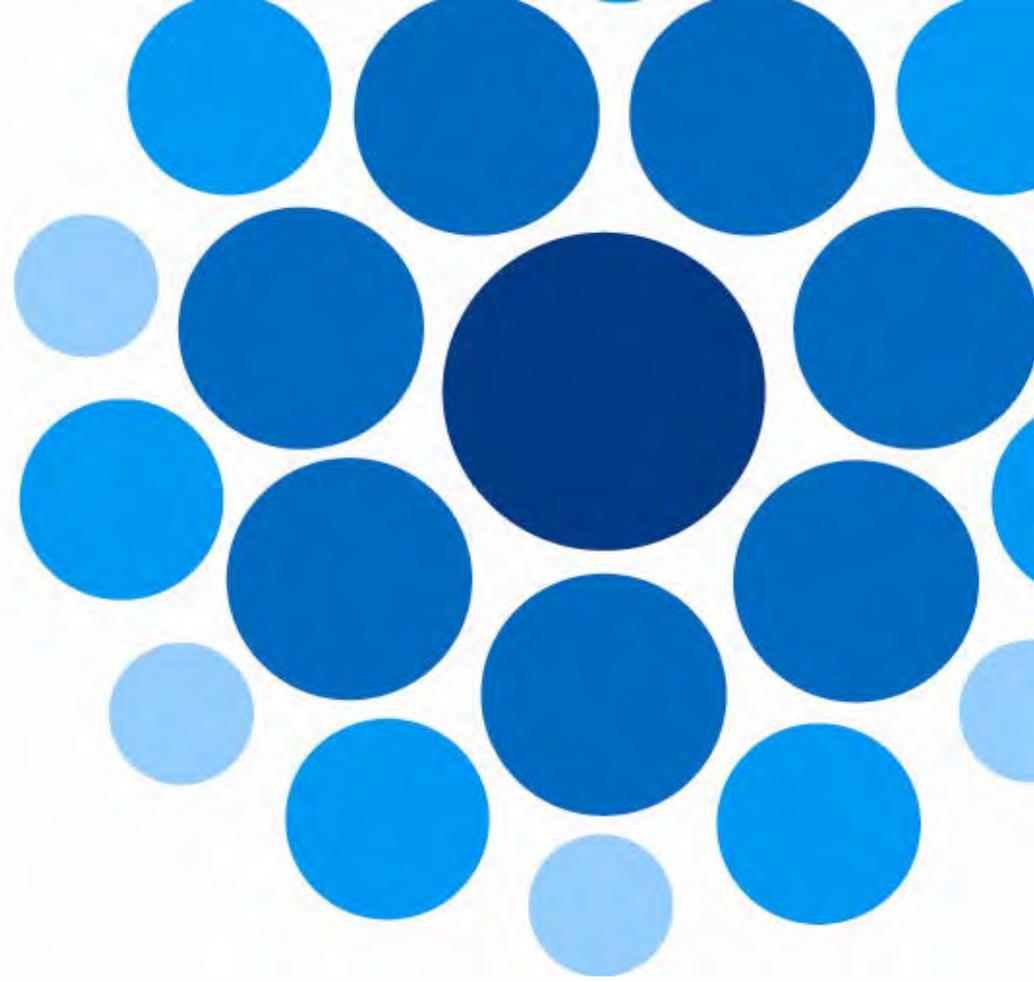


**Professor Richard Holdich**



**Water encapsulation in oil emulsions: manufacture of low fat products using membranes**

# Outline

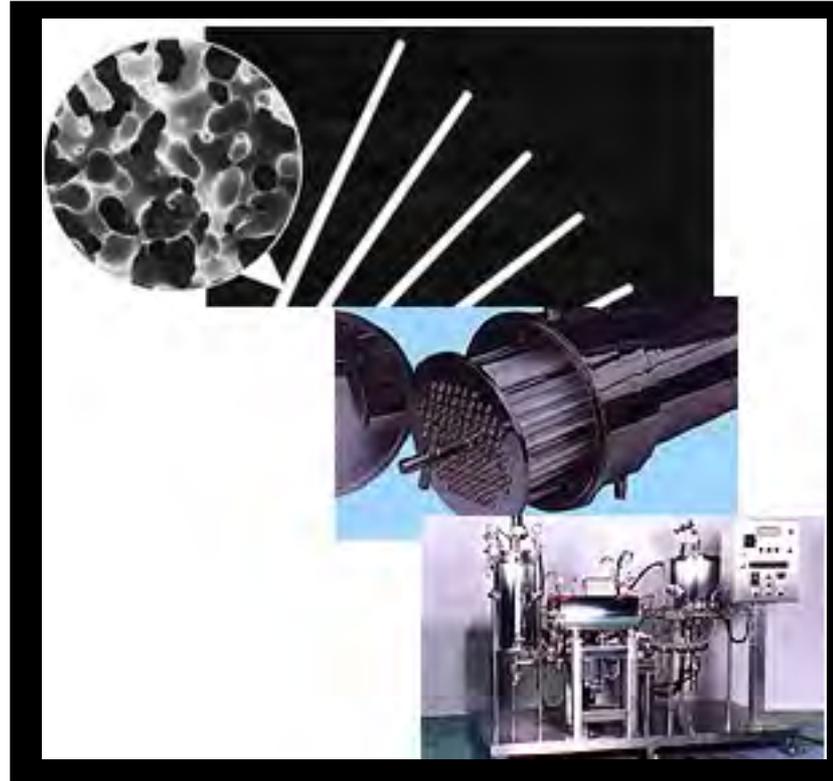
- Membranes and **pore size**
- Membrane emulsification: **testing and scaling**
- Example: **large coacervates**
- Example: **fine emulsions**
- **Chocolate**

