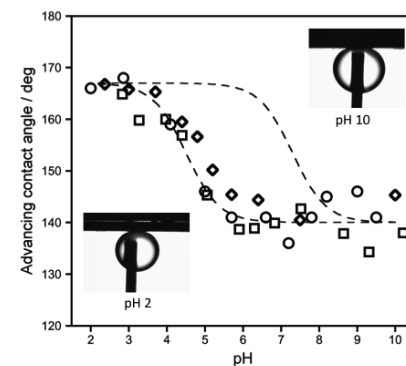


Polymer Brushes as Components of Oil/Water Separation Meshes

-Gary Dunderdale, Department of Chemistry, University of Sheffield, UK

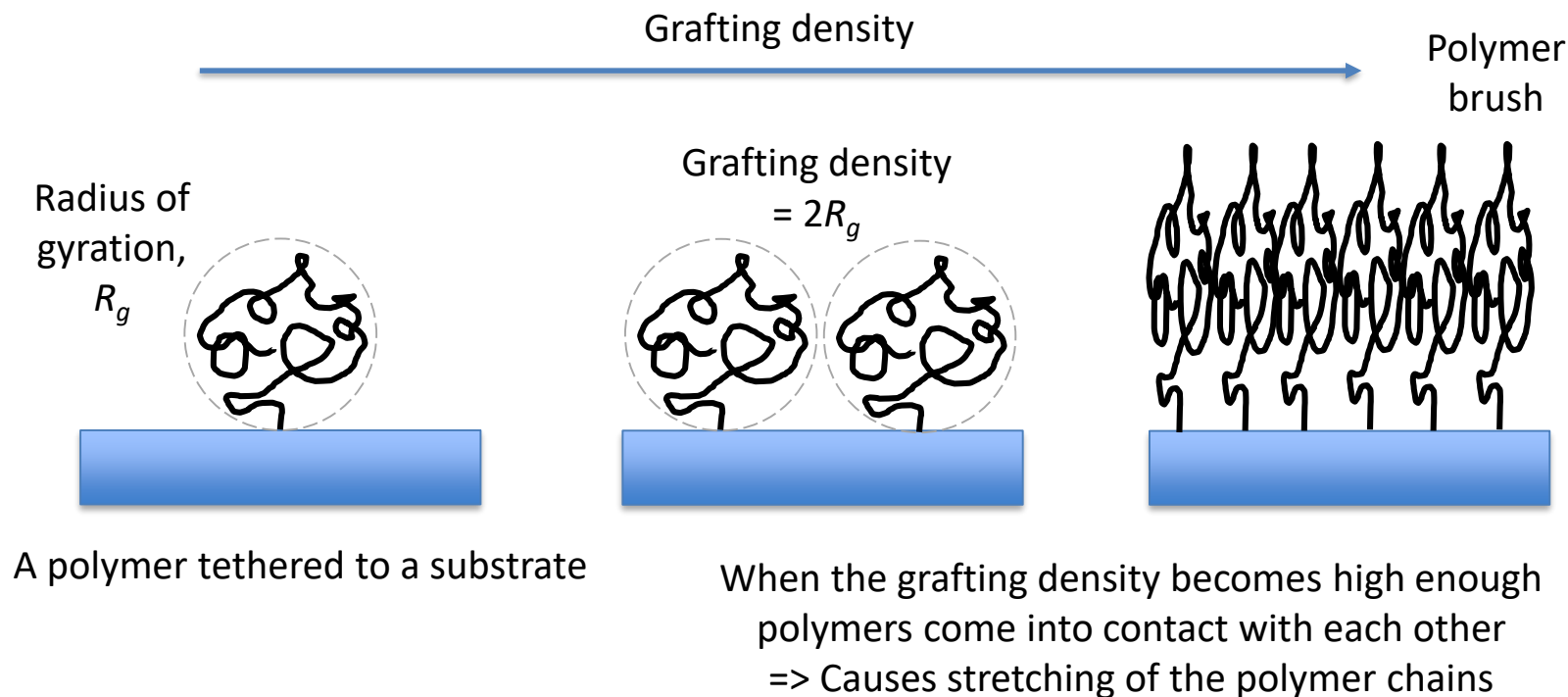


Line up:

