

Where there's muck there's brass

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Life is mucky



How much soap?

UK estimate

37% of households own a dishwasher

9 million appliances

6.5-20 litres per wash

60,000-180,000 tonnes of water per day

UK uses ~50,000 tonnes of dishwasher powder per year

UK uses ~100,000 tonnes of hand wash liquid

The challenge : green cleaning

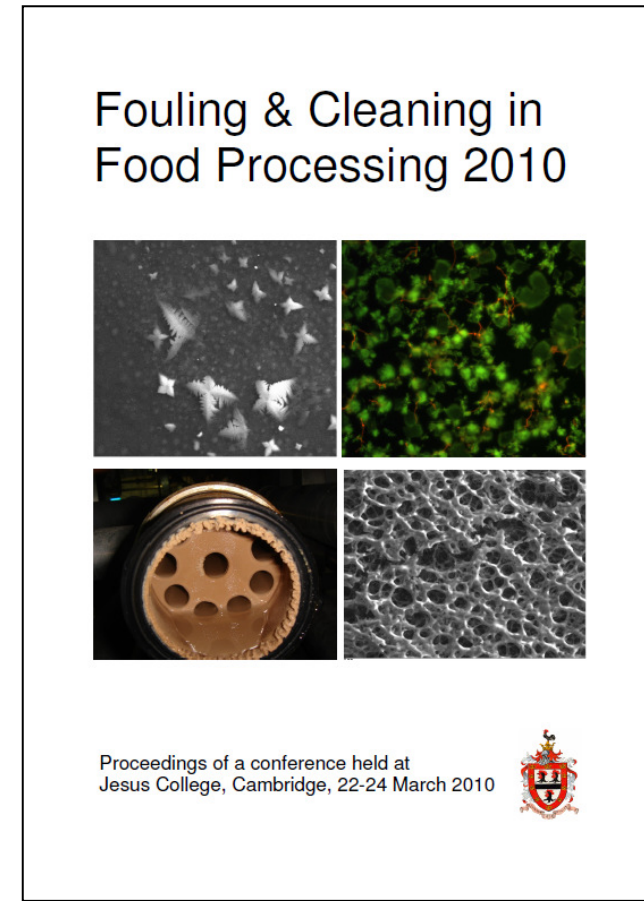
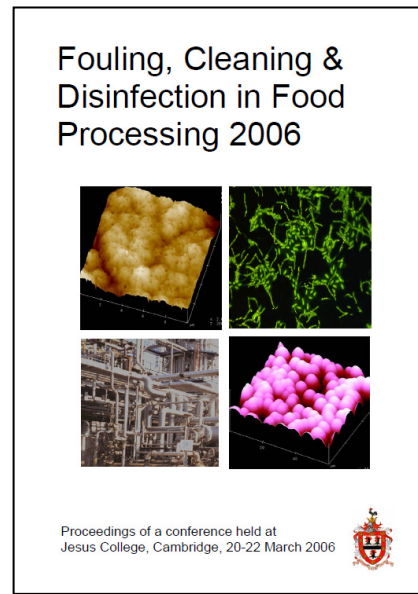
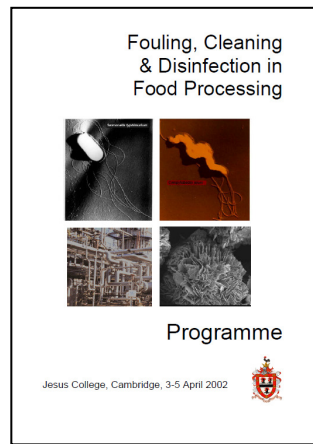
Cleaning uses large amounts of
chemicals
solvents
energy

How do we reduce these costs and environmental impacts?

cleverer chemicals
water
low temperature – other forms of energy

An ongoing challenge

1989 ... 1994, 1998, 2002, 2006, 2010...



‘What is Clean?’

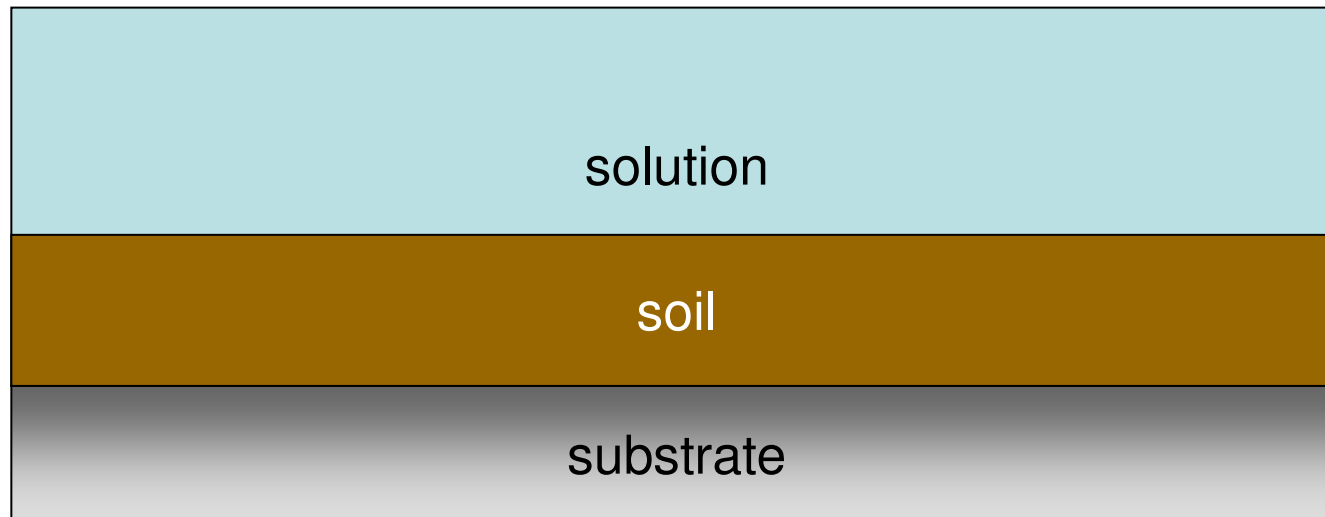
adj, free from dirt or contaminating matter, unsoiled

- Process efficiency returned
- Product contaminant free
- No microbial survival
- Optically clean
- No microbial growth or spores : micro-clean
- Nutrient clean
- Nano-clean : no salts or films

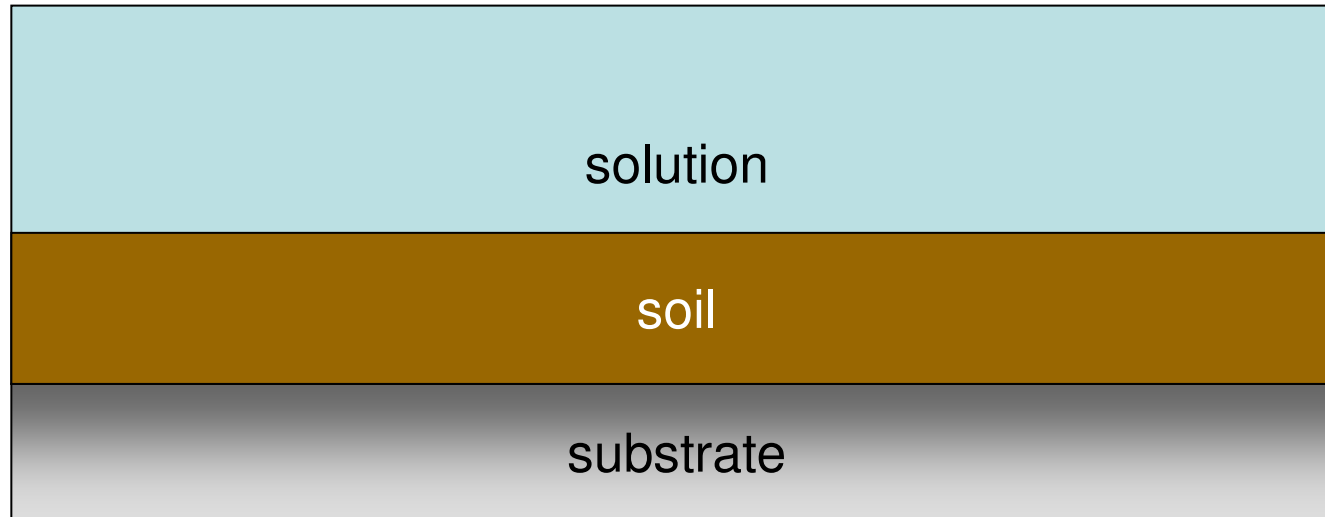


© DI Wilson, 1997

Cleaning science: surfaces & interfaces



Cleaning method (1): thermodynamics



Dissolution

How?

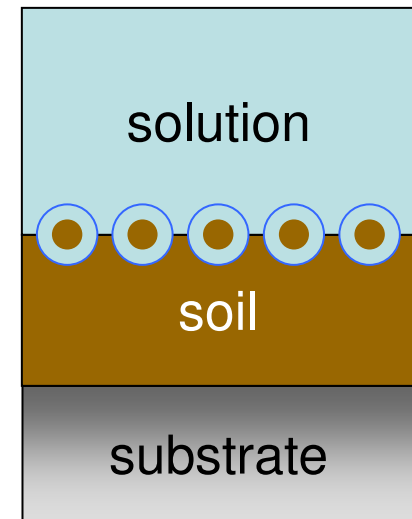
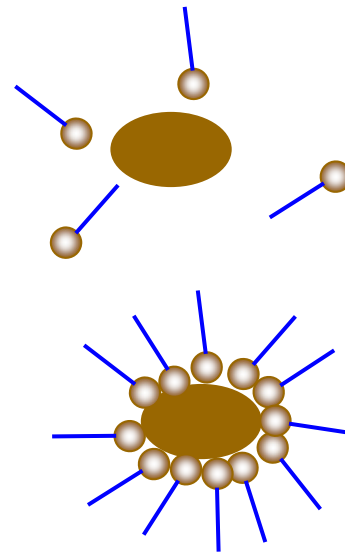
Can't change the soil
Substrate?

Solvents : oxygen dihydride?

