

Fabrication of Microfluidic Devices for Advanced Rheological Measurements

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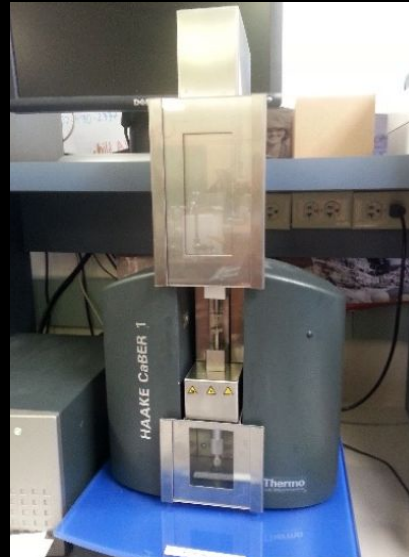
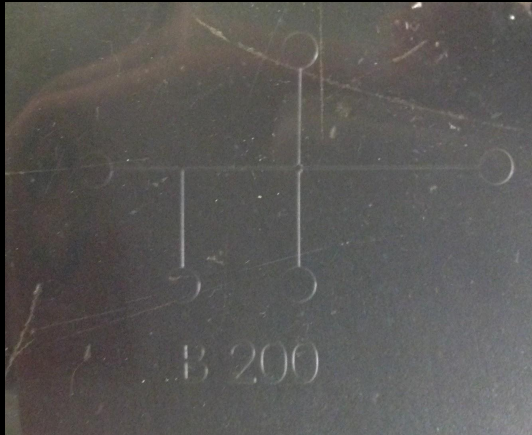
Organization: Oregon State University CBEE

Extensional Rheology

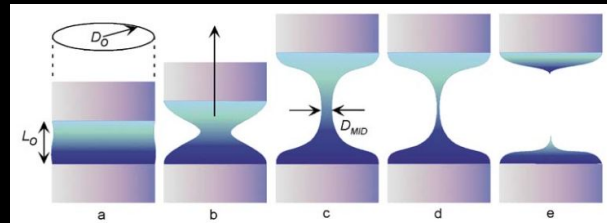
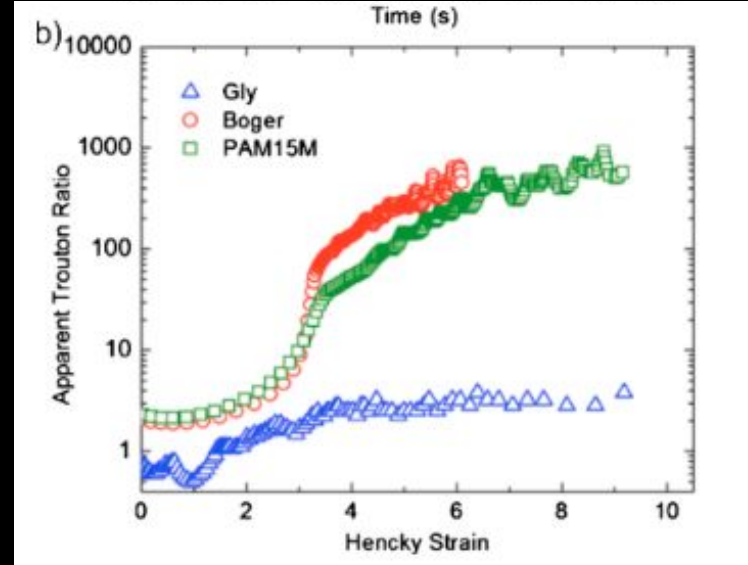
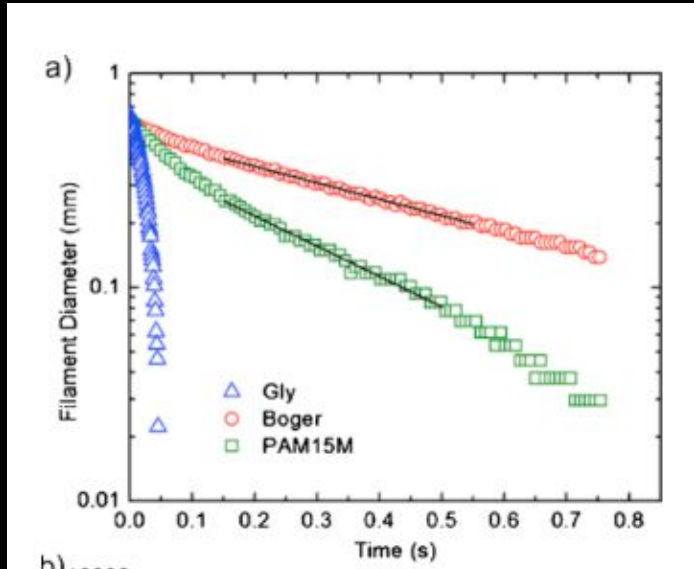
- Extensional viscosity is the measure of a fluid's resistance to an extensional stress.
- Used to measure properties of materials
 - Cosmetics
 - Inks
 - Biological fluids