- 1) Why oil/water separation meshes need to be used in pairs
- 2) Programmable oil/water separation meshes



Humber Bridge, N. Lincs, UK

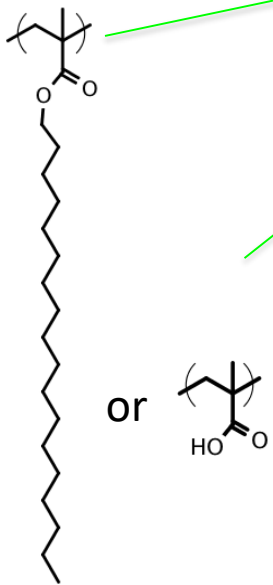
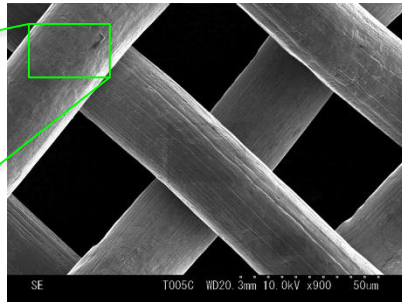
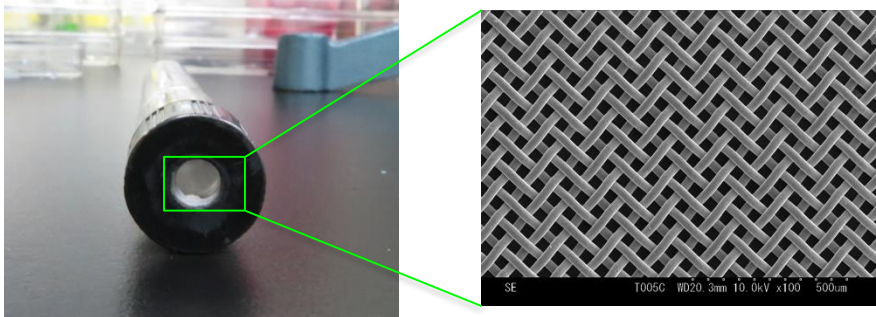


A polymer tethered to a substrate

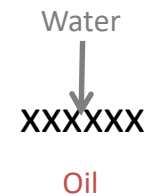
When the grafting density becomes high enough polymers come into contact with each other
=> Causes stretching of the polymer chains

Excellent properties such as no-stick, anti-fouling, low-friction, anti-icing, anti-bacterial ... etc

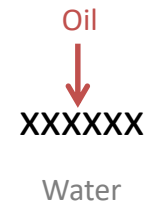
Polymer Brush Functionalized Mesh

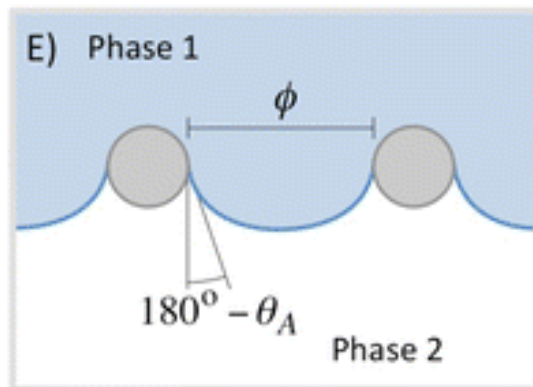
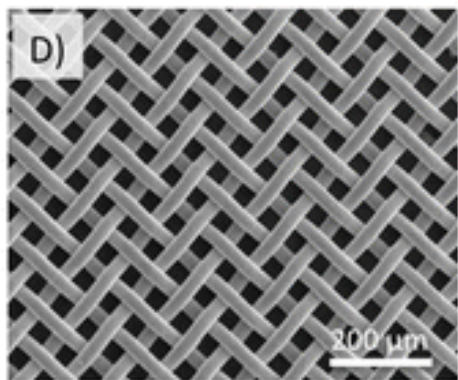


Superhydrophobic poly(StMA)



Superoleophobic poly(MAA)





The mesh resists the flow of phase 1 through the mesh if θ_A is $>90^\circ$.

