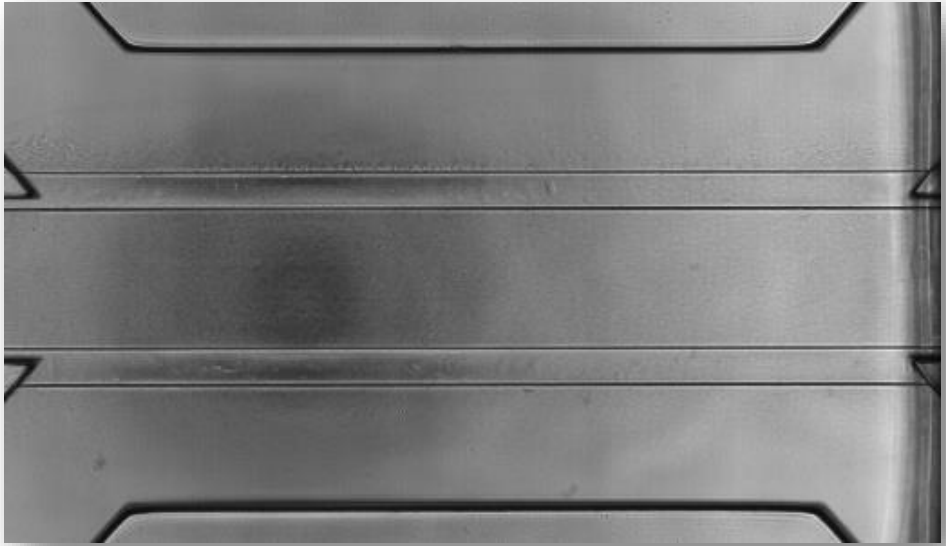
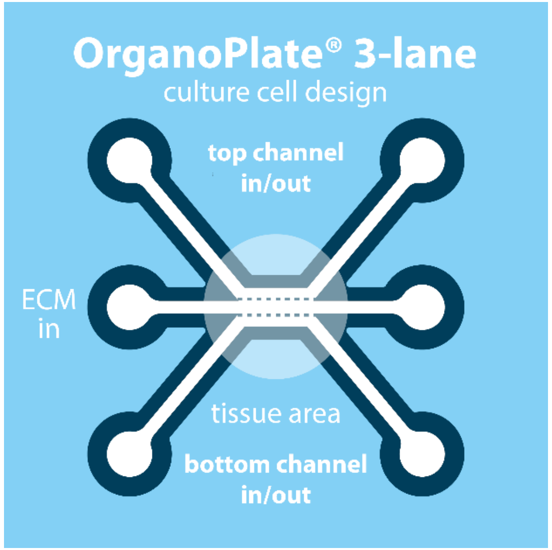
Polimer Talk

