Abstract:

A crucial step of biological detection systems is to separate analytes of interest from contaminating background elements within a sample. This is required in order to reduce false positives, events which can turn out to be extremely costly errors in the case of initiating action from first responders to a possible accident or attack. We report here two techniques that utilize beneficial scaling laws to effect highly efficient separation in microfluidic environments. The first technique, AC dielectrophoresis, involves observations of a new electric field- and shear-induced many-body phenomenon in the behavior of particle suspensions. This electro-hydrodynamic method uses both dielectrophoresis and field-induced phase transitions to selectively capture and concentrate cellular analytes from a heterogeneous sample. This non-optical separation technique relies upon intrinsic electric polarizability properties of analytes, and thus requires no time-consuming and costly labeling steps. The effect is frequency dependent, and by tuning these field-driven phenomena to the maximum response of the analyte of interest, a particular analyte can be spatially localized and concentrated. Non-cellular contaminants can be rejected, and a non-optical detection method such as dielectrophoretic impedance monitoring can be utilized to detect the accumulation of cellular analytes. The theoretical predictions are consistent with experimental data even though our electrohydrodynamic model contains no fitting parameters. The second technique utilizes magnetophoresis of targets bound to magnetic chaperones. In this technique, target labeling is required, but separation efficiency can be enhanced by manipulating surface chemistry and introducing internal optical bar-codes to the chaperones. Microscale electromagnets embedded within a fluidic system are used for preconcentrating targets and flushing raw samples. We see these two complementary techniques being implemented in front-end components of biodetection microsystems specifically to address issues with handling raw environmental samples.

Conrad D. James received the B.S. degree in electrical engineering, summa cum laude, from the University of Notre Dame, in 1996. He received the M.S. and Ph.D. degrees in applied and engineering physics from Cornell University, Ithaca, NY, in 1999 and 2002, respectively. Since 2002, he has been a Senior Member of Technical Staff at Sandia National Laboratories in Albuquerque, NM. His research interests include MEMS and microfluidic devices for biological and electrochemical detection applications.

RSVP: Susan Stoltje at stoltje@uta.edu or 817-272-1536