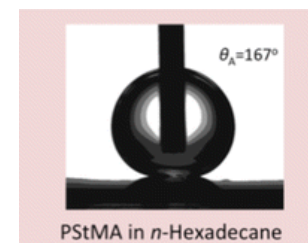
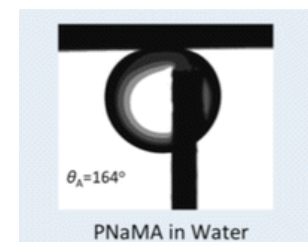
Intrusion pressure

$$P = \frac{4\gamma \cos(180^\circ - \theta_A)}{\phi}$$

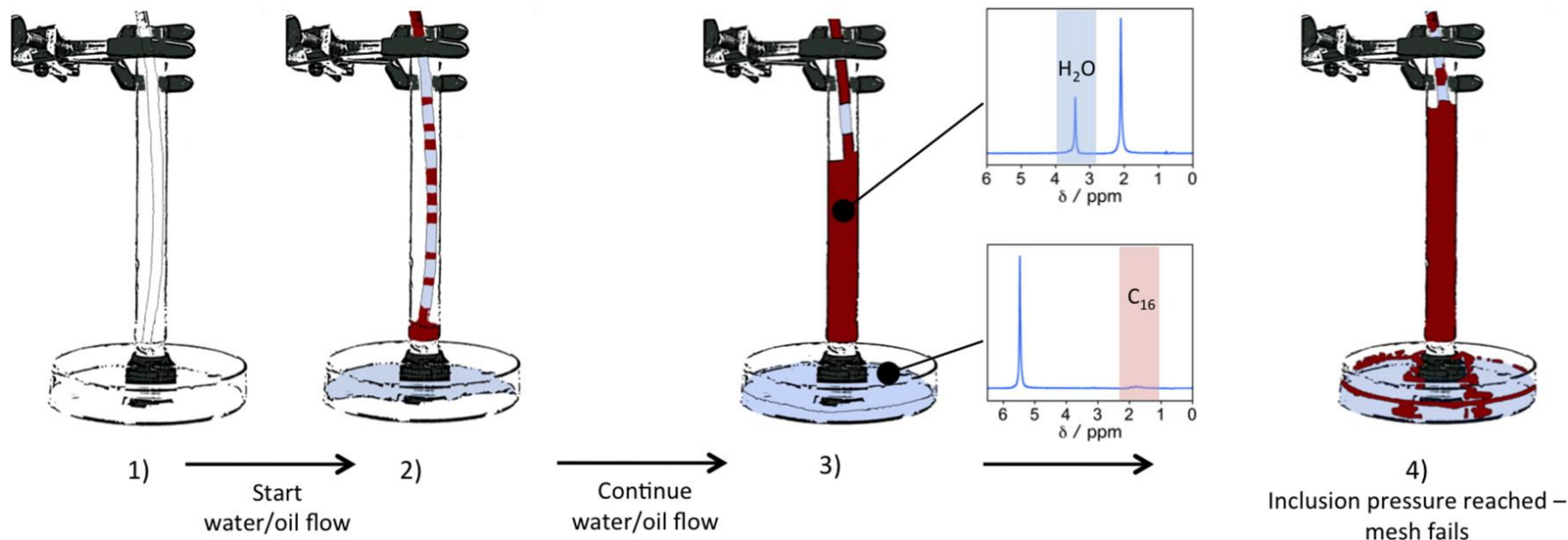
$\gamma \cos \theta$ - interfacial tension and contact angle
 f - diameter of hole

To prevent oil passing through => large Oil-in-Water θ_A
“hydrophilic surface”

To prevent water passing through => large Water-in-Oil θ_A
“hydrophobic surface”



Can the Oil-Water separation meshes be used in a continuous process rather than a batch process?