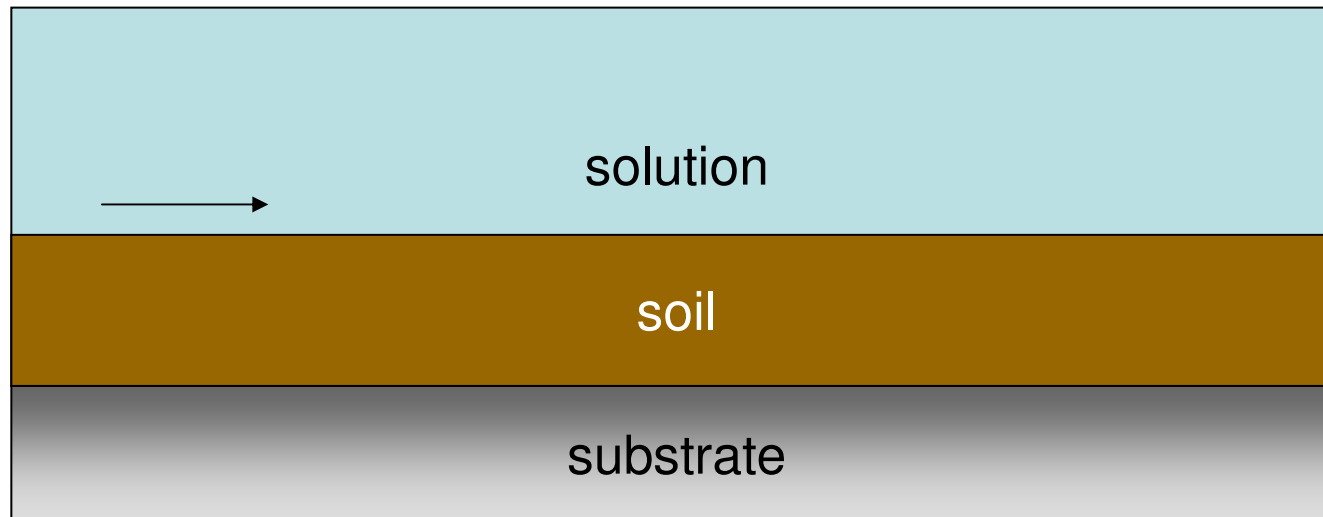
Can change the temperature

Energy

Clever chemicals - surfactants

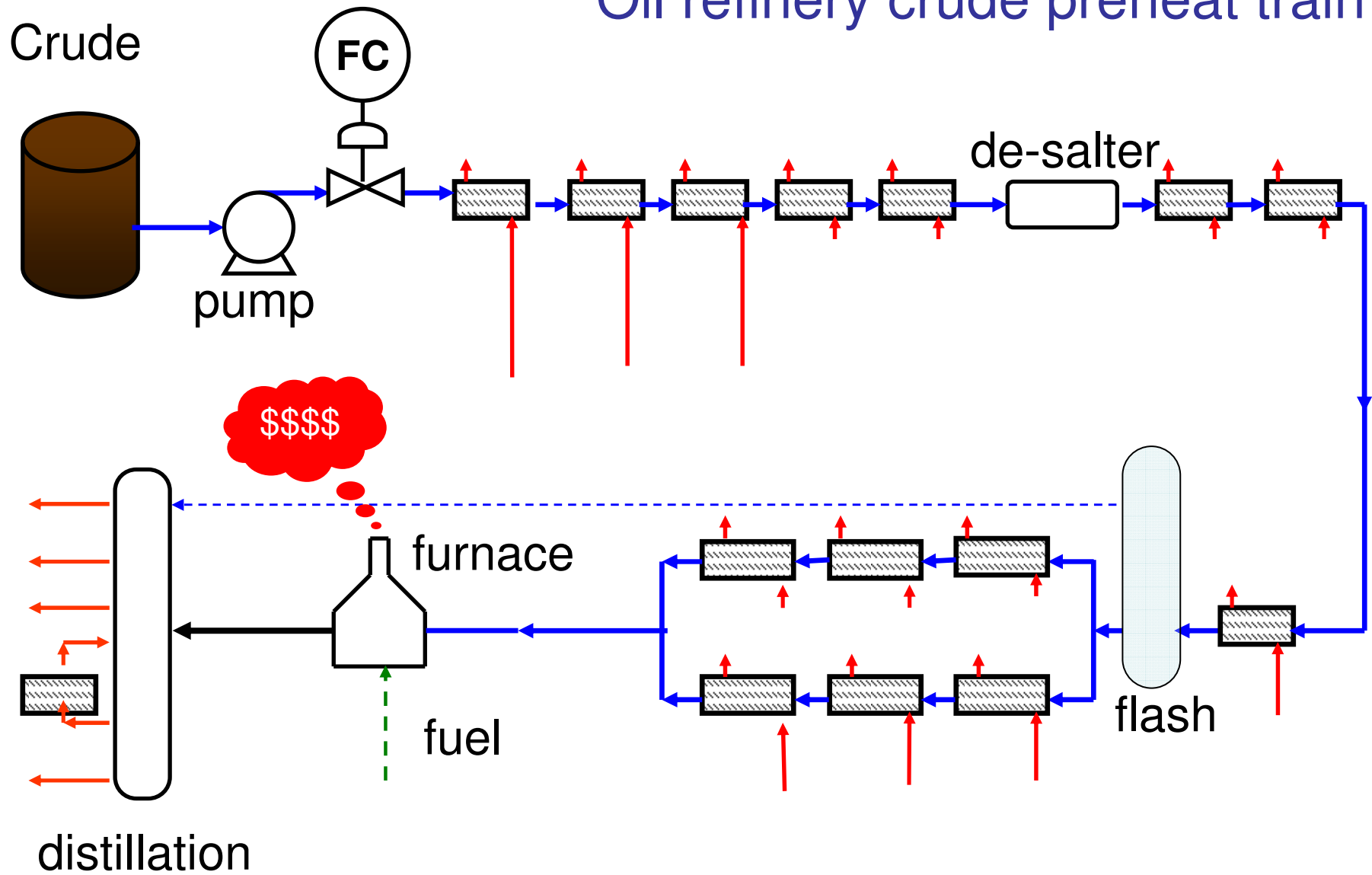


Cleaning method (2): erosion



2nd Law of Thermodynamics : Tha don't get owt for nowt!

Oil refinery crude preheat train



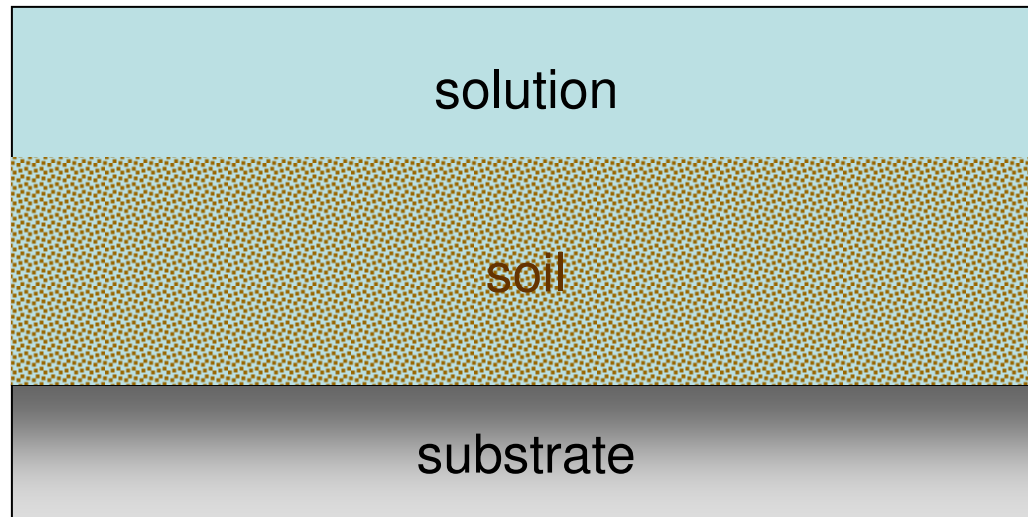
Thinking outside the little box..

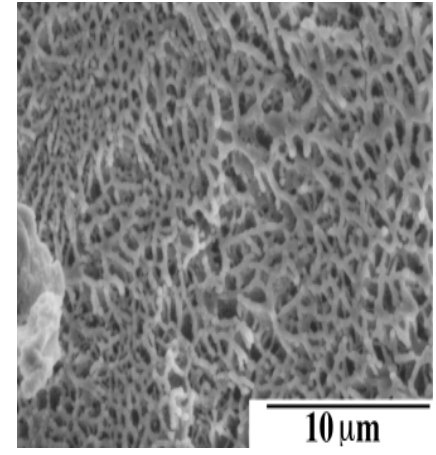
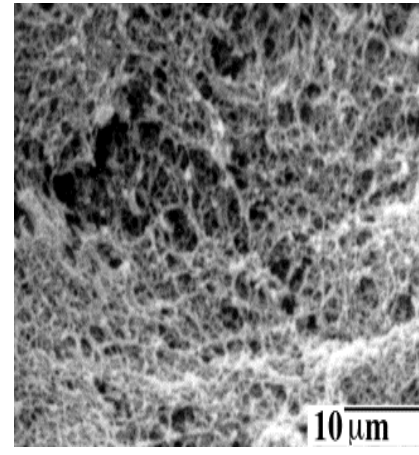
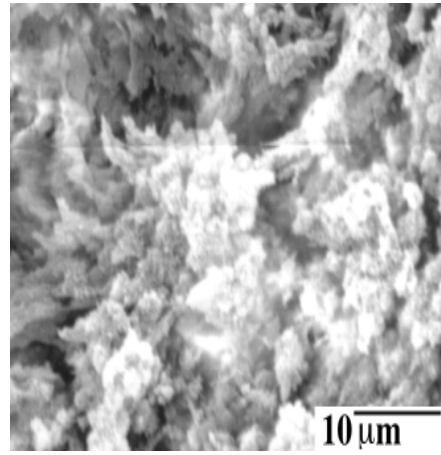
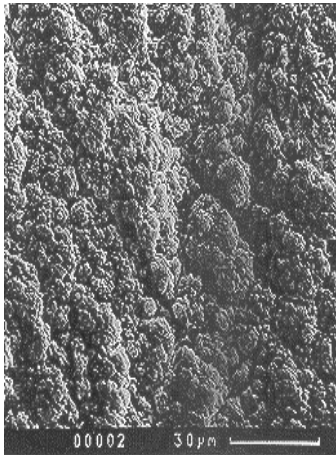
Ultrasonic cleaning of heat exchangers

