

# Wheat gluten protein structures in processed foods and non-foods

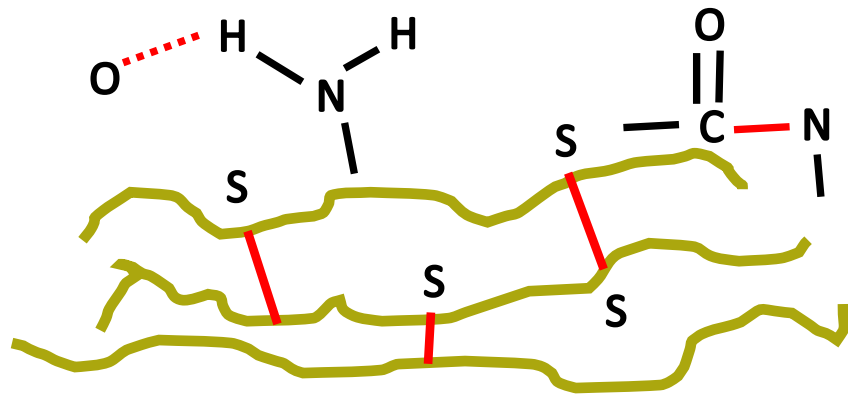
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Department of Plant Breeding, SLU, Alnarp

13<sup>th</sup> International Gluten Workshop, March, 2018

# Research question

- How do the wheat gluten protein structure steer the functionality?



Plasticize  
Thermo-  
process  
Blend  
Freeze-dry

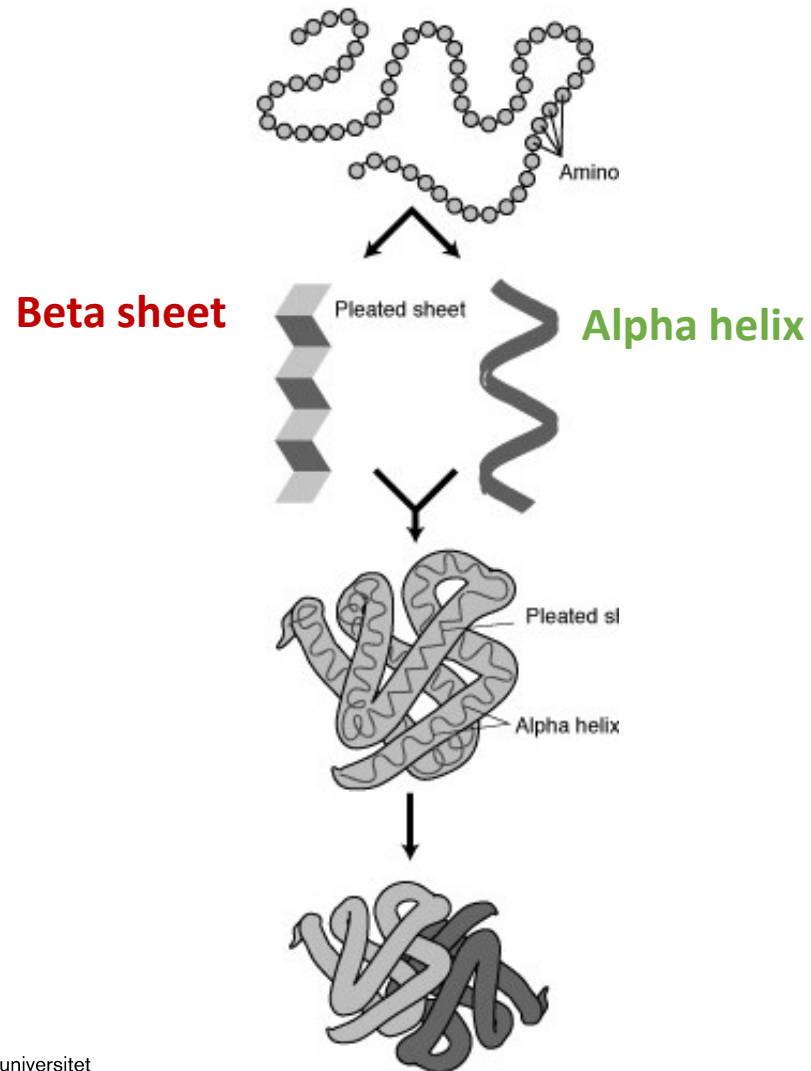


?

