



Industrial applications of synchrotron and neutron radiation: Agriculture and Food Science

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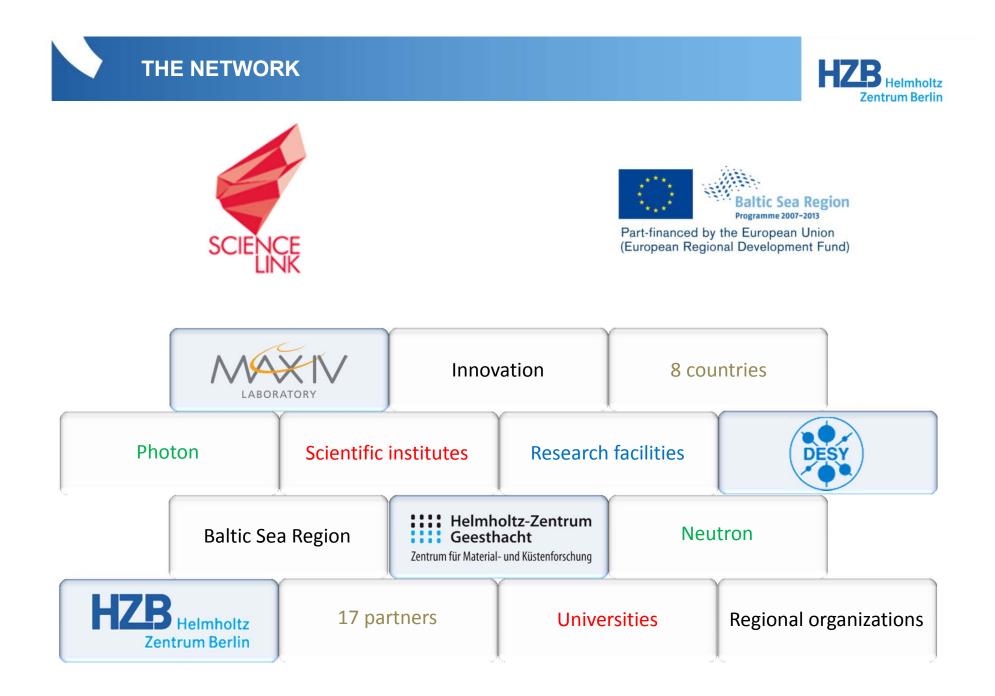


A possible solution to your R&D problems: for free





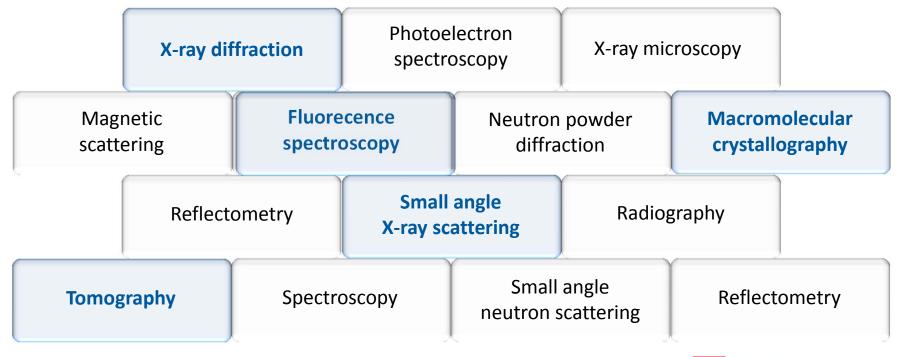






- Agriculture and food science
- Chemicals
- Construction and Engineering
- Environmental and Energy

- Home and Personal Care
- Life Science and Biotechnology
- Material Science and Nanotechnology















Agriculture

- Polluted soil
- Natural fertilizers
- Water distribution in plants
- Drought resistance

Food

- Ice cream structure
- Oil droplet disgestion
- Milk structure
- Cheese structure
- Microgels
- Structure of foams
- Food and pressure





Polluted agricultural soil

Trace element distribution in rice

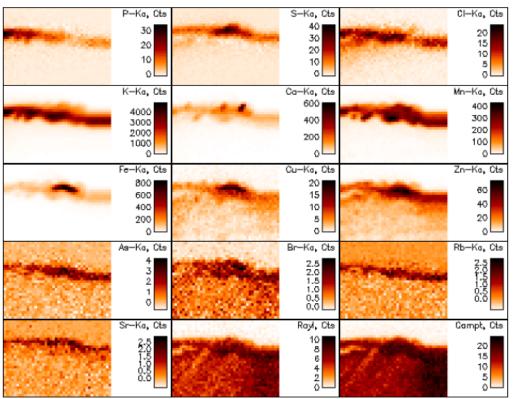


Figure 1: Horizontal normalised elemental 2D maps in a fresh Hungarian rice grain (normalised to 1 s and 100 mA, 30 x 42 pixels).