Problems:

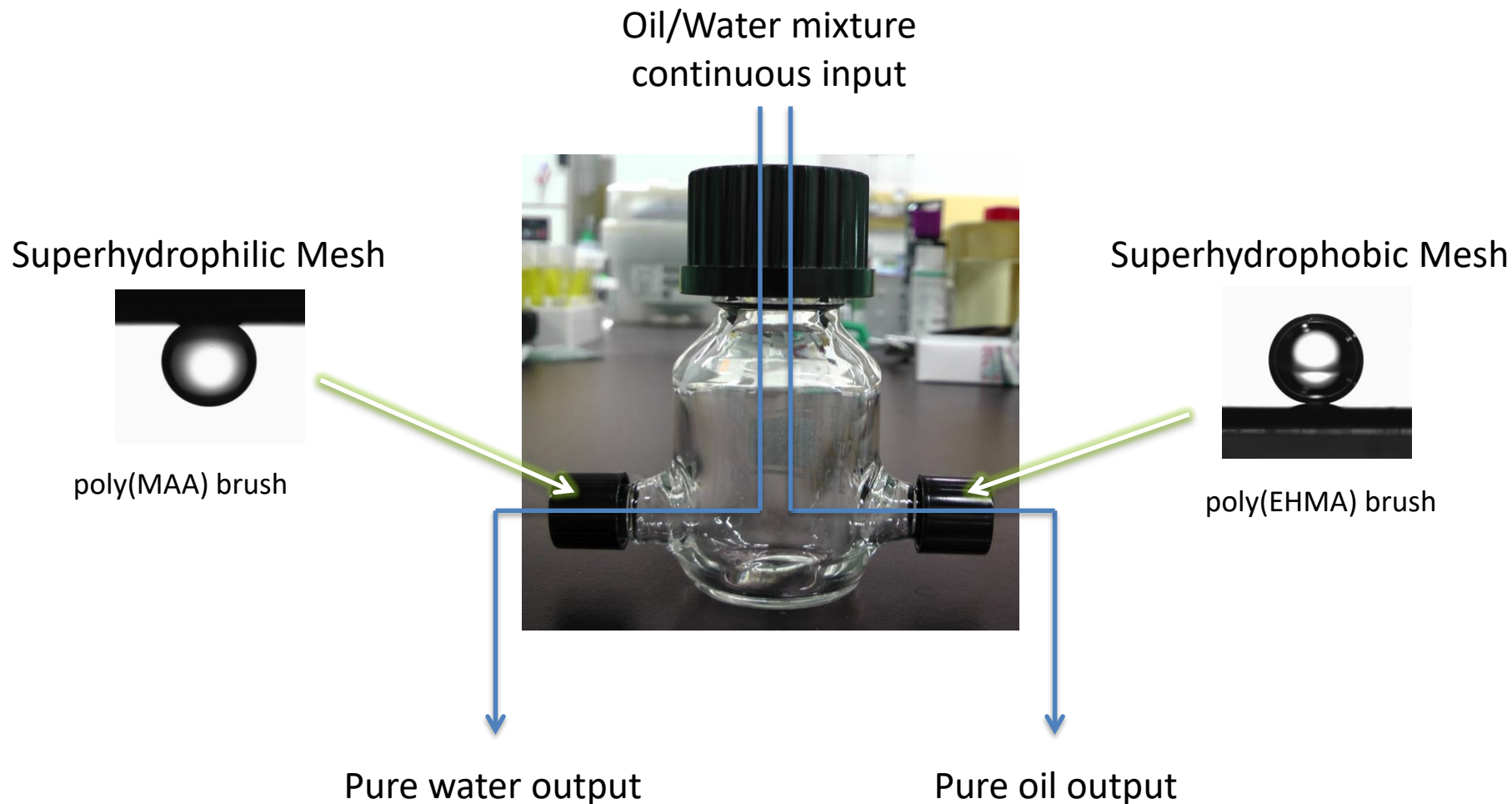
- 1) Oil is not purified
- 2) Cannot be used in a continuous process