Molecular scale

Visco-elastic and  
mechanical properties

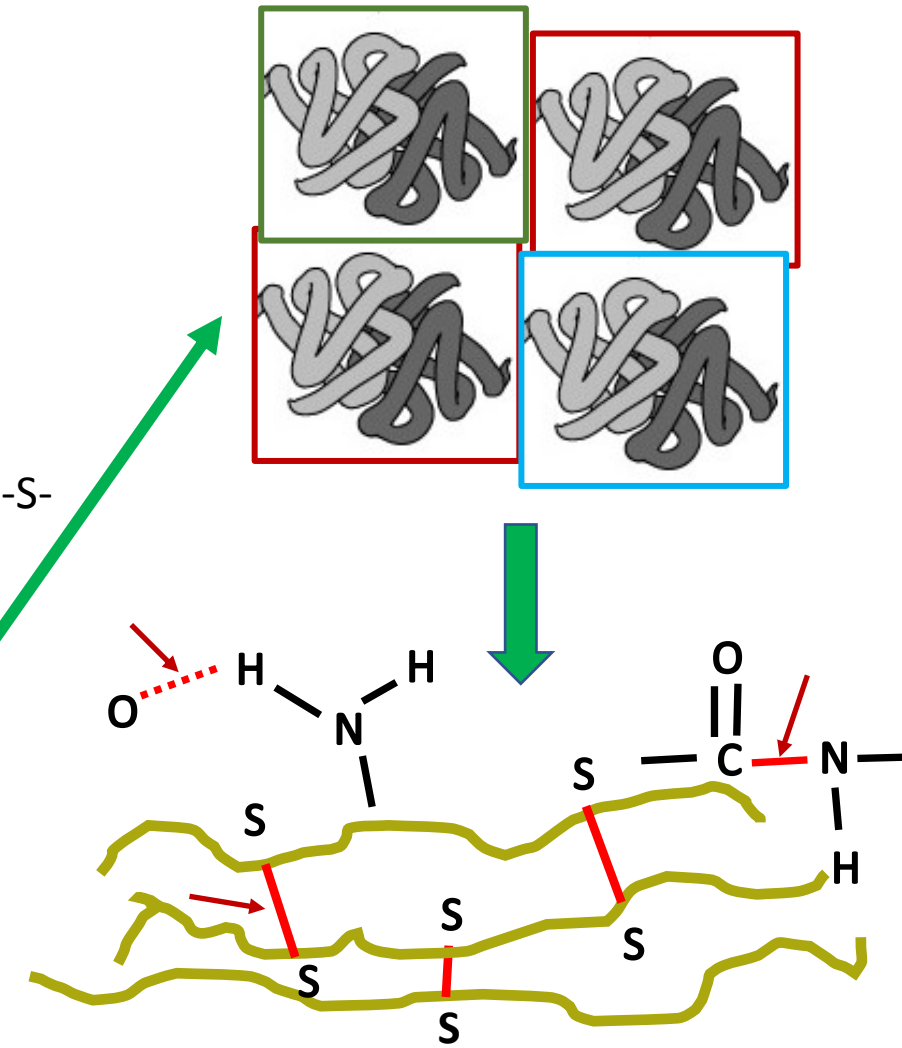
# Plant protein structure is a key for function



