Overcoming the hurdles towards sustainable food production - Advanced measurement needs

Fredrik Innings

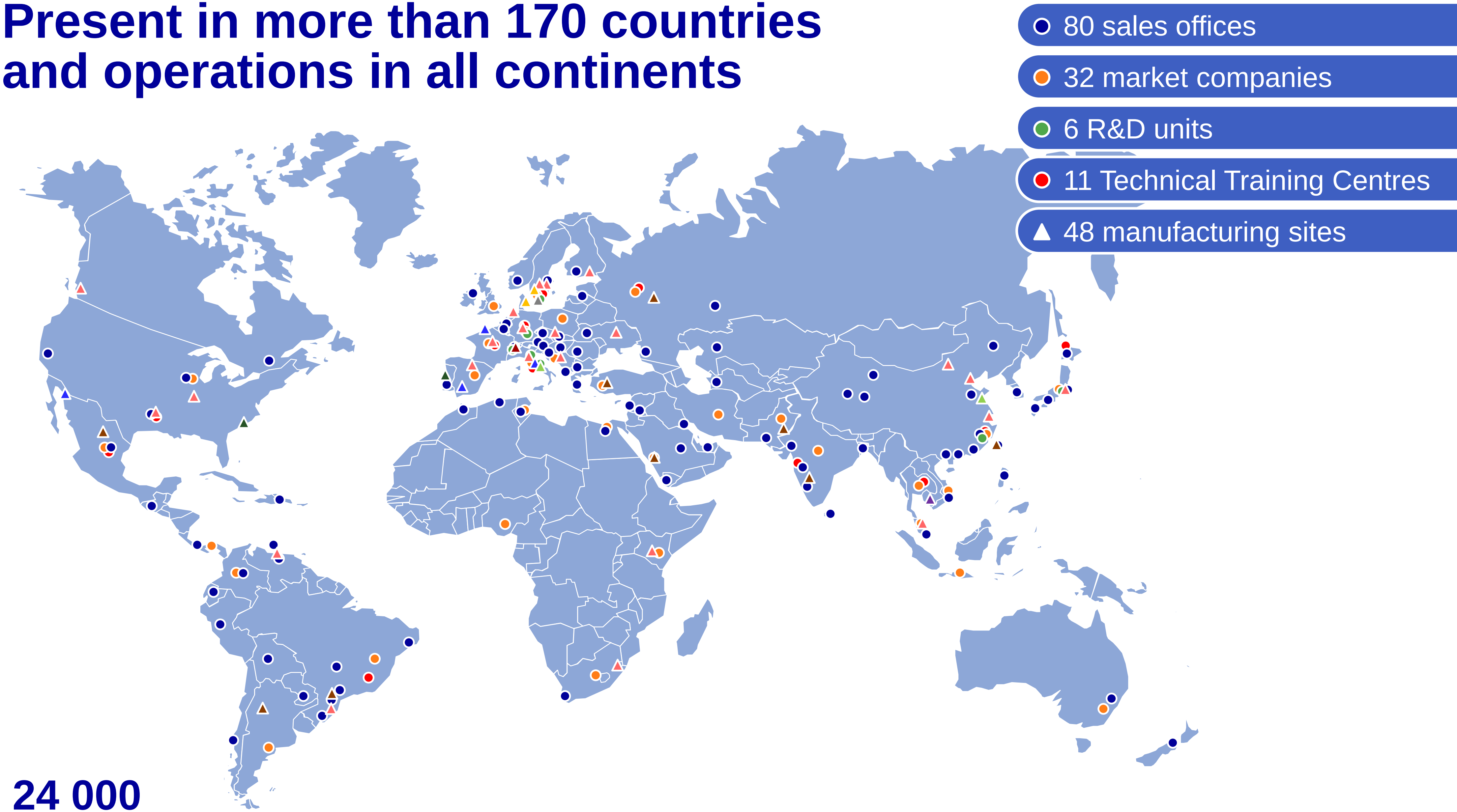
Tetra Pak

Lund University

Tetra Pak

We specialise in providing customers with complete solutions for the processing, packaging and distribution of food products

Present in more than 170 countries and operations in all continents



Employees: **24 000**

Net sales billion €: **12**

Total world deliveries 2015

Carton packaging material, billions of packs

184

Processing units

2,118

Packaging machines

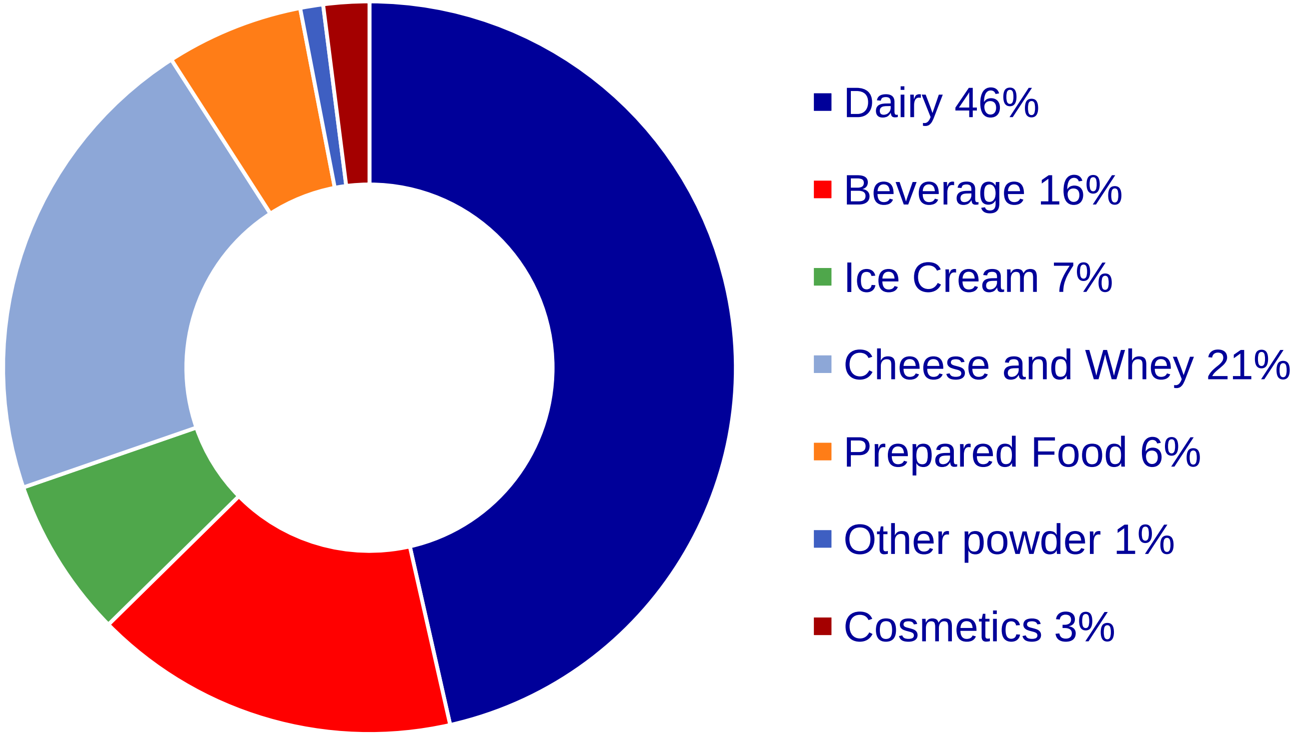
411

Distribution machines

1,047

Well-proven processing systems

Total number of delivered processing units 2015: 2,118



Our development focus has shifted over time

60´s
Rationalization of production

70´s
Rationalization of distribution

80´s
Consumer in focus

90´s
Environment in focus

2000´s
Integrated solutions

2010
Sustainability

Providing more sustainable business

Environment

- Energy efficiency
- Carbon footprint
- Water efficiency
- Effluents (COD)

Drivers
Brand reputation
Retailer demands
Legal requirements

Energy
Water
Waste

Drivers
Production efficiency
Operational cost

- Product cost
- Utility cost

Economy

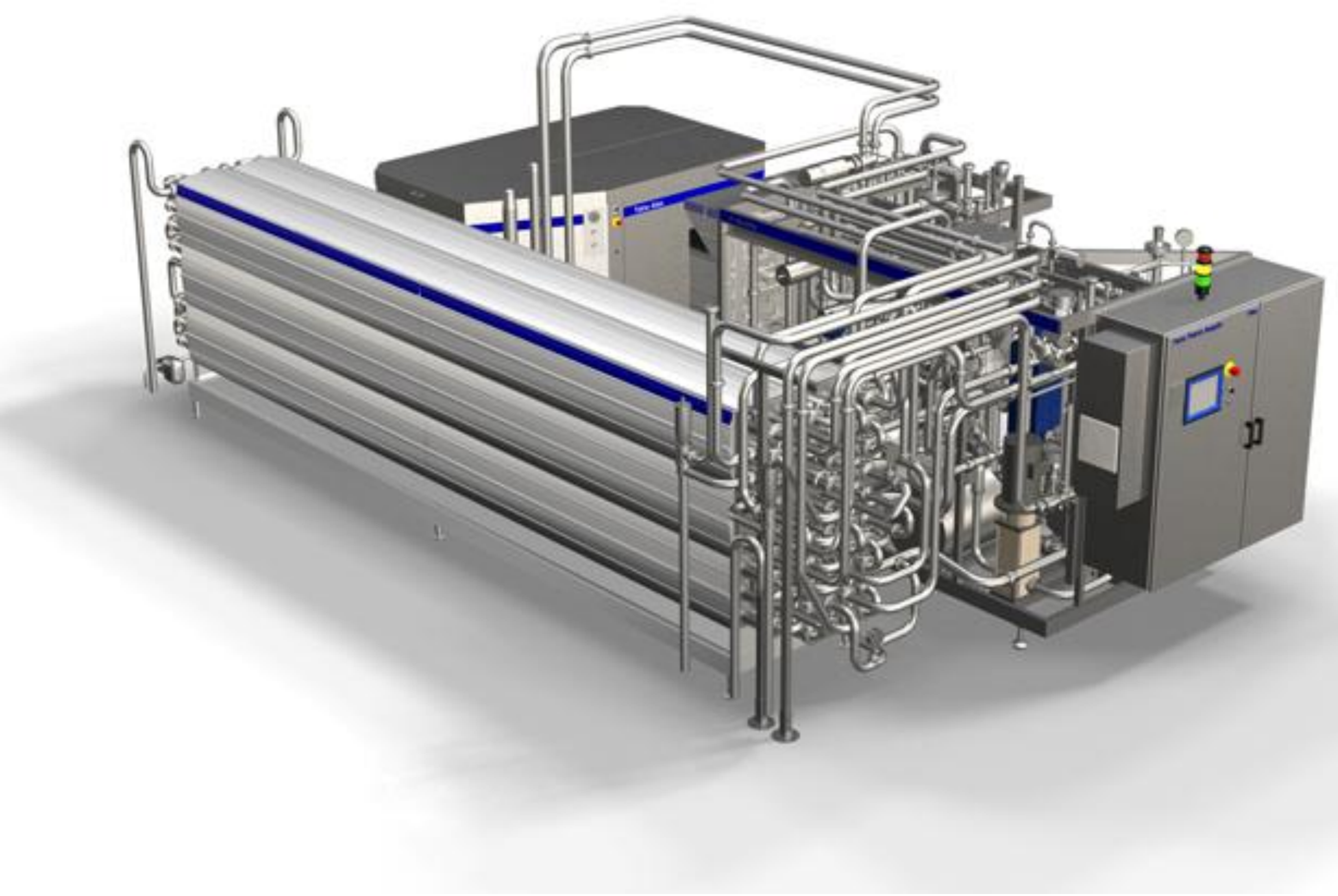
Ensure customer value from the very beginning

Technology Development should

- Create a meaningful change in **total cost of ownership** of your production solutions.
- Ensure **product quality**, **food safety**, and **environmental performance**.
- Result in **high-level innovation** solutions from strong **collaborations** with customers, universities and industry partners.