# Needs & Challenges

- **Social issue – Obesity.**
- **Demand for low fat food products.**
  
- **Water reacts with components**
  
- **Moist sugar sticks together:**
  
- **Forms irreversible paste:**

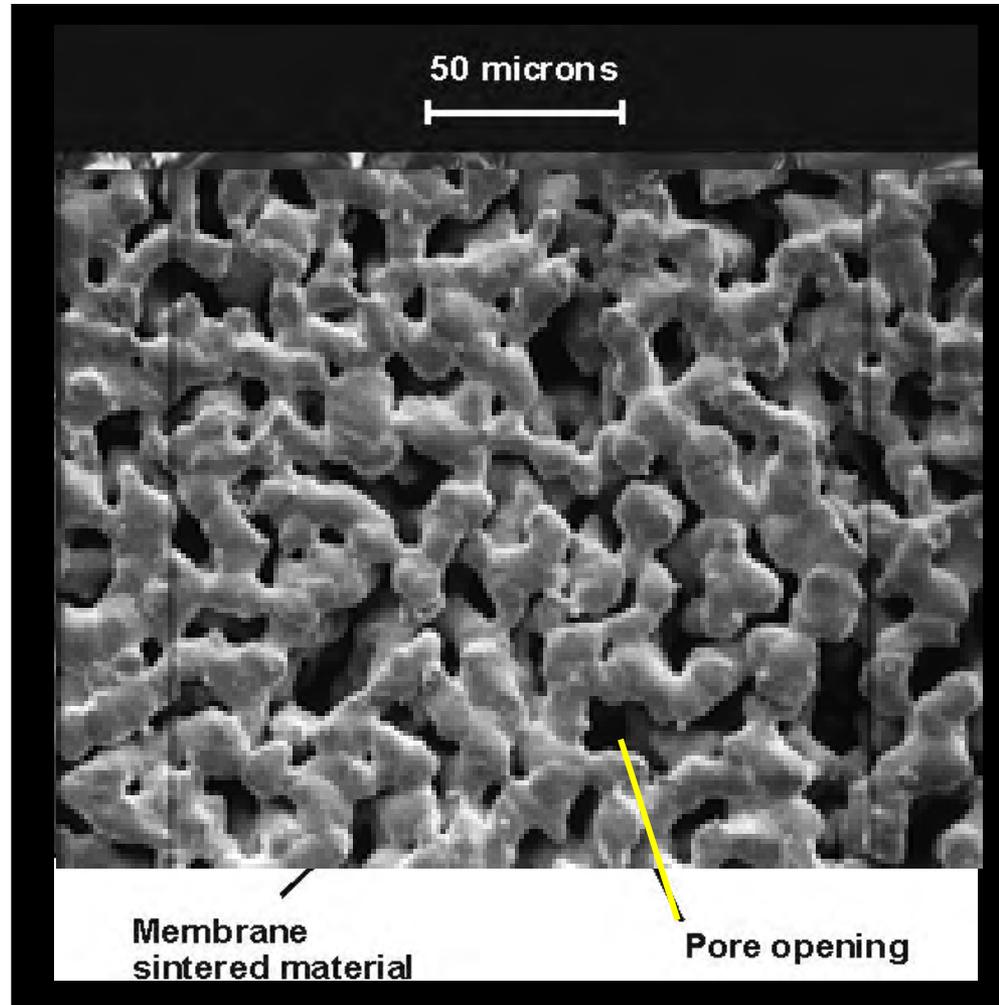


# Microfiltration membranes

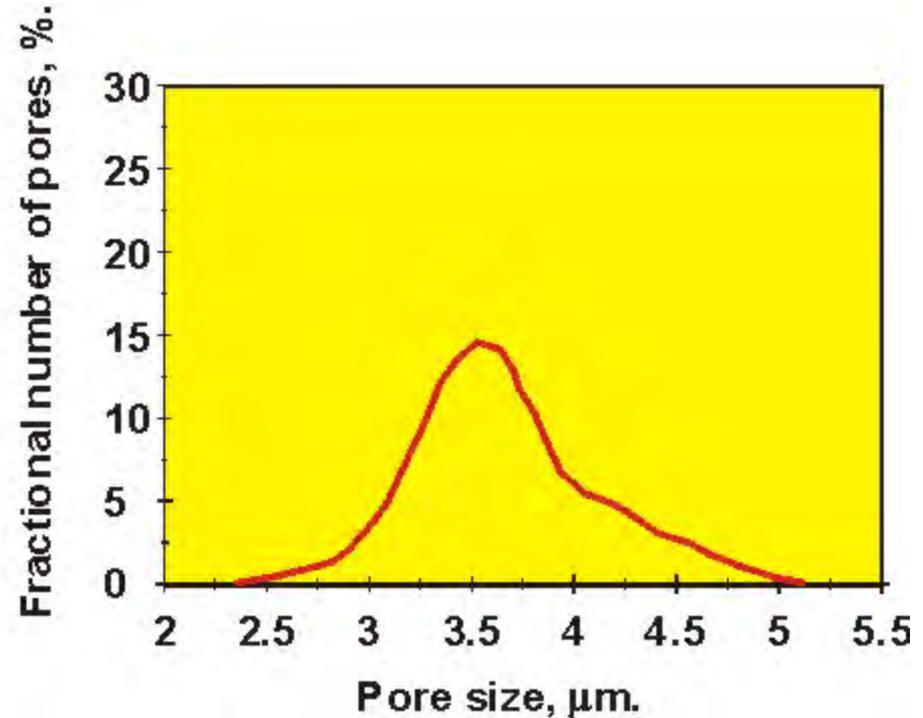
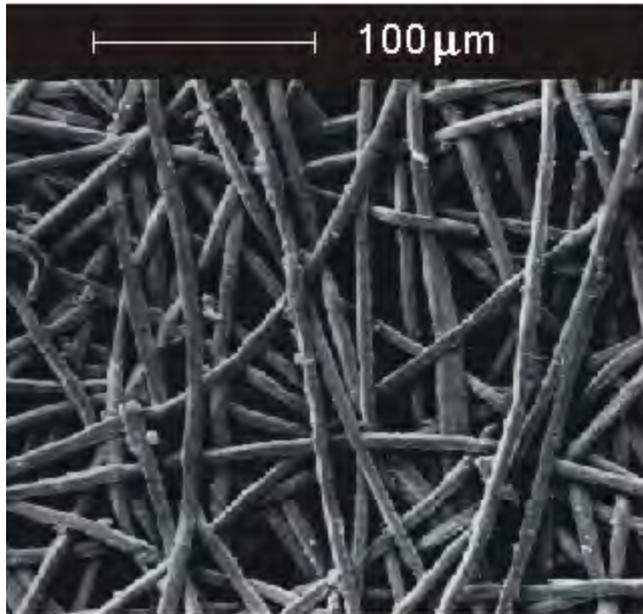