hydrogen bonds

stronger bonds -S-S-

poly-peptides

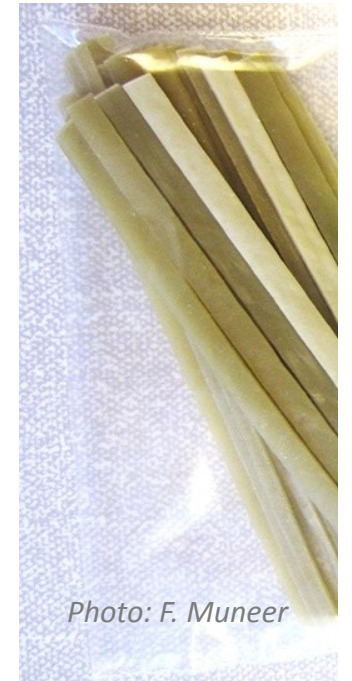
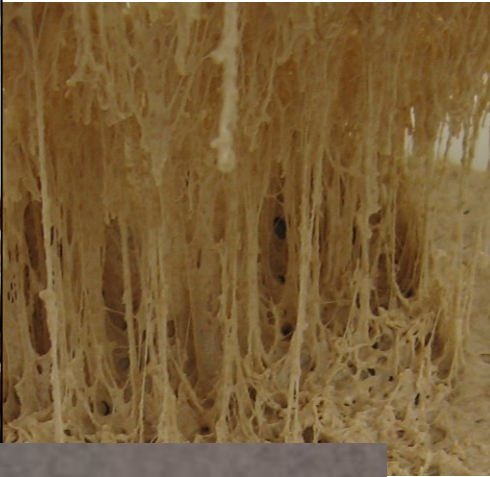