Todd Burton- Hardware R&D

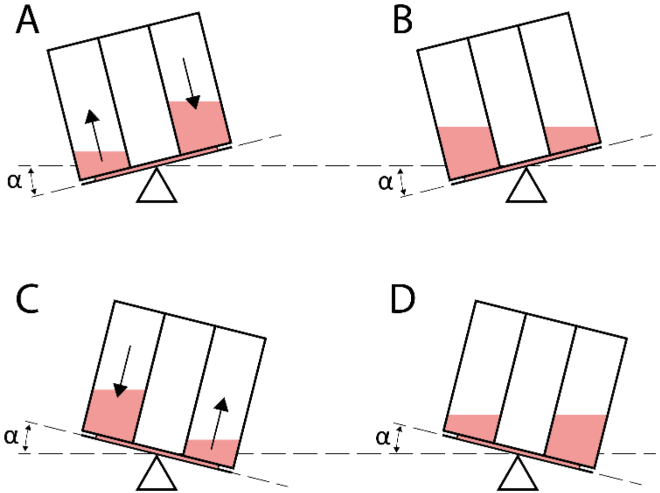
09/09/2020

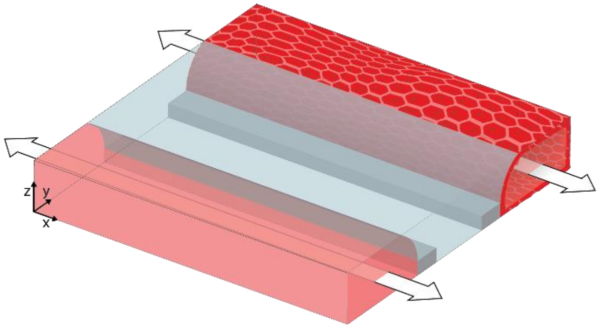
3-lane OrganoPlate

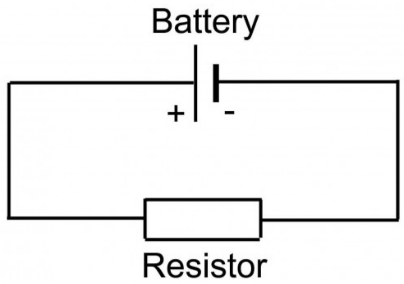




Gravity driven flow



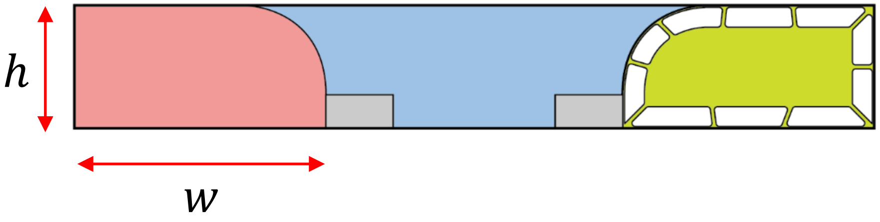




$$V = IR \rightarrow \Delta P = QR_{hyd}$$

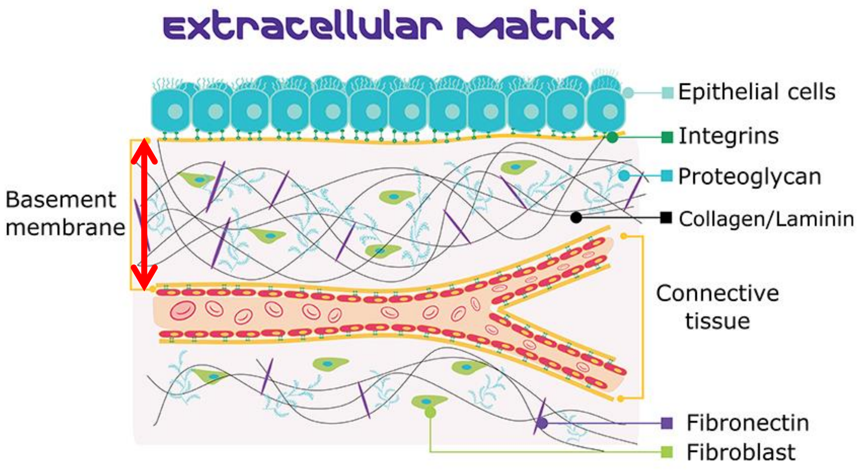
Shear stress

- Where $w >> h \rightarrow \tau = \frac{6\mu Q}{h^2 w}$
- μ is dynamic viscosity
- Q is the flow rate