$$h\rho g = P = \frac{4\gamma \cos(180^\circ - \theta_A)}{\phi}$$

h – height of liquid

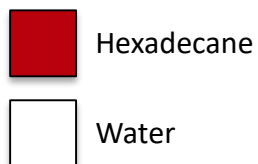
ρ – density

g – gravity



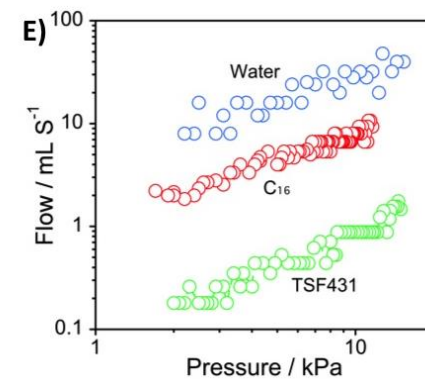
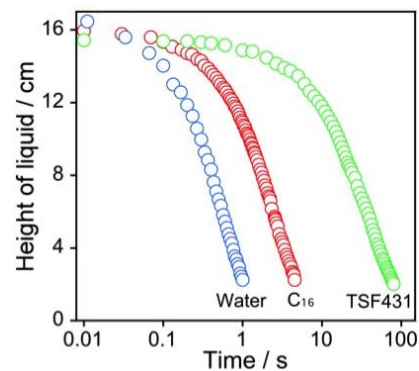
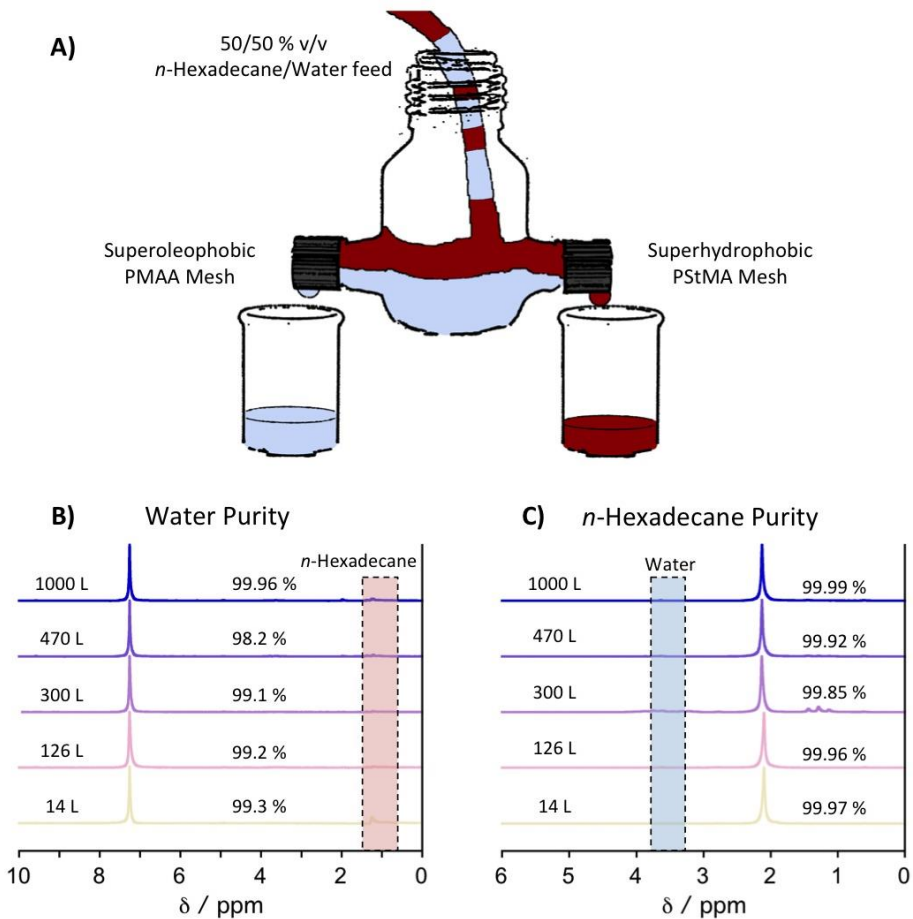
- Prevents the accumulation of liquid above the meshes
- Purifies both phases