The groundwater and soil in some rural areas in China and Hungary exhibit a high concentration level of arsenic which can be taken up by different plants. The 2D distribution of arsenic and other trace elements in rice grains were measured by confocal µ-XRF technique

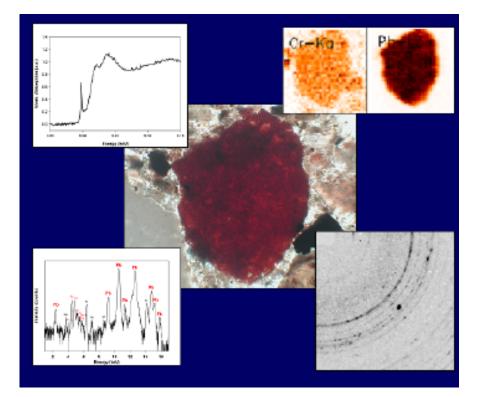






Industrial polluted soil

Assessment of heavy metals by XRD and XRF





The major geochemical forms of Cr, Ni, Cu, Zn, Pb, and V in a soil from an industrial polluted site in the South of Italy were determined by means of synchrotron X-ray micro-analytical techniques. Two major former industrial activities were tentatively ascribed as being responsible of the observed major pollution: PVC and cement-asbestos productions.





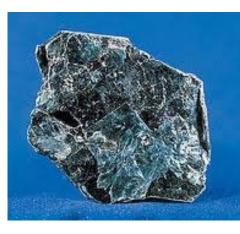


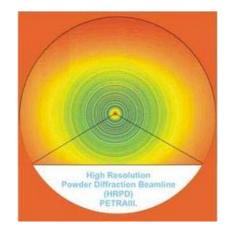


Natural fertilizers

Structural changes on heating by XRD







Finnish environmental technology company NanoGeo Finland Oy produces a filtering sand and fertiliser using a natural mineral. XRD at DESY was used to measure structural properties of the minerals at different temperatures, which is necessary to optimise the materials for use as fertilisers.



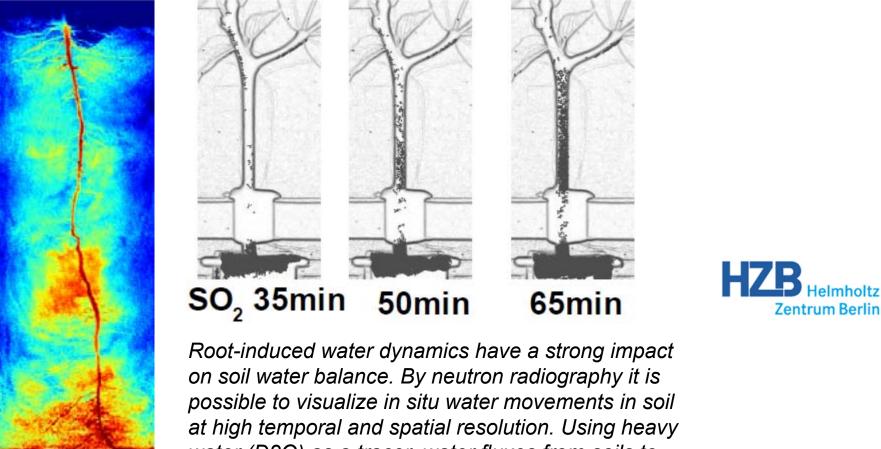






Water distribution in plants

Plant root structure and water uptake from soil



water (D2O) as a tracer, water fluxes from soils to roots and within the root system can be detected.