The Gel

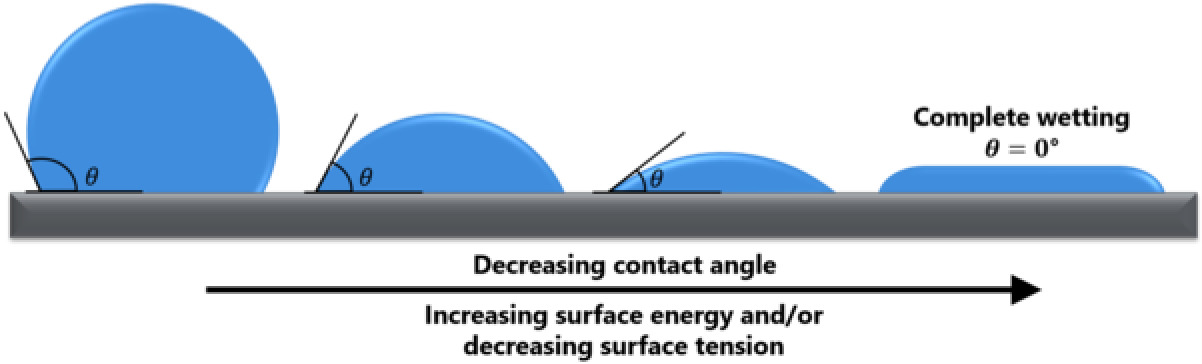
- Basement membrane
  - Basal Lamina
    - Lamina lucida
    - Lamina densa
  - Reticular connective tissue



Design considerations for gel loading

- Mode of gelation
- Optimise energy involved in loading gel
  - Surface energy of materials
  - Capillary pressure
  - Surface area in contact with gel
  - Entry force of gel
  - Viscosity of gel