## SPG Glass Membrane & system

# Microfiltration membranes

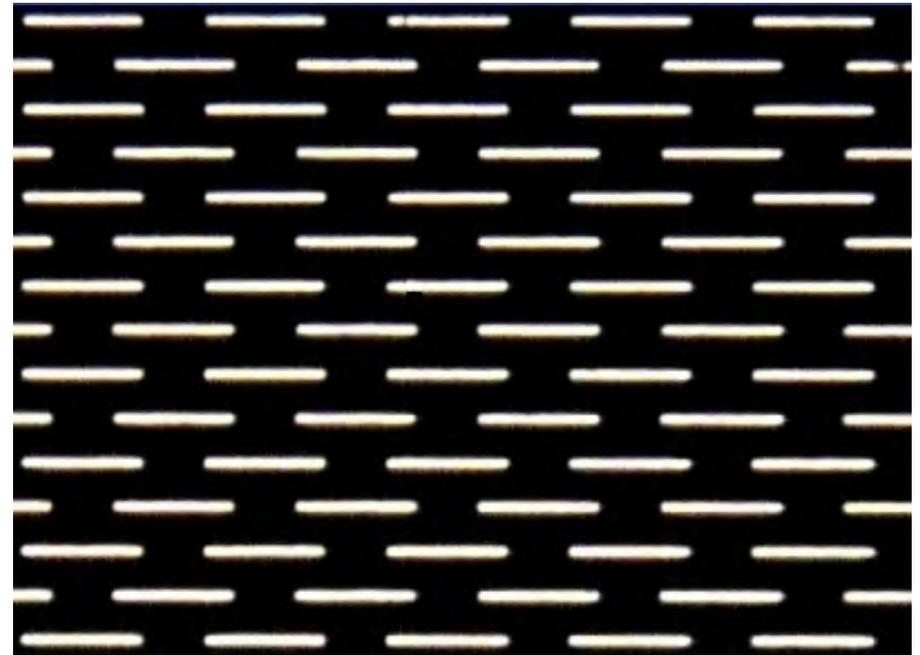


# Conventional Microfiltration membranes



Metal fibre microfiltration medium - rated at 3 microns

# Micropore metal microfilters

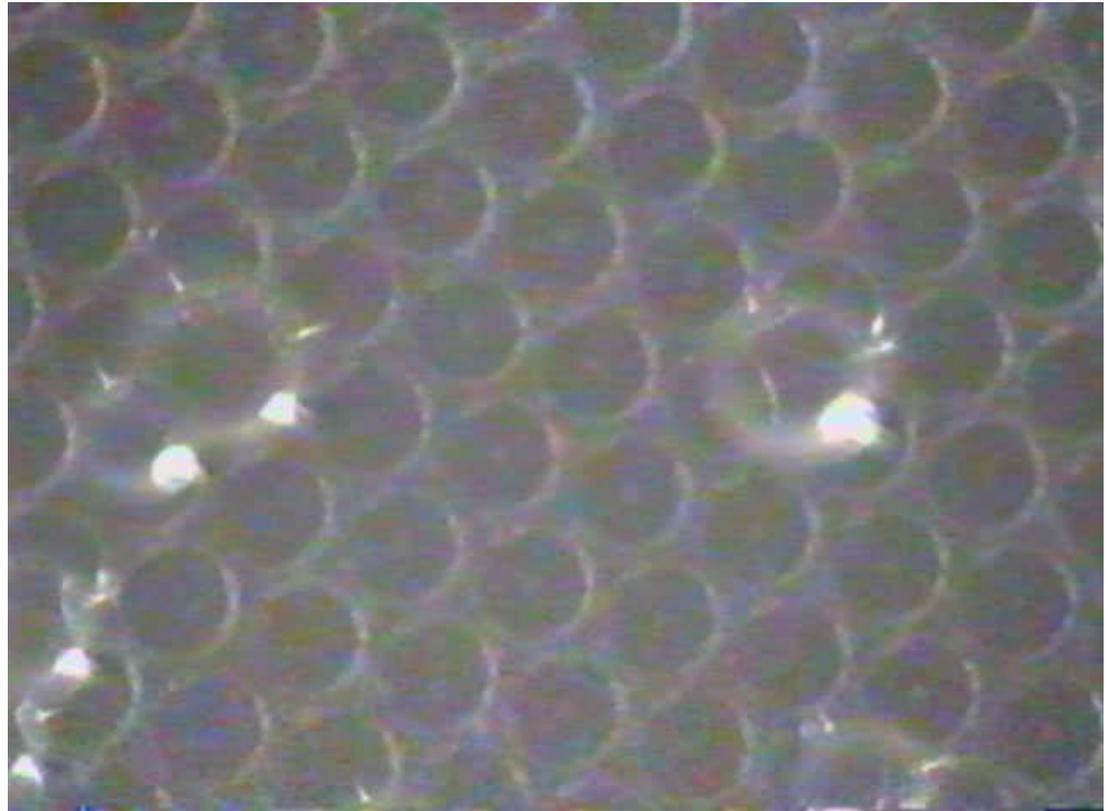


**particles** products containing fine particles within the dispersed phase can pass the membrane during formulation

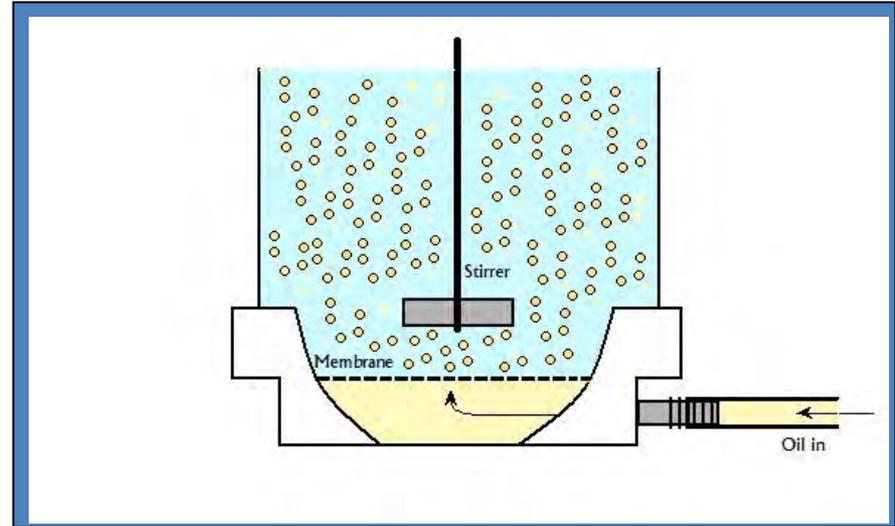
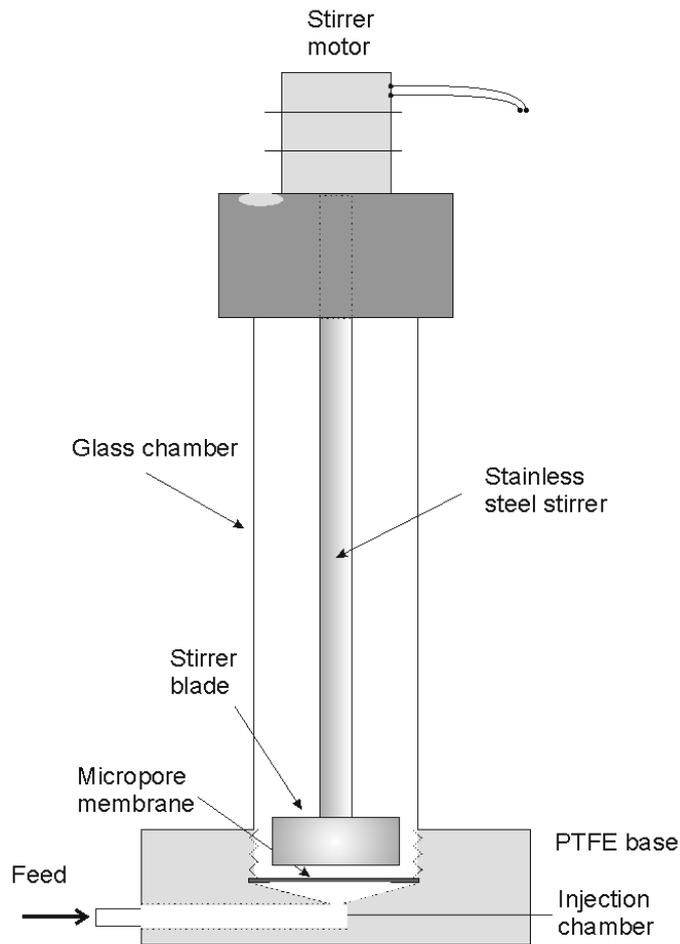
# Membrane emulsification

## Core Competence

- Patented membrane
- Uniform pore structure
- Strong material
- Specialised surface coating
- Zero fouling
- Low resistance

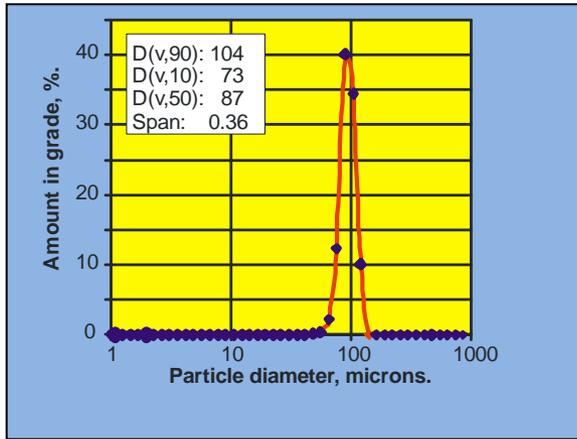


# Dispersion Cell (*Formulation testing*)



# Dispersion Cell

## Membrane Emulsification



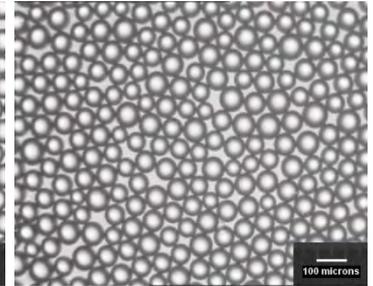
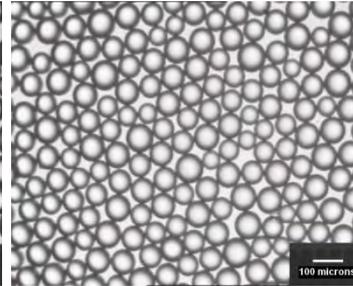
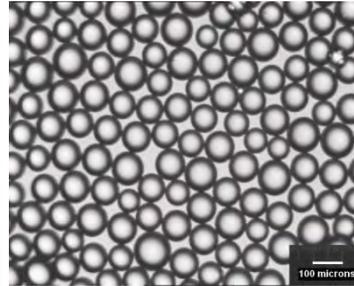
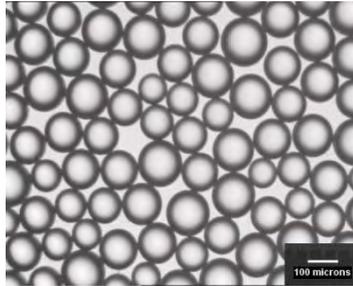
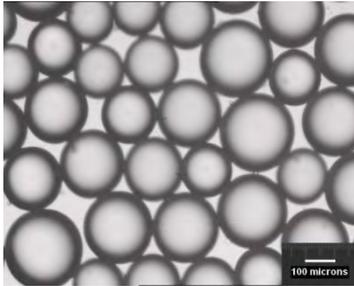
13