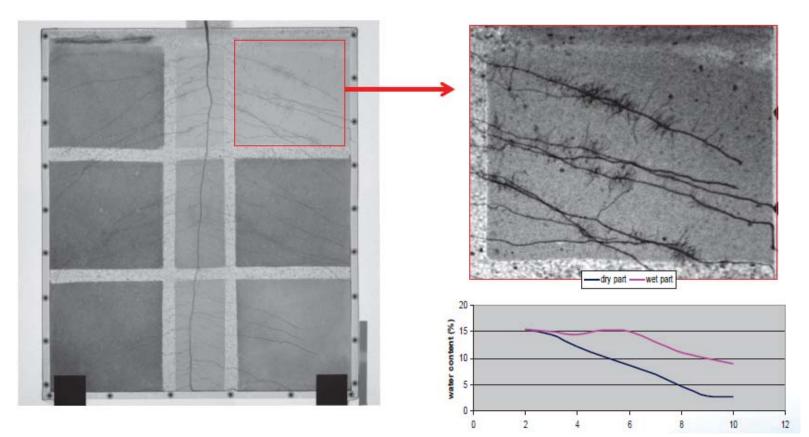






Water distribution in plants

Root patterns in heterogeneous soils (diff water and phosphor contents)





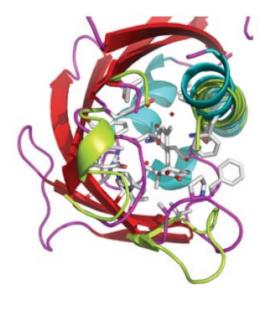






Drought resistance in plants

Biomolecular origin of stress reaction in plants







0 Pedro L Rodriguez

X-ray crystallography was used to determine protein structure of plant hormone ABA. Open and closed form of ABA interactiondetermines the process of stress response starts: by binding to PYR1 protein, ABA causes it to hijack PP2C protein molecules, unable then to block the stress response eg. on drought.







The Basis for R&D on Food and Nutrition

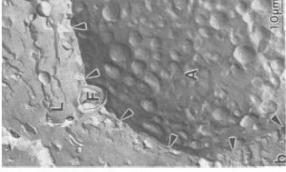
From the farm...



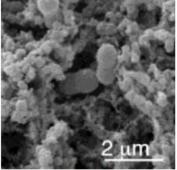




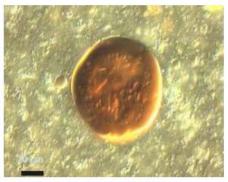
The Basis for R&D on Food and Nutrition



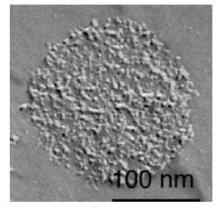
Air Bubble in Ice cream



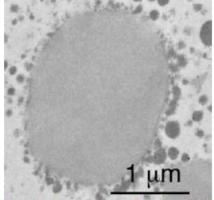
Casein micelle network in Yogurt



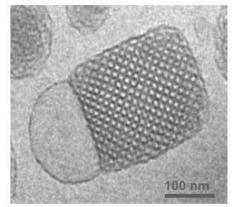
Oil droplet Coffee



Casein micelle in Milk



Emulsion droplet in Milk Stabilized by Protein



Cubosome as is formed during fat digestion

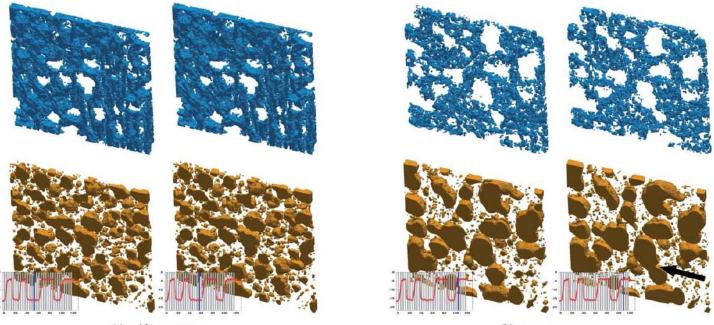






Air bubbles in ice cream

X-ray tomography to probe coarse grain structure



(a) cold temperature

(b) warm temperature

The non-destructive measurements allow for a quantification of structural parameters of one and the same subregion of the sample, which gives new insight into the coarsening process of ice cream.

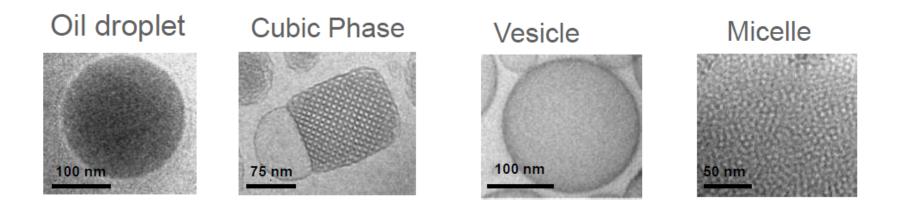
Pinzer et al., Soft Matter, 2012, 8, 4584







Structure evolution as function of the lipophilicity of "oily" ingredients



Increase hydrophilicity of lipophilic molecules

- Online investigation of Triolein digestion using Time resolved . SAXS.
- Influence of lipase, pH and bile salts on formed structures during . digestion and kinetics can be measured.

