MEETING NEWS

News from the **224th ACS National Meeting***—Michael Felton reports from Boston, Mass.*

Dancing drops

When moving liquids, most people think of pipes and channels. After all, this is how we get water into our homes and move microvolumes of fluid around on microfluidic chips. Against this conventional thinking, Robin Garrell, Chang-Jin Kim, and colleagues at the University of California–Los Angeles and Benjamin Shapiro at the University of Maryland have developed a microfluidics device that uses electrowetting to push liquids about without channels. "We can use this technique to digitize flow—making droplets, moving them around, cutting and merging them, [and] manipulating solutions such as biological fluids," says Garrell.

The problem with other approaches is that, "as you get smaller and smaller channels, the surface-to-volume ratio increases, and friction begins to 'kill' you," explains Garrell. The current solution is to use higher voltages for electrophoresis, which results in heating and cannot be used for all analytes.

The answer is to use water's properties at the microscale in your favor, she says. "The important concept is that surface tension is the dominant force at the microscale. Any time you get below about a millimeter [in scale], surface tension dominates over gravity," she explains. This surface tension can then be changed by applying an electrical potential across the liquid and used to move the fluid. Such a potential changes the ion distribution at the liquid–solid boundary, reducing the contact angle at the liquid–solid interface and making the drop spread out and "wet" the surface.

To accomplish this, the researchers built a silicon microchip with an underlying grid of electrodes and coated it with silicon oxide and then Teflon to create a hydrophobic surface with a high dielectric constant. On a dielectric such as Teflon, the contact angle for water is about 115°. If the angle is reduced by 30° or more, the drop can be moved.

As the liquid moves, it can leave materials such as biological analytes behind—"like the slime that a slug leaves on a sidewalk," jokes Garrell. With no applied potential, biofouling occurs because of hydrophobic interactions, she explains. "But we can minimize that by controlling applied potential, the pH, and analyte concentration. With the applied potential, biofouling is dominated by electrostatic interactions, but again we can control that by controlling the buffer and ac frequency."

The investigators are now incorporating separation, mixing, and sensing functions into their electrowetting-based biofluidic chips. They envision that electrowetting-based microfluidics will have wide application in biosensors, as well as in sample preparation for separations and spectroscopy.

Size exclusion goes small

Size-exclusion chromatography (SEC) typically brings to mind multiple columns, a lot of reagents, and pumps. All of these contribute to the high cost of conducting SEC. However, what if size exclusion could be accomplished with relatively inexpensive capillary electrochromatography (CEC)? Ira Krull at Northeastern University and colleagues at Dow Chemical and Merck, Inc., have developed a CEC method to conduct SEC of polymers and biomacromolecules.

Krull says that the technology could replace polymer and biopolymer characterizations using HPLC-based SEC. "This gives you an alternative way of doing it so you don't have to buy the columns [often two or three in series] that are routinely used in SEC that are very expensive." CEC requires much smaller samples than HPLC, which can be important for hard-to-obtain biomacromolecules. Moreover, CEC separations are much faster and require smaller amounts of solvent than traditional SEC, reducing cost and waste.

For the CEC method, the researchers mixed conventional size-exclusion and ion-exchange packing together in one capillary. The ion-exchange medium provides negatively charged sites inside the capillary. Placing a potential across the capillary sends the mobile phase flowing electroosmotically, and the analytes are separated by size.

The mixture of two packing materials brings tremendous advantages, says Krull. "You can change the ratio of the size-exclusion packing to the ion-exchange packing [materials] at will. And there is an infinite [number of] combinations and permutations that you could come up with—many of which we have looked at—until you get the right intensity of electroosmotic flow as a function of voltage and the right range of molecular weights to resolve [your sample]."

Krull presented data showing the characterization of polysaccharides from 180 to ~112,000 Da. "This would appear to be the largest molecular weight range of polysaccharides that has yet been analyzed by any form of CE, though, of course, SEC is able to do much better." However, conventional SEC has difficulty resolving large polysaccharides, giving CEC a possible advantage.

"You could do this on any CE instrument," says Krull. "And because there are a lot of instruments that are commercially available now that allow you to bundle capillaries, you can have 8, 16, or 96 capillaries in one bundle and run that number of samples simultaneously." This could bring polymer and biopolymer characterization to the high-throughput world, he adds.