38

68

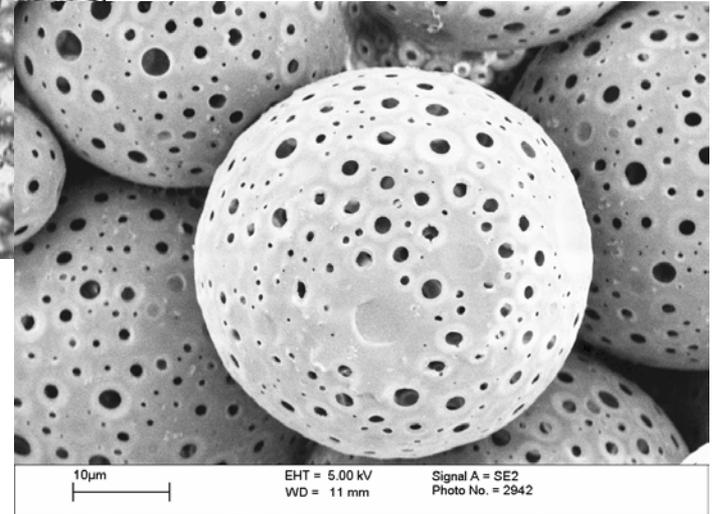
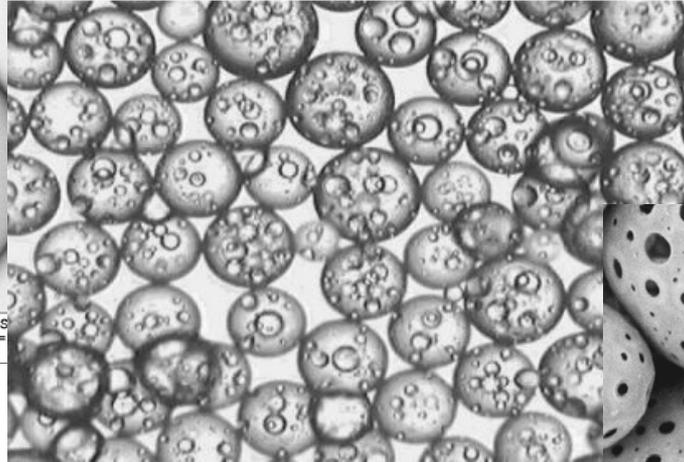
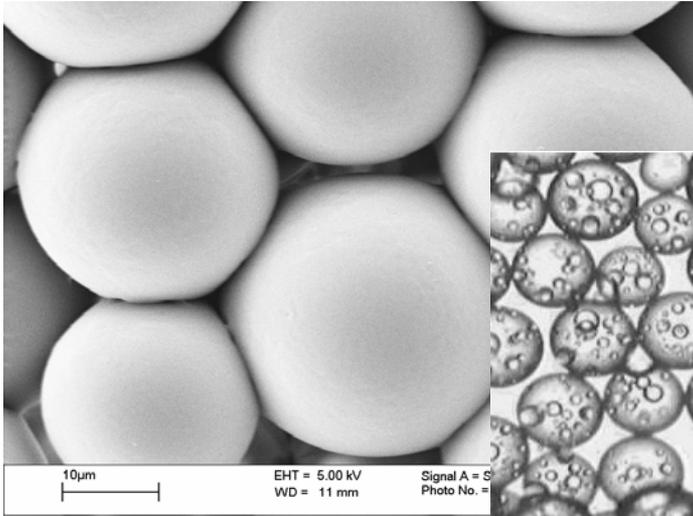
105

146 **dynes/cm<sup>2</sup>**



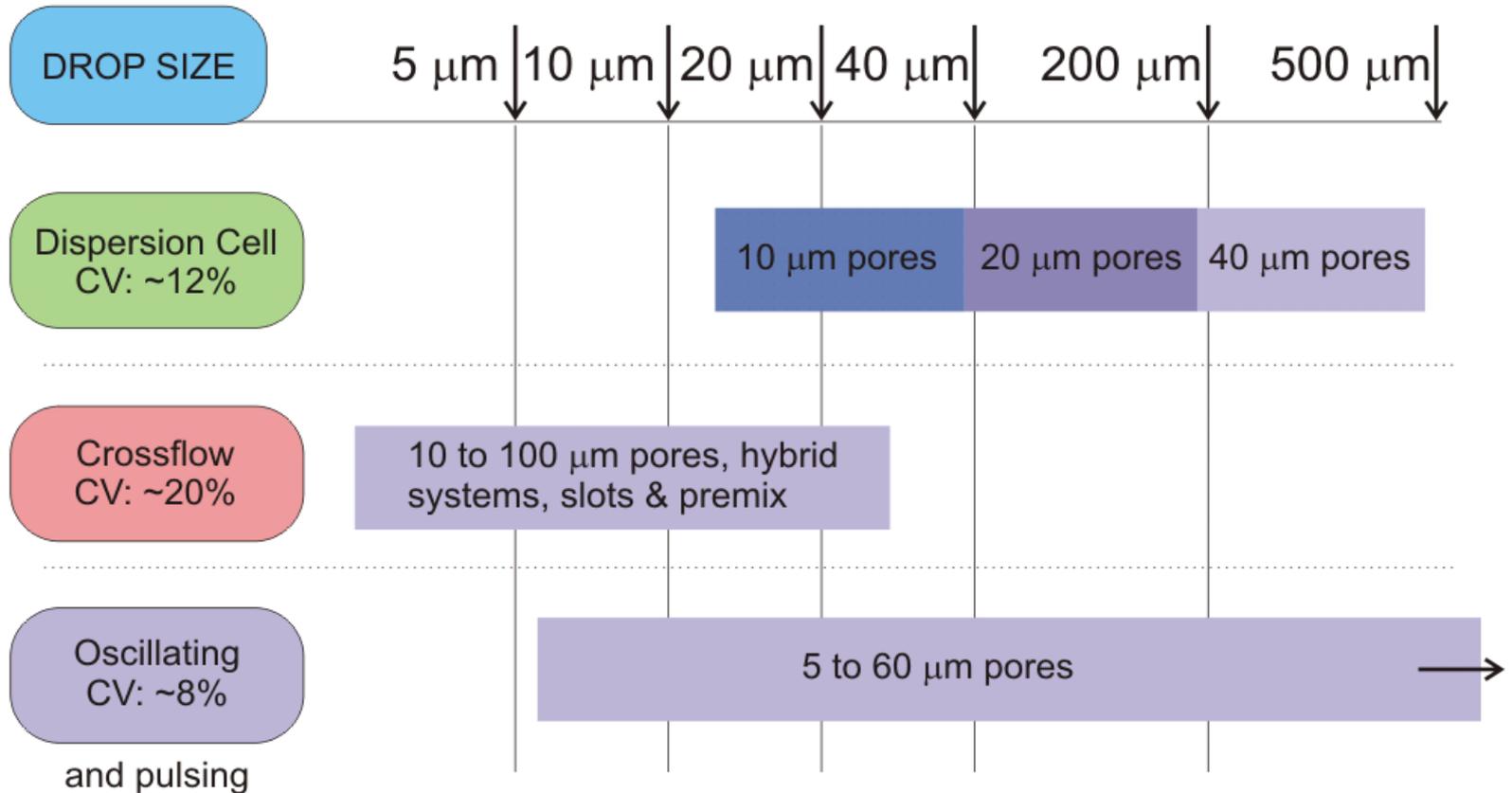
**pressure** drop is very low, due to the membrane design, so the shear is low and emulsification conditions are gentle