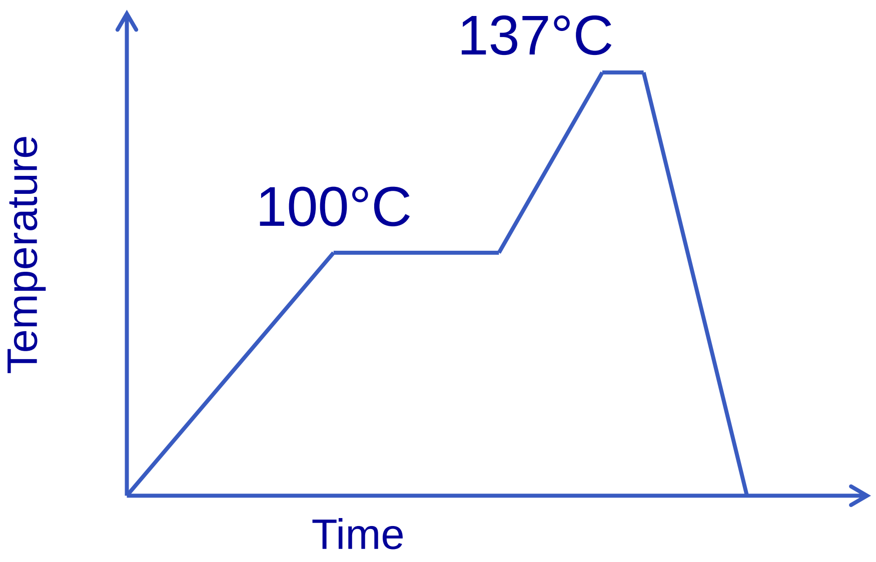
Milk fouling on heat exchangers

UHT with Tubular heat exchanger



Fouling is a deposit formed when processing milk

Time-temperature profile:



