Docket #: S07-084

Improved Control of Chemical Reactions using Isotachophoresis

Stanford researchers have designed a microfluidic method for improved control of chemical reactions on-chip using isotachophoresis (ITP). This method allows for simultaneous reaction and separation of reaction products and/or reactants. Separating reaction products potentially enhance reaction dynamics and enables real-time reaction monitoring.
One application of the technology is a chemical cycling scheme to replace thermal cycling in PCR (and so achieve isothermal PCR). This invention introduces a new technique based on chemical concentration cycling that has the potential to greatly simplify PCR system design and supporting instrumentation, and enhance PCR specificity and quantitative PCR accuracy. With this new technology, a flow control scheme establishes spatial fluctuations in the concentration of denaturants along a microchannel, while electromigration drives DNA through this spatially varying denaturant concentration field. Locally high denaturant concentration regions melt the DNA, while locally low denaturant regions allow for DNA annealing and extension. The researchers are currently working to optimize denaturant field and flow control, as well as DNA injection and control, with the goal of exploring the validity and performance of spatial chemical cycles as a competitor to thermal cycles.

Other applications of the invention include optimized control of other reactions including antibody-antigen reactions.

Applications

- On-chip, controlled isothermal quantitative real-time polymerase chain reaction (PCR)
- On-chip immunoassays using isotachophoresis for preconcentration of reactants and separation of hybridization products

Advantages

- Separation of (non-specific) reaction product during reaction
- Simplified reaction system design and supporting instrumentation
- Chemical cycling PCR with order 15 seconds per cycle
- Increased PCR specificity and accuracy
- Robust control of isothermal PCR -- can be automated and integrated with other on-chip functional components

Publications

- Persat A, Morita T and Santiago JG (2007) “Toward On-Chip Isothermal Polymerase Chain Reaction.” MicroTAS 2007 Conference.
- Persat A and Santiago JG (2008) “On-Chip Device for Isothermal, Chemical Cycling Polymerase Chain Reaction.” MicroTAS 2008 Conference.

Patents

- Published Application: 20100084271
- Published Application: 20130146462
- Published Application: 20140360879
- Published Application: 20160209360
- Published Application: 20180372682
- Issued: 8,394,251 (USA)
- Issued: 8,821,704 (USA)
- Issued: 9,297,039 (USA)
- Issued: 10,073,054 (USA)
- Issued: 10,830,732 (USA)

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