Tech Sonic Solutions, Canada

Promoting erosion

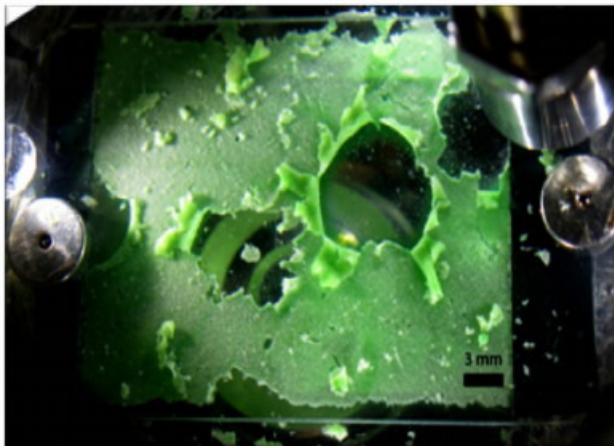
Break down the soil.. make it weaker



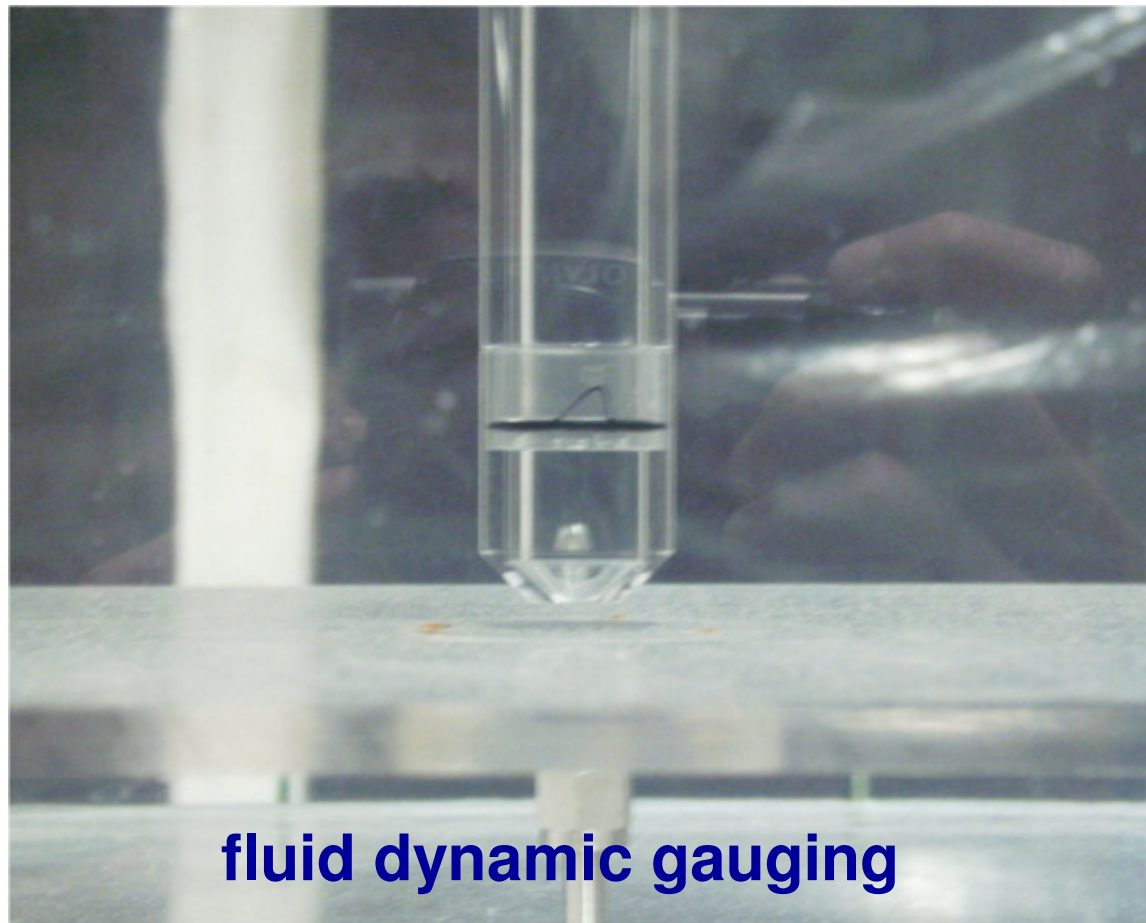


The soft tissue issue

How do you measure soft layers
immersed in liquid
in situ
in real time
inexpensively
?

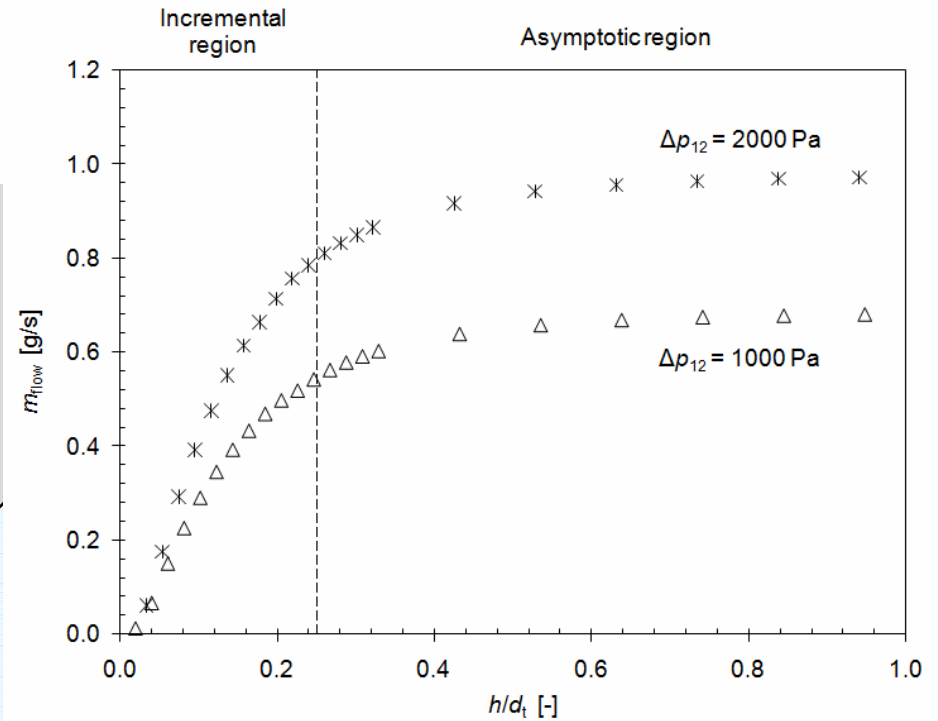
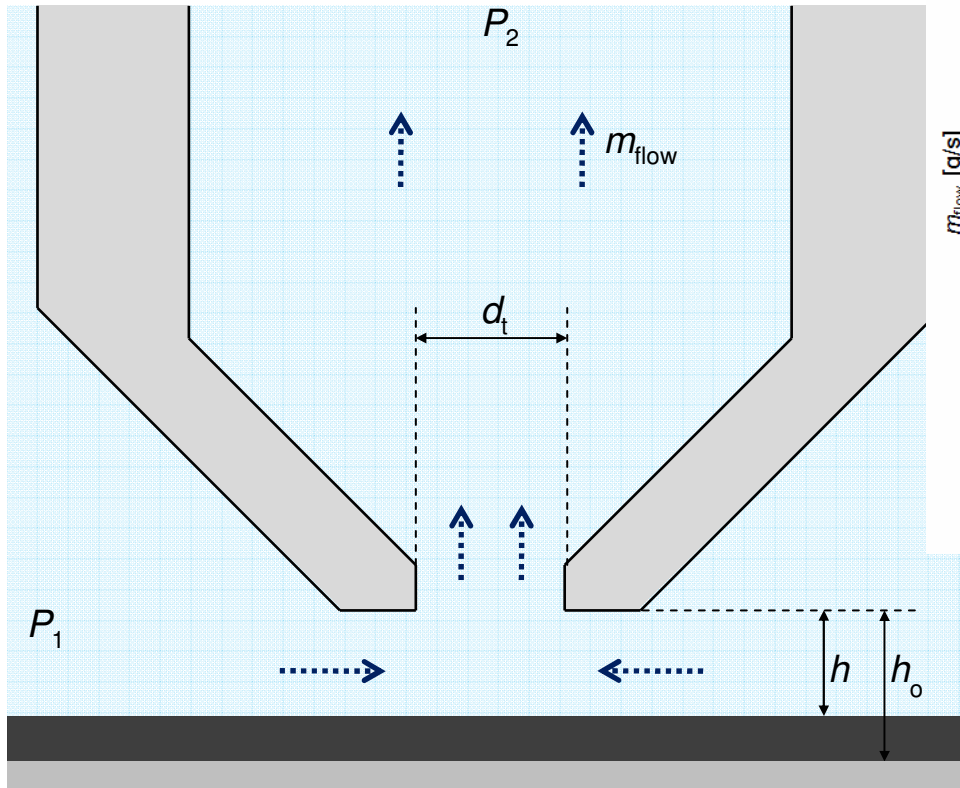


our way..