~50:50 water/hexadecane pumped in



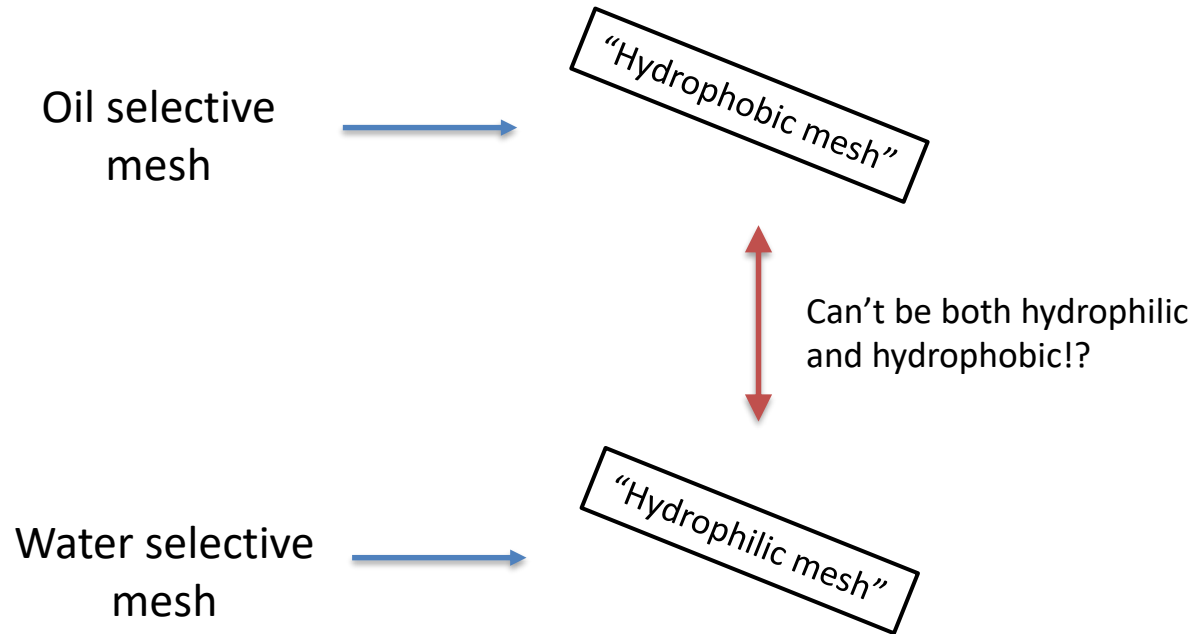
Hydrophilic mesh

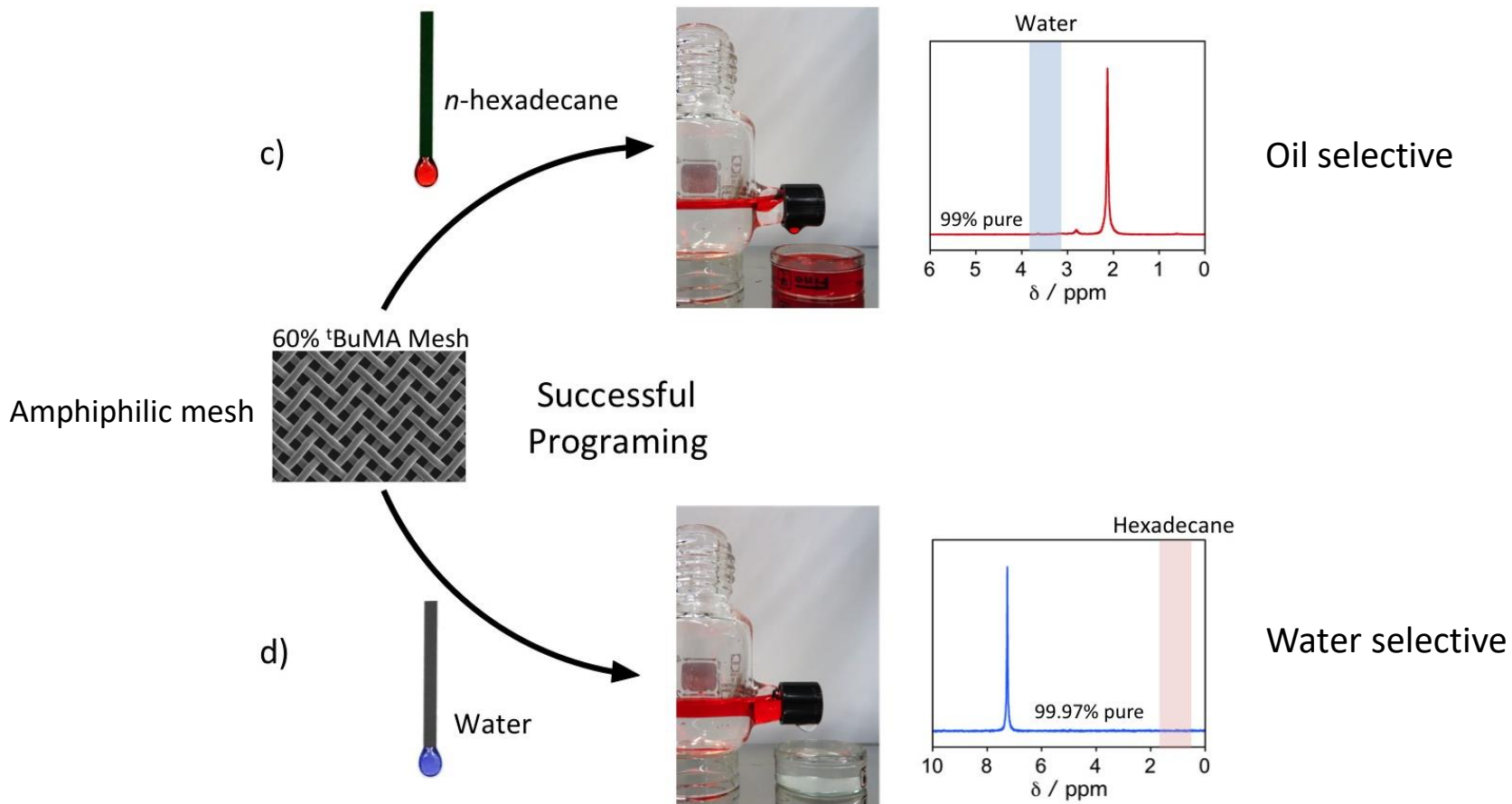
Oleophilic mesh



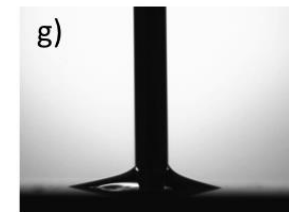
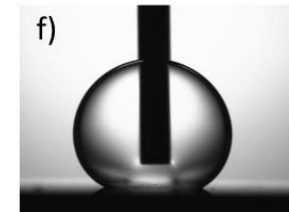
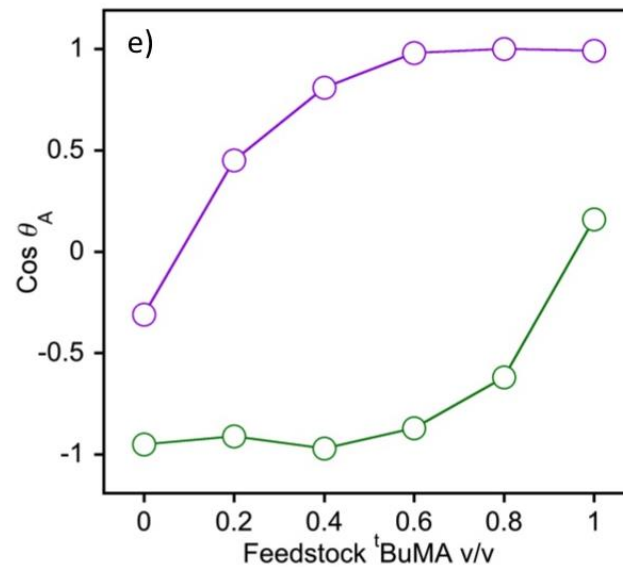
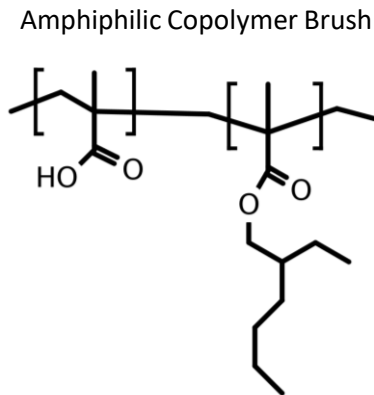
Good flow rates even at low pressures
