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AES Newsletter

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Our traditionally strong meetings would simply not be possible without help from our supporters. Their donations are greatly appreciated.

Send news for the web page **www.aesociety.org** to Webmaster Adrienne Minerick **minerick@mtu.edu** or Associate Webmaster Rafael Davalos **davalos@vt.edu**

Send news for the newsletter to Editor Nancy Kendrick **nancy@kendricklabs.com** or Assoc. Editor Victor Ugaz **ugaz@tamu.edu**

Contact Matt Hoelter AES Executive Director with questions about the society **matt-aes@tds.net**

Please join us at the American Electrophoresis Society annual meeting in Pittsburg, PA on Oct 28 - Nov 2, 2012

MEETING ANNOUNCEMENTS

Late breaking poster deadline: October 7th

Please submit abstracts to Dr. Victor Ugaz (ugaz@tamu.edu) or to Dr. Blanca Lapizco-Encinas (bhlbme@rit.edu). Awards will again be offered for the best student posters.

Students: Join the AES Lunch with Leaders for a unique experience!

Join us for our second **"Lunch with Leaders (LWL)"** event, on Tuesday 10/30 from 11 AM to 12:30 PM at **August Henry's Saloon** (http://www.augusthenrys.com/). This is a wonderful opportunity for students to get to know leading researchers in the area of electrokinetics in an informal setting. The cost is only $5.00 and includes a full meal. Advance signup is required, and can be completed at the time of conference registration. For more information, contact Dr. Christa Hestekin (chesteki@uark.edu) or Dr. Alexandra Ros (alexandra.ros@asu.edu).

Don't forget the AES discount when you register at the 2012 AIChE conference!

Your AES membership provides a significant discount on the AIChE registration fee. On average, AES members save **$400** for full meeting registration and **$180** for graduate student full meeting registration. Don't miss out on these important savings! Watch your email for instructions. You will need your AES member number, which will be emailed to you along with the registration instructions.

Not a member? AES costs only $75 for full membership; $25 for students.
Join now at: www.aesociety.org/apply/apply_online.php

Turn the page for more meeting news...

AES invites you to attend

Electrokinetics & Microfluidics Workshops

at the 2012 AES-AIChE Annual Meeting

Sunday October 28th, 2012

Courtyard by Marriott, Meeting Room A, Pittsburg PA

*AES is offering two **Electrokinetics & Microfluidics** workshops on Sunday, October 28th. These workshops are a great opportunity for learning fundamentals of electrokinetics and microfluidics, and observing live experiments. The morning workshop, given by **Dr. Todd Squires** and sponsored by **LabSmith**, will cover the fundamentals of electrokinetics and microfluidics, including live "demo" experiments. Attendees will have the opportunity to see LabSmith equipment working real time in foundational microfluidic manipulations. An opportunity to use the equipment will be provided as time allows. The afternoon workshop will focus on mathematical modeling with COMSOL to solve microfluidics problems covered in the morning workshop. This is a unique set of two microfluidic-focused workshops that complement each other.*

For further information and to register, please visit the following link:

http://www.aesociety.org/meetings/2012/workshop_reg.php

AES Microfluidics Workshop Part I – Fundamental of Electrokinetics and Microfluidics

Instructor is ***Dr. Todd Squires (UCSB)*** *http://squerver.chemengr.ucsb.edu/Welcome.html*

Topics to be covered include:

- Linear electrokinetic phenomena and how to think about them
- Nonlinear electrokinetic phenomena
- Effects of surface conduction and ion conservation
- Convection vs. diffusion, Peclet number for separations, filtration and mixing
- Convection, diffusion, and reactions for sensor applications
- Live demo experiments with LabSmith equipment

Workshop runs 9:00 AM to 12:00 PM. **Fees:** Professors and Industry, **$149**; Students and post-docs, **$99**; Undergraduates, **$10**. The morning Registration fee includes *both morning and afternoon workshops: Microfluidics Part 1 and Part II*.