Surface energy of materials: contact angle



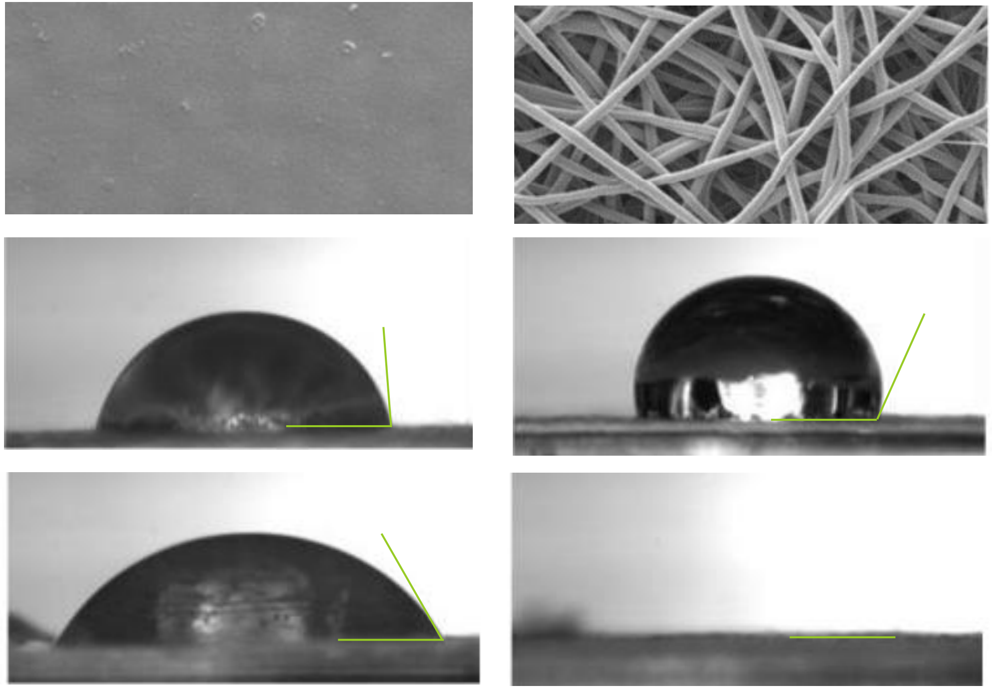
- Hydrophobic > 90
- Hydrophilic < 90

Contact Angle

Film | Fibres

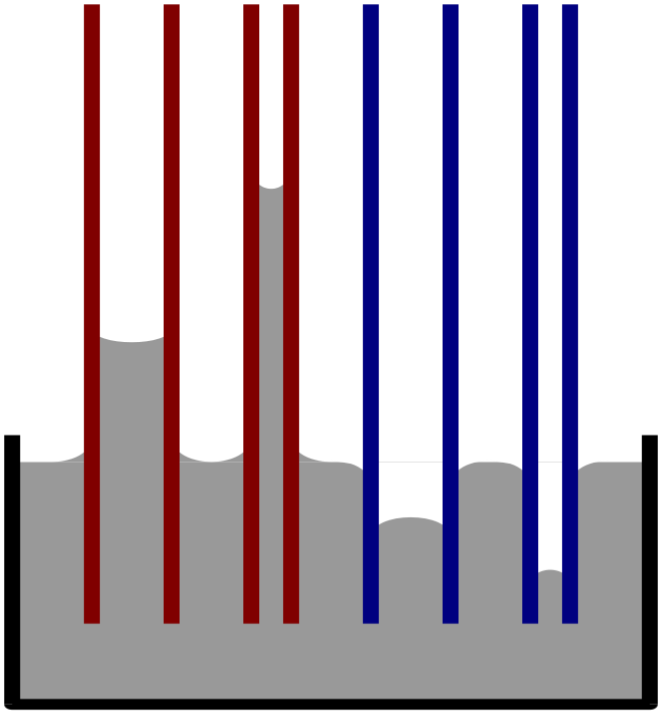
No surface treatment

Surface treatment



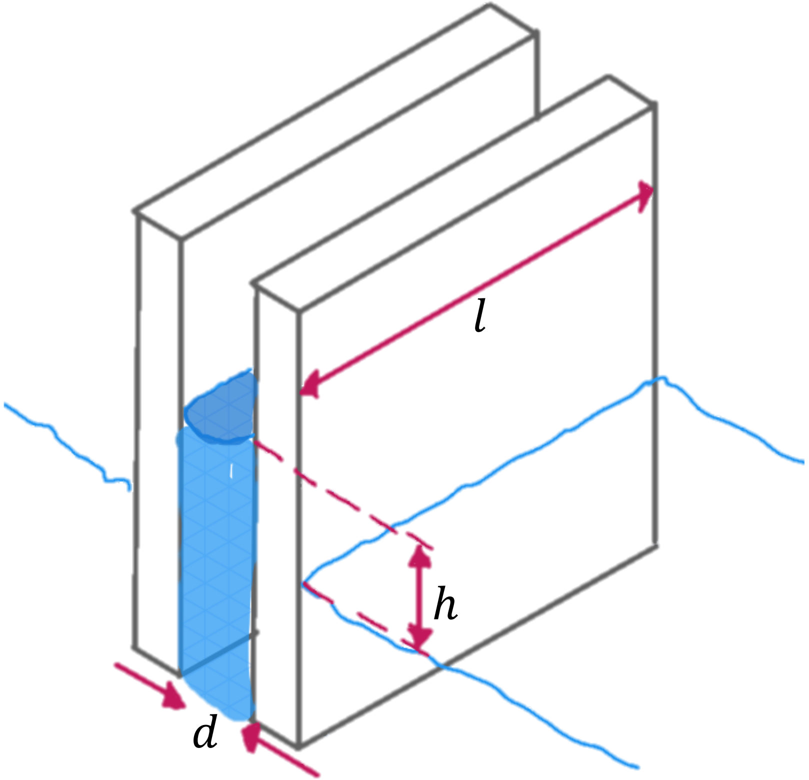
Capillary pressure

- Contact angle below 90°
- Contact angle above 90°



Capillary rise in parallel plate

$$h = \frac{2\gamma Cos\emptyset}{l\rho d g}$$



L- Length of water in contact with plate

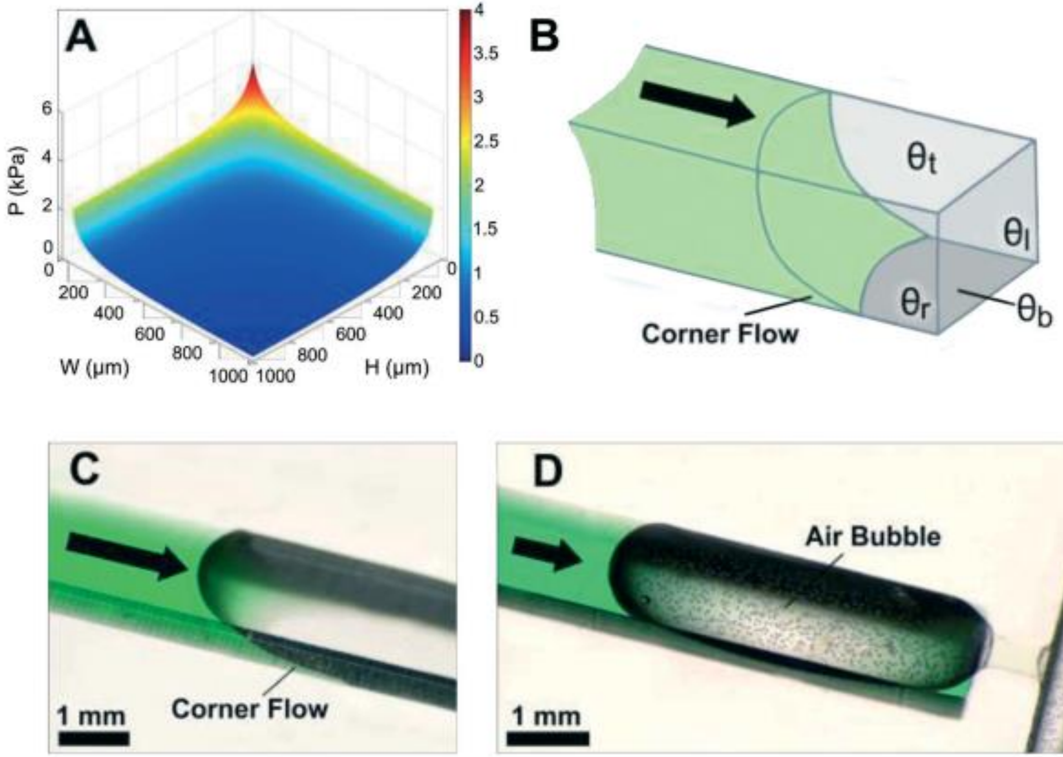
ρ- Density

γ- Surface tension

g- Acceleration due to gravity

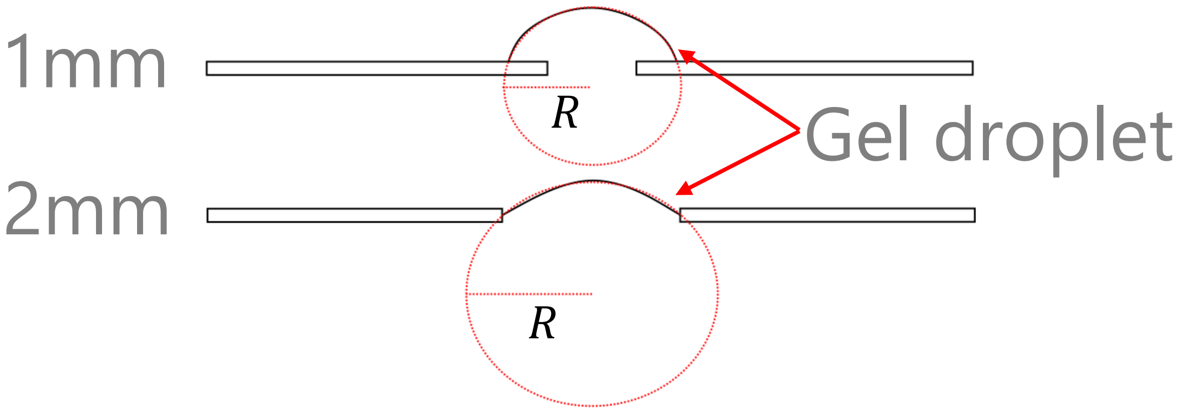
