the discrete solute zones are formed, this ITP "stack" assumes a fixed concentration profile with a constant velocity moving in the direction of the leader.

Kohlrausch [3] developed the basic theory of ITP 110 years ago, but it hadn't received much attention until the development of capillary electrophoresis in the 1970s. Since then, ITP, along with zone electrophoresis (ZE) and isoelectric focusing (IEF), became indispensable analytical tools, especially for high resolution and fast analysis of biological samples. This development formed the foundation in the early 90s of the book, "The Dynamics of Electrophoresis" [4], which comprehensively covers electrophoresis theory, modern applications and computer simulations of electrophoresis. During the past decade the rapid development of microfluidic-based electrophoresis makes it one of the most promising candidates to replace gel and capillary electrophoresis. ITP has played an increasingly important role in the application of microchip electrophoresis due to two unique features:

First, ITP is an extremely powerful concentration method. No matter how low the sample concentration is, it can be concentrated to a plateau concentration which, in the ideal case, is described by the following equation:

$$C_{Sample-plateau} = \frac{z_{LE}\left(\left|\omega_{LE}\right| + \left|\omega_{Counter-ion}\right|\right)\omega_{Sample}}{z_{Sample}\left(\left|\omega_{Sample}\right| + \left|\omega_{Counter-ion}\right|\right)\omega_{LE}} C_{LE}$$

where C is the concentration, z the charge, and ω the electrophoretic mobility. This unique characteristic of ITP is very helpful when it comes to microchip electrophoresis, where detection is challenging due to the low sample mass loadings and small detection window in a microfluidic chip. The best way to increase the loading capacity of a microfluidic chip is to preconcentrate the sample; ITP provides a simple and powerful concentration method that can be easily integrated onto a chip prior to other on-chip operations, especially ZE. It has been reported recently that a two million fold concentration increase of Alexa Fluor 488 was achieved by on-chip ITP [5].

Second, ITP is self-resharpening, i.e., the stacked zones can quickly recover their shape after a dispersive event. This feature makes ITP a very desirable method for microchip applications where T-junctions, intersections and U-turns frequently present as dispersion sources. For example, Cui and Ivory [6] have demonstrated the self-sharpening ability of ITP after dispersion by a T-junction in a networked microfluidic chip both by experiments and 2D simulations, as shown in Figure 1A, where the sharp leading boundary of a moving zone of proteins approaches a T-junction. As the stack passed through the junction, the upper part of the leading boundary is stretched and sharply twisted as it was drawn about 150 μm (roughly half the channel width) into the junction channel while the lower part of the stack continued moving left to right, stretching and dispersing as it crossed the T-junction (Figure 1B). The trailing zone boundaries then catch up with the top of the leading boundary and execute the same maneuver. After the protein zones have left the vicinity of the junction, they eventually finished resharpening with slightly tilted boundaries (Figure 1C). This feature was also simulated, as shown in Figure 1D-F by an ITP model developed in COMSOL (Burlington, MA), a finite-element based program that is widely available and easy-to-use.

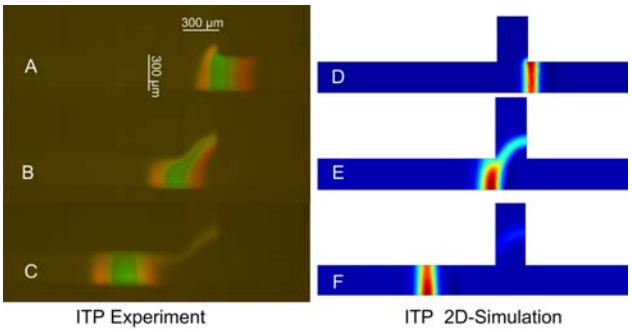


Figure 1. The time-series photos A-C show how an ITP train of three fluorescent proteins first disperses and then resharpens as it migrates straight through a T-junction. D-F are part of an ITP simulation using three "virtual" proteins to illustrate how the ITP model mimics the essential mechanisms of dispersion and resharpening.

ITP has already shown its superiority to other electrophoretic separation techniques in terms of those two features discussed above. With more features, e.g., prediction of ITP steady-state zone positions [7] and turn-induced isotachophoretic focusing in microfluidic channels [8] being discovered, ITP should find wider use in biological applications such as microscale protein purification and enzymatic assays on compact microfluidic chips.

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Salt Lake City 2007 – Meeting Recap *by Dave Garfin, AES President*

Three plenary speakers, two invited talks, 85 technical talks, 14 posters, a field trip, and a banquet all in four and a half days added up to another fine meeting. Congratulations and thanks to Joe Biernacki, AES Councilor, and Wayne Patton for organizing the good show, and thanks also to the session chairs and all the presenters.

The three plenary speakers spoke on various aspects of proteomics. Carol Giometti, from Argonne National Lab, is a longtime member of AES and former Councilor and Secretary of the Society. She presented results of an ongoing proteomic study of bioremediation of radioactive wastes using a metal-reducing bacterium. Katheryn Resing, Associate Professor in the Chemistry & Biochemistry Department at the University of Colorado, heads the proteomic resource facility there. Katheryn is a proponent of carrying out all proteomic studies in mass spectrometers and spoke of the advantages as well as problems of shotgun proteomics, but demonstrated her lab is expert in 2DE as well. David Friedman, from the Proteomics Laboratory at Vanderbilt University, spoke about differential expression analyses using DIGE technology and the need for validation of experimental results. David stressed repetitive experimental runs and use of multivariate statistical analyses such as hierarchical clustering and principle component analysis for data handling. All three speakers showed that there is no "right" proteomic approach. Each technology has its own benefits and the various approaches complement each other.

Invited speakers Victor Ugaz, AES Vice President, and Neil Ivory, AES Councilor, both described studies aimed at improving resolving conditions in microchannels; Victor for DNA separations and Neil for proteins. Victor has designed a multi-channel gel electrophoresis device with multiple embedded electrodes that allows for whole-column monitoring of migrating molecules. From mobility data, he derives information on the mechanics of DNA motion in gels. Neil has built a variety of specialized instruments with which to study the several types of dispersion that take place during electrophoresis runs.

The technical talks covered just about everything from fundamental electrokinetics to advanced apparatus designs to sophisticated proteomic and genomic analyses. Since the chemical engineers among us groove on mathematics, there was no shortage of solutions to transport equations or, for that matter, of Poisson's equation (from, as expected, Pedro Arce's colleagues at Tennessee Tech). There was much on microchannel devices, but that field is still in its infancy with no single platform that is generally accepted. Noteworthy among the microdevice work were chips aimed at reducing the costs of genomic sequencing (Daniel Hert at Northwestern and Palani Kumaresan at UC Berkeley). Dielectrophoresis for manipulation of cells continues to get a lot of attention, especially from Adrienne Minerick's (AES Webmaster) group at Mississippi State. The winners of the student poster competition are shown on page 2; congratulations to all three of them!

Thirty or so people went on a field trip to Bruce Gale's microfabrication lab on the University of Utah campus. Those taking the trip were a mixture of AIChE and AES members including several graduate students. We met Bruce's students and saw how microchips are devised and fabricated in that facility.

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