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Life in the shock wave: Accelerating DNA reactions with isotachophoresis

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We use isotachophoresis (ITP) to achieve fast and specific analyses of molecular targets in complex mixtures. We use ITP to pre-concentrate and purify; molecular recognition for specificity; and ITP to control and increase the rate of chemical reactions between molecular probes and target macromolecules. ITP is an electrophoresis technique that uses two buffers which include a high mobility leading electrolyte (LE) and a low mobility trailing electrolyte (TE). Sample species with mobilities bracketed by those of the LE and TE focus into the TE-to-LE interface. For trace sample concentrations, multiple species focus in so-called peak mode wherein multiple analytes mix and strongly overlap within an order of 10 μm wide ionic concentration shock wave. This co-focusing mixes target species and pre-concentrates them to accelerate reactions. We have integrated DNA and RNA extraction with sequence-specific quantitation using a variety of mobile and immobile cDNA probes. We pre-concentrate target and probe molecules by $>10,000\times$ and achieve in 30 sec reactions which would normally take 4 days. We have shown specific and sensitive detection of target sequences in order 5 minutes with little or no off-chip sample preparation, and without target amplification.

Biography

Juan G Santiago received his MS and PhD in Mechanical Engineering from the University of Illinois at Urbana-Champaign in 1992 and 1995. His research includes the development of microsystems for on-chip chemical analysis, drug delivery, sample preparation methods, and desalination of water. Applications of this work include molecular medical diagnostics, drug discovery, environmental monitoring, and the production of drinking water. He is a Fellow of the American Physical Society, a Fellow of the American Society of Mechanical Engineering, an Associate Editor of the journal *Microfluidics and Nanofluidics*, co-founder of several companies in the microfluidics area, co-inventor of micron-resolution particle image velocimetry, and director of the Stanford Microfluidics Laboratory. He served as Associate Editor of *Lab on a Chip* '08-'13. He has given 26 keynote and named lectures and more than 100 additional invited lectures. His work is cited about 1000 times per year. He has graduated 26 PhD students and advised eight Postdoctoral researchers. 16 of his former advisees are now professors at major universities. He has authored and co-authored over 150 archival publications and 200 conference papers, and holds 36 patents (16 of which are licensed).

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