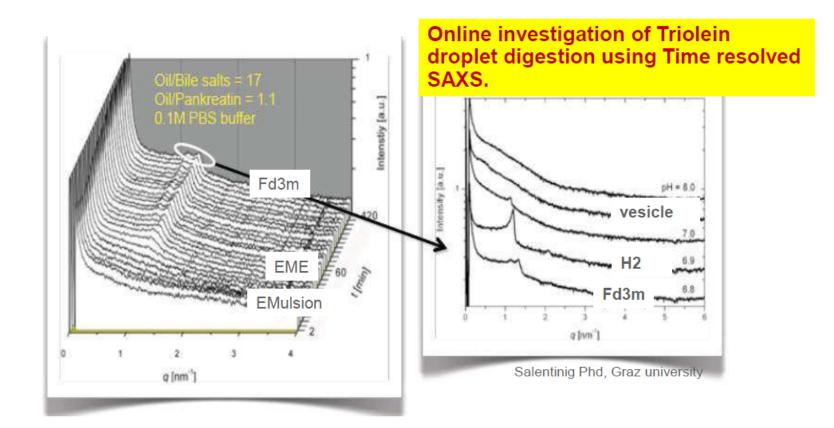








Structure evolution as function of the lipophilicity of "oily" ingredients



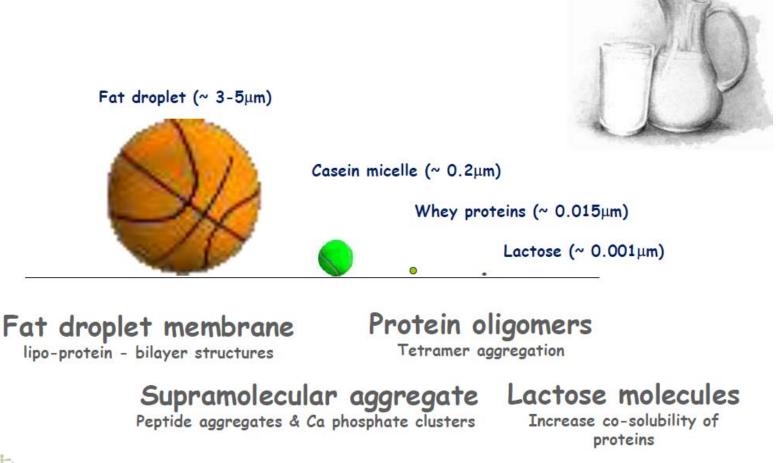








Milk - A hierarchically designed natural product











Milk protein concentrates for cheese

To design a process for production of MF cheese it is crucial to understand the interactions between protein, water and calcium in the concentrate as well as in the cheese.

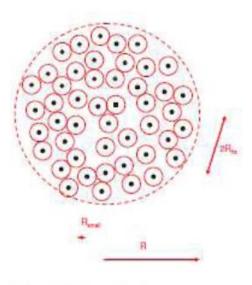


Figure 1: Model of case in micelle



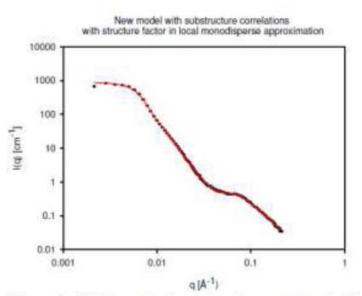


Figure 3: SAXS scattering data of concentrated milk casein isolate with the corresponding fit to data.





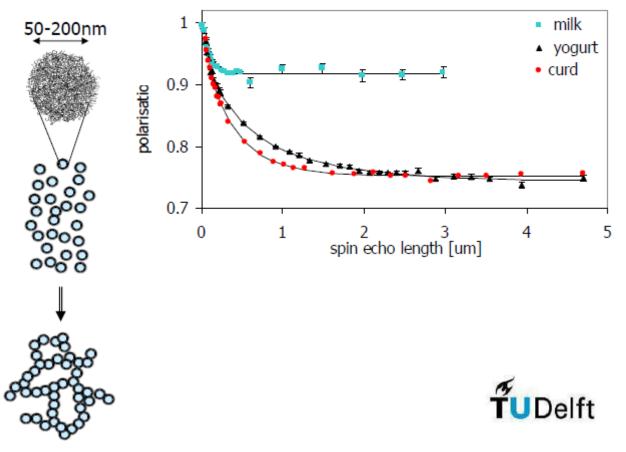
From milk to yoghurt to curd

Structure determined of dairy products



Evolution of aggregation of casein micelles was probed by small angle spin echo measurements from nanometer to micrometer range.