# Plant protein systems

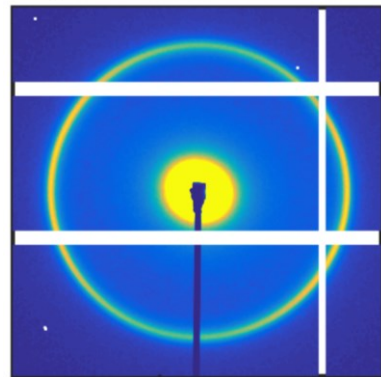
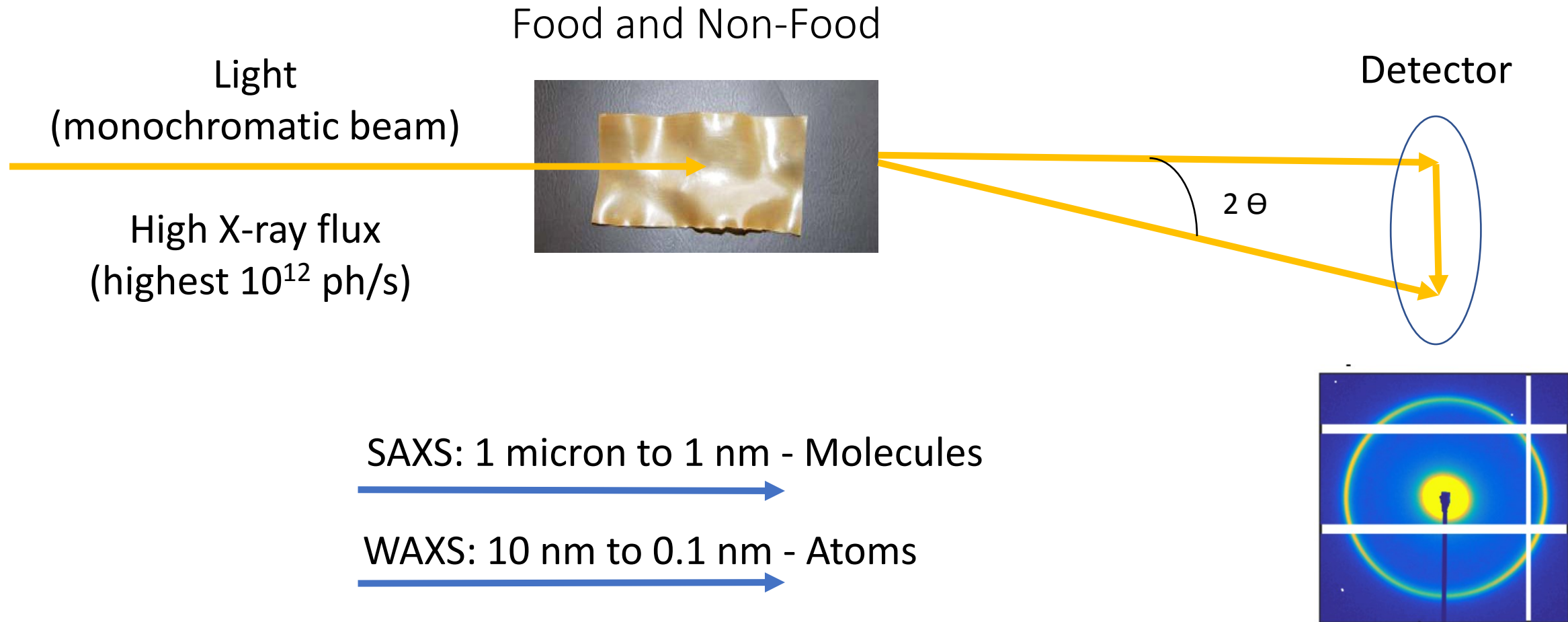
## Food