Current Measurement Techniques

- CaBER
- RFX
- Microfluidics

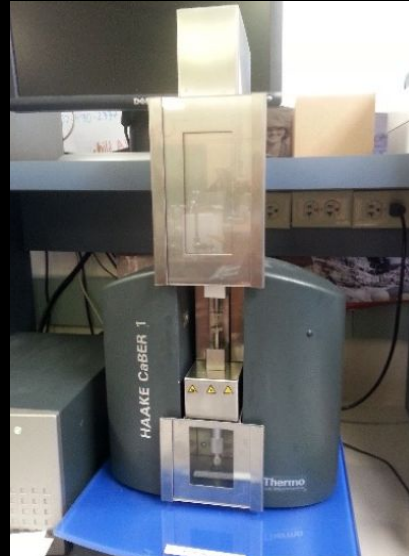
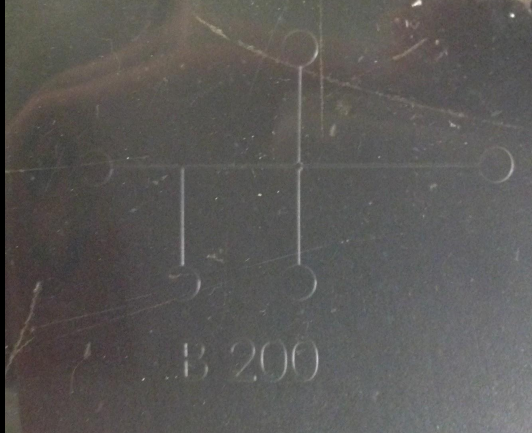


CaBER Data



Current Measurement Techniques

- CaBER
- RFX
- Microfluidics



Microfluidics

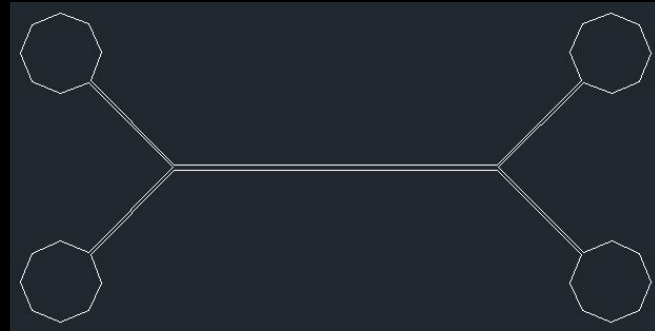
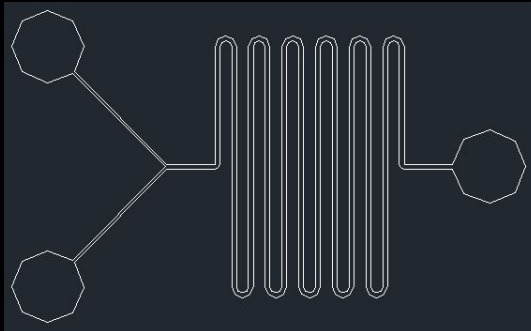
- Observing the flow of liquids at a small scale (nanometers and micrometers)
- Surface-to-volume ratio

$$m \frac{dv}{dt} \sim \rho(L^3) + \tau(L^2) + \gamma(L)$$

- Scaling Phenomena
 - In microscale, inertial effects become insignificant relative to surface interactions

Applications of Microfluidics

- Chemical separation and analysis
- Medical diagnostics
- Microreactors
- Inkjet printers



Fabrication Techniques

- Photolithography
- Solidification or Reshaping
 - Casting, Replica Molding, Hot Embossing, etc.
- Subtractive Processes
 - Etching, Laser Ablation, Abrasive Jet, etc.
- Additive Processes
 - Vapor Deposition, Electroplating, Contact Printing, etc.