Tromp et al. Food Hydrocolloids 21, 154-158 (2007)







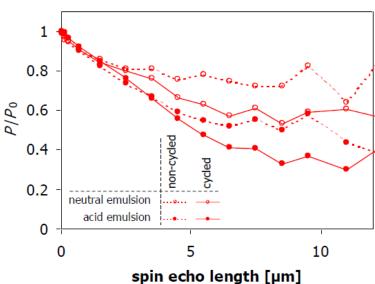


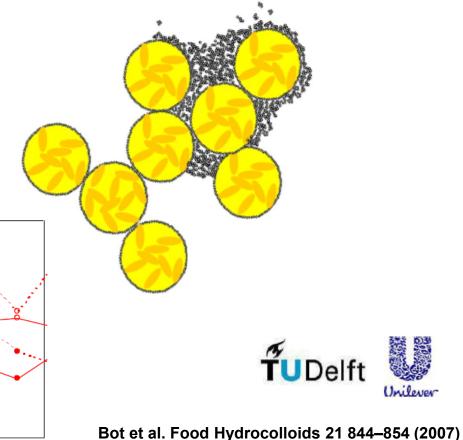
Fresh cheese texture

Microstructure determines taste and shelf life time

Fresh cheese-type products have a complex microstructure, built from elements of quite different size and properties:

- fat droplets, stabilised by protein
- fat droplet aggregates
- protein aggregates











Properties of gels

Structural changes as seen by SANS

Stabilization *via* attractions Pourable "gel" Structure *via* attractions (More) solid gel









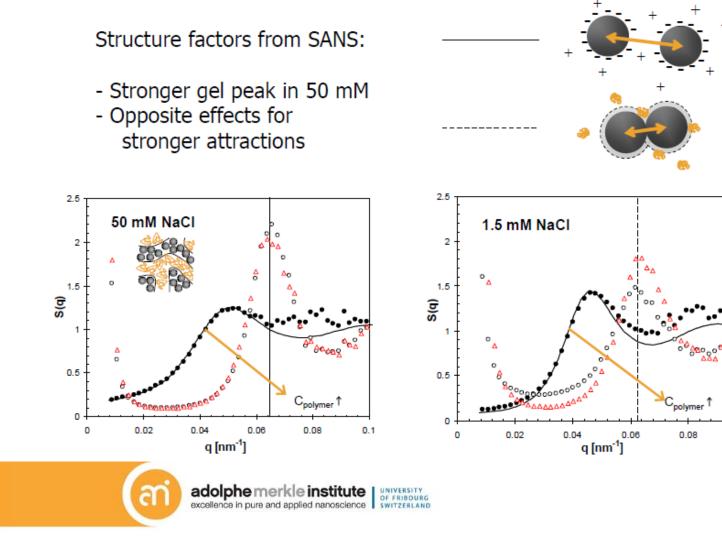






Properties of gels

Structural changes as seen by SANS



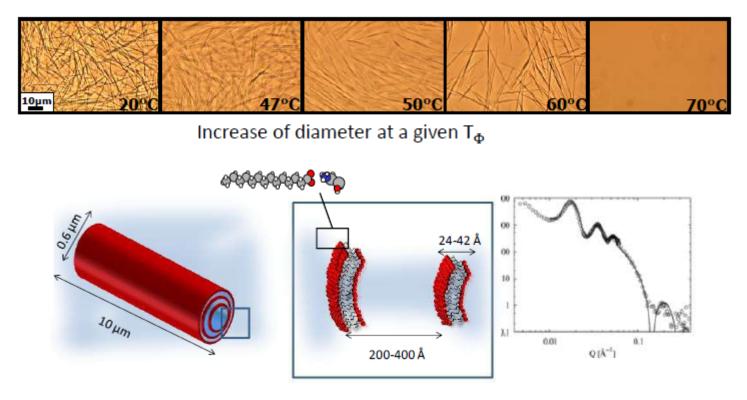
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Stabilization of smart foams