- Good quality
- Sufficient shelf-life

- Deposit with a mix of protein and mineral

Different temperatures give different fouling

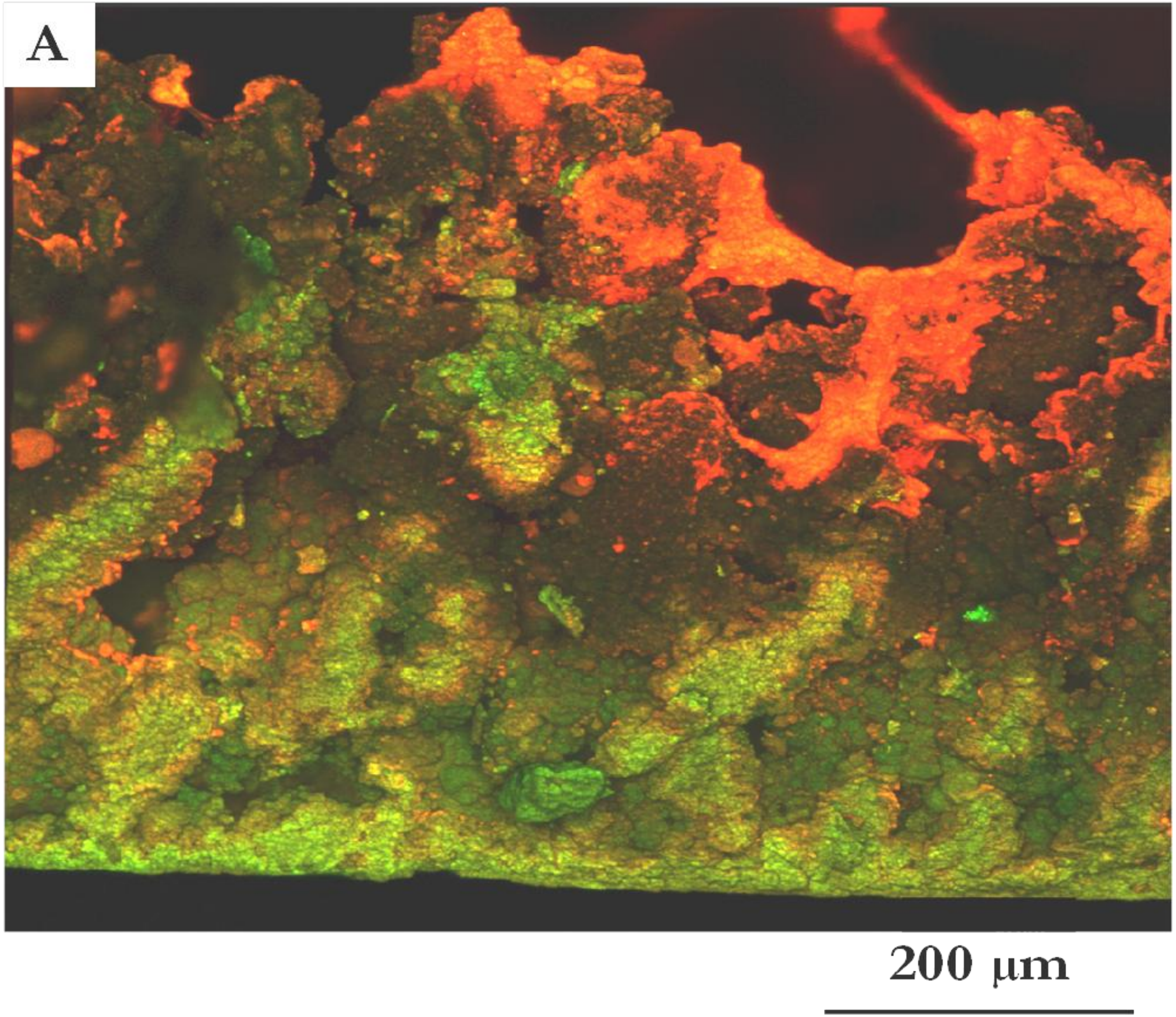
Low temperature fouling
~100°C

Ca	20 wt-%
PO_4	25 wt-%
Protein	40 wt-%

High temperature fouling
137°C

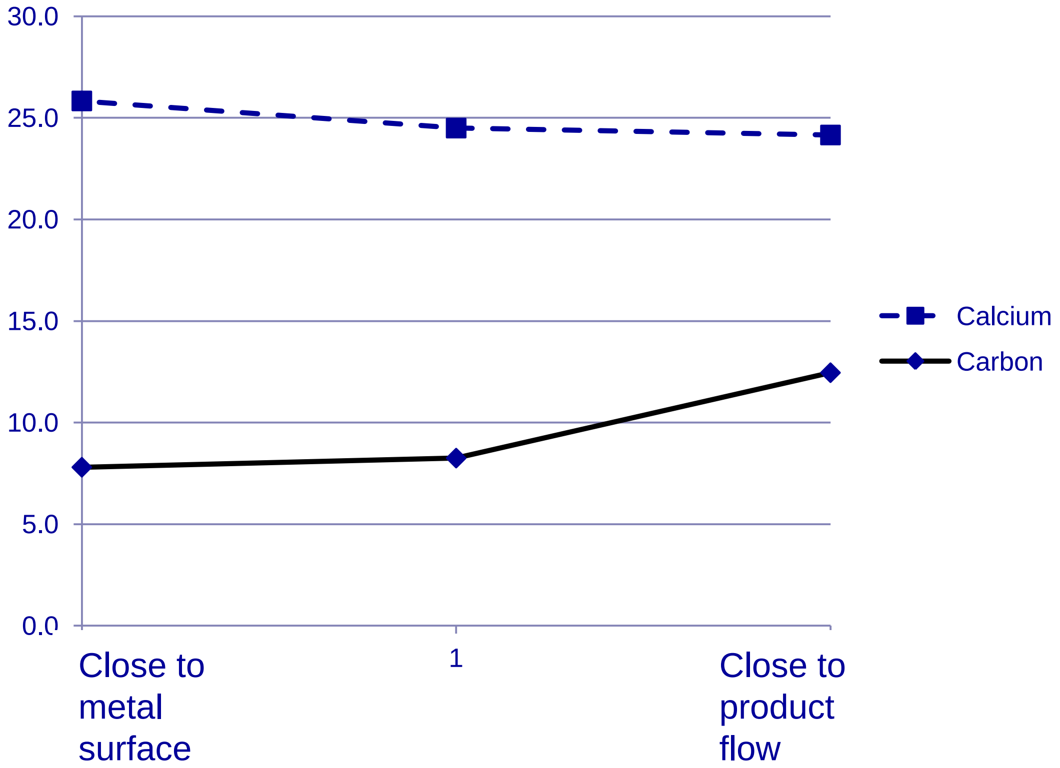
Ca	20 wt-%
PO_4	45 wt-%
Protein	10 wt-%

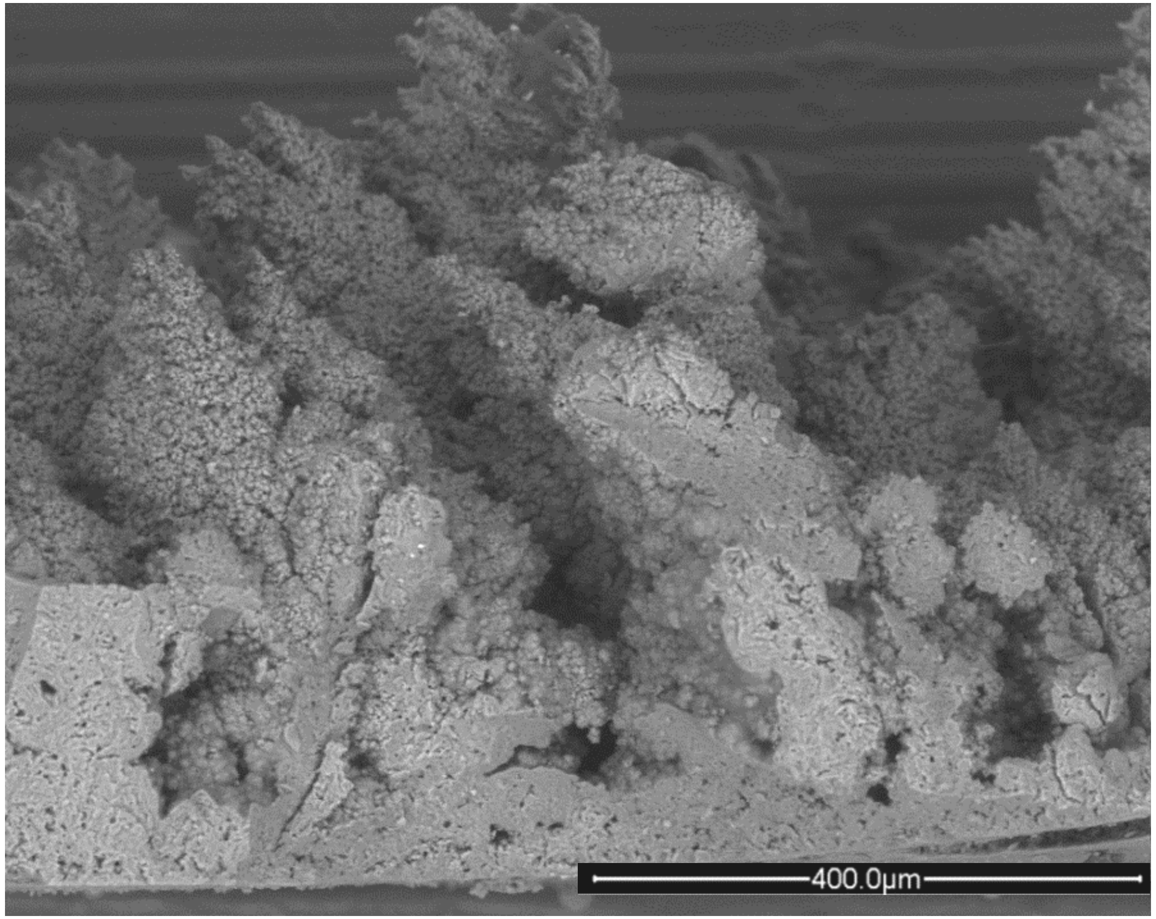
UHT fouling



High temperature milk fouling

Ca	PO_4	Protein	Ca/P	Water content
27± 2 %	44± 3 %	11± 1 %	1.5	40-60 %





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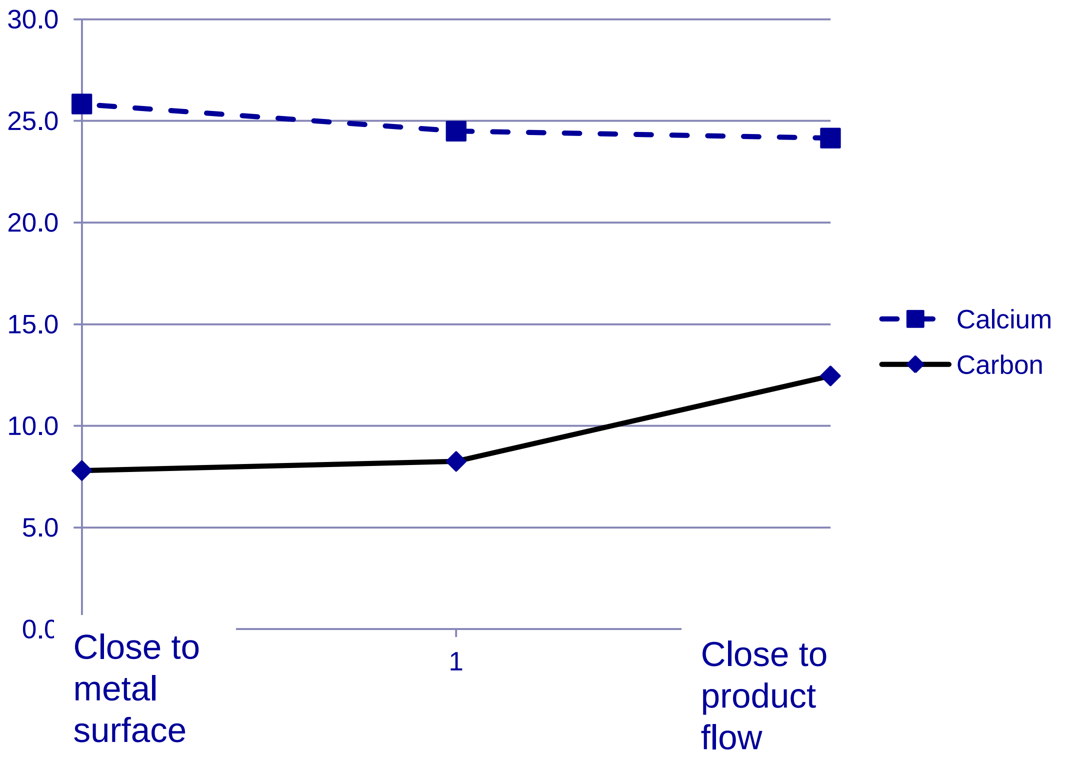
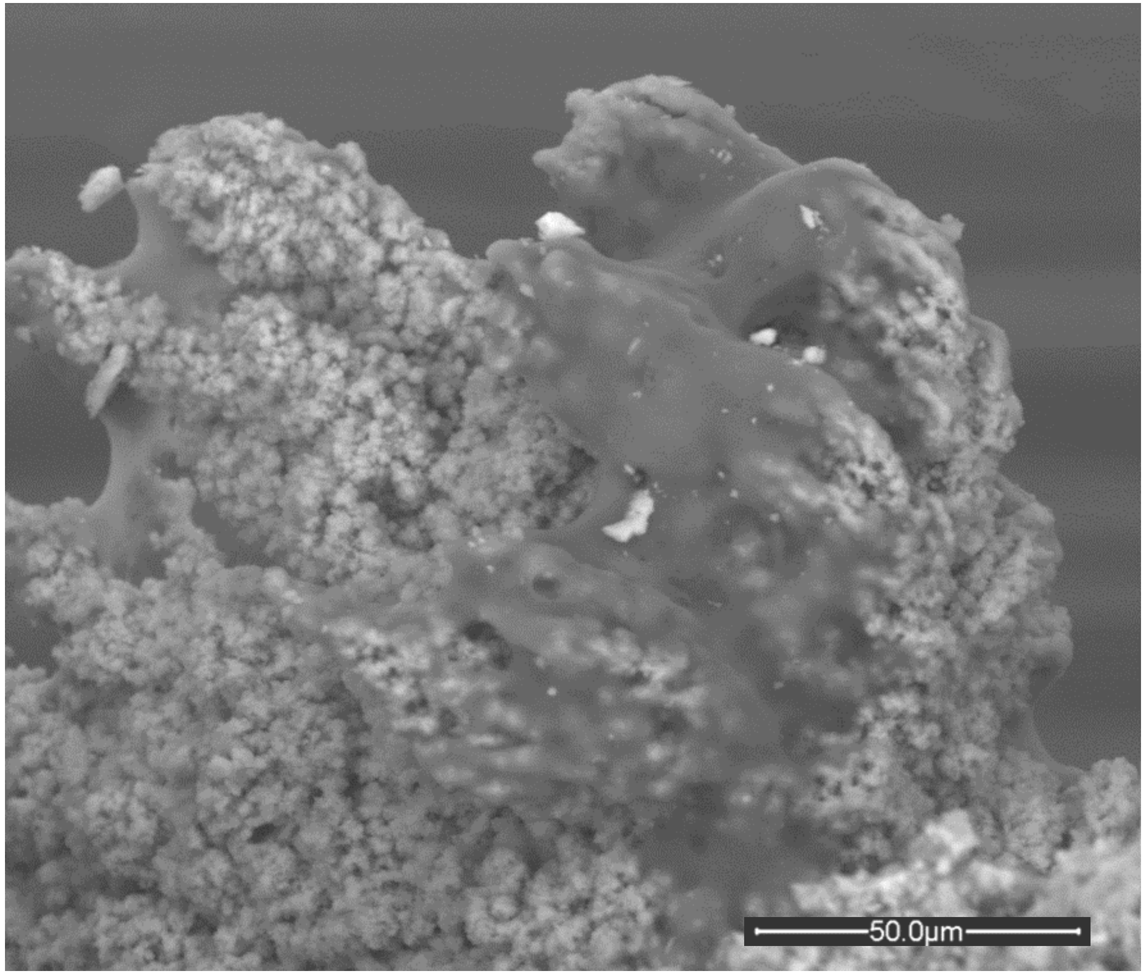
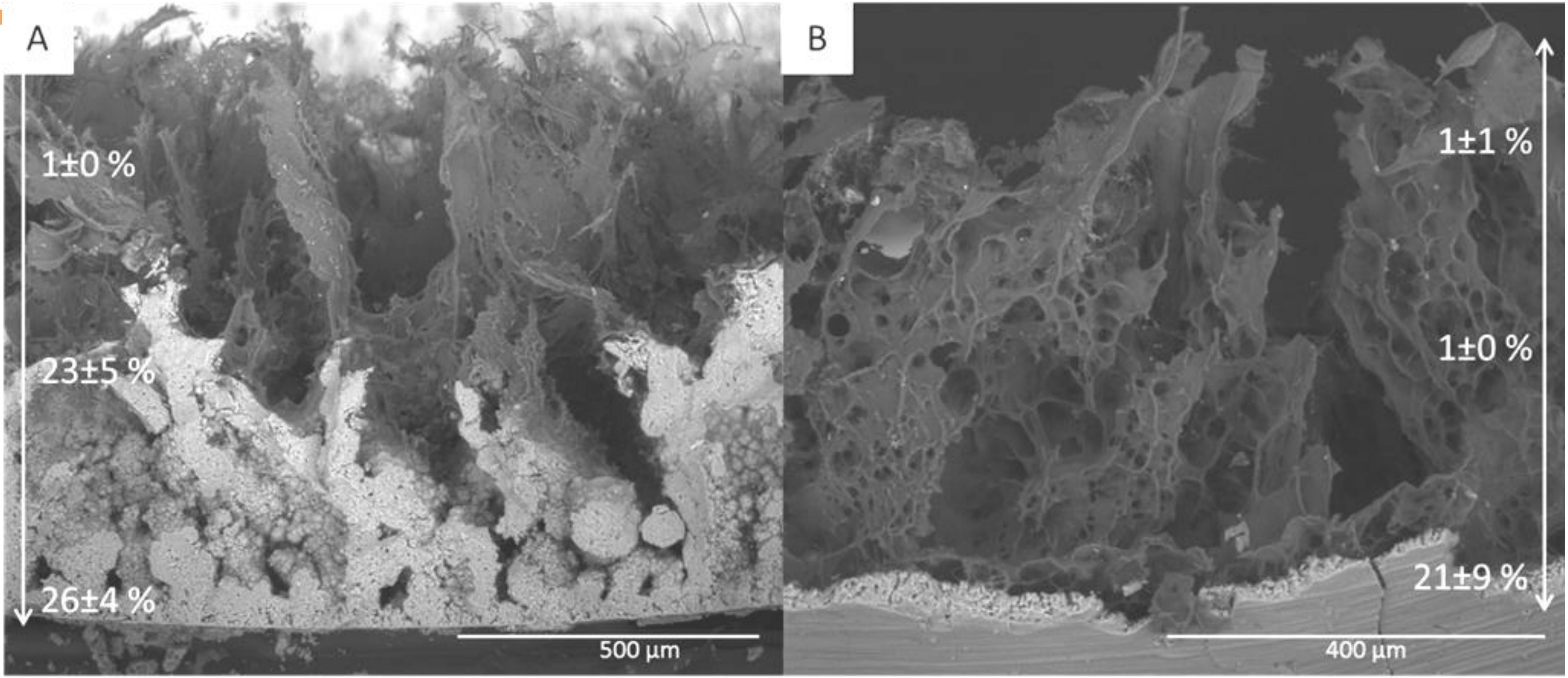




Short Acid Etching

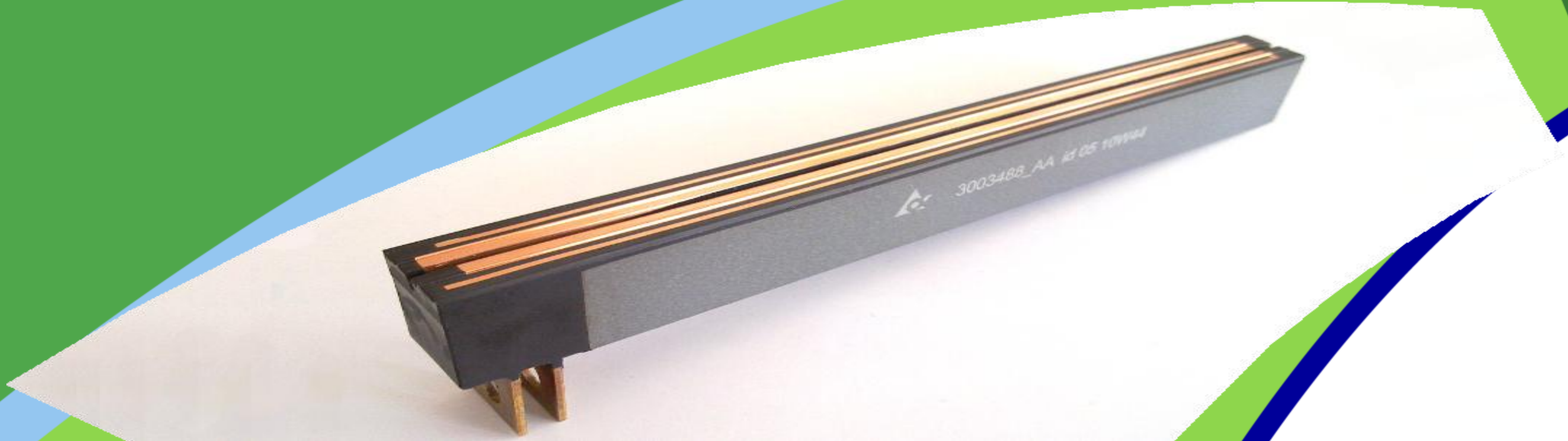


Questions/Measurment needs

- What proteins build up the fouling?
  - We can only measure carbon content
- Is the fouling built up of 5µm spheres?
- Are the spheres only β-$Ca_3(PO_4)_2$?
- Is the protein network a result of rearangement during time?