AES Microfluidics Workshop Part II – Modeling of Electrokinetic microfluidic problems with COMSOL

The instructor, Dr. Ahsan Munir, will provide copies of the latest COMSOL numerical simulation software, including a two-week temporary license, and work through example problems from the morning session. This workshop runs 1:00 PM to 4:00 PM. The fee is **$25.00 for the afternoon Workshop, Part II only.** It is included in the fee for the Microfluidics Workshop Part I given in the morning.

Technical Sessions at a Glance

Topical 3: 2012 Annual Meeting of the American Electrophoresis Society (AES)

See the complete program at https://aiche.confex.com/aiche/2012/webprogram/T3.html

Monday, October 29, 2012

8:30 AM-11:00 AM	T3006	Advances in Electrokinetics and Electrophoresis: Fundamentals
12:30 PM-3:00 PM	T3002	Advances in Electrokinetics and Electrophoresis: Bioanalytical, Biosensing, and Biomedical Applications
	T3003	Electrokinetics in Non-Polar Media
3:15 PM-5:45 PM	T3011	Plenary Session of the American Electrophoresis Society

Tuesday, October 30, 2012

8:30 AM-11:00 AM	T3005	Advances in Electrophoresis for Protein Separation and Analysis
	01J06	Microfluidic and Microscale Flows I (Co-Sponsored Session with Area 1J)
11:00 AM-12:30 PM	Lunch with Leaders	
12:30 PM-3:00 PM	T3008	Nanoscale Electrokinetics
3:15 PM-5:45 PM	T3001	Detection: Surface Techniques and Spectroscopy
	T3010	Electroporation, Electrophysiology, and Cell Electrokinetics
6:00 PM-8:00 PM	T3012	Poster Session of the American Electrophoresis Society

Wednesday, October 31, 2012

8:30 AM-11:00 AM	T3009	Electrokinetic Behavior of Micro- and Nano-Particles: Directed Assembly Under Electric Fields
	01J10	Microfluidic and Microscale Flows II (Co-Sponsored Session with Area 1J)
12:30 PM-3:00 PM	T3000	Award Session of the American Electrophoresis Society in Honor of Nancy Stellwagen
3:15 PM-5:45 PM	T3004	Electric Fields At Interfaces: Electro-Wetting, Droplets, and Vesicles
	T3007	DNA Analysis in Microfluidic and Nanofluidic Devices
6:00 PM-6:45 PM	AES Business Meeting	
7:00 PM-10:00 PM	AES Banquet	

Thanks to Our AES 2012 Meeting Co-Chairs!!

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Microfluidic Free Flow Electrophoresis (mFFE) – What would you do with a separation if you didn't need to wait?

By Dr. *Michael T. Bowser, Department of Chemistry, University of Minnesota, Minneapolis, MN*

Time is never far from a separation scientist's thoughts. Time is a currency that can be sacrificed for resolution, or vice versa. Entire workflows (and coffee break schedules) revolve around the time to produce an analysis and the number of analyses that can be performed in a day. Considering the number of separations performed in a high throughput lab, even shaving a minute off a routine analysis could save thousands of dollars. So after a career of waiting (albeit across a wide range of time scales) it is almost difficult for the separation scientist in me to consider the question: What if time didn't matter?

Free Flow Electrophoresis.

Free Flow Electrophoresis is one of a limited number of separation techniques capable of separating a continuous stream of analyte. The separation mechanism is shown schematically in Figure 1. Analyte enters a planar separation channel in a continuous flow stream. An electric field is applied perpendicularly to the direction of flow, deflecting charged analytes as they travel through the flow chamber. Note that the separation occurs in space, not time. Transit time through the device is the same for all analytes as determined by the linear velocity of the buffer flow. FFE is not a new technique. Conventional macroscale FFE was first demonstrated over 50 years ago.[1] The dimensions and flow volumes of these instruments make FFE more amenable to preparative separations of proteins, organelles and cells than quantitative applications. The relatively large dimensions also make precise control of flow paths and detector integration challenging. As such, conventional FFE has remained a niche technique.

Microfluidic Free Flow Electrophoresis (μFFE).