## Non-food

GENOTYPE  
CULTIVATION  
EXTRACTION  
PROCESSING



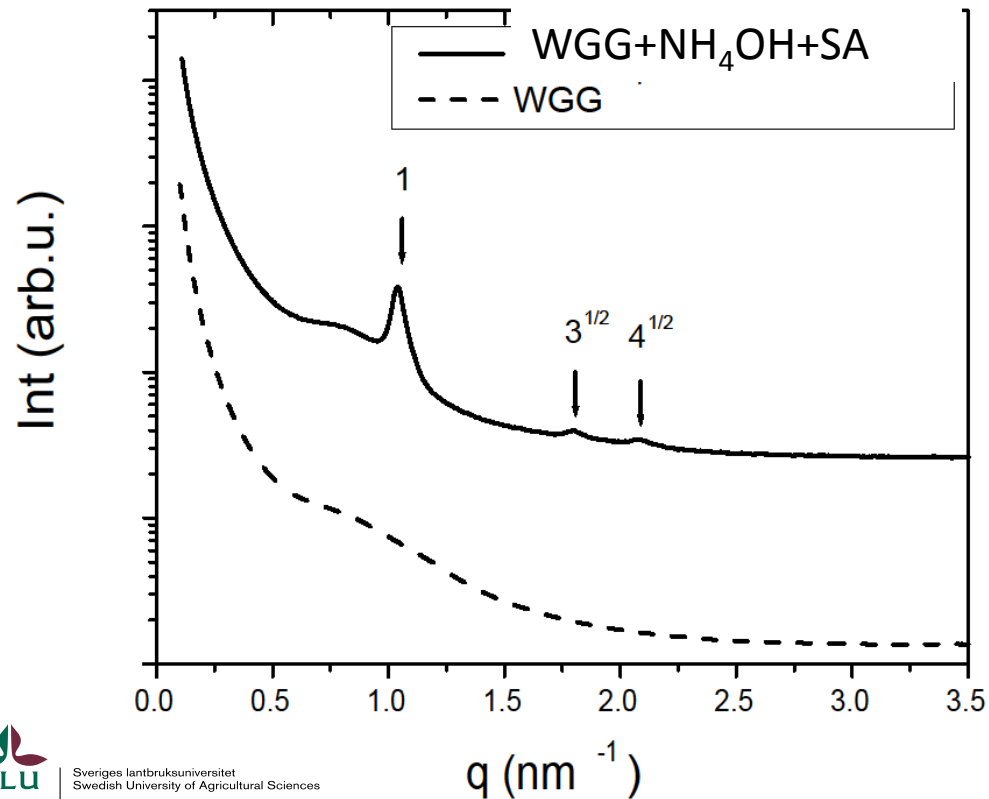
# Synchrotron light: SAXS and WAXS



## Example 1

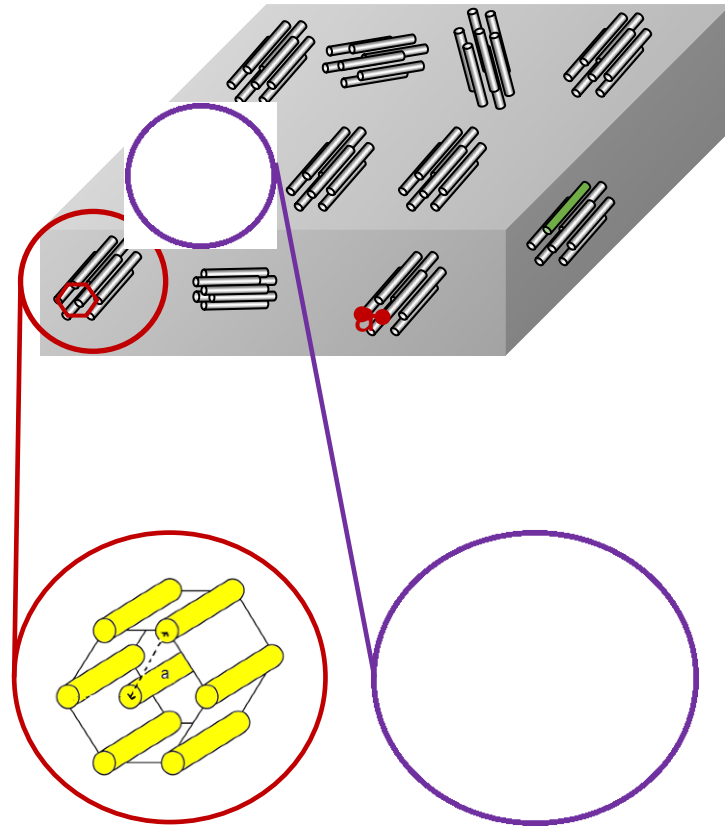
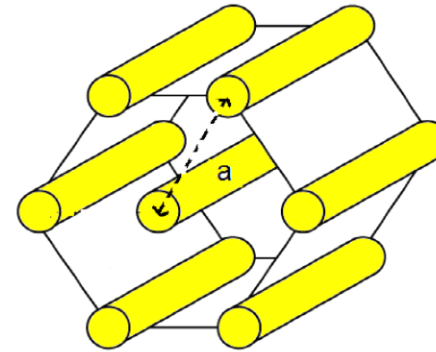