Induction Heating

Sealing packages at Tetra Pak



High demand pushed on to our packages

Making a composite material an efficient solution

Outside polyethylene: **protection**

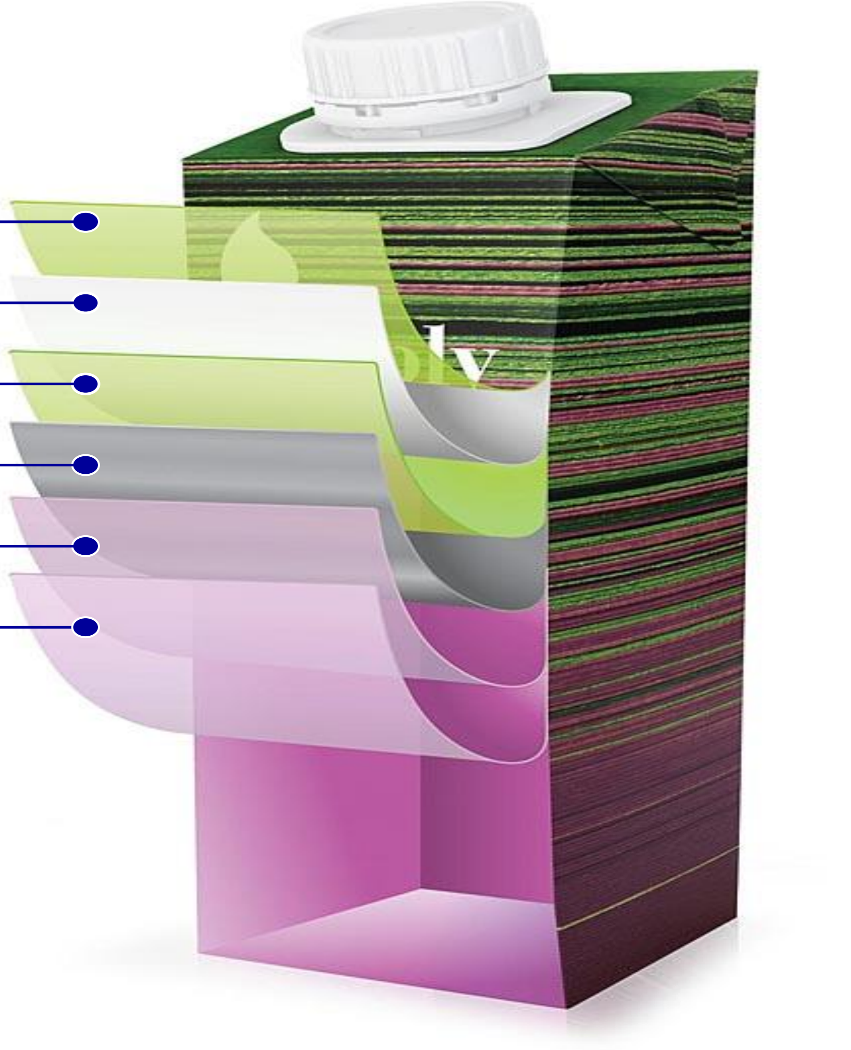
Paperboard: **stability and print**

Laminate polyethylene: **adhesion**

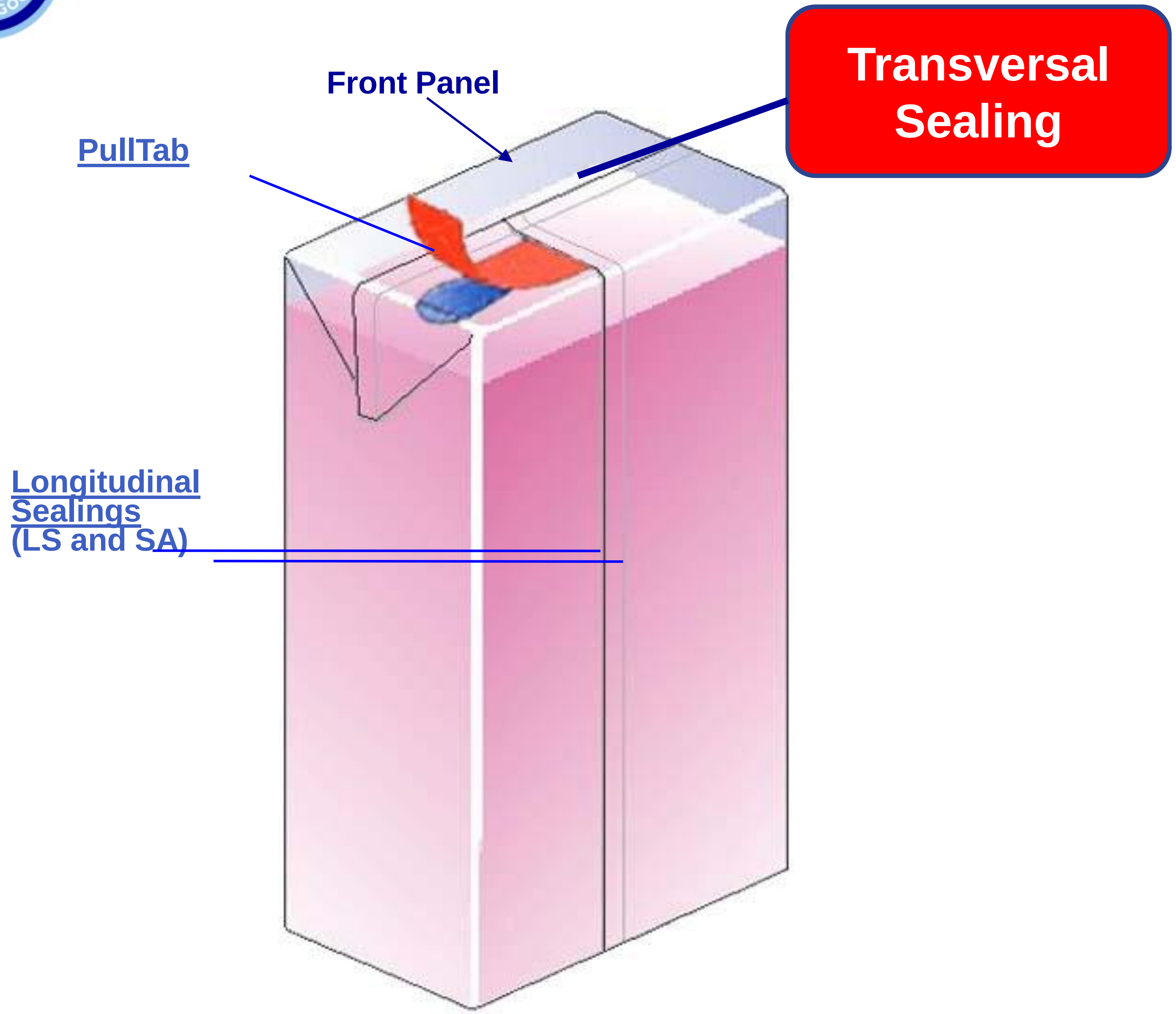
Aluminium foil: **oxygen, flavour and light barrier**

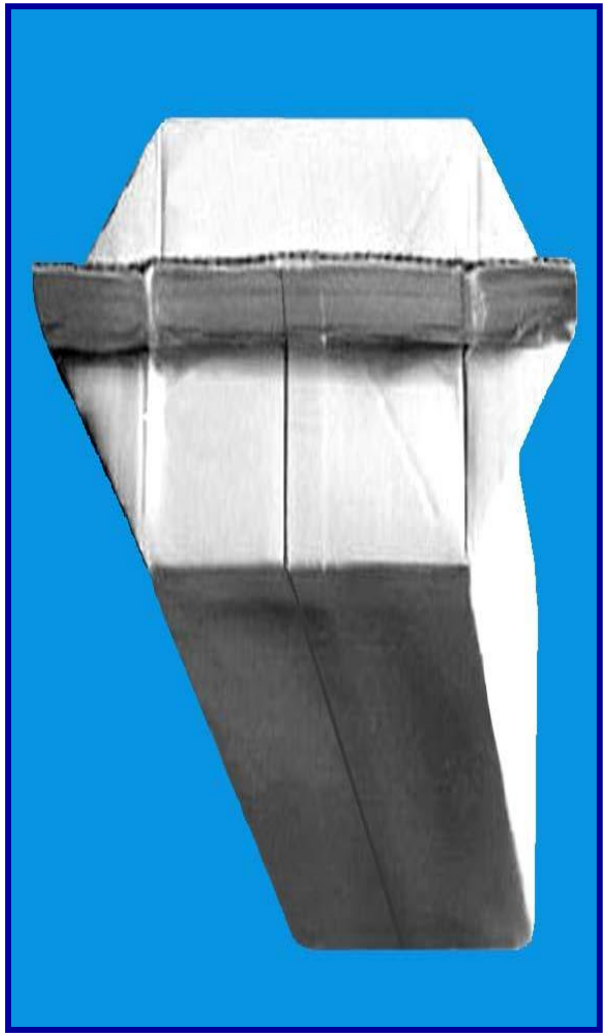
Inside adhesive polyethylene: **adhesion**