# Encapsulation: WOW

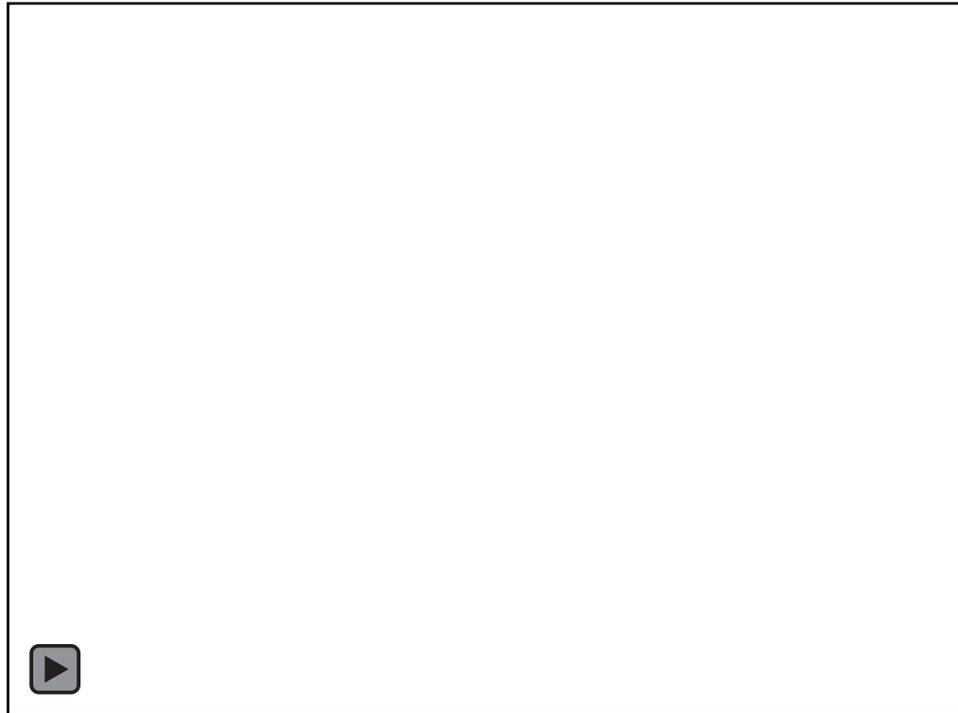


**W/O/W emulsions**  
**encapsulation efficiency close to 100%**

# Products and Scaling Up/Out



# Crossflow



# Crossflow



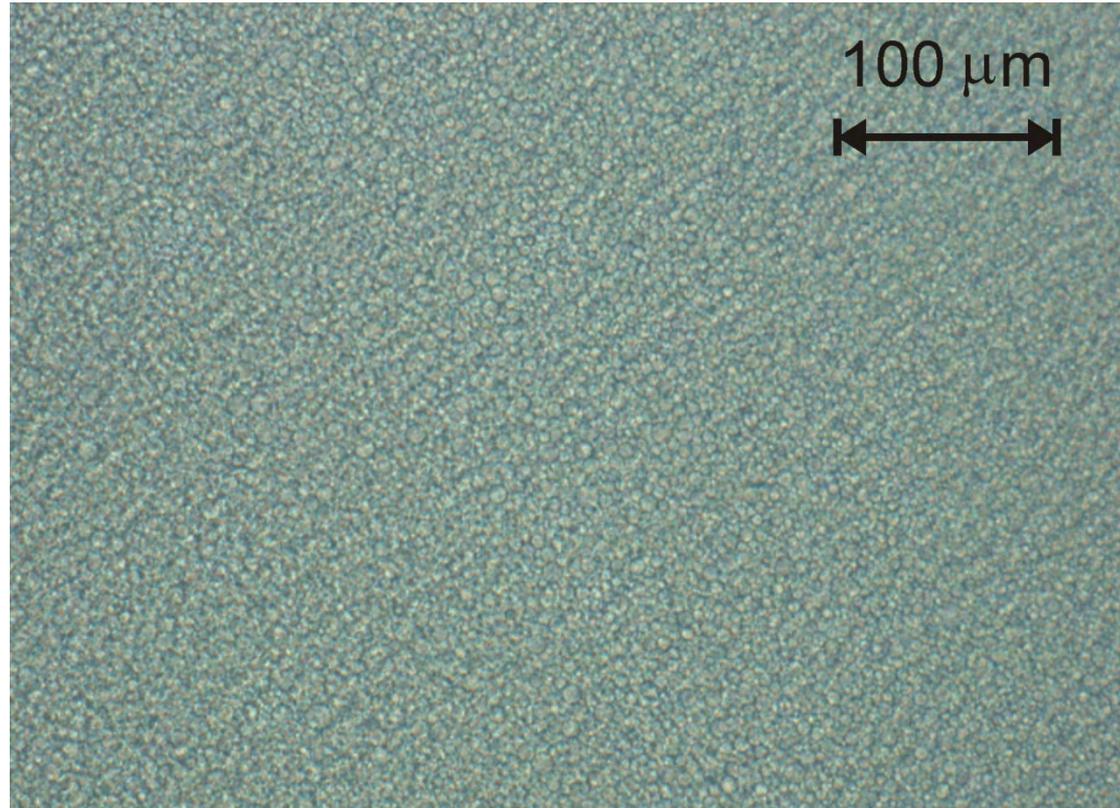
**Membranes**

**Process tank and pump**

**Four tube – insert system (100 kg/h)**

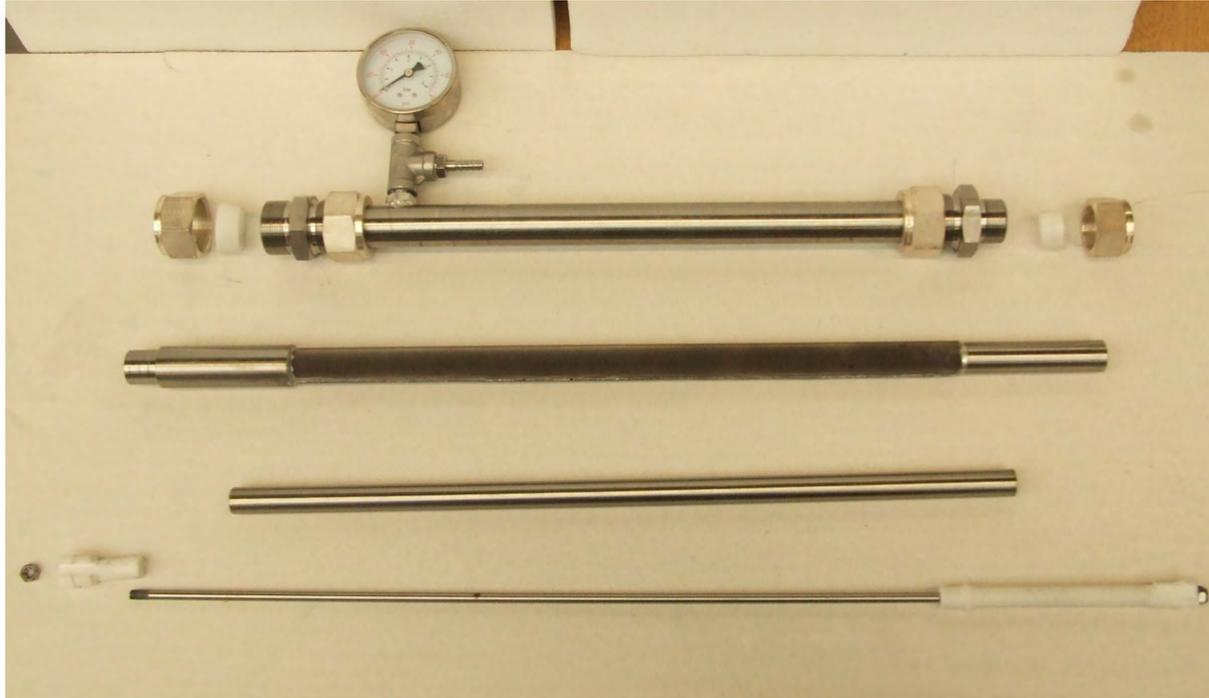
# Crossflow

**Resulting  
emulsion:  
no drops  
bigger than  
12 microns**



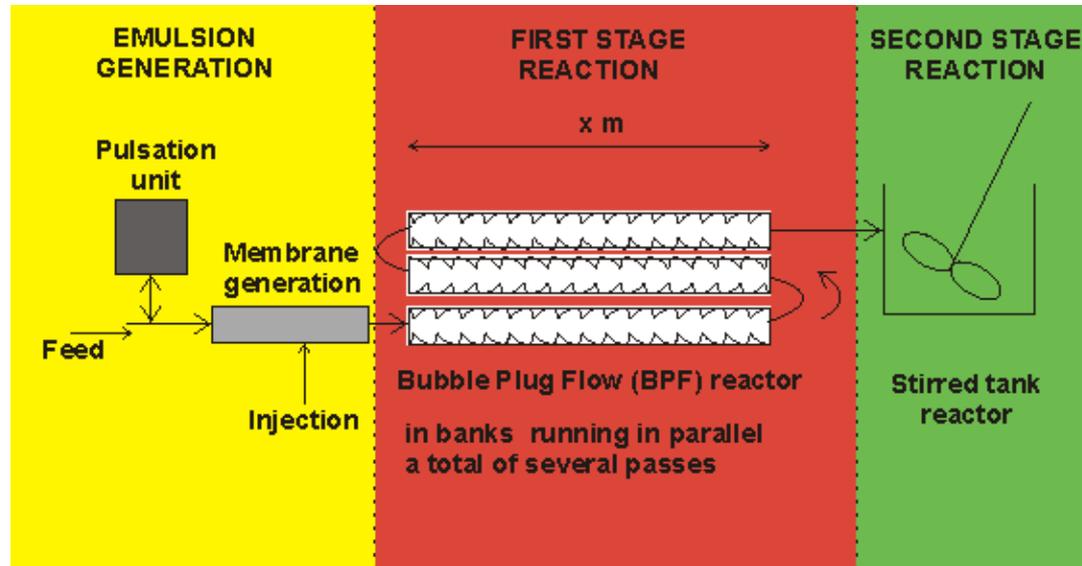
**Single tube – insert test system (up to 20 kg/h)**