FFE was first demonstrated on the microscale in 1994.[2,3] Early devices fabricated in silicon or PDMS were limited by restrictions imposed by the substrate material. We first fabricated an all glass device in 2005.[4] These early designs were severely limited by electrolysis bubbles generated at the electrodes. Since then designs[5] and buffer additives[6] have been introduced to mediate the effect of bubble generation, making long term operation of μFFE devices feasible for the first time. The separation theory of μFFE separations has been developed, clearly demonstrating the relationships between electric field, buffer flow rate, band position and resolution.[7] Free zone, MEKC, isoelectric focusing and isotachophoresis separations have all been demonstrated on μFFE devices.[5] μFFE has finally emerged as a viable technique. The question is: how best to take advantage of the continuous nature of μFFE separations? Our efforts have focused on two areas where μFFE outperforms existing separation strategies: high speed monitoring and microscale purification.

High Speed Monitoring.

μFFE offers the selectivity of a separation with the time response of a sensor. This suggests a re-evaluation of what applications are best suited for separations vs. those that are better addressed using sensors. Note that while the transit time through the separation chamber is on the order of 10-20 seconds, μFFE is capable of measuring much faster changes. If the concentration of analyte entering the device changes, this change is maintained in the flow stream as it travels through the device. The temporal response of the device is therefore limited by how fast the detector can record images. We routinely record fluorescence images using a CCD camera every 100 ms, but much faster detector frequencies are possible. The high sampling rate of μFFE opens the door to some interesting applications. Numerous measurements can be taken in a relatively short time period, allowing the signal averaging strategies more often used in spectroscopy to be applied. We have demonstrated a 24-fold enhancement in S/N by recording 500 images over a period as short as 2 minutes.[8] μFFE is capable of monitoring samples with changing compositions. For example, we introduced a sample where we titrated a fluorescently labeled aptamer with a continuous gradient of increasing target protein concentration.[9] This allowed the equilibrium mixture to be assessed at 300 different concentrations in 5 minutes. Similarly we have introduced gradients in the separation buffer. Using this strategy we were able to measure the μFFE

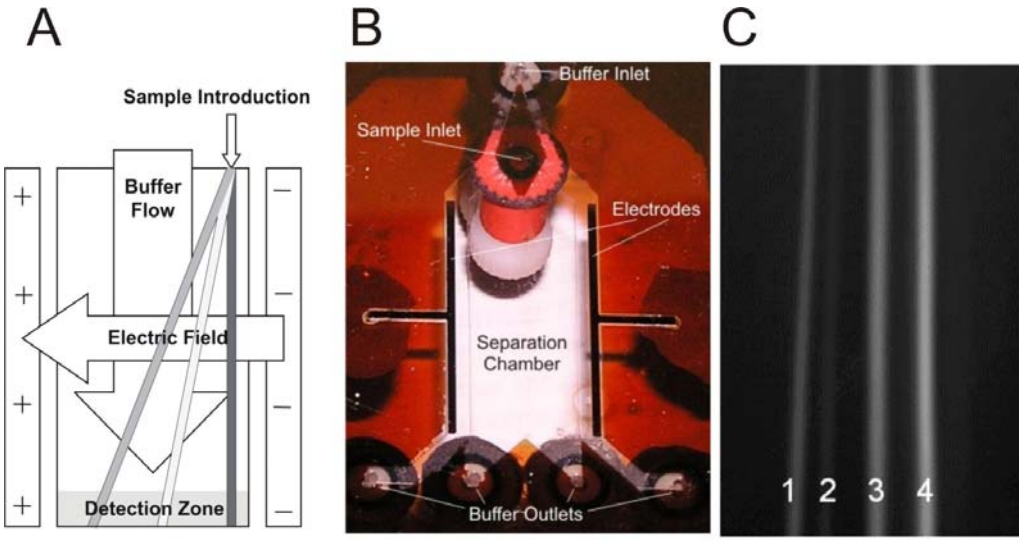


Figure 1. A) Schematic of the μFFE separation mechanism. B) Image of a μFFE device. C) μFFE separation of fluorescein (1), an impurity (2), rhodamine 110 (3), and rhodamine 123 (4). The electric field was 259 V/cm with the cathode at the right.

separation of a mixture of fluorescently labeled amino acids at 60 different cyclodextrin concentrations, again in 5 minutes.[10]

Microscale Purification.