Inside polyethylene: **sealing, product contact**

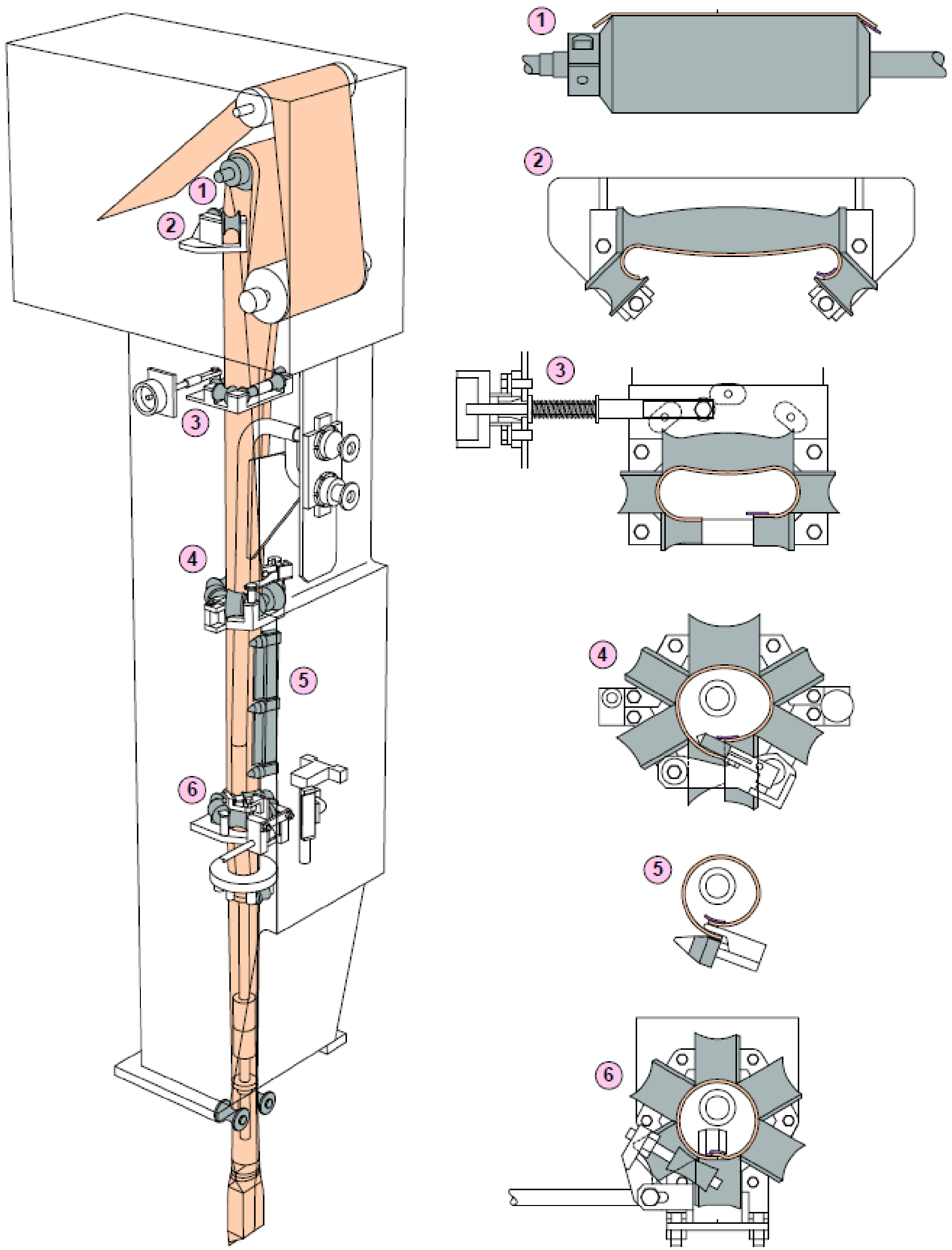


Aseptic sealings in Tetra Pak

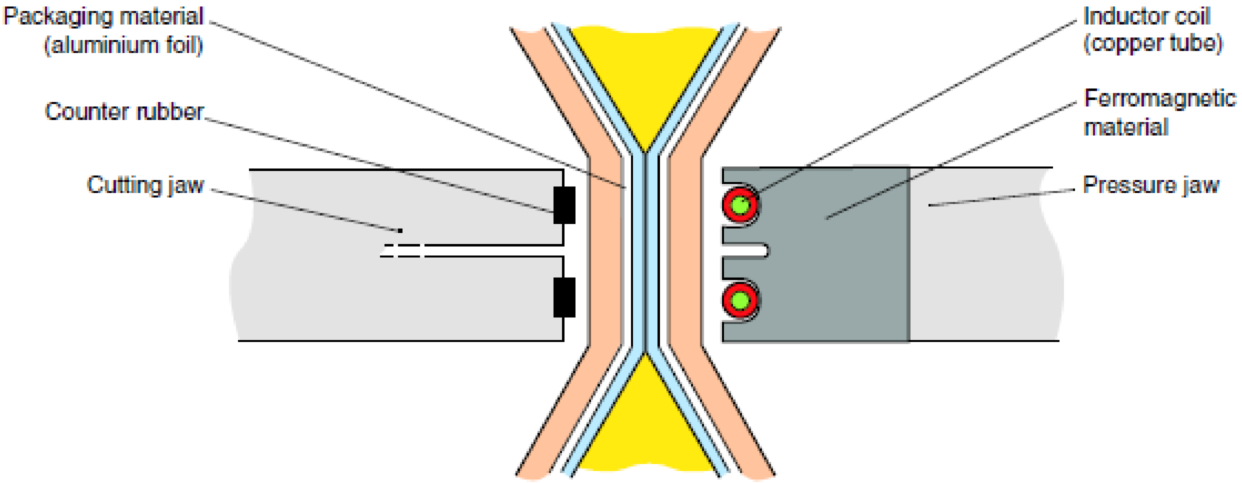




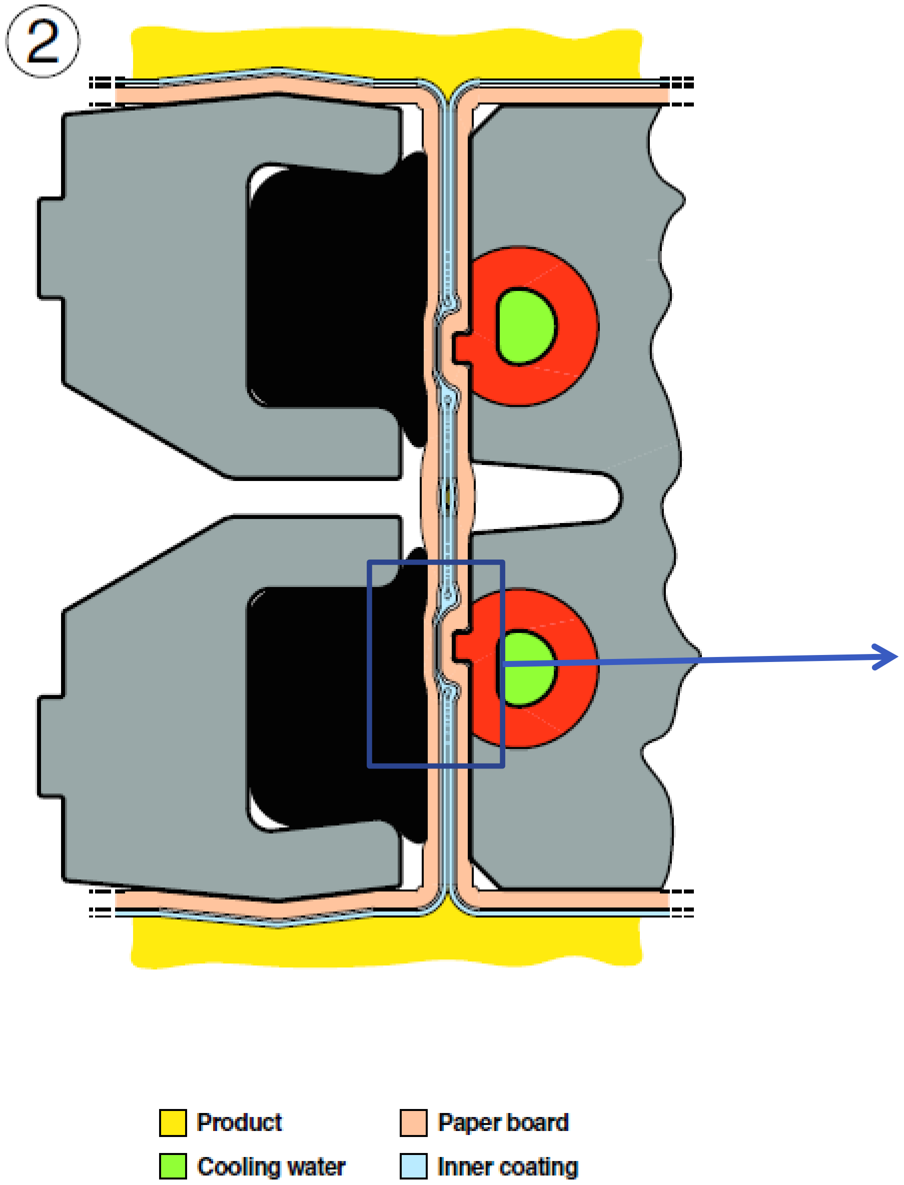
Forming of the tube

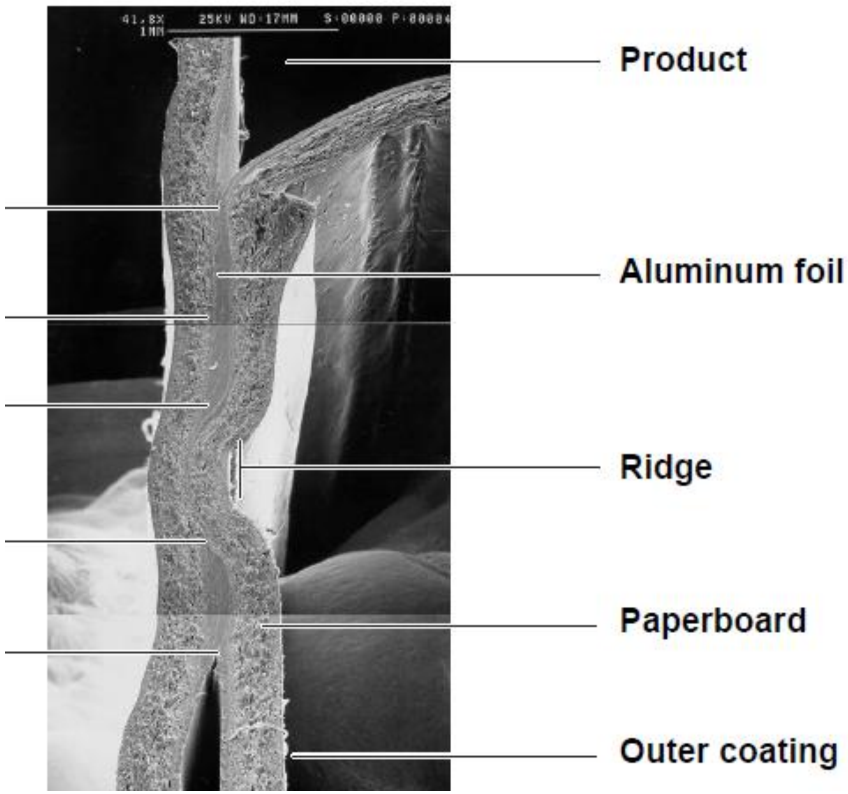


The principle of Induction Heating

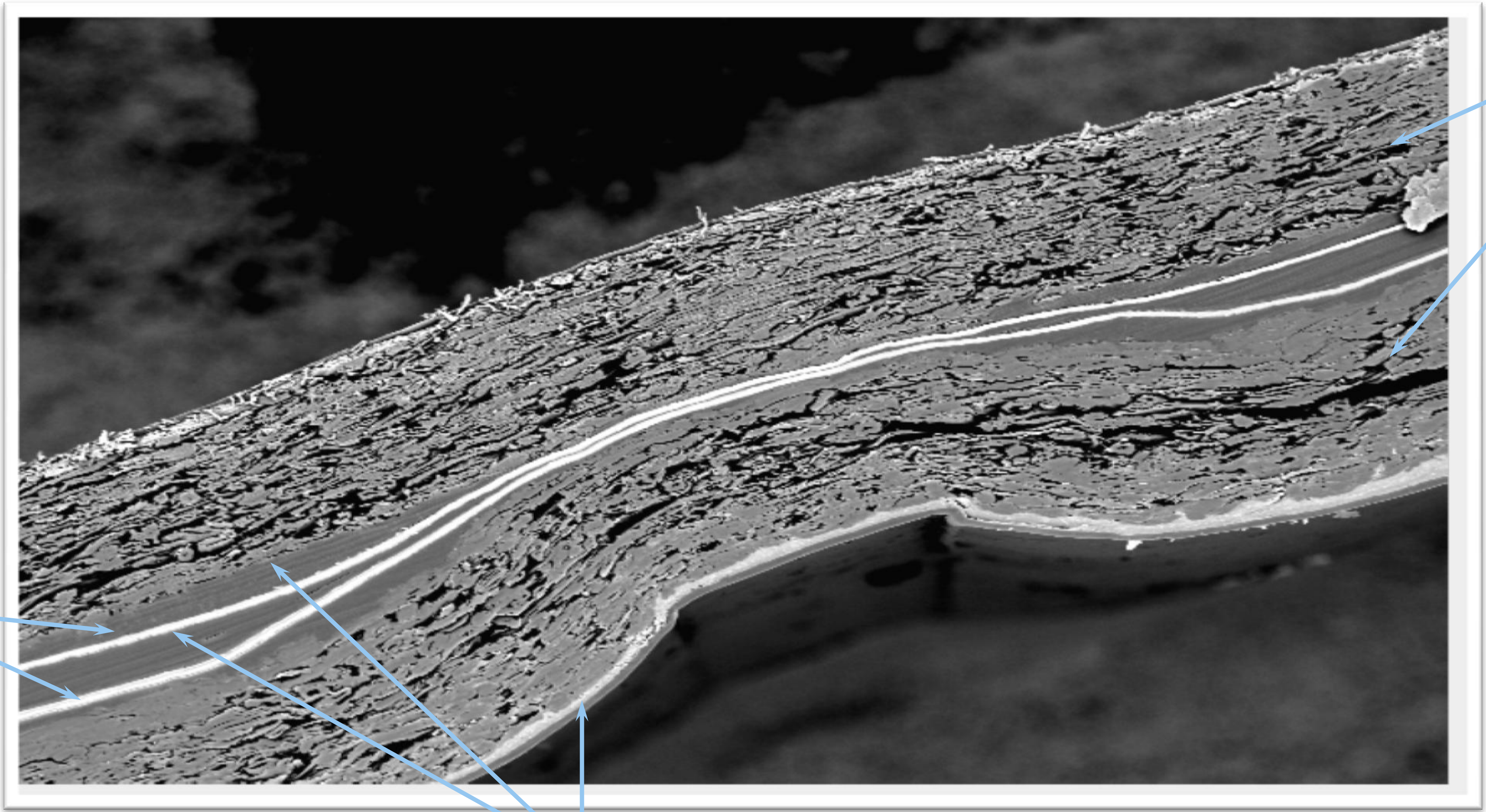


Transversal sealing TBA


2
Product
Paper board
Cooling water
Inner coating


Product
Aluminum foil
Ridge
Paperboard
Outer coating

Macro scale: SEM picture of a seal (Cross-section)

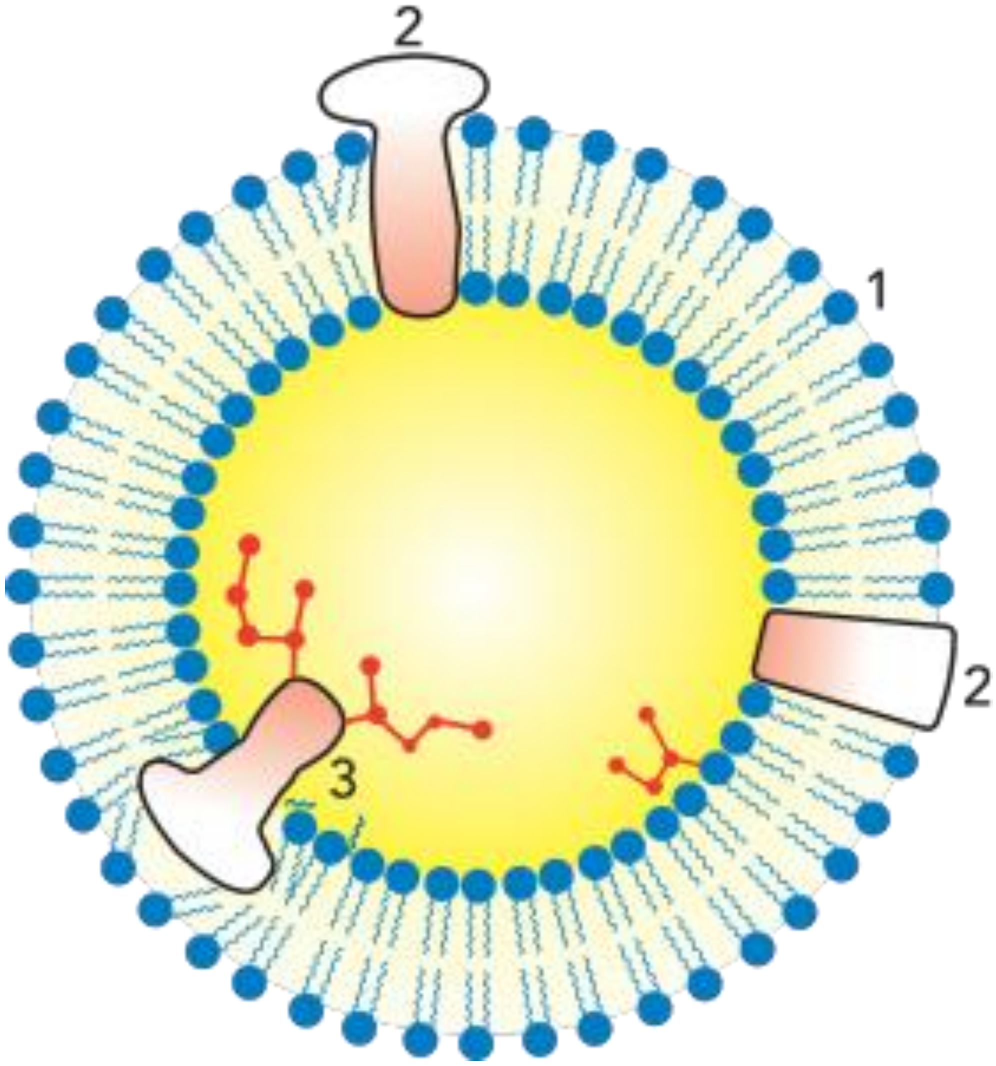


Questions/Measurment needs

- Does the food and the polyethylene interact?
  - Does the fat droplets in the food dissolve into the polyethylene?
- Does the food mix with the polyethylene or will it form regions?