fluid dynamic gauging

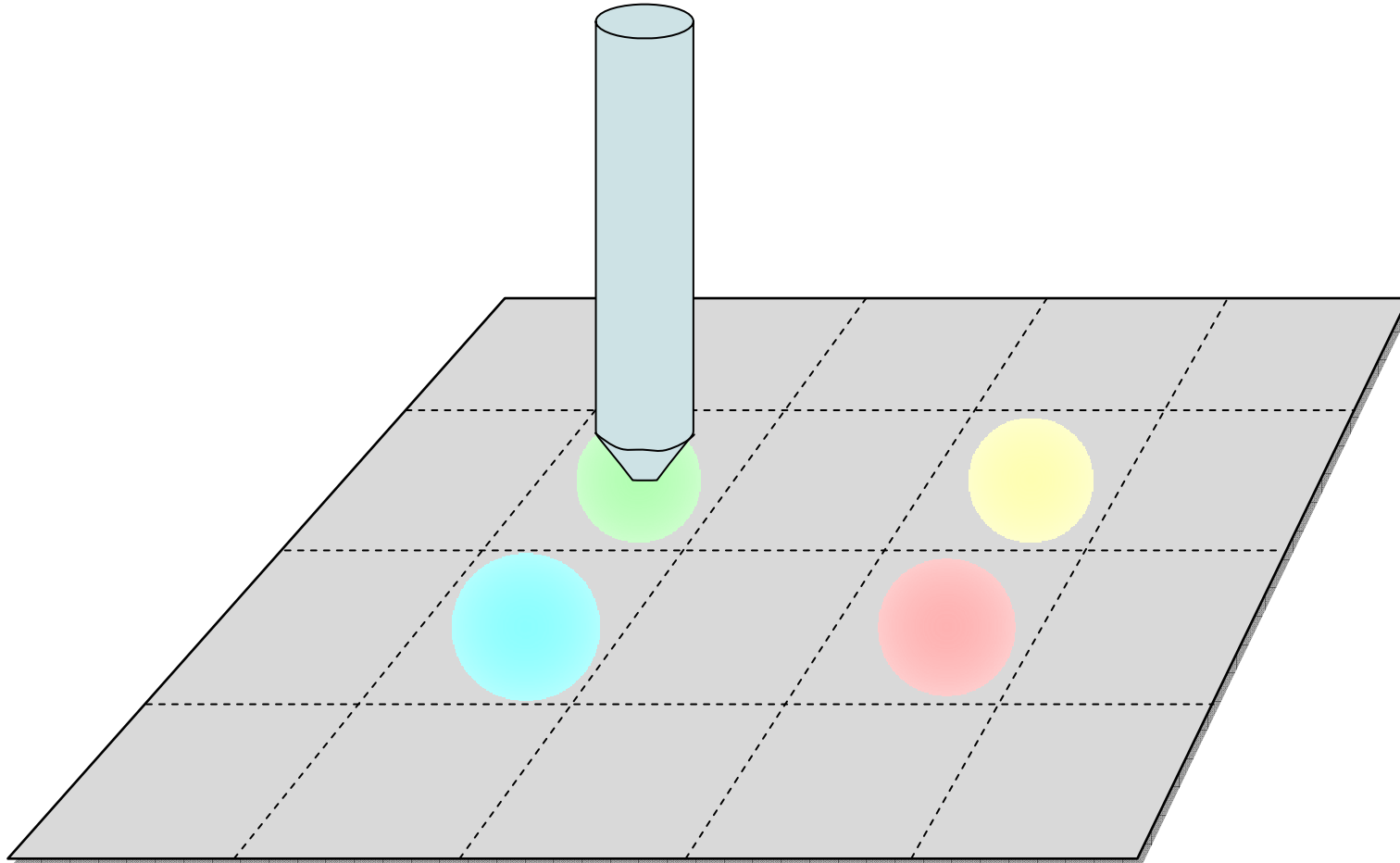
FDG

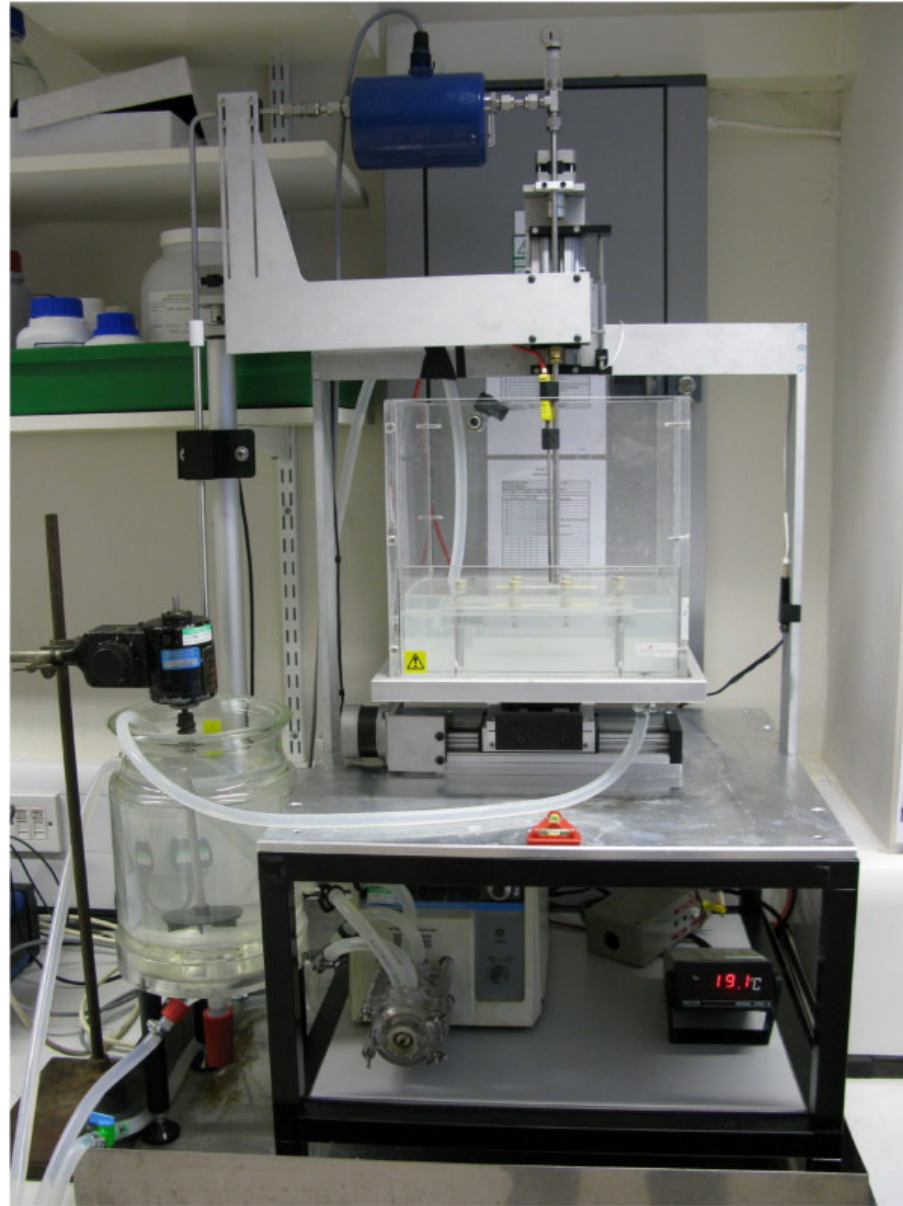


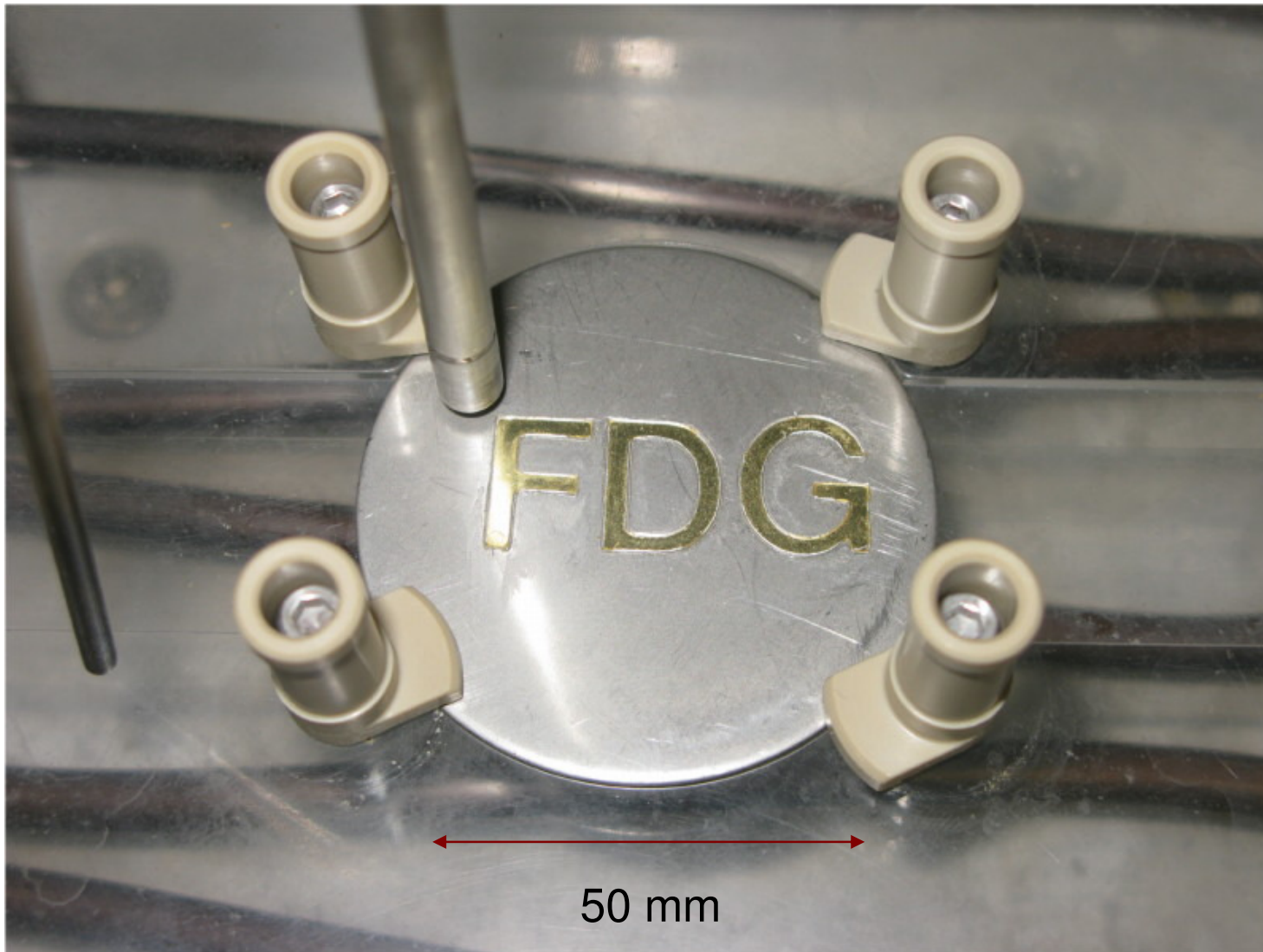
$$\delta = h_0 - h$$

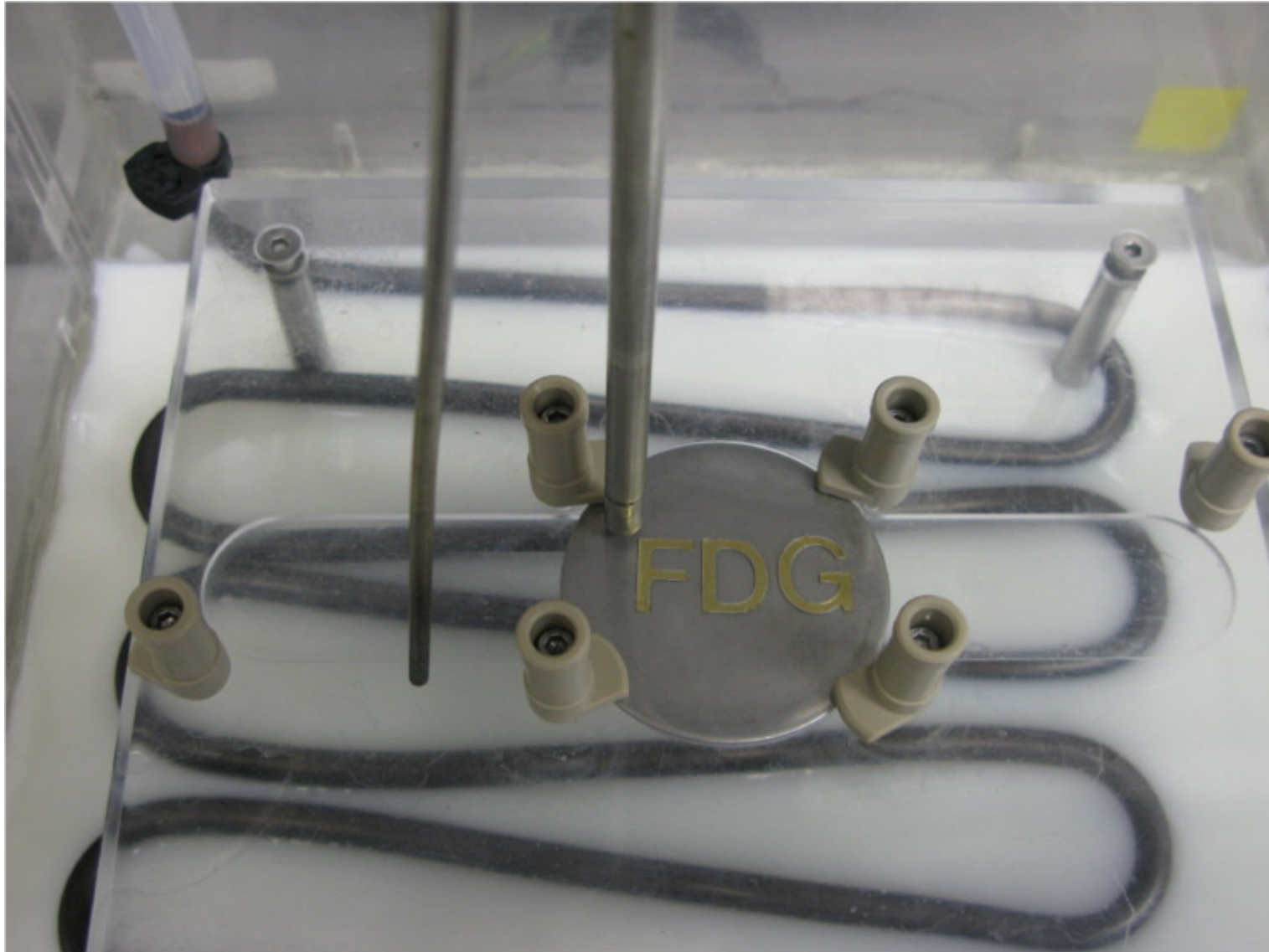
- FDG can measure:
 - Soft deposit **thickness** and **strength**
 - In **real time**, **in situ**, during a cleaning process