# Equipment



**Single tube – insert test system (up to 20 kg/h)**

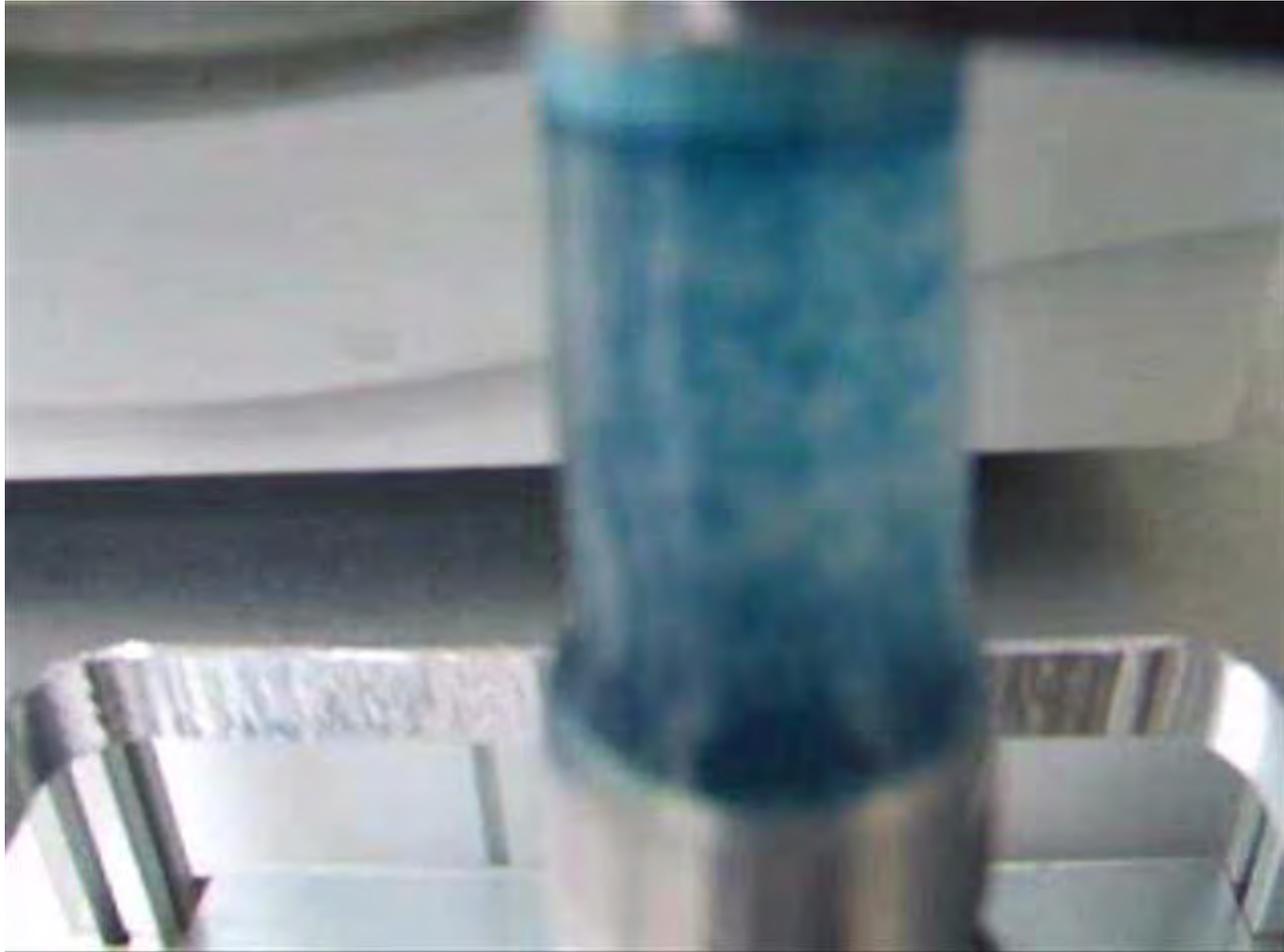
# Once through production - using membrane emulsification



Single pass and 40% v/v emulsion produced

This new technology opens up new possibilities, lowering energy costs and assists in the drive towards emulsion stabilizers using more natural products.

# Membrane emulsification

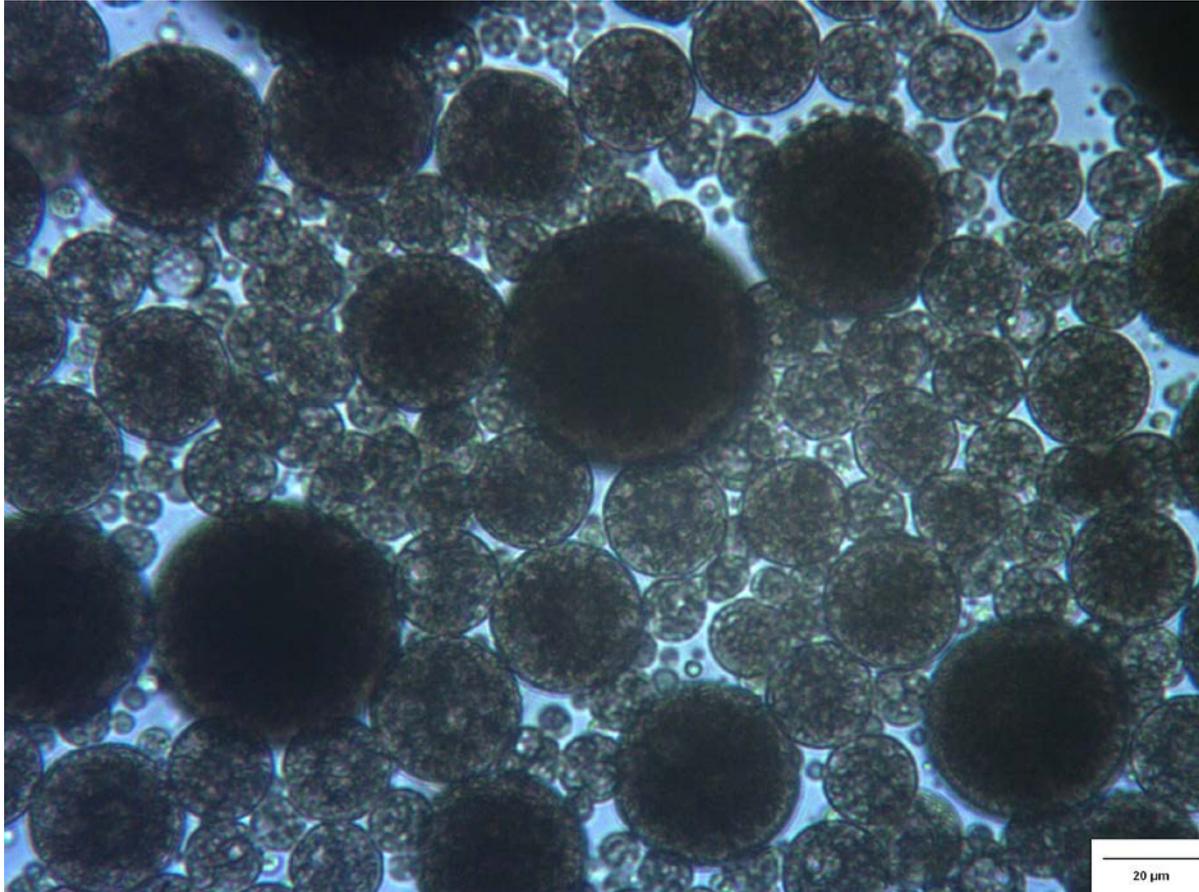


# Examples: low fat mayonnaise & cheese

## Requirements:

- **Stable drops sub 25 microns**
- **Above 30% by volume water in oil**
- **Hydrocolloid can be used but physical properties remain close to original**
- **Possibility of nutraceutical addition**