Proteins on fat drops X2

Fat droplets (in milk)



1. Phospholipid
2. Protein
3. Glycoprotein

Improving product shelf-life for milk

- Stokes' relation

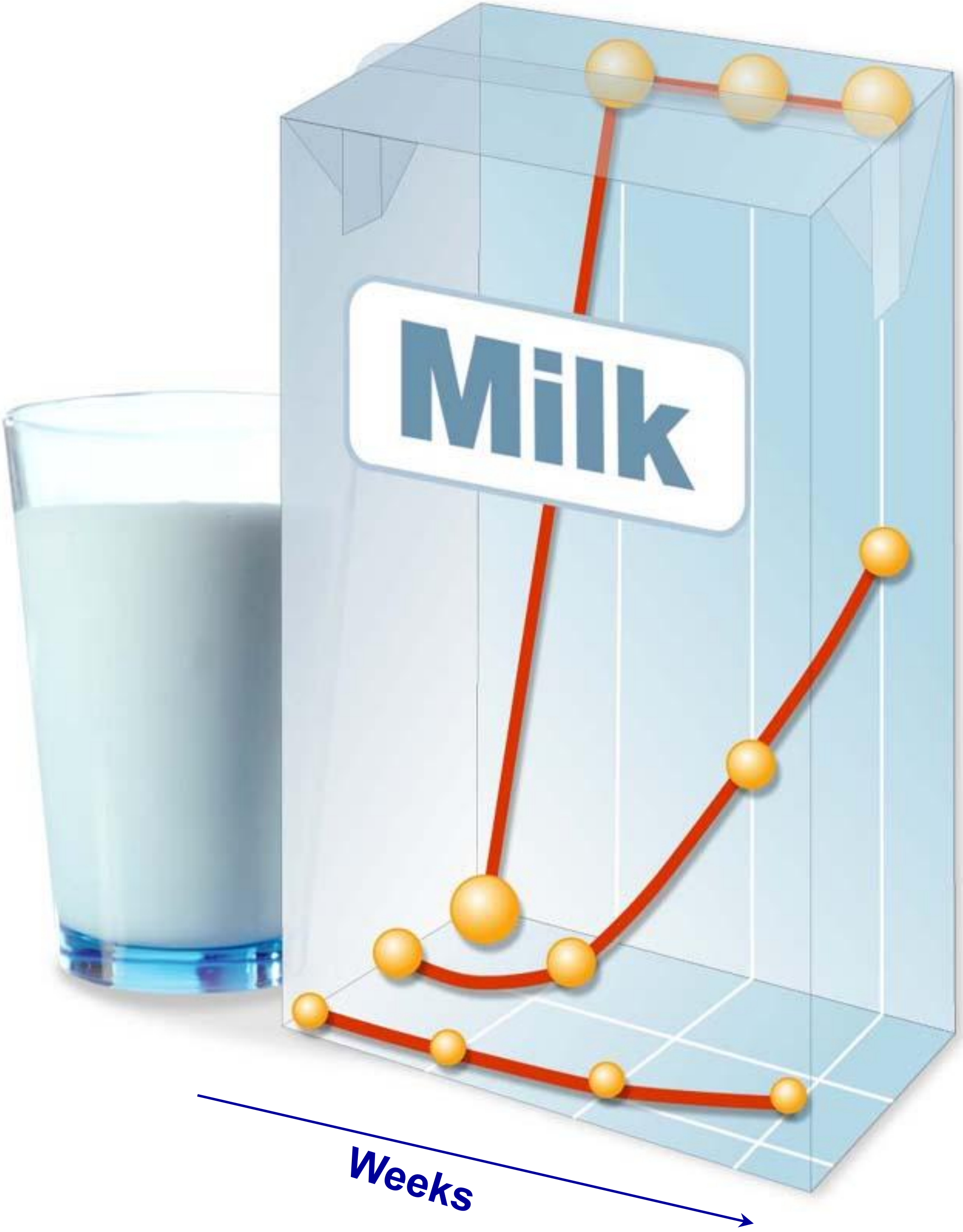
Rising velocity is given by

$$\frac{g \times \text{particle size}^2 \times (\text{dens. SM- dens. fat})}{18 \times \text{visc. milk}}$$