Preparative microscale separations present their own unique challenges. Volumes are often too small to recover a reasonable amount of material. Traditional separations require precise timing and valving for effective fraction collection. μFFE presents a unique solution to both of these issues. The continuous flow of analyte into the device introduces enough material to make microscale purifications feasible. Analyte typically flows into the device at ~100 nL/min, allowing a μL of material to be purified every 10 minutes. To recover more material all you need to do is wait longer. Fraction collection is as simple as directing analyte streams to different exit channels. Once it is running no timing or valving is required, greatly simplifying the fabrication and operation of the device. We have recently demonstrated the microscale purification potential of μFFE by using this device to isolate high affinity aptamers for IgE.[11] Notably, we were able to double the number of sequences used in the selection while decreasing the concentration of the library 10-fold in comparison to previous CE based selections.

References

1) Roman, M. C.; Brown, P. R. *Anal. Chem.* **1994**, *66*, 86A-94A.

2) Raymond, D. E.; Manz, A.; Widmer, H. M. *Anal. Chem.* **1994**, *66*, 2858-2865.

3) Raymond, D. E.; Manz, A.; Widmer, H. M. *Anal. Chem.* **1996**, *68*, 2515-2522.

4) Fonslow, B. R.; Bowser, M. *Anal. Chem.* **2005**, *77*, 5706-10.

5) Turgeon, R. T.; Bowser, M. T. *Anal. Bioanal. Chem.* **2009**, *394*, 187-198.

6) Frost, N. W.; Bowser, M. *Lab on a Chip* **2010**, *10*, 1231-36.

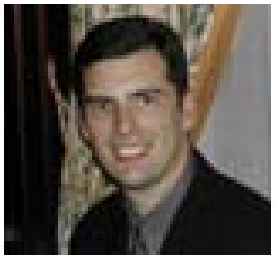
7) Fonslow, B. R.; Bowser, M. T. *Anal. Chem.* **2006**, *78*, 8236-8244.

8) Turgeon, R. T.; Bowser, M. T. *Electrophoresis* **2009**, *30*, 1342 -1348.

9) Turgeon, R. T.; Fonslow, B. R.; Bowser, M. T. *Anal. Chem.* **2010**, *82*, 3636-3641.

10) Fonslow, B. R.; Bowser, M. T. *Anal. Chem.* **2008**, *80*, 3182 - 3189.

11) Jing, M.; Bowser, M. T. *Lab on a Chip*, **2011**, *11*, 3703-3709.



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AES Member News

AES Member to Receive AIChE Award

Associate Professor Kevin Dorfman will be the 2012 recipient of the Allen P. Colburn Award for Excellence in Publications by a Young Member of the Institute.

The Colburn Award is the highest honor given to a member of AIChE under the age of 36 for "significant contributions to chemical engineering through publications." Professor Dorfman joins a large number of Minnesota faculty and alumni who have been recognized by this award, including Ed Cussler, Skip Scriven, and Matt Tirrell.

Kevin co-organized our 2010 Annual Meeting, and currently serves as an AES Councilor.

Congratulations Kevin for this well-deserved honor!

AES Member Reviews Microfabrication Technologies in Dielectrophoresis

AES member Rodrigo Martinez-Duarte, from the *Laboratory of Microsystems (LMIS4)* at the *École Polytechnique Fédérale de Lausanne* in Switzerland had his review paper, "Microfabrication technologies in dielectrophoresis applications – a review" accepted for publication in the journal ELECTROPHORESIS.

This is the first review focusing on the different techniques currently used to generate an electric field gradient in a microfluidics network. The techniques reviewed include metal-electrode, insulator-based, light-induced, carbon-electrode, contactless and doped PDMS. These and other technologies are critically reviewed in terms of material and infrastructure cost, fabrication complexity, and potential for high throughput.

An encouraging conclusion is the clear tendency in the community to develop devices that are less expensive, easier to fabricate, and most importantly easy to use.

Rodrigo Martinez-Duarte
Laboratory of Microsystems
École Polytechnique
Fédérale du Lausanne
Switzerland

The Trailing Zone **by Victor M. Ugaz**

A column highlighting broader perspectives and observations about science and the lives of those who pursue it.

