Disposable Electrokinetic Micro Preconcentrator for Proteomic Sample Preparation using PDMS Microfluidic Chip
Technology #11335

Applications

- Biomolecule pre-concentration
- Sample preconcentrator for advanced blood proteome analysis and diagnostics
- Sample injection for microchip electrophoresis or chromatography
- Environmental trace analysis (e.g. water purification)
- This is a disposable device for biomolecule pre-concentration.

Problem Addressed

This is a disposable device for biomolecule pre-concentration.

Technology

A major challenge in proteomic studies is the detection of low-abundance proteins such as biomarkers in complex samples, for example blood plasma or serum. Many important biomarkers such as cytokines and other signaling molecules in the blood are available only in trace amounts. Pre-fractionation and separation is needed for analysis of these markers, but sample preparation is difficult because it may further dilute the concentration of these molecular markers. To address this issue, various preconcentration techniques have been developed, including field-amplified sample stacking (FAS), isotachophoresis (ITP), electrokinetic trapping, micellar electrokinetic sweeping, chromatographic preconcentration and membrane preconcentration. To date, the highest concentration factor achieved using these technologies is on the order of 500-700 fold. Another method of efficient preconcentration, which can be done on a microfluidic chip, is based on electrokinetic trapping. An electric field is applied across an ion-selective membrane such as Nafion, so that a charge depletion region is developed. In combination with tangential flow, driven by pressure or electroosmosis, preconcentration of charged analytes can be achieved inside a microchannel. A novel fabrication method for a simple and disposable device is developed. Instead of integrating solid Nafion membrane into the microfluidic device, perfluorinated resin solution is patterned, cured and integrated into the microchannel device through plasma bonding to the PDMS material. This resolves the problem of sealing the device, ensuring that no leaking takes place. Each device channel consists of two microchannels connected with one or several nanofilter channels. Through the application of an electric field across the nanochannel, cations are selectively transferred through a semipermeable nanofilter. To maintain charge neutrality, anions are repelled from the filter region, creating a depletion zone that carries induced space charge and acts as a charge barrier. A tangential field in the microfluidic channel, on the anodic side, carries biomolecules through electro-osmotic flow. Because biomolecules cannot overcome this charge barrier they become trapped and therefore concentrated. The impressive efficacy of this device - with a concentration factor greater than currently used techniques- suggests applications for biomolecule pre-concentration in medicine and water purification.
Advantages

- Disposability
- High integration capability (e.g., with a mass spectrometer)
- Massive parallelization of preconcentrators
- Adjustable shape and geometry
- Structure flexibility

Categories For This Invention:

Medical Devices
Diagnostic
Life Sciences
Biotechnology
Clinical Applications
Therapeutics

Intellectual Property:

Electrokinetic concentration device and methods of use thereof
Issued US Patent
7,651,600

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Publications:

Nanofluidic Concentration Devices For Biomolecules Utilizing Ion Concentration Polarization: Theory, Fabrication, And Application
Chem Soc Rev

Multiplexed Proteomic Sample Preconcentration Device Using Surface-Patterned Ion-Selective Membrane
Lab Chip

Million-fold Preconcentration of Proteins and Peptides by Nanofluidic Filter
Analytical Chemistry
2005, 77 (14), pp 4293–4299

External Links:

Micro/Nanofluidic BioMEMS Group
http://www.rle.mit.edu/micronano/

Image Gallery:

![Micro/nano stamping of Nafion on glass](image-url)