# X-rays to monitor gluten protein nano-structure



1:  $\sqrt{3}$ :  $\sqrt{4}$

$$a = \frac{4\pi}{\sqrt{3} q 1}$$



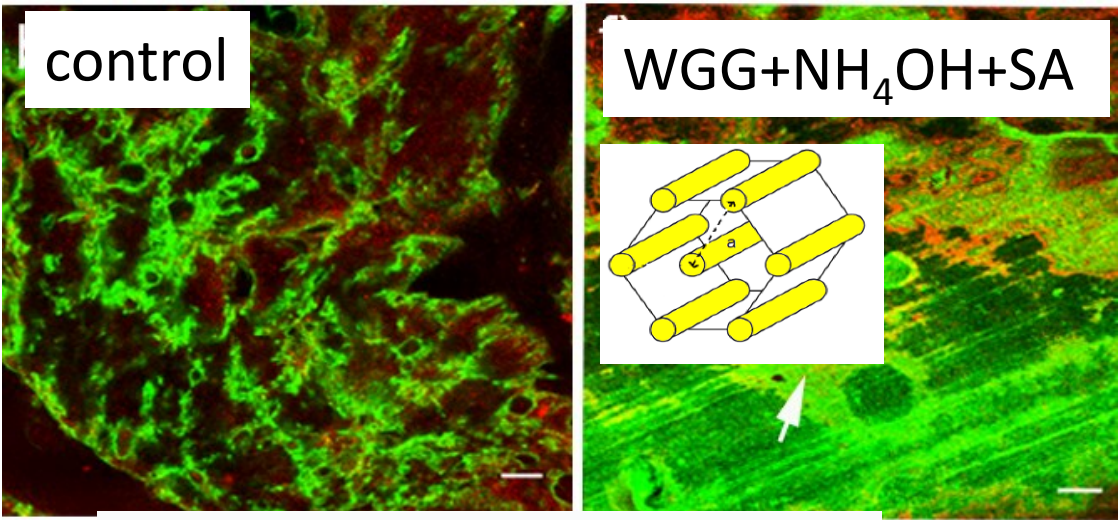
Hexagonal structure,  $a = 70 \text{ \AA}$

The strongest, patented WG + additive material =  
unique supramolecular structure!

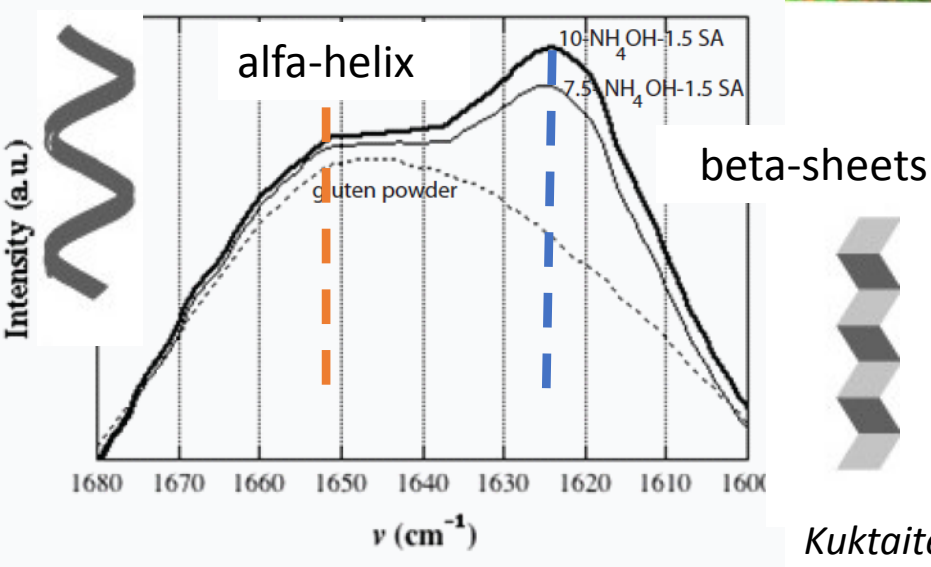
*Kuktaite et al. 2011.*



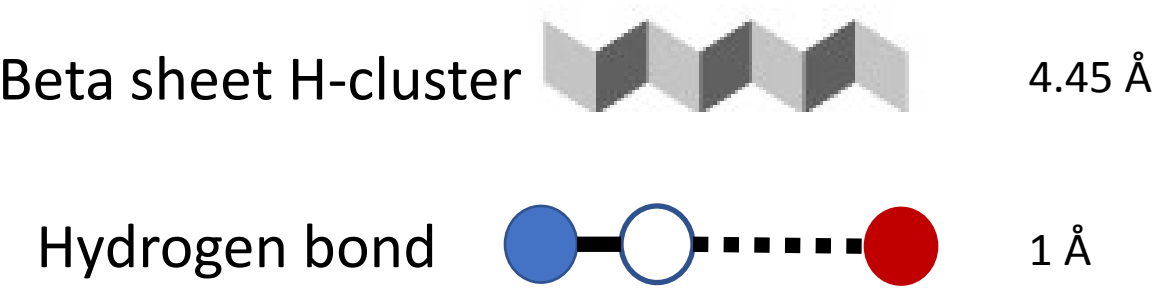
# Why the protein structure for design of functionality?