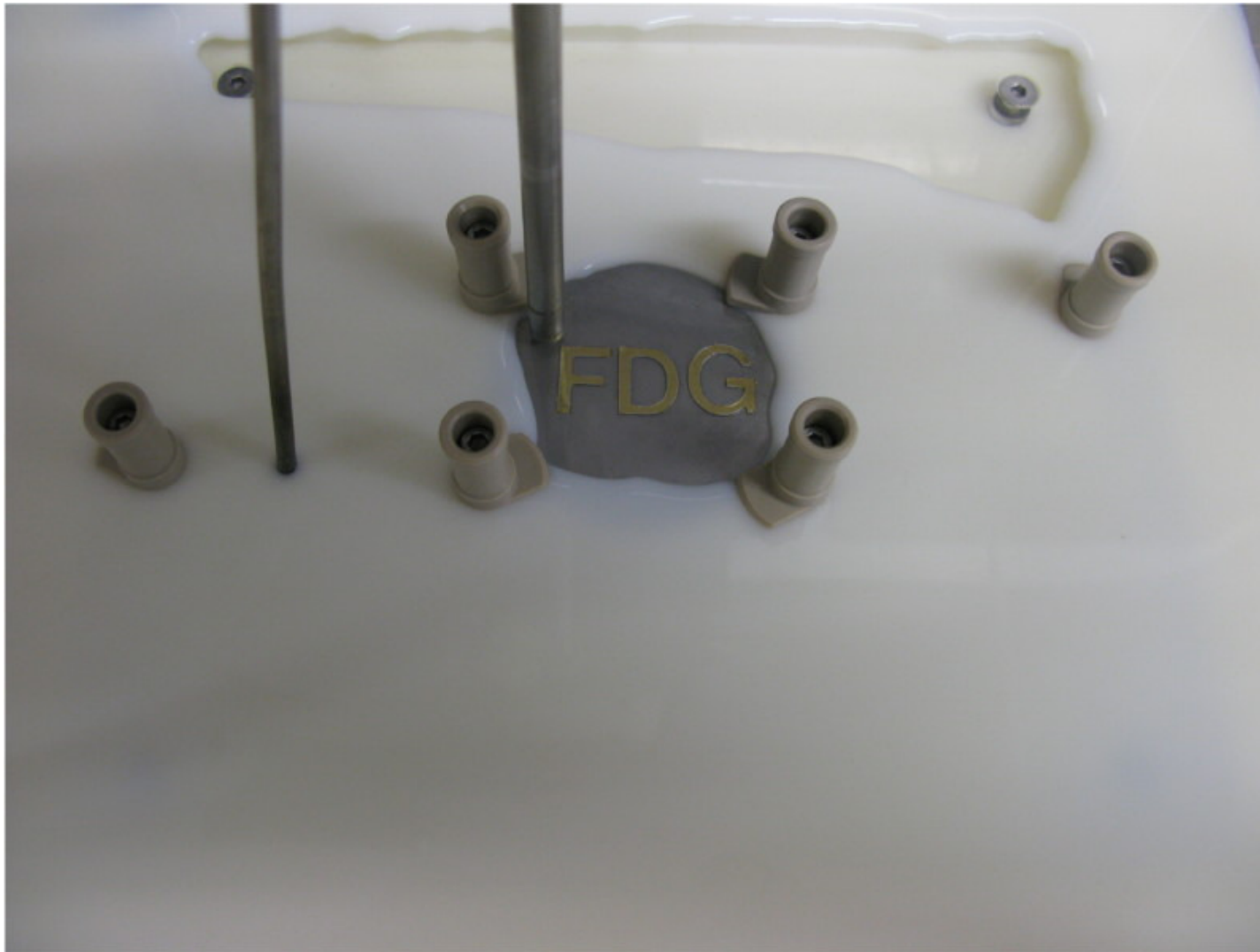
FDG today : scanning, ± 5 micron



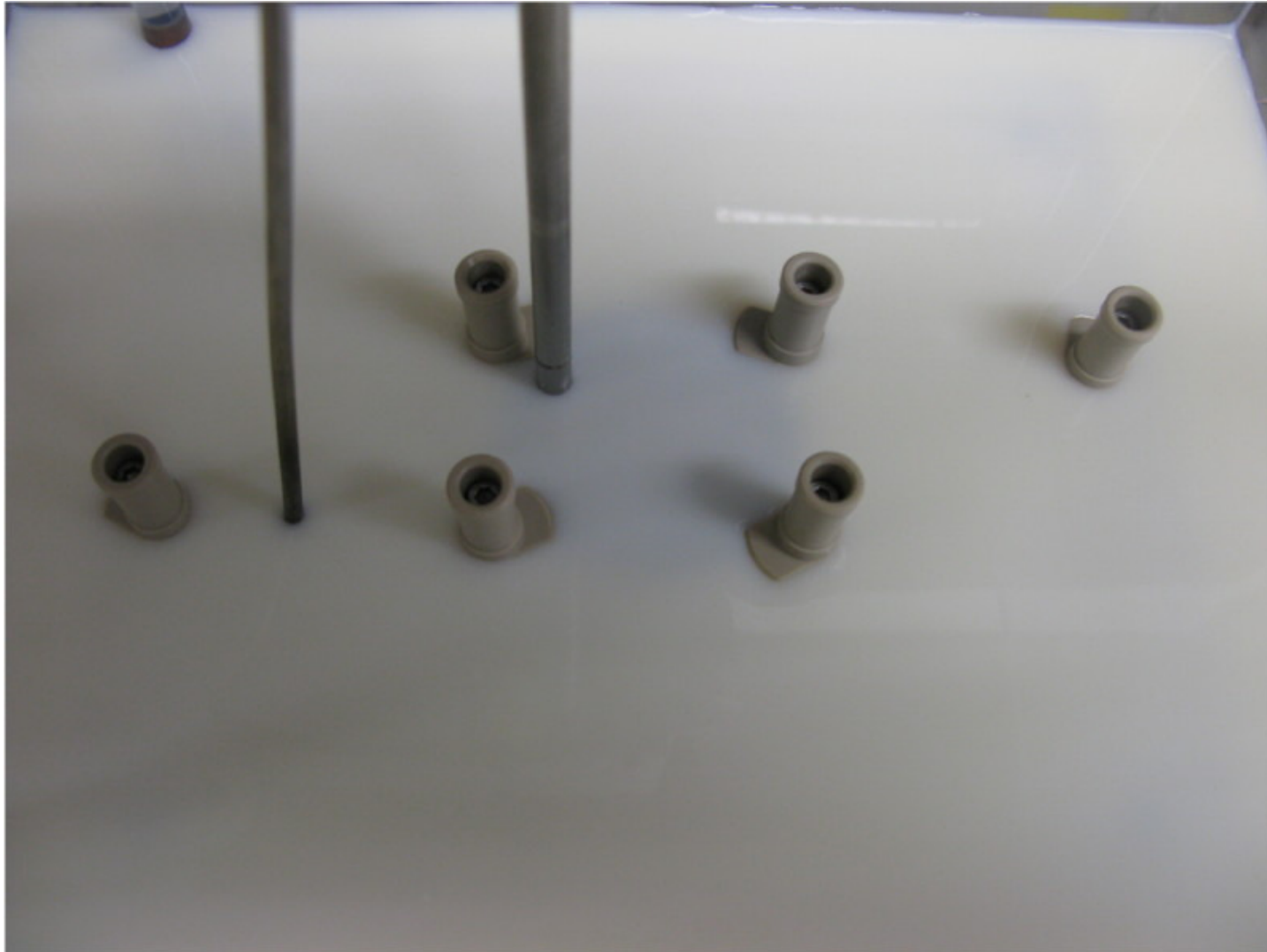


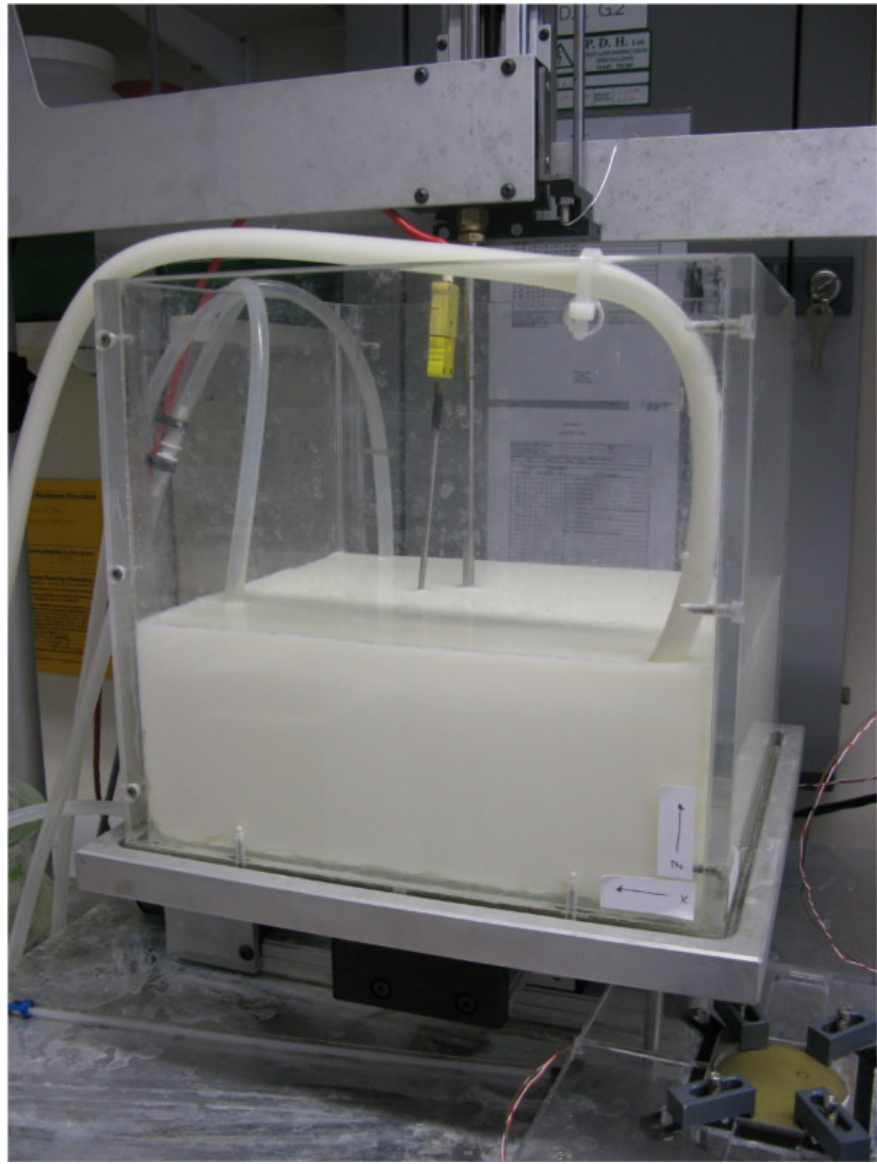


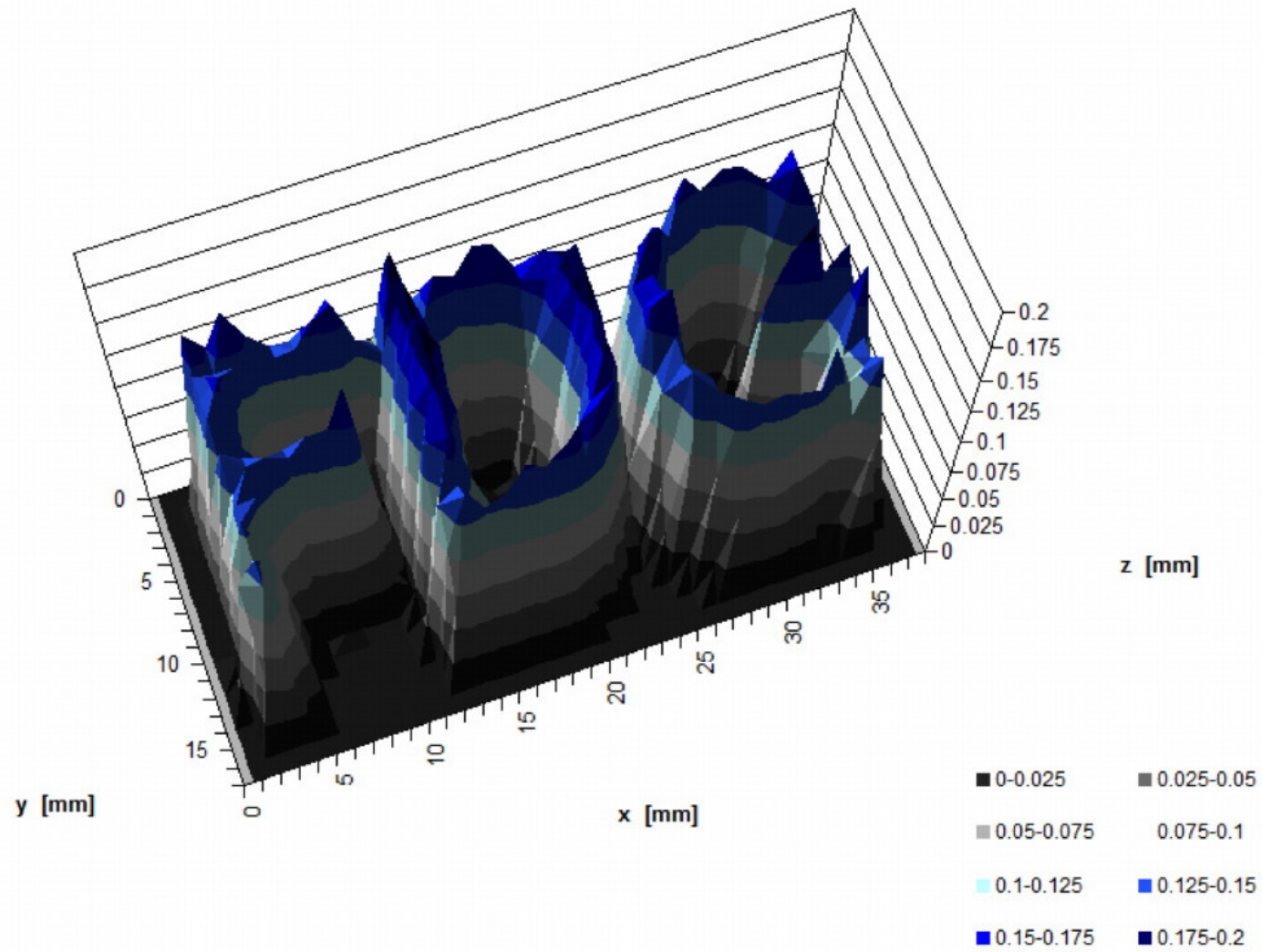




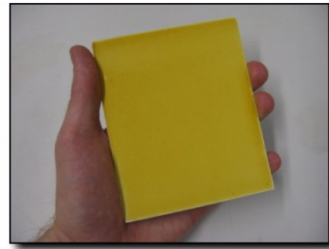




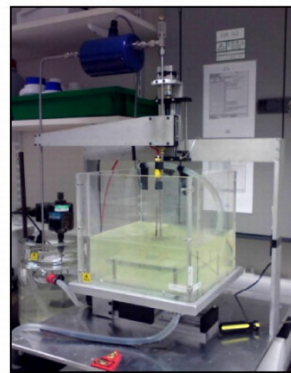
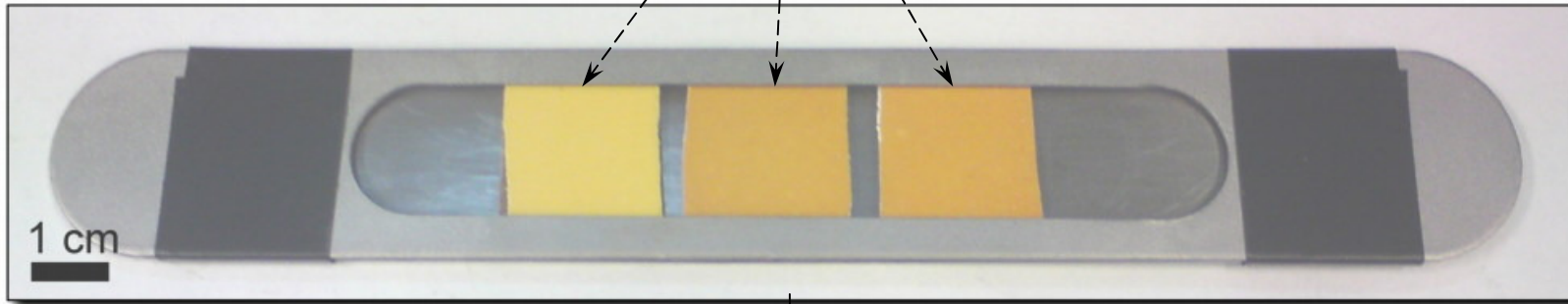
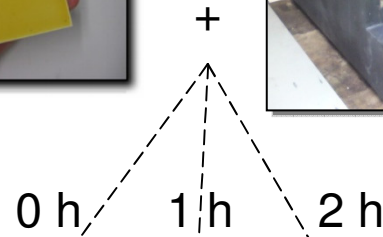