Temperature dependent aggregation in bulk



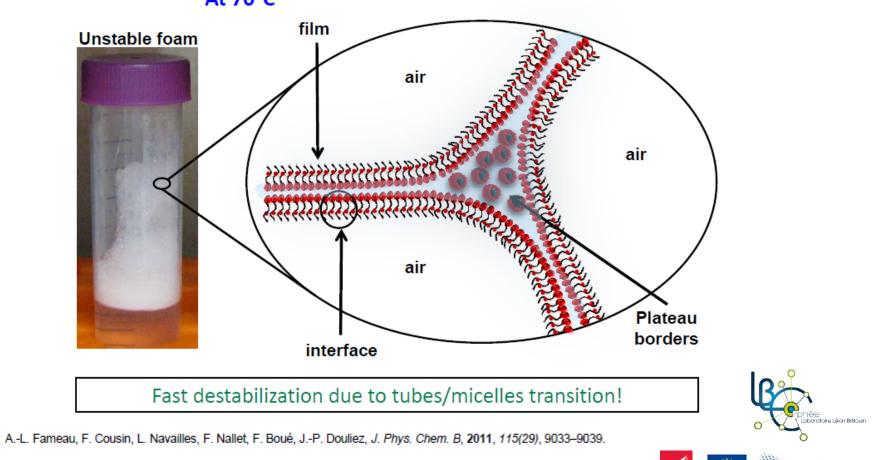
A.-L. Fameau, F. Cousin, L. Navailles, F. Nallet, F. Boué, J.-P. Douliez, J. Phys. Chem. B, 2011, 115(29), 9033-9039.





Stabilization of smart foams

Temperature dependent aggregation in bulk



At 70°C

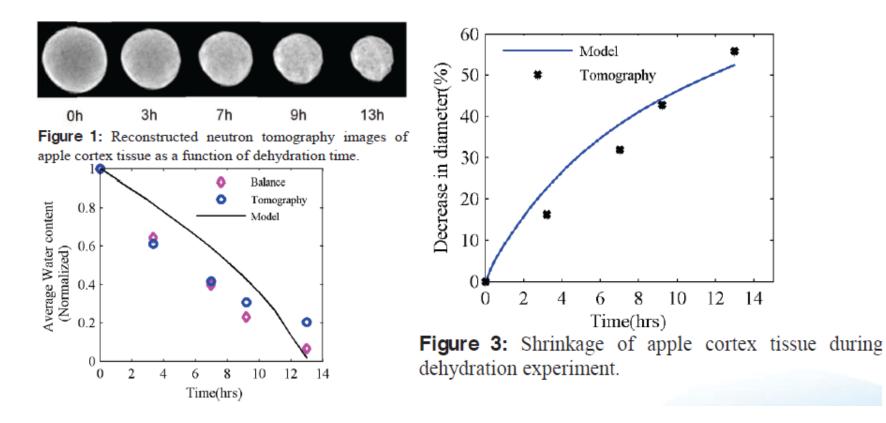






Dehydration of fruits

Dehydration of fruit tissue in tomographic studies (here apple)



W.A. Aregawi et al. (Leuwen Univ., Deptm. Of Biosystems)



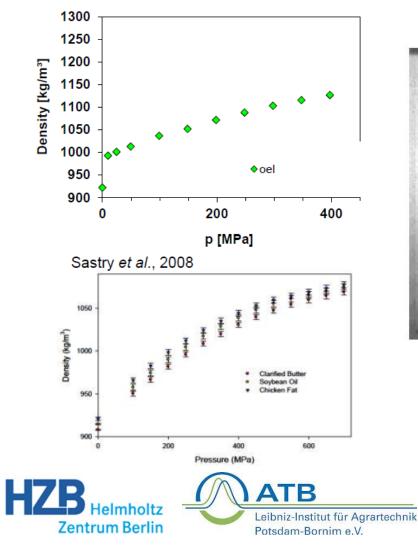


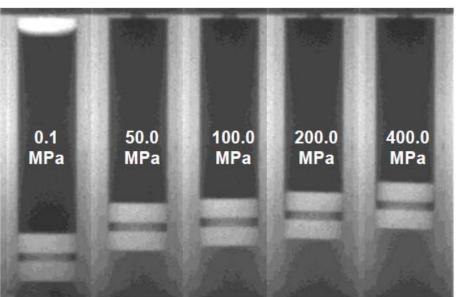




Food and pressure

Volume changes and densities in olive oil











Food and pressure

Pressure studies on food (freeze dried potato cylinder)