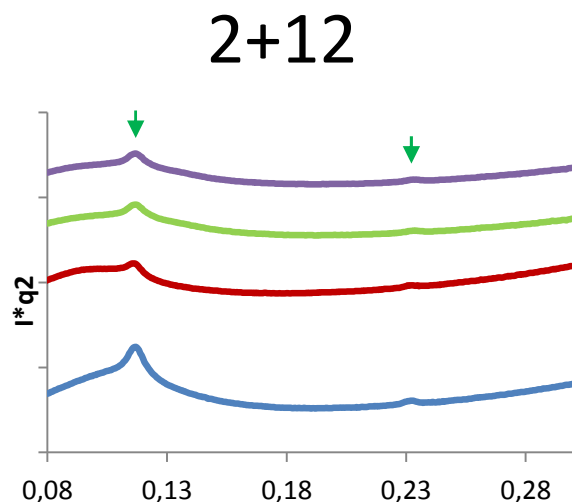
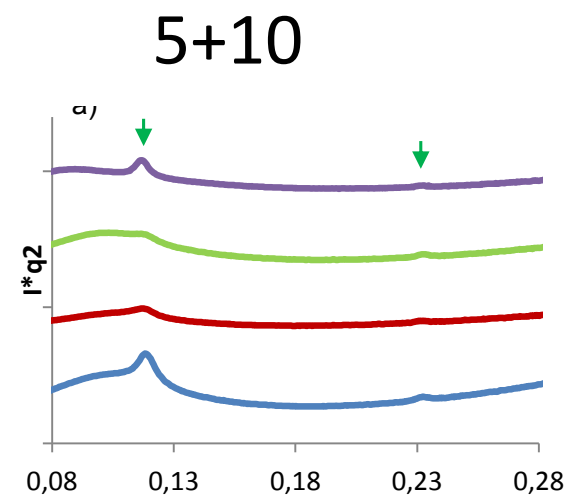
Young's modulus (MPa)	Max stress (MPa)	Strain at max stress (%)
75	5.8	30