Back to cleaning

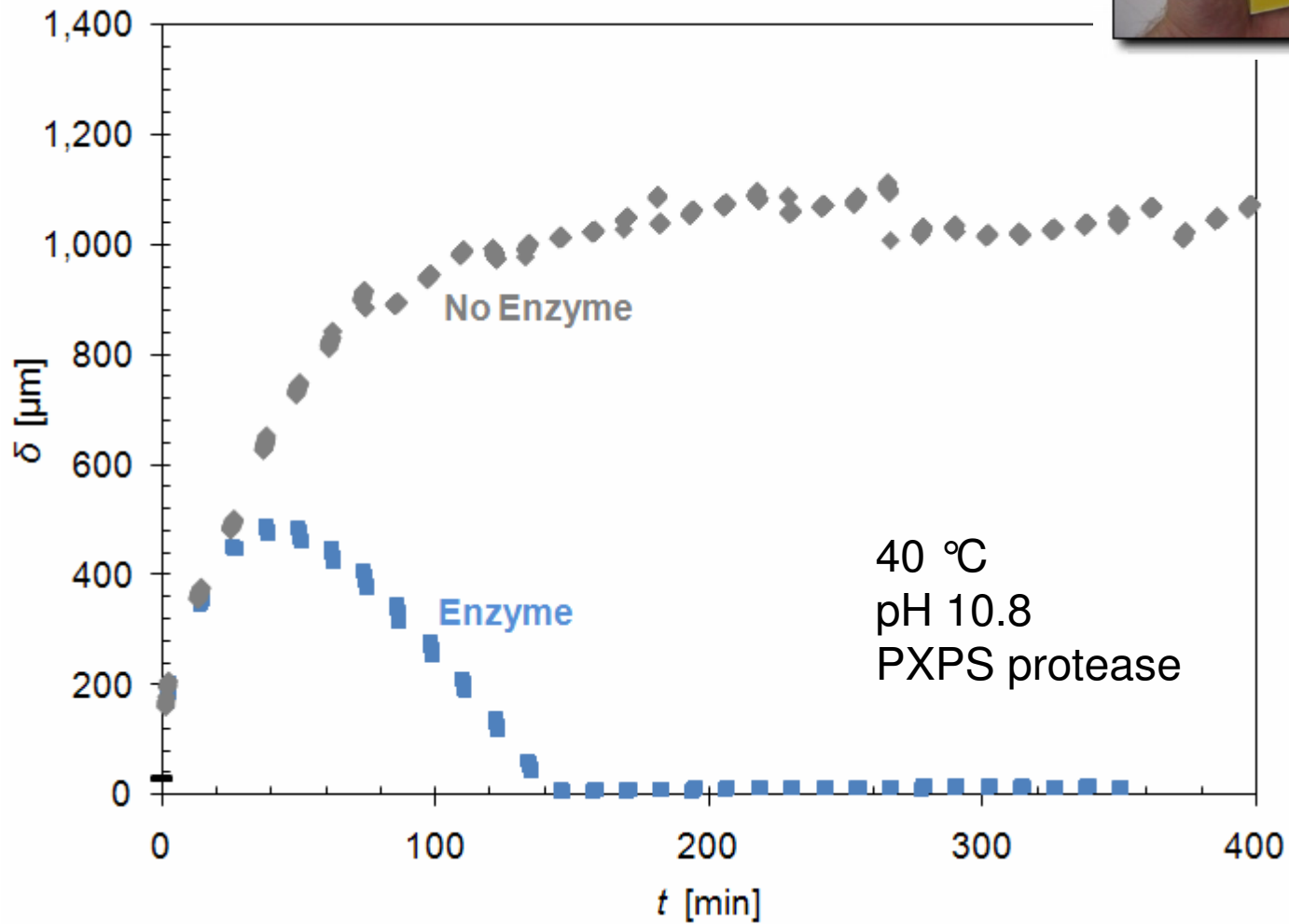


150 °C

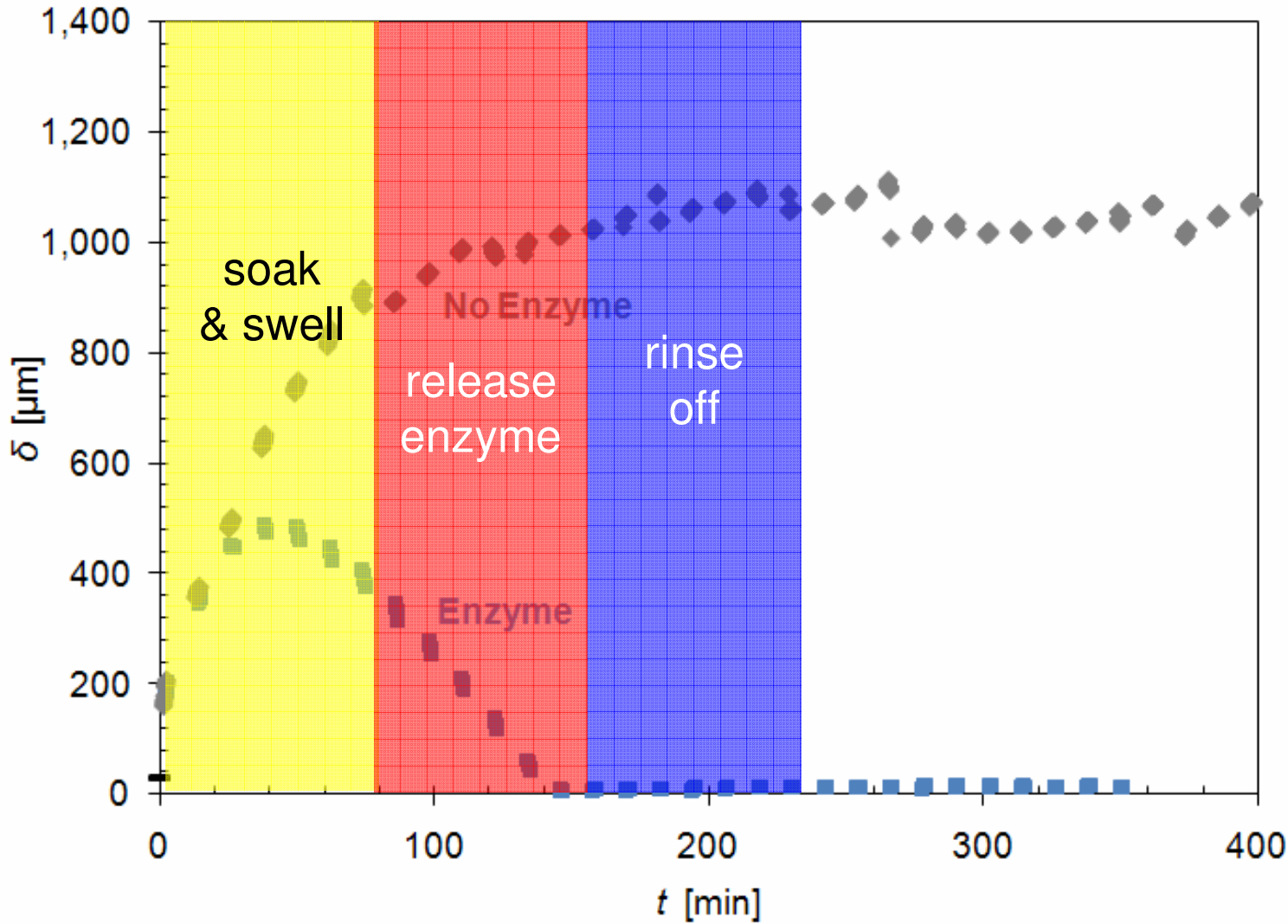


40 °C
buffer solution pH 10.8
protease

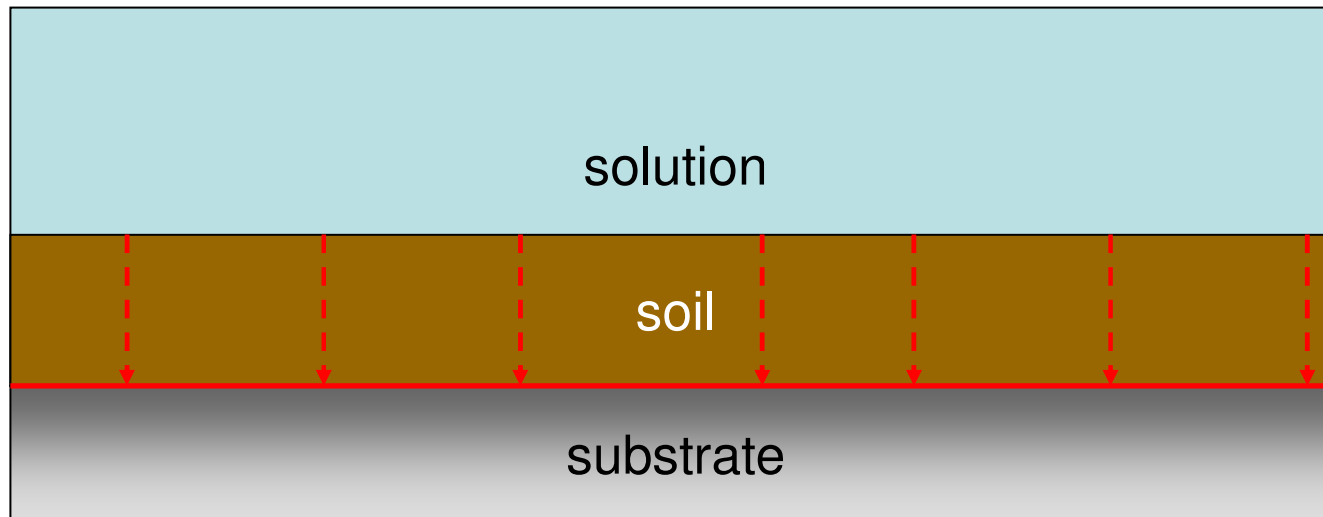
unbaked egg yolk



Design detergents



Cleaning method (3): rejection