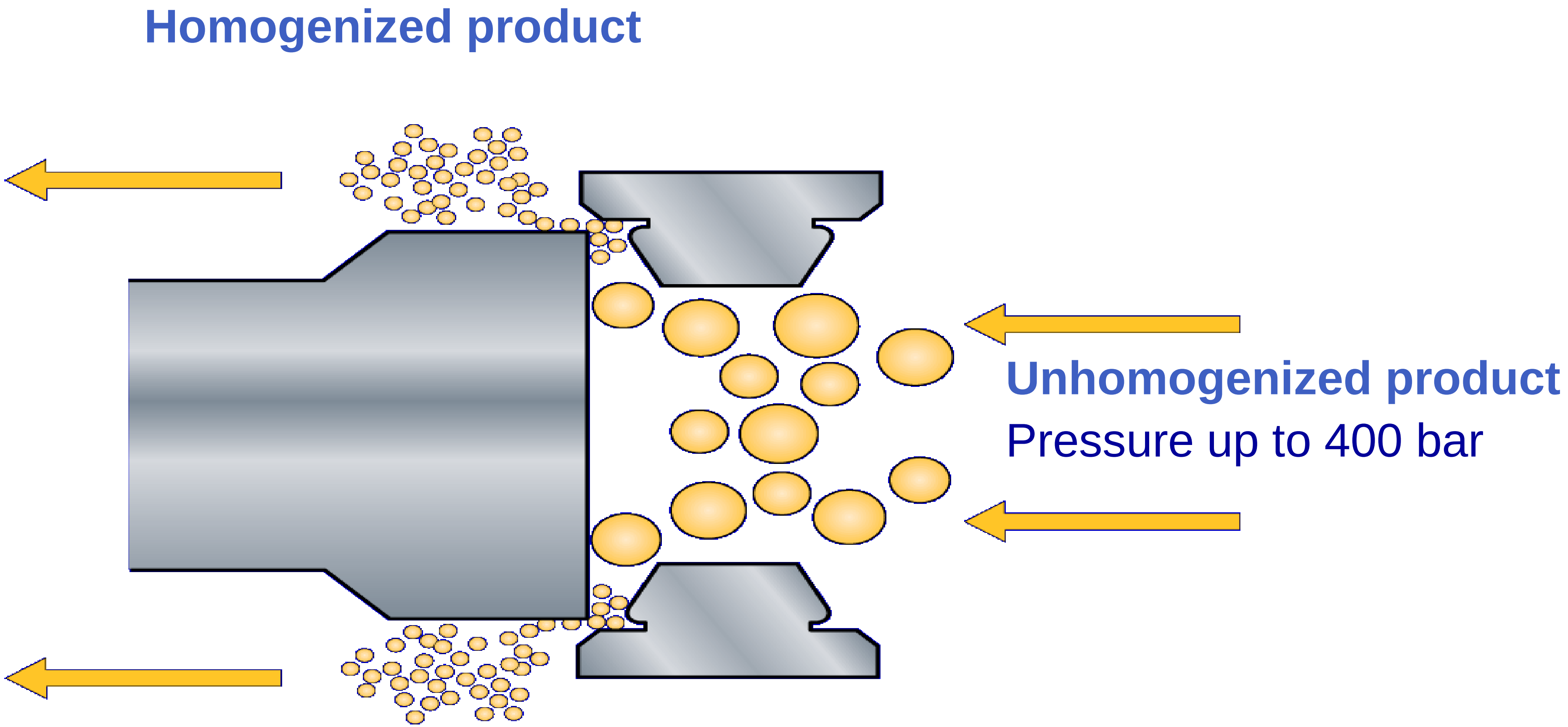
3.2 micron

0.8 micron

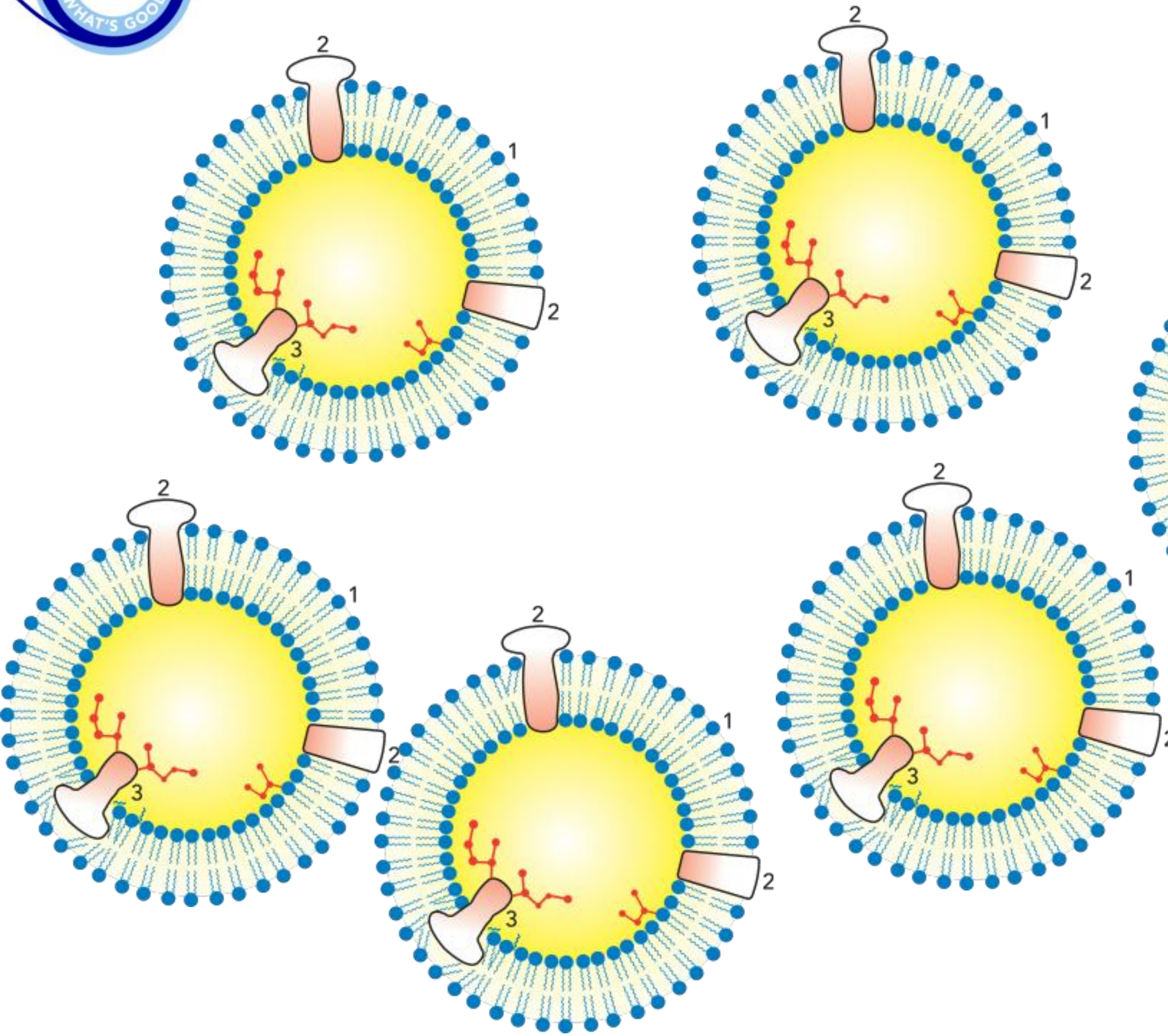
0.2 micron

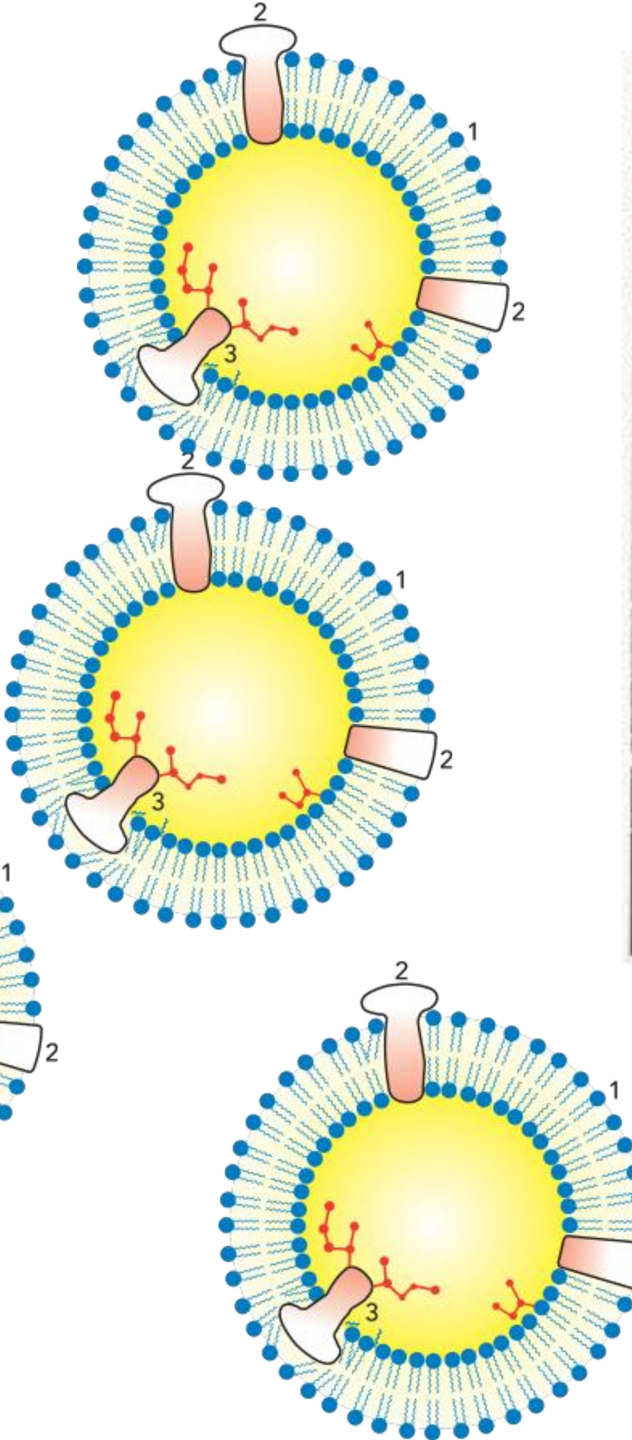


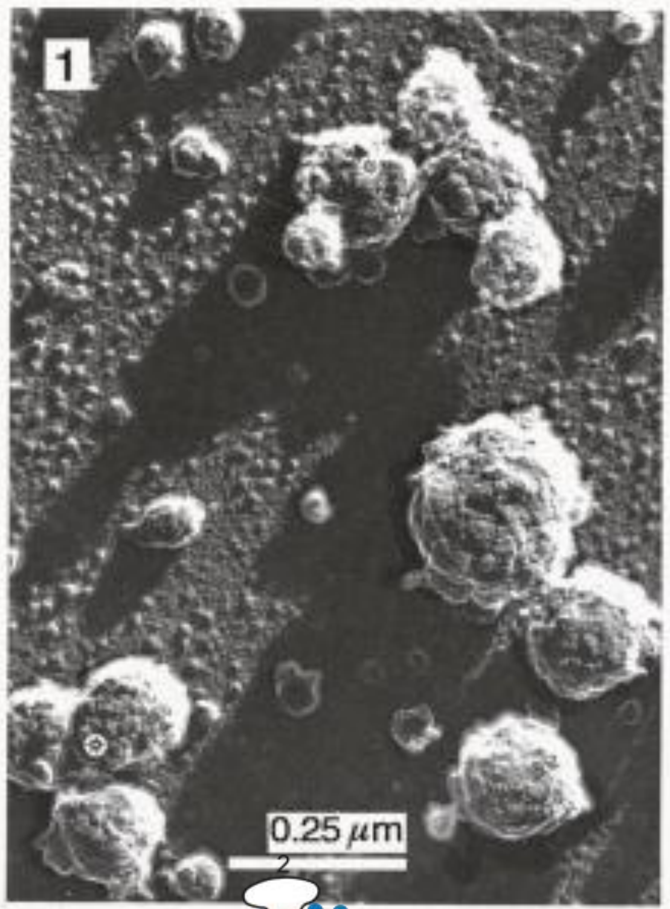
Process in the homogenizing device



Increase in surface area





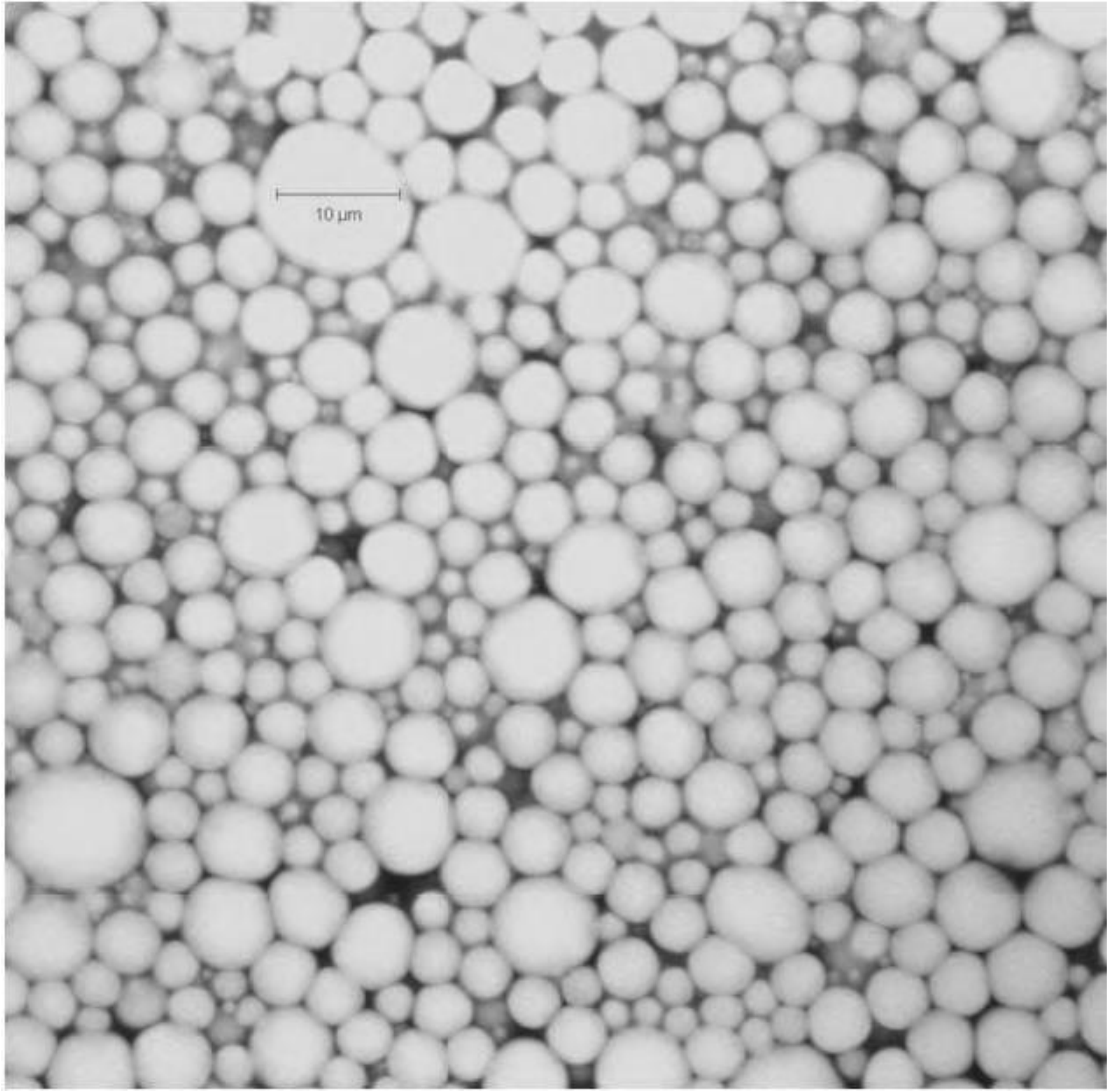


Questions/Measurment needs

- What is the surface composition of homogenized milk?
- What is the density of the surface layer? (and the complete drop?)
- What changes when we change protein type? (Soy or oats)
- How fast does the proteins unfold and cover the surface?

Mayonnaise

- Oil in water emulsion
- Egg as emulsifier
- Semi-solid behaviour



Ingredients

Dispersed phase

- Oil
  - High volume fractions 65-80%

Emulsifier

- Egg yolk

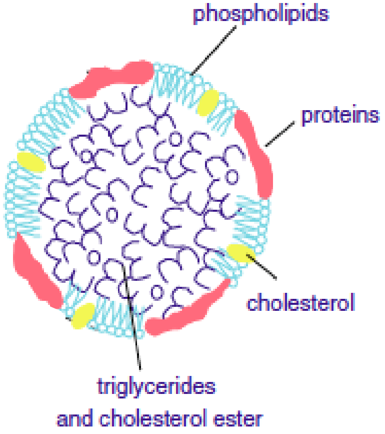
Water phase

- Vinegar
  - pH 4
  - Charged proteins
- Mustard
- Salt
  - Screening of charges
- Sugar

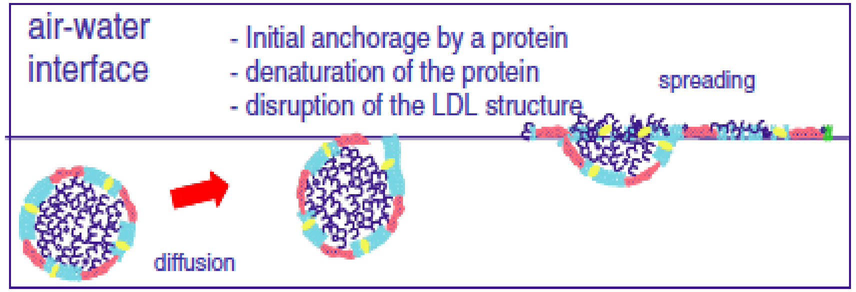
Egg yolk

- Egg yolk
  - Granules
    - HDL 70%
    - Phosvitin 16%
    - LDLg 12%
  - Plasma
    - Livetins 15%
    - LDL 85%

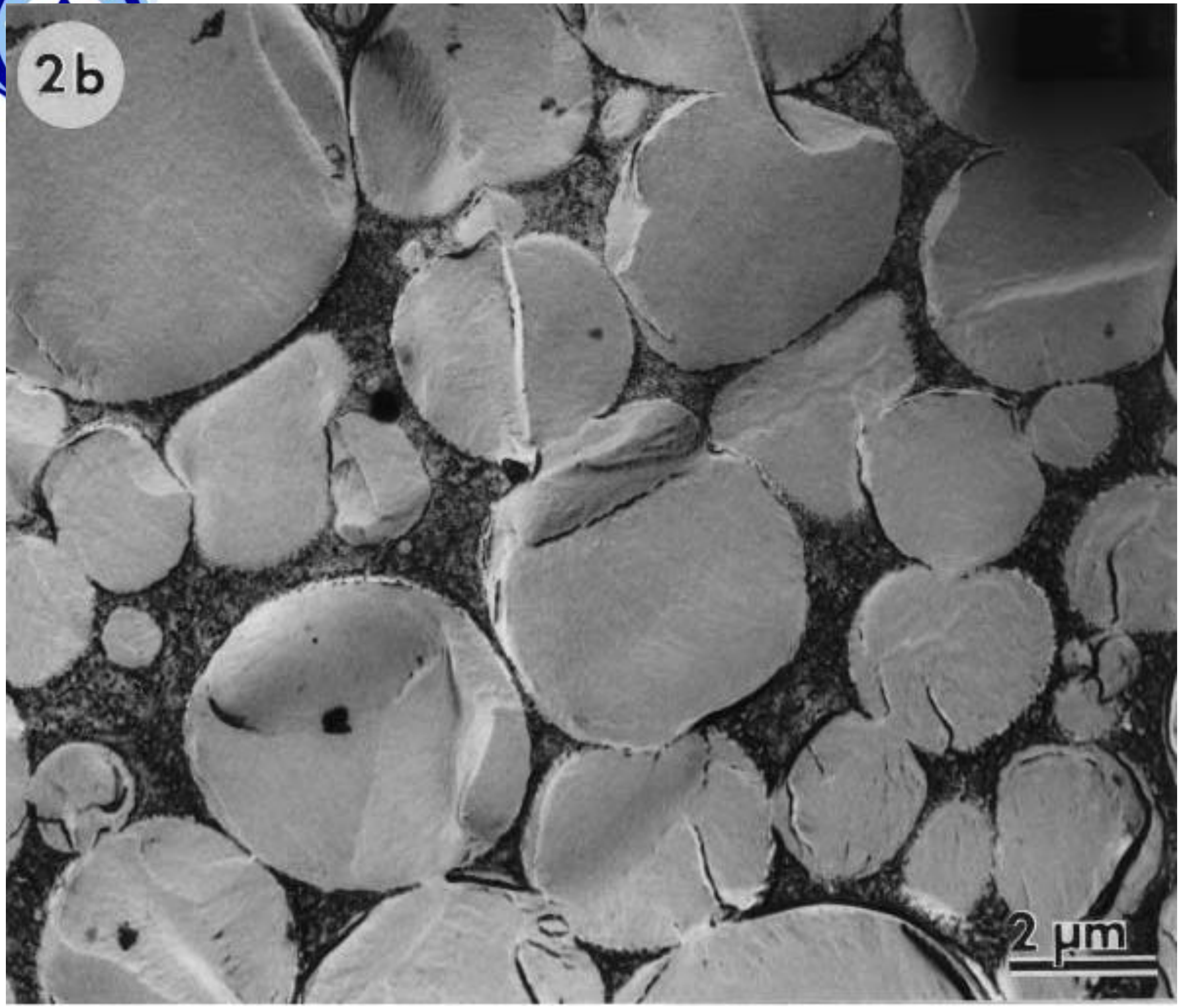
a)