Kuktaite et al. 2011

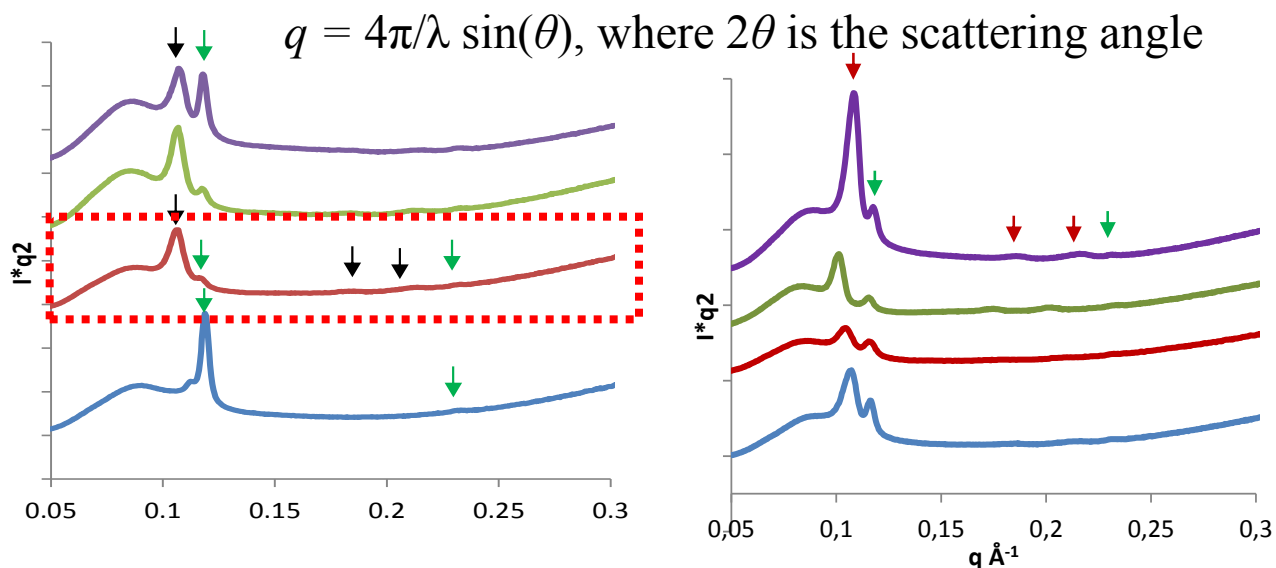
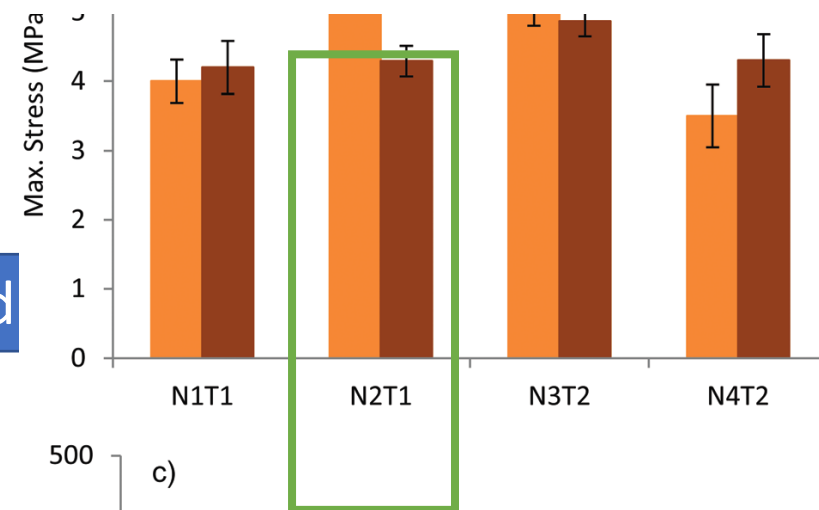


# WG processing: nano-structure and mechanical properties

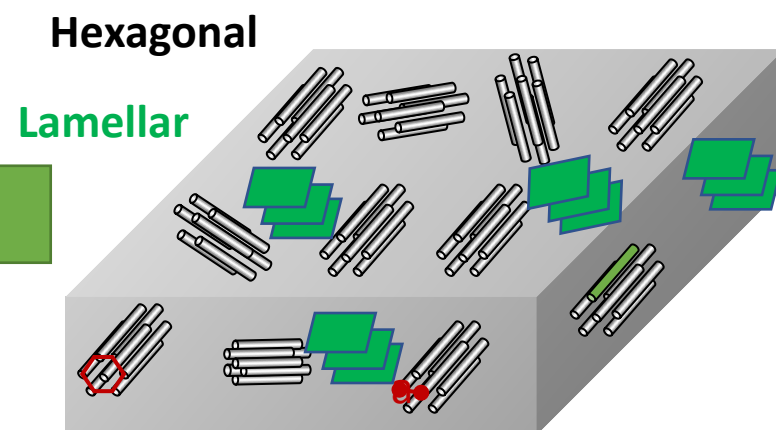


— N1T1 — N2T1  
— N3T2 — N4T2

**Unprocessed**



**Processed**