- .. change adhesion to substrate
 - .. diffusion through a swelling matrix
 - ... surface energies

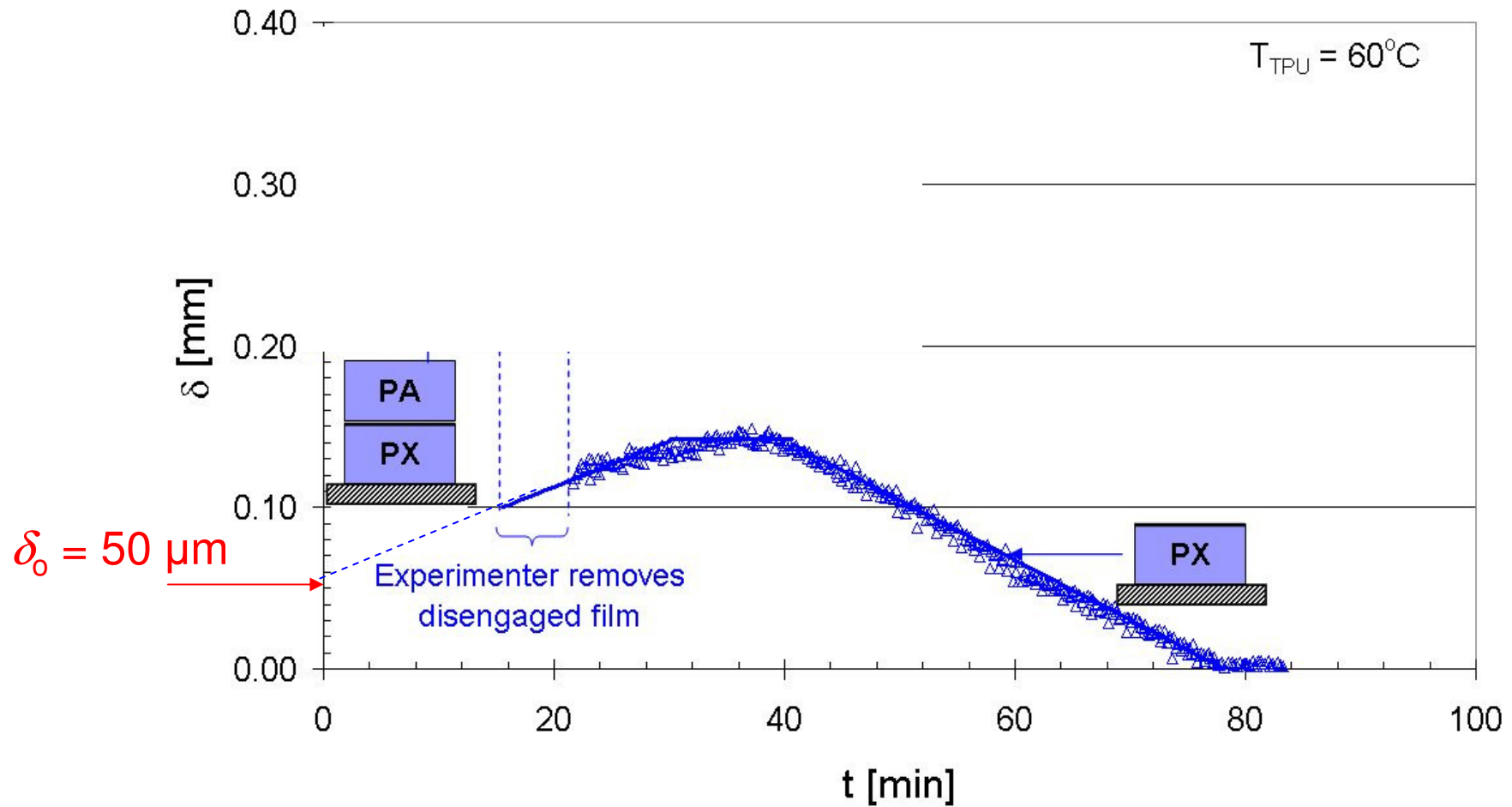
Cleaning polymerisation reactors



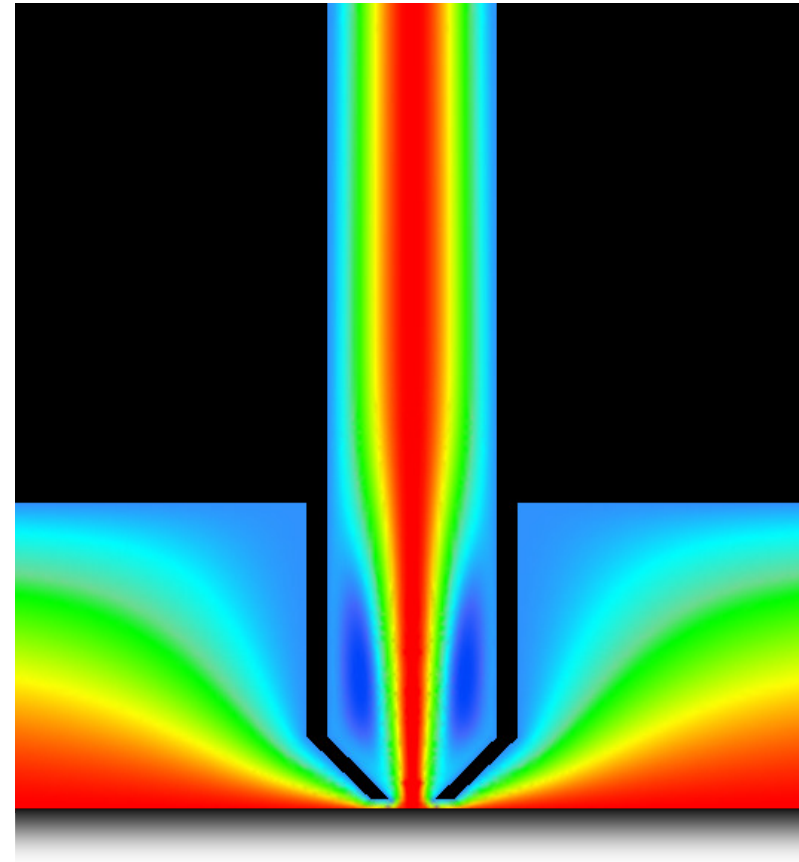
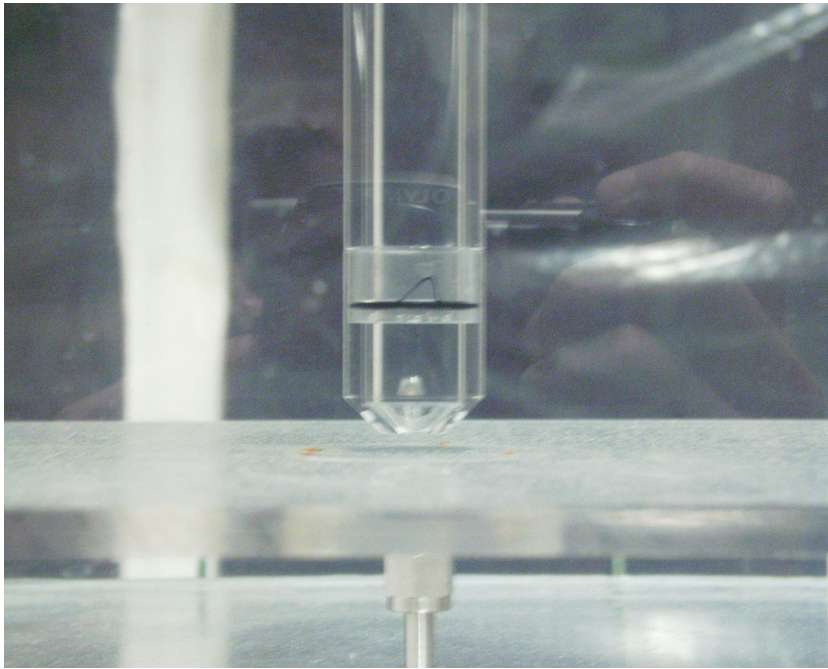
© John Chew (2005)