$\emptyset$- Contact angle

Capillary rise in parallel plate

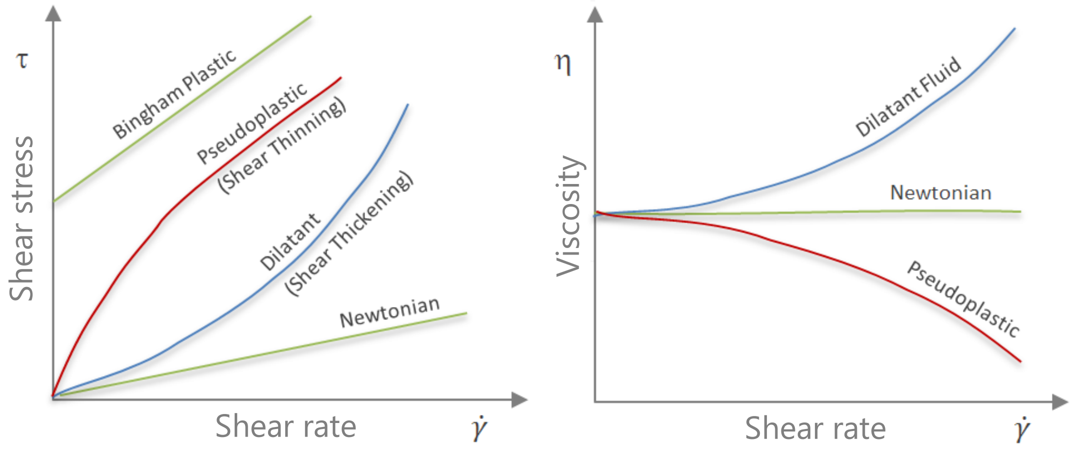


Entry force of gel

- Backpressure created by gel droplet
- Laplace law states: $\Delta P = \frac{2\gamma}{R}$
- Pressure is inversely proportional to radius
  → Smaller radius creates more pressure

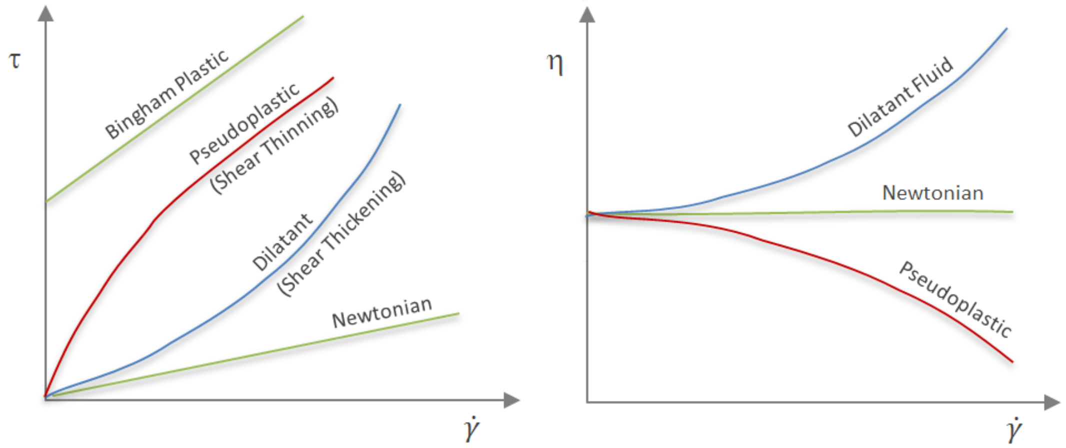


Rheology of non-Newtonian fluids



- Newtonian fluids have the same viscosity irrespective of the shear rate
- Non-Newtonian fluid viscosity changes as a function of shear rate

Rheology of non-Newtonian fluids



- Collagen gel has a time dependant viscosity when neutralised and cross linking.
- Collagen has a shear thinning behaviour
- Increased viscosity increases the time taken to fill the channel.

Gel requirements

- Loading and unloading → low viscosity required
  - Gel as support or removal of gel after curing
- Tall + Thin gel → Stiffer gel required
- Gelation mechanism
  - Photocurable
  - Neutralisation
  - Heat induced

Summary

- Flow within microfluidics can related back to electrical circuits
- Fluid shear stress is a function of flow rate and geometry of the channel
- Surface properties and geometry play a key role in how the microfluidic fill.

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