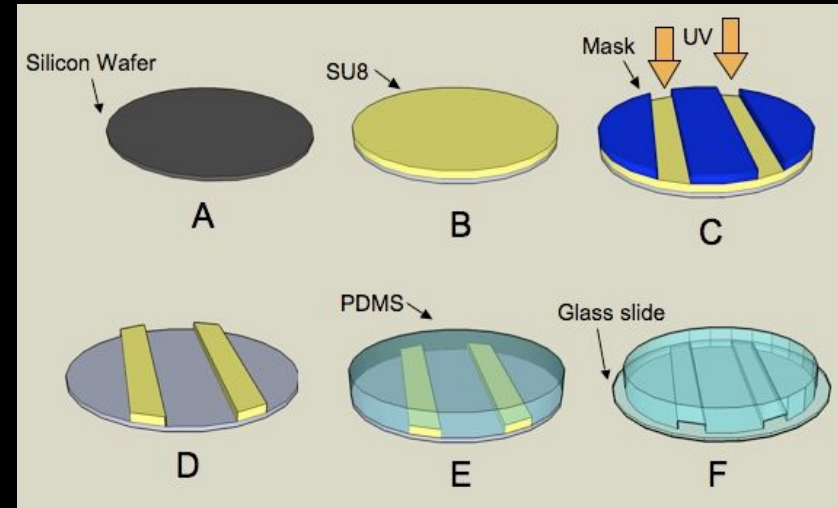
Photolithography/Soft Lithography

Photolithography

- Clean and heat the silicon wafer
- Apply the photoresist (spin coating)
- Pre-bake the photoresist
- Expose the photoresist to intense light
- Complete a post-exposure bake
- Apply the developer

Soft lithography

- Pour and cure PDMS
- Use a UV Ozone machine to bond the PDMS to a glass slide



www.sybbure.org

Photolithography/Soft Lithography

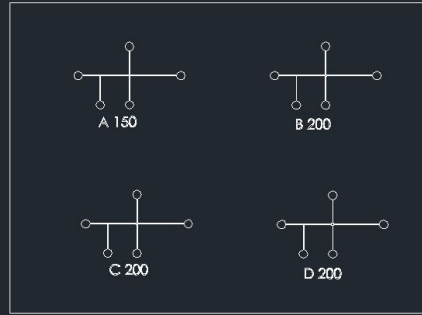


Plate 001 7/21/15

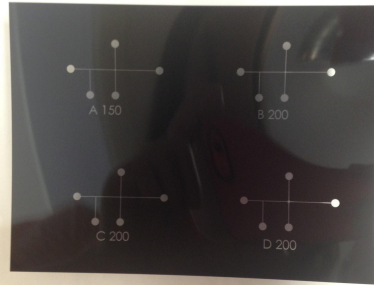
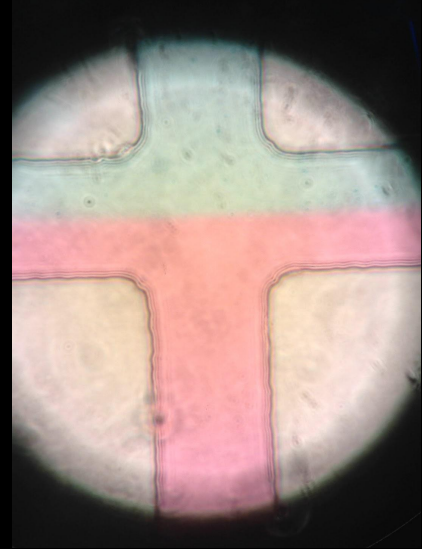
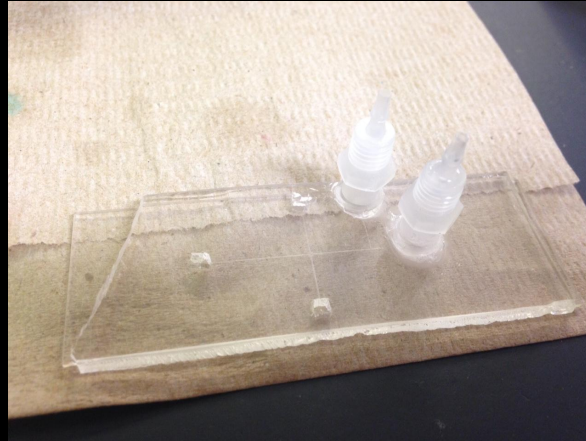


