Preface to Special Topic: Papers from the 13th International Conference on Surface and Colloid Science (ICSCS) and the 83rd ACS Colloid and Surface Science Symposium, Columbia University, New York, 2009

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This Special Topic section is a compilation of several original contributions covering both fundamental and practical aspects of electrokinetic microfluidic phenomena that were presented during the Electrokinetics and Microfluidics sessions held at the conference. [doi:10.1063/1.3332379]

Electrokinetics is currently the mechanism of choice for the manipulation of fluids as well as colloidal and biological particles at microscale and nanoscale dimensions.[1] The popularity of electrokinetics is perhaps not so surprising as electrodes are easy to fabricate and embed into microfluidic chips, thus allowing the entire fluid and particle actuation mechanism to be completely integrated into the device. In addition, driving microfluidics with electric fields is relatively straightforward and allows for precise actuation. Nevertheless, considerable challenges remain in understanding the complex mechanisms associated with the hydrodynamics of conducting and dielectric fluids and particles under the influence of electric fields. Concomitantly, there has been an exponential increase in research and development in this field along both fundamental and applied themes in the past five years.

This sustained growth in the microfluidics community of electrokinetics research has led to a sequel to the first Electrokinetic Phenomena and Microfluidics session at the 82nd ACS Colloid and Surface Science Symposium in Raleigh, NC, in 2008, and which we hope will now be a regular feature at successive ACS Colloid and Surface Science meetings. This year at the combined 2009 13th International Conference on Surface and Colloid Science (ICSCS) and the 83rd ACS Colloid and Surface Science Symposium in New York, the Electrokinetics and Microfluidics symposium proved to be extremely popular, with three keynote lectures presented by Professor Howard Stone, Professor Hsueh-Chia Chang, and Professor Thomas Healy, and 44 oral presentations. In both 2008 and 2009, *Biomicrofluidics* has organized a special issue to cover some of the contributions reported at these meetings.[2]

The growing interest in using electric fields to manipulate biological entities such as cells, DNA, and even single molecules is reflected in this year's collection of papers with dielectrophoretic (DEP) phenomena comprising the bulk of the contributions. In Ref. 3, a new theory to describe Stern layer conductance along the surface of nanocolloids is proposed, forming the basis for the derivation of a more accurate prediction of the DEP crossover frequency. This theory is then employed to determine the conformation and, hence, optimum coverage of oligonucleotides on the surface of nanocolloid functionalized molecular probes during DNA hybridization under the influence of DEP, which can be exploited for biomolecular sensing. Other fundamental DEP papers include the investigation of particle motion under DEP induced optically via a photoconductor, in which Zhu *et al.*[4] characterized the frequency dependence of the motion through the synchronous velocity spectra of the particles, and a numerical study of particle trapping at the

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throat of converging-diverging microchannels under the influence of negative DEP using a transient arbitrary Lagrangian–Eulerian finite element method.[5] A more practical implementation is, on the other hand, reported by Yang *et al.*[6] in which the negative DEP is exploited to separate colorectal cancer cells from other cells in a microfluidic device as a demonstration of a portable cancer detection tool.

Continuing along the separation theme, but with regard to DNA separation using pulsed-field gel electrophoresis aided by sparse but regularly ordered microfabricated arrays of nanoposts, is a Brownian dynamics simulation model reported by Ou *et al.*[7] in which DNA channeling, which predicts that the motion of DNA is undisturbed by the presence of arrays for large spacing to DNA equilibrium size ratios and when the field lines are straight, is predicted, consistent with experimental observations. In another fundamental paper, a direct numerical simulation model is presented to predict the current-voltage relationship across conducting pores along cell membranes, which is of fundamental importance in the electroporation process.[8]

We hope that you will enjoy reading the contributions in this special topic and that it encourages you to participate in future Electrokinetics and Microfluidics meetings at the ACS Colloid and Surface Science Symposia, which we definitely hope will continue on a regular basis.

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