Halfway There

Recently I accompanied my wife to her 25th high school reunion. I was a reluctant partner in this adventure because I didn't attend her high school and was therefore guaranteed to know virtually no one. Once there I naturally gravitated toward the other tag-along spouses and significant others, and soon found myself in a conversation with a guy who had one son already in college and another almost old enough to go. When I mentioned that I taught at Texas A&M, his response was not what I expected. He asked me a simple question: "Do you care?"

It seems his son just finished a difficult semester at another university. He had initially been doing well academically but now was struggling, and dad was considering whether the continued financial investment was going to be worthwhile. I was unprepared for this kind of question and didn't have a coherent response in mind. Having just finished the semester, I was still in a defensive mindset—the kind that occurs when I submit course grades, then brace for an influx of students looking for a few extra points to raise their grades. My initial answer was something along these lines, but not what he was looking for. He asked again: "Yes, but do you care?"

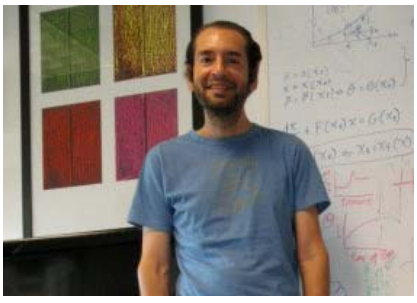
Now, I began to see different perspective. The parent's perspective, the story behind the face in class that is easy to forget (or to ignore). Of course I care, we all do, but the question made me realize how challenging it can be to show this side. Each time I teach a class I learn something new, and step by step my knowledge and mastery of the material grows. This passion for learning is one of the things that drives those of us who choose academic careers. But this same process can also widen the divide between teacher and student.

When I first began teaching nearly a decade ago, it was very easy for me to place myself in the seats of the students. I could even do this while lecturing. Seriously. I could be writing at the board and simultaneously be watching myself doing it, like a bizarre out of body experience. But now, I have to remind myself to do this. It has become challenging to remember that the students are seeing the material I am presenting for the first time...ever. Almost everything that I take for granted as common knowledge is new and strange to them. It's incredible how the long time and struggles I endured to learn these things are so easily forgotten. But the students are only beginning the journey. I tried to explain this, but I'm not sure if my new friend was satisfied with my response.

Presentism refers to the process by which we tend to view past and future events through the lens of today. But as Daniel Gilbert points out in his book *Stumbling on Happiness*, the remarkable thing is not that this process occurs but that it happens so naturally we don't even realize it's going on. If I don't make a conscious effort to remember this perspective, it can lead to negative pre-conceptions about the students (why can't they get this...it's so obvious?!?). It's exceedingly tempting to see the glass as half empty.

I thought about this a lot the next day during the drive home. "Do you care?" "Is the glass half empty or half full?" Maybe those aren't the right questions to ask. Perhaps it's more about being halfway there. Wherever "there" is will be different for each individual. It's not just about helping students get to a certain place. It's about helping them figure out where "there" is, and equipping them to fully reach that unique destination.

There are other realities of course, the world of metrics and numbers cannot be completely ignored (especially by those of us accustomed to the measurement-based language of science and engineering, which can at times be both illuminating and blinding). But thinking about the potential—what can be, as opposed to what is now—can help set a tone of possibility. Deep inside we all know this. We all care. But the presentism we are wired to embrace makes it incredibly easy to forget.



Victor M. Ugaz (ugaz@tamu.edu) is Associate Professor and K. R. Hall Development Professor in the Artie McFerrin Department of Chemical Engineering at Texas A&M University. Comments and suggestions are welcome.

Upcoming Elections

Now is the time to get involved!!

The officers and council of the AES Electrophoresis Society are inviting nominations (self nominations are encouraged) for the following positions:

* **Executive Vice-President:** This is a new two-year position in addition to the AES Vice-President. The responsibilities of the Executive Vice-President are to oversee sponsorship, help maintain corporate relationships, and manage the image of the Society for all external identities. The Executive Vice-President and the Vice President are eligible to run for the position of President, which is also a two-year term. An election will be held amongst the membership if both desire the position of President.