Plate 001 7/21/15

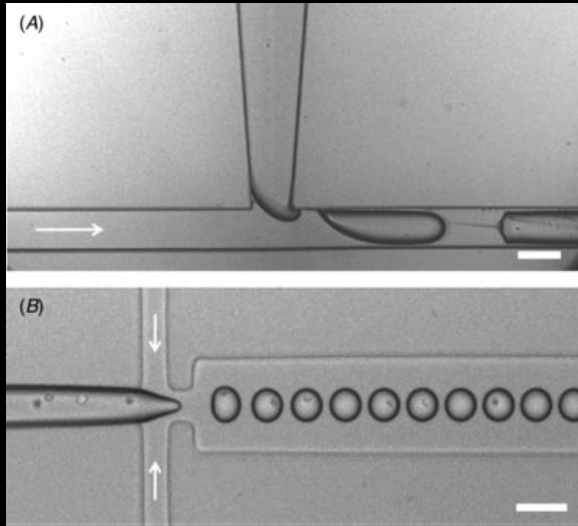


Setup of Devices

- Syringe Pumps
- Luer Connections
- Needles
- Direct Tubing



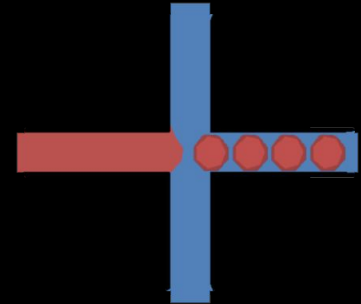
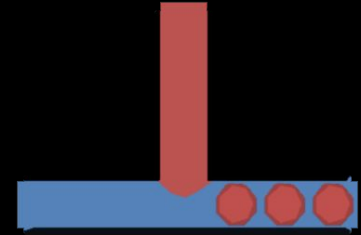
Droplet Formation



www.iopscience.org

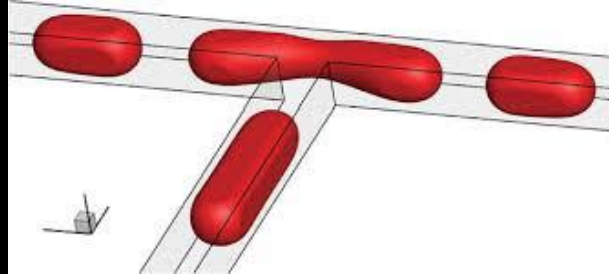
T-junction

Flow-focussing



www.elveflow.com

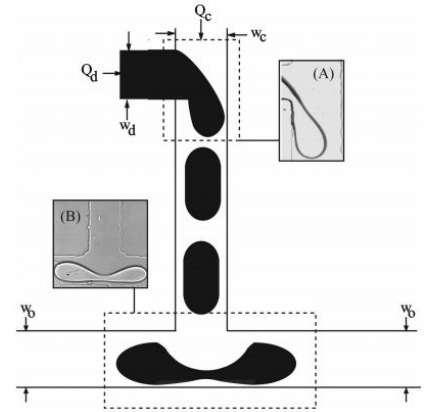
Measuring Extensional Viscosity



cheme.nl

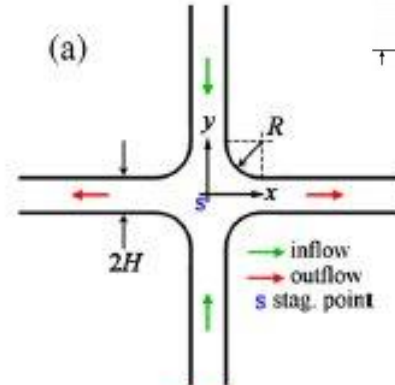
T-junction

G. F. CHRISTOPHER AND S. L. ANNA



Alves *et al.* (2012)

Cross-slot



Anna *et al.* (2009)

Acknowledgements

- Travis Walker and Kristin Marshall
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