ICE 10.491 MicroFluidics Module - 2001

Klavs F. Jensen
Will the Microsystems Evolution Carry over to Microchemical Systems?

- Can instrumented microreactors and scale-up by replication revolutionize chemical research and production?
  - From discovery to testing - speed up time to production with reduced need for upfront capital investment
  - Obtain chemical information (e.g., kinetics) and optimize chemical processes more efficiently
  - Bring increased productivity to chemical industry R&D and ultimately production as in other industry sectors
μTotal Analysis Systems - “Laboratory On A Chip”

- Laboratory automation
- Drug discovery
- Clinical diagnostics
- Advantages:
  - small volumes of expensive reagents,
  - parallel operation,
  - high throughput screening,
  - high productivity,
  - reduced human errors
- Application examples:
  - DNA/RNA separation and sequencing
  - Immunoassay

J.D. Harrison (Univ. Alberta)

Caliper Labchip™


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Reagent Metering by Using Surface Tension Effects

The high surface area to volume in MEMS devices provide opportunities for using surface forces that are small in conventional systems.
Laminar Flow in $\mu$Fluidic Structures

*Langmuir* 2000, 16, 8311-8316

GM Whitesides group Harvard


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Active Polymer Fluidics

Beebe, *Nature*, 404, 588

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μChemLab™ Gas Phase Analysis System

Sandia National Laboratories

<table>
<thead>
<tr>
<th>Sample Collection/Concentration</th>
<th>Separation</th>
<th>Chemically Selective Detection</th>
<th>Gas Flow Control</th>
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Laboratory on a CD Technology

David C. Duffy, Heather L. Gillis, Joe Lin, Norman F. Sheppard, Jr., and Gregory J. Kellogg*; Microfabricated Centrifugal Microfluidic Systems: Characterization and Multiple Enzymatic Assays, Analytical Chemistry; 1999; 71(20); 4669-4678.

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ICE 10.491 MicroFluidics Module - Basics

- Time and Location: MTWF 10-11 - Room 66-168

- Instructor: Klavs F. Jensen
  - Room 66-566 - Phone: 3-4589 - email: kfjensen@mit.edu
  - Office hours: by appointment

- Teaching Assistant: Wendy Prudhomme
  - Room 56-291 - Phone: 3-8644 - email: prudhom@mit.edu
  - Office hours: 1-3 PM Fridays

- Web page: http://web.mit.edu/10.491/

- Grading:
  - Problem Sets (3) 40%
  - Final Project (group of four) 50%
  - Class Participation 10%

- Project reports will be due Friday March 9

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ICE 10.491 MicroFluidics Module - Outline

Week 1:
- Introduction to microfluidics
  - chemical and biological applications
- Microfabrication techniques
  - silicon based approach
  - alternative microfabrication strategies – “soft lithography”

Week 2:
- Microfabrication techniques (continued)
- Fundamentals of microfluidics
  - flow – heat transfer – mixing – mass transfer and reactions

Week 3:
- Fundamentals of microfluidics (continued)
- Applications of microfluidics
  - chemical synthesis
  - biological systems including polymerase chain reaction (PCR)

Week 4:
- Project design and reports