* **Councilors:** This is a three-year position and two Councilor positions will be open this year. The responsibilities of the position are to participate in all teleconferences (once per month), serve on one committee (sponsorship, membership, or ad-hoc), and contribute as needed based on individual contacts or ideas. We also encourage (but certainly don't require) our Councilors to participate as meeting co-organizers.

* **2014 AES Annual Meeting Co-organizers:** This is a one-year position held jointly by two individuals. These individuals are responsible, with the assistance of the council, for arranging session chairs who field calls for papers, organizing contributions into sessions, and developing an outstanding three-day schedule. These individuals are the key contacts coordinating with AIChE with all co-programming duties and overseeing of the entire annual meeting experience.

* **2013 AES-SciX Meeting Co-organizer:** This one-year position has similar duties as the annual meeting, but co-programs with a SciX representative performing all of the duties discussed above.

The nomination phase will close Friday, August 17th. Please send nominations to Adrienne Minerick, AES President at minerick@mtu.edu. The nominees their and statements will be posted online at http://www.aesociety.org/about_us/nominations.php. Membership voting for the Executive Vice-President and Councilors will be open until October 15th. The elected individual will assume the position at the board meeting at the AES Annual Meeting October 28 in Pittsburgh, PA.

Nominations should include your full name, contact information and affiliation accompanied by a 50 to 100 word statement introducing yourself to the membership, commenting on why you would be good for the position, what you would do to move AES forward, as well as ideas to advance electrophoretic applications. Nominations will be posted online by August 20th and will be included in the Fall newsletter to aid with member voting.

AES Bylaws are available at http://www.aesociety.org/about_us/bylaws.php. Feel free to contact any of the board members at http://www.aesociety.org/about_us/council.php with any questions.

Best Regards,

AES Officers and Councilors

Join AES in the celebration of its 2nd Award Session in Honor of Professor Nancy Stellwagen

Wednesday Oct 31, 12:30 PM
Room 406, David L. Lawrence Convention Center

- **Counterion Condensation and DNA Electrophoretic Mobility**
  Nancy C. Stellwagen and Earle Stellwagen
- **Testing Fundamental Theories for Polyelectrolyte Electrophoresis: Comparing Theory and Experiment As Polyelectrolyte Charge Spacing and Solvent Dielectric Constant ARE Independently Varied**
  David A. Hoagland and Alexey Popov
- **The Electrophoretic Migration of Partially Denatured dsDNA in a Gel: Why Does It Block?**
  Gary W. Slater and David Sean
- **DNA Gel Electrophoresis in the Entropic Trapping Regime: A Versatile Tool for Enhanced Separations and Nanostructural Analysis**
  Victor M. Ugaz and Nan Shi
- **Rational Design of DNA Electrophoresis Devices and the Nanofence Array**
  Kevin D. Dorfman, Daniel W. Olson and Sung-Gyu Park
- **A New Type of Silicon Nanofet Detector with Single-Nanoparticle Sensitivity**

AES Plenary Session

Monday Oct 29, 3:15 PM, Room 406, David L. Lawrence Convention Center

Nonlinear Electrokinetics in Porous Media **(3:15 PM)**		**Martin Z. Bazant** **Dept. of Chemical Engineering** **Dept. of Mathematics** **MIT**
The DC Force Exerted On a Charged Microparticle by an AC Electric Field **(3:45 PM)**		**Dennis C. Prieve** **Dept. of Chemical Engineering** **Carnegie Mellon University**
Microfluidic Force Fields for Biochemical and Cellular Analysis **(4:15 PM)**		**Zachary R. Gagnon** **Dept. of Chemical & Biomolecular Engineering** **Johns Hopkins University**
Electrokinetics and High Pressure Liquid Chromatgraphy **(4:45 PM)**		**Don Arnold** **Founder and VP, Advanced Technologies** **Eksigent Technologies, Inc.**
Controlling Ionic & Water Transport Through Nanopores: Ionic Diodes, Ionic Transistors and Water Valves **(5:15 PM)**		**Zuzanna Siwy** **Dept. of Physics and Astronomy** **University of California, Irvine**