Aim: replace methylethylketone (MEK) with aqueous cleaners

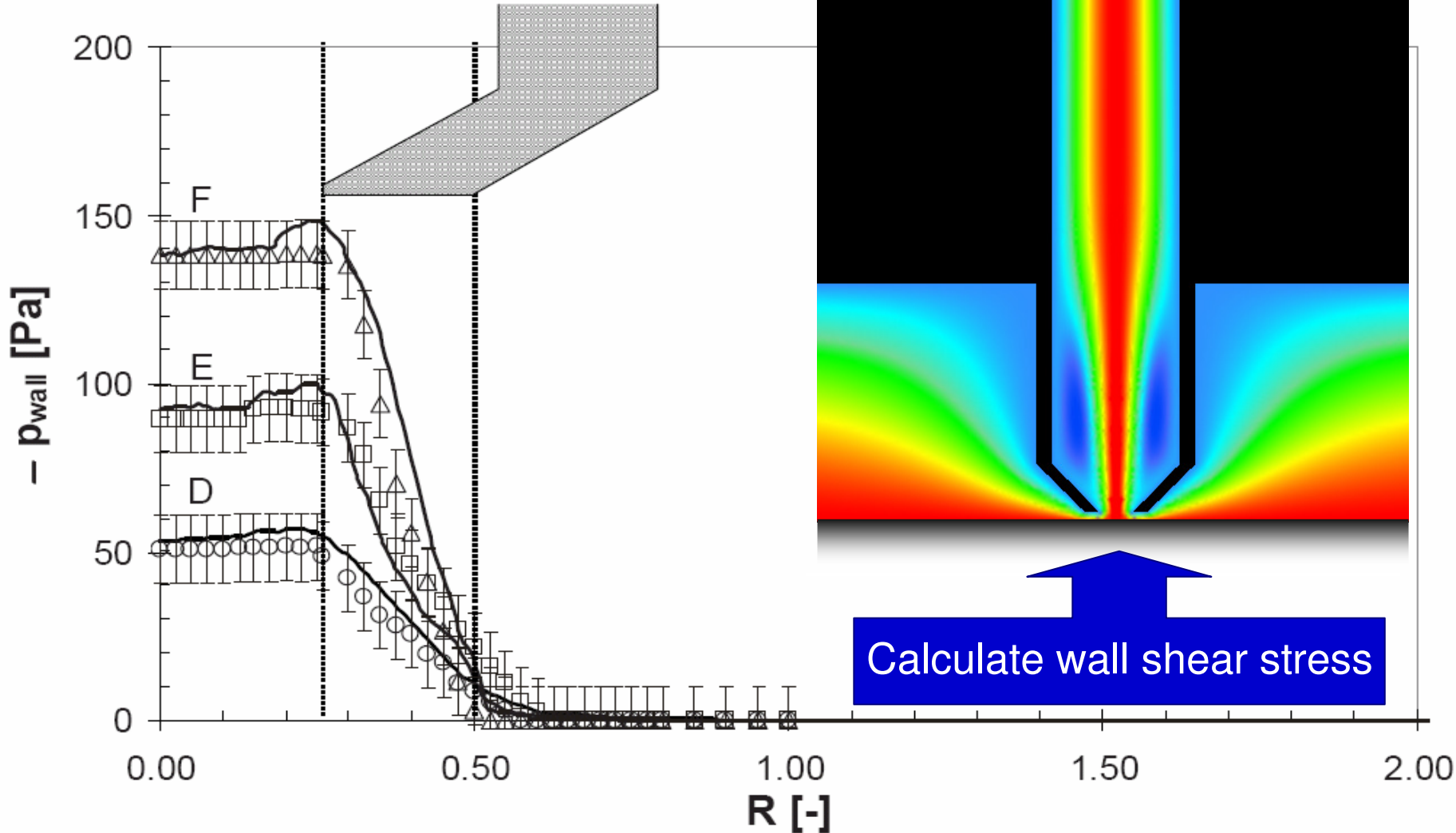
Products PX and PA



Simulating liquid flow

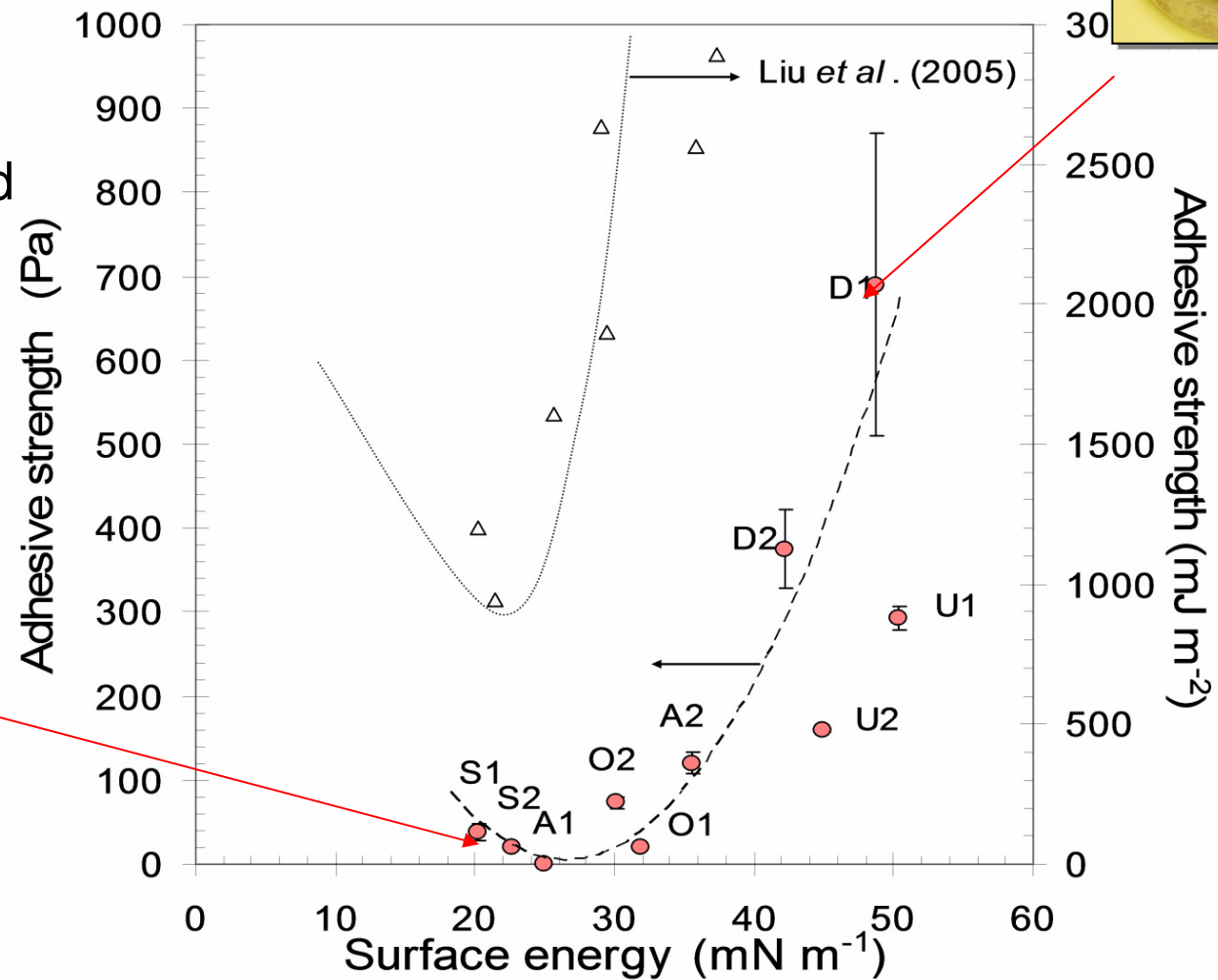
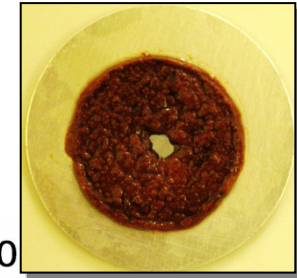
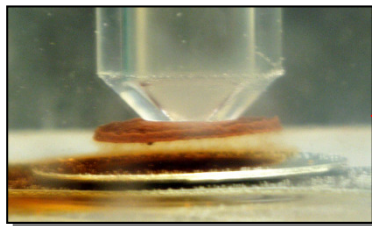


Simulating liquid flow

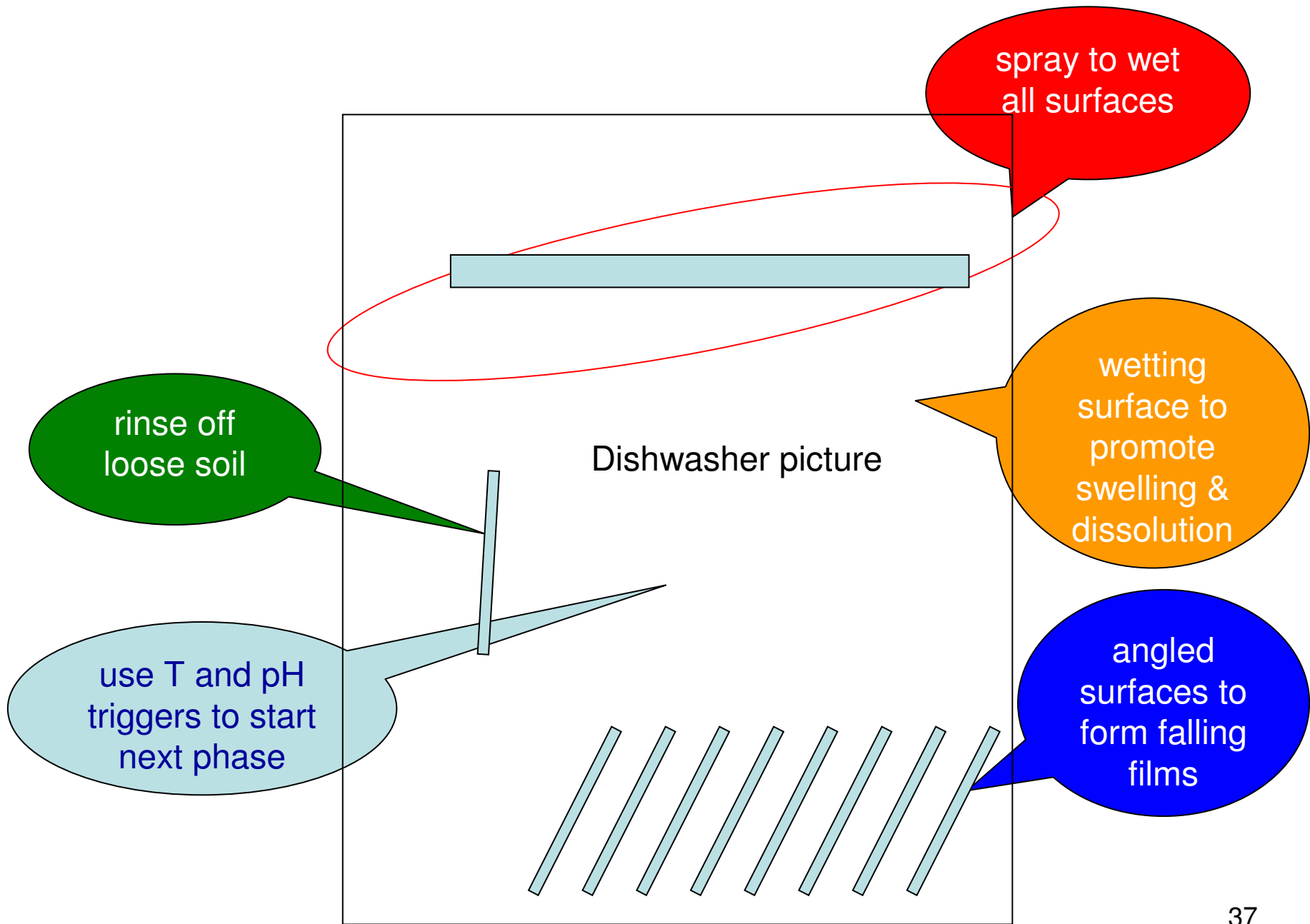


Surface Treatment

Tomato paste layers on treated stainless steels



www.youtube.com/watch?v=Nt7utFNisil



Closing remarks

There is a lot of cleaning going on

'Clean' means different things to different people

There is more than one way to clean

Cleaning is a truly interdisciplinary subject

You can be green and clean!

the 'Muckers'



the Craftsmen: Andy Hubbard and Surinder Sall

P&G – Dave York & Anju Brooker