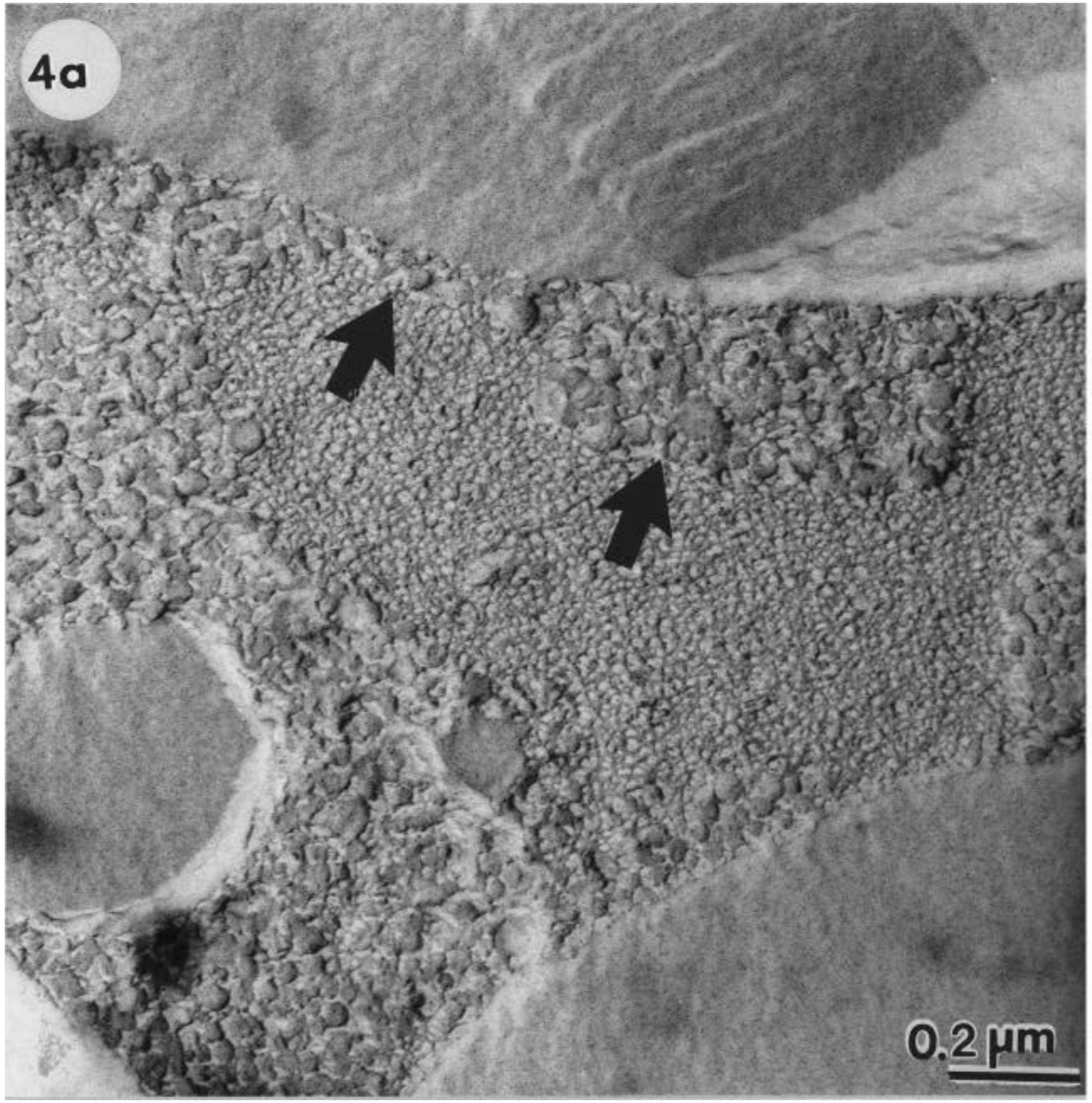


b)



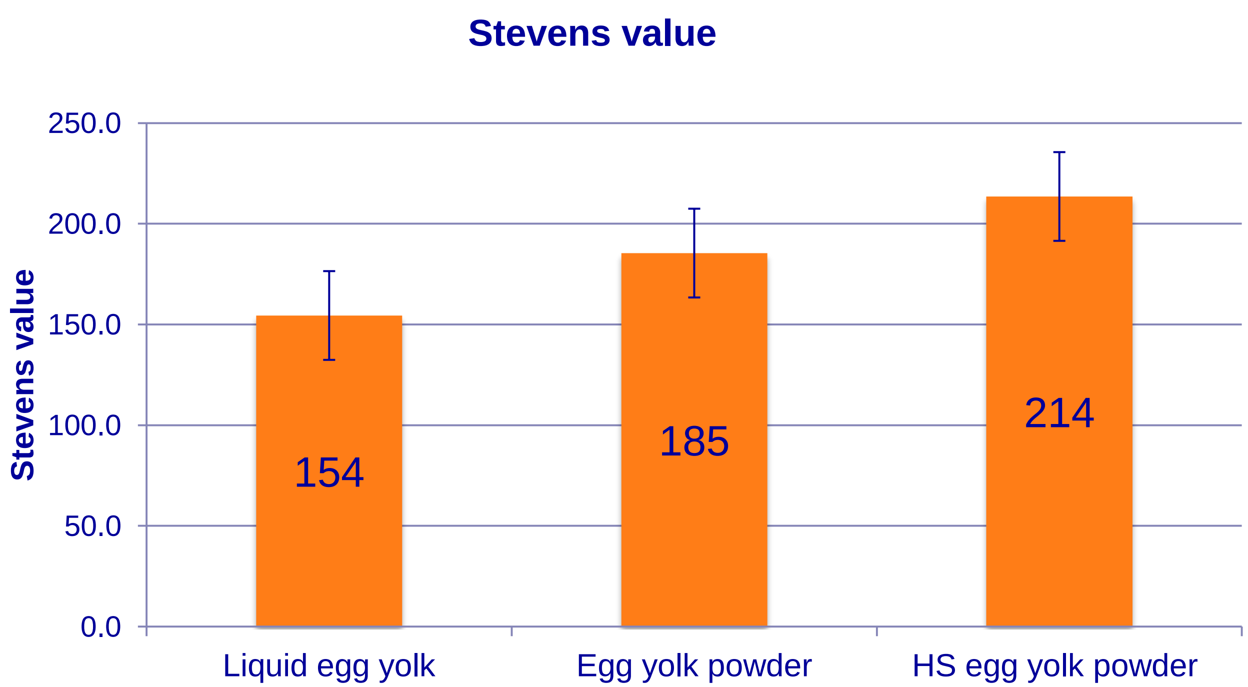
lipoprotein





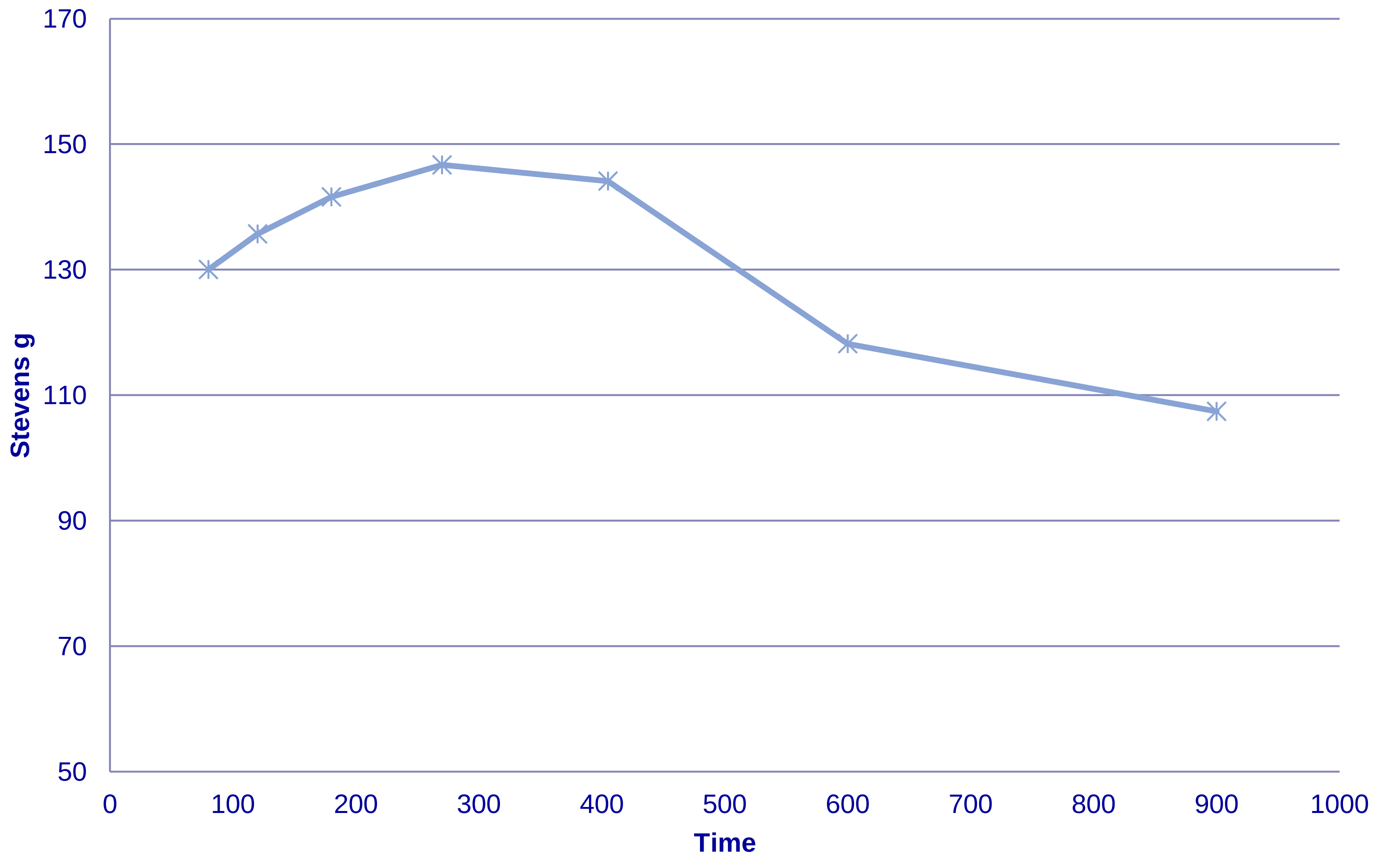
Langton, M., Jordansson, E., Altskär, A., Sørensen, C., & Hermansson, A. M. (1999). Microstructure and image analysis of mayonnaises. Food Hydrocolloids,13(2), 113-125.

Impact of egg yolk type



- Liquid egg yolk (salted and pasteurized)
- Egg yolk powder (spray-dried)
- Heat stable egg yolk powder (enzymatically treated and spray dried)

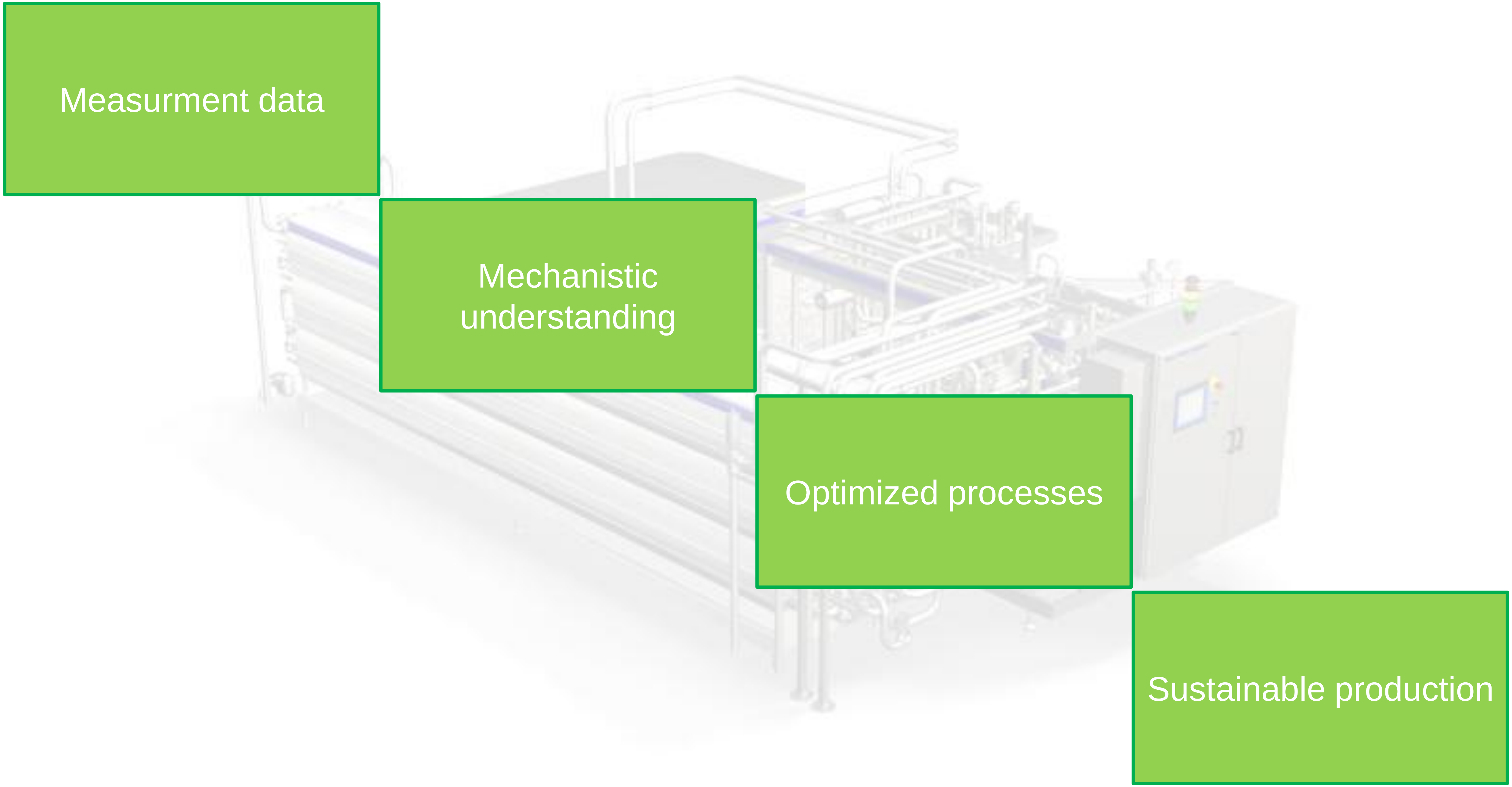
Impact of treatment time



- Peak in quality
- Egg adhesion properties destroyed by time
- Over-shear

Questions/Measurment needs

- How does the lipoproteins interact with the fat drops?
- How do they create adhesion between the drops?
- Do we break or agglomerate the lipoproteins during over-shear?


Measurment data
Mechanistic understanding
Optimized processes
Sustainable production