- gravity feed

Purity of phases measured by NMR

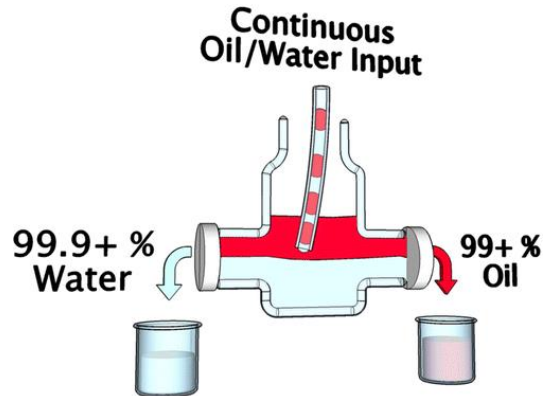




Programming can be achieved using an amphiphilic surface



Lots of Contact Angle Hysteresis

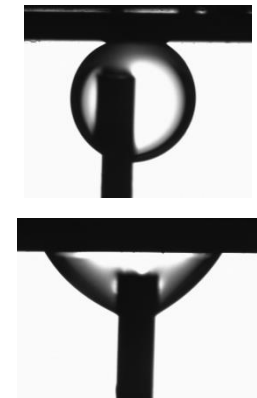


1) Oil-Water separation meshes need to be used in pairs

- Otherwise pressure builds up causing failure of mesh
- Can separate large volumes of oily water

2) The concept of “hydrophobic / hydrophilic” is misleading

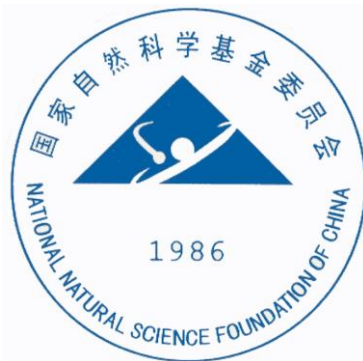
- The important parameter is the relevant advancing contact angle
- Meshes can be programmed by pre-wetting



Thanks to



Dr. O.O. Mykhaylyk
Prof. AJ Ryan



Dr. A. Hozumi
Dr. C. Urata