# Low fat cheese project: 35% water



# Example – water in cocoa oil

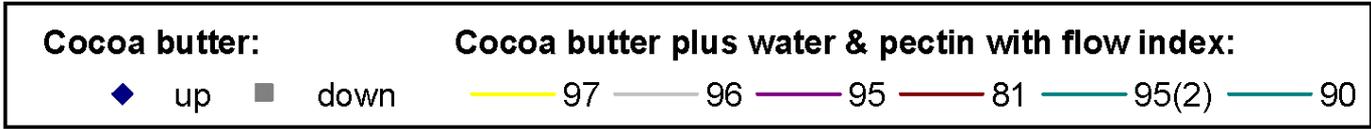
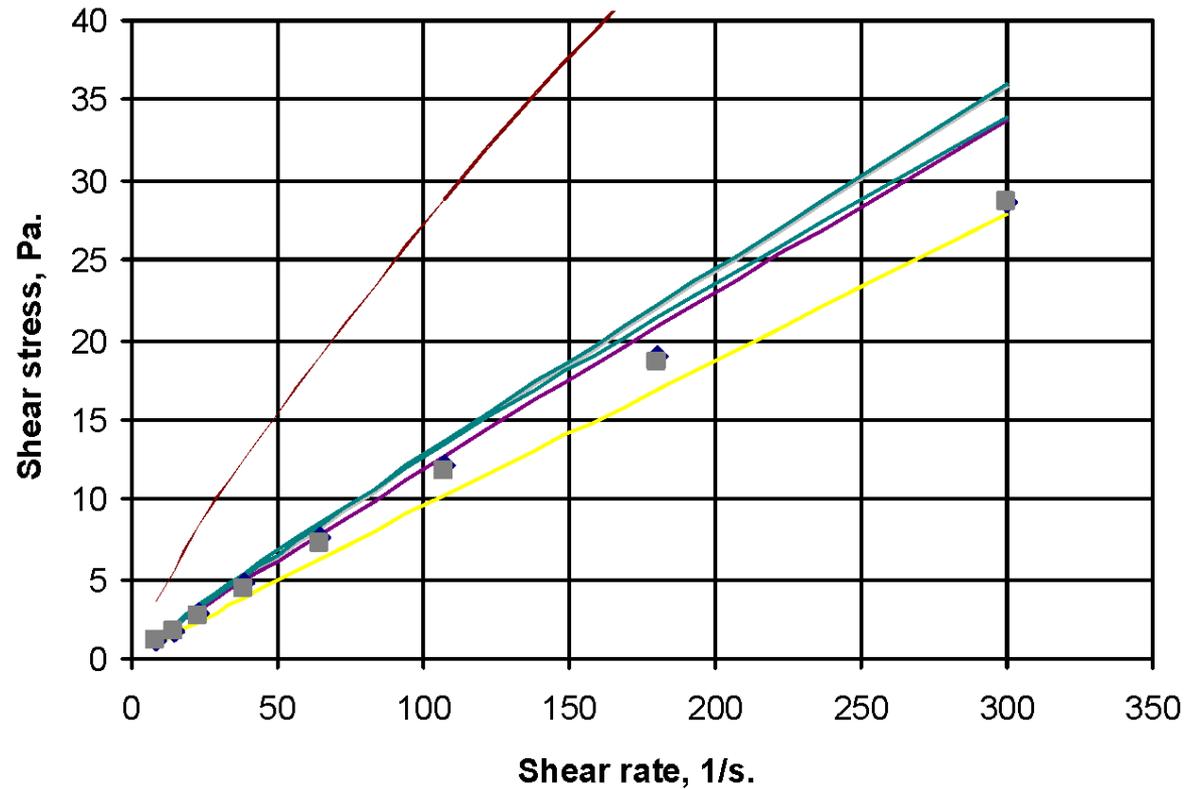
- **Chocolate**
- **Ice cream coatings**
- **Other coverings**
- **W/O low fat products**
  
- **PCMA meeting in Hershey**
- **Can you call it chocolate?**

# Example – water in cocoa oil

Hydrocolloid	Synerise	Comments
Xanthan, CMC, guar gum	YES	Not effective by themselves, synerise
Agar, pectin, carrageenan	POSSIBLY	hot at some point to be functional
Alginate	POSSIBLY	can be used cold, control gelation using sequestrants, high G types synerise
Xanthan/LBG gels	NO	set at about 55C, >0.2% doesn't crack open – complete gel, no dependency on calcium, clarified grade of Xanthan and LBG available
Kappa carrageenan	NO	Highly calcium dependent, >0.2% required, clear product

# Example – water in cocoa oil

N.B. with  
PGPR:



# Example – water in cocoa oil



**Hardness  
tests**



# Tempering Chocolate with 11% water



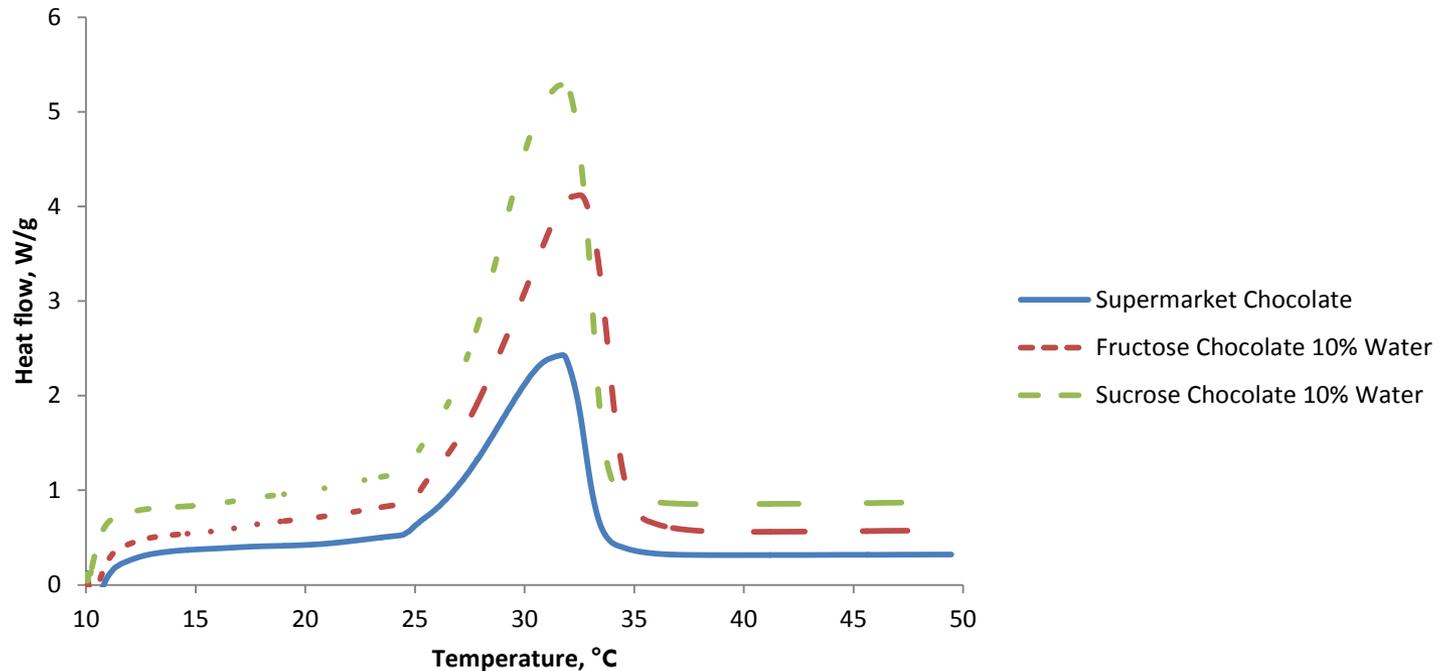
# Hardness, Snap & Properties

- Hardness evaluate using a penetrometer.
- Yield value gives an evaluation of the hardness.
- Subjective snap test conducted.
- Compared among chocolates.

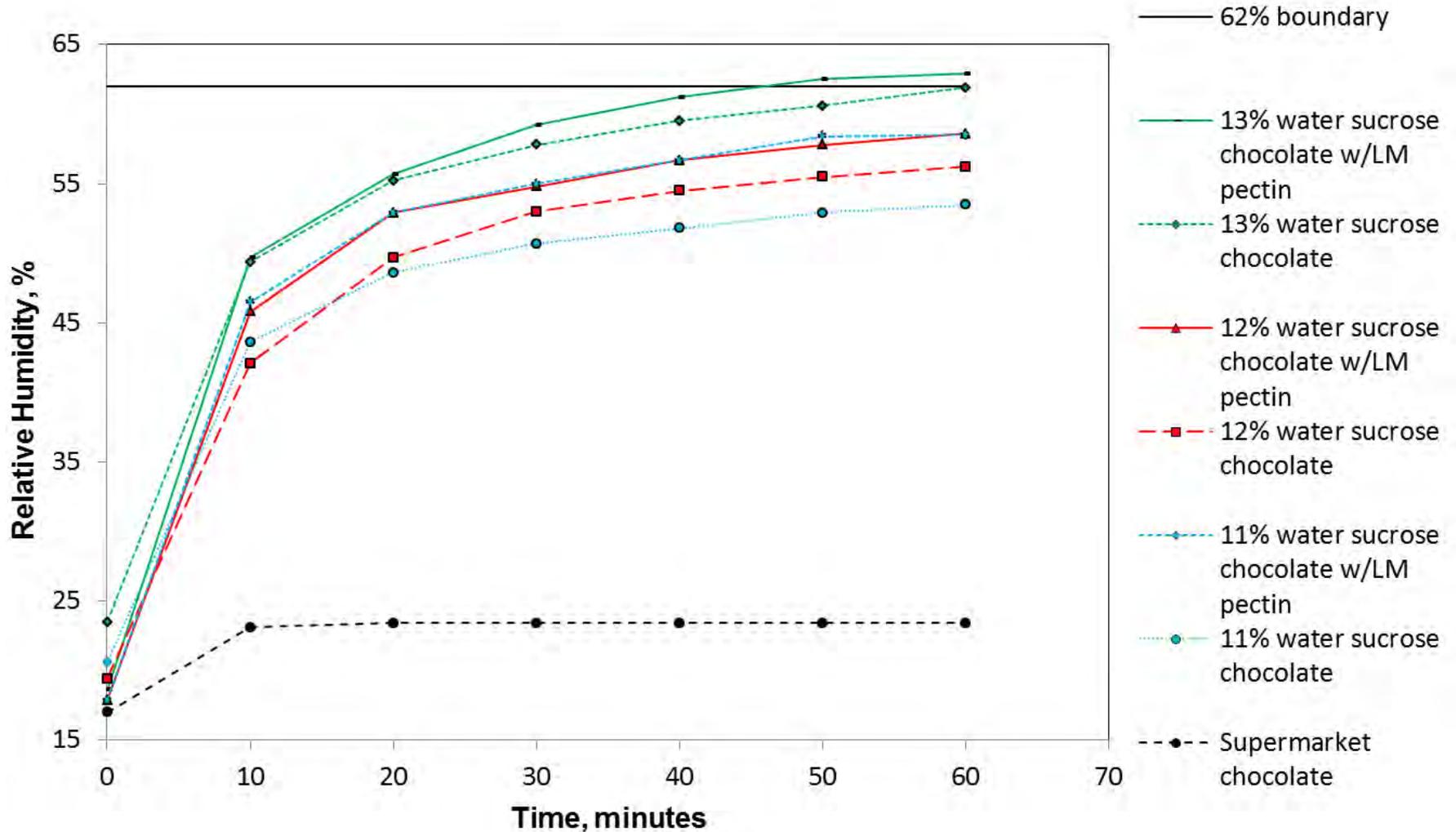


# Low Fat Chocolate

## Comparison of Fructose and Sucrose Chocolate



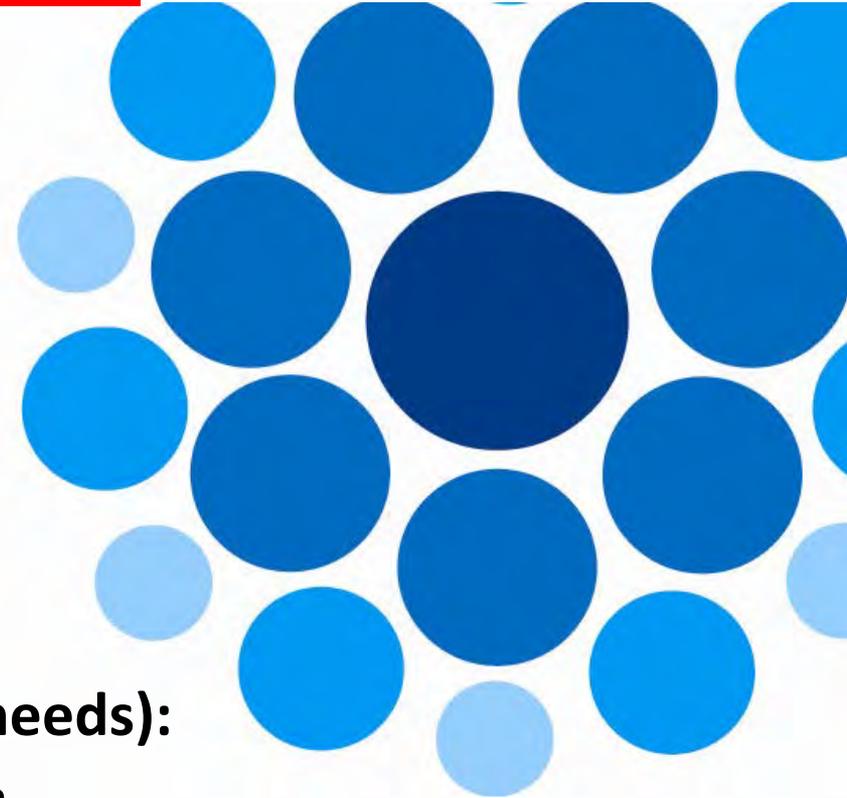
# Water activity

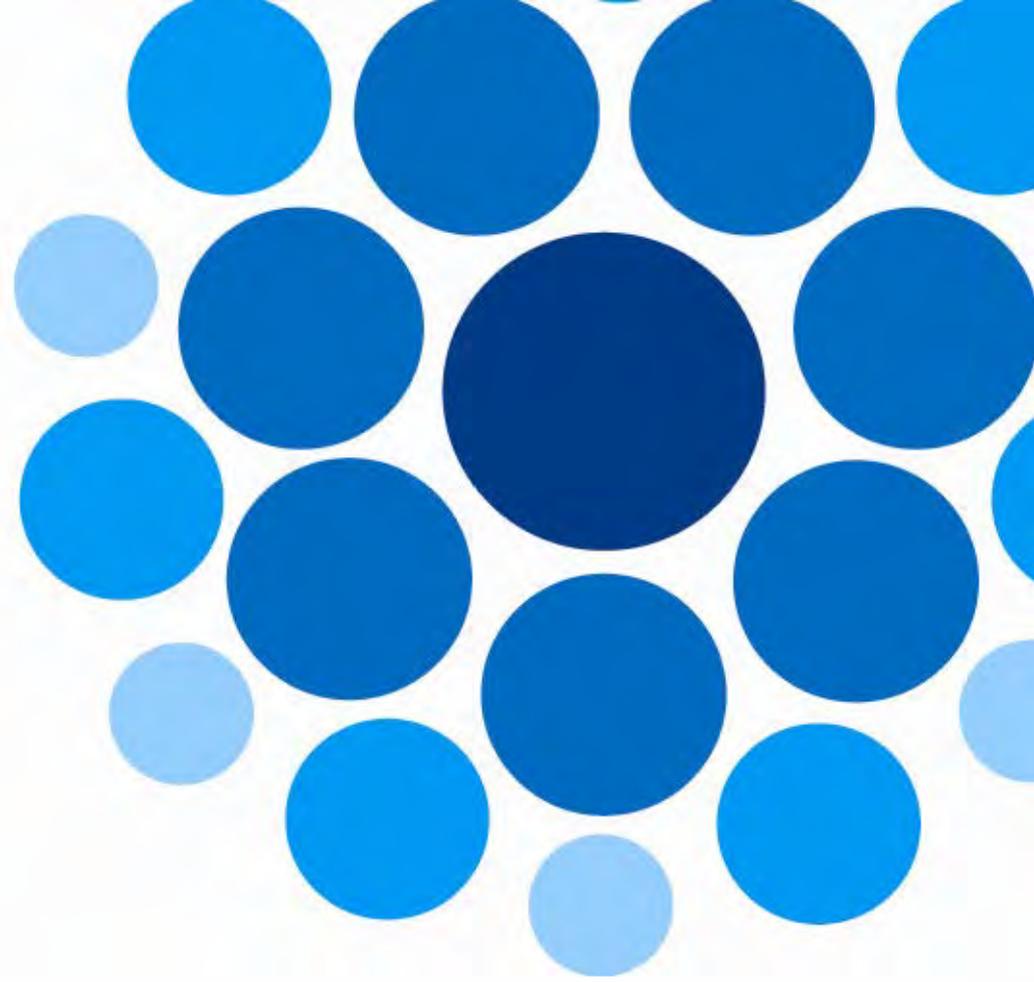


# Water encapsulation in oil emulsions: manufacture of low fat products using surface membranes

## Summary

- Low energy process
- Low pressure process
- Formulation is still key
- Small-scale through to production
- Novel and robust membrane design
- Variety of shear techniques (clients' needs):
  - Mainly crossflow and oscillation/pulsation
- Good for multiple emulsions and continuous production
- Small/large drop production: low fats and coacervate encapsulation





Thank you for your attention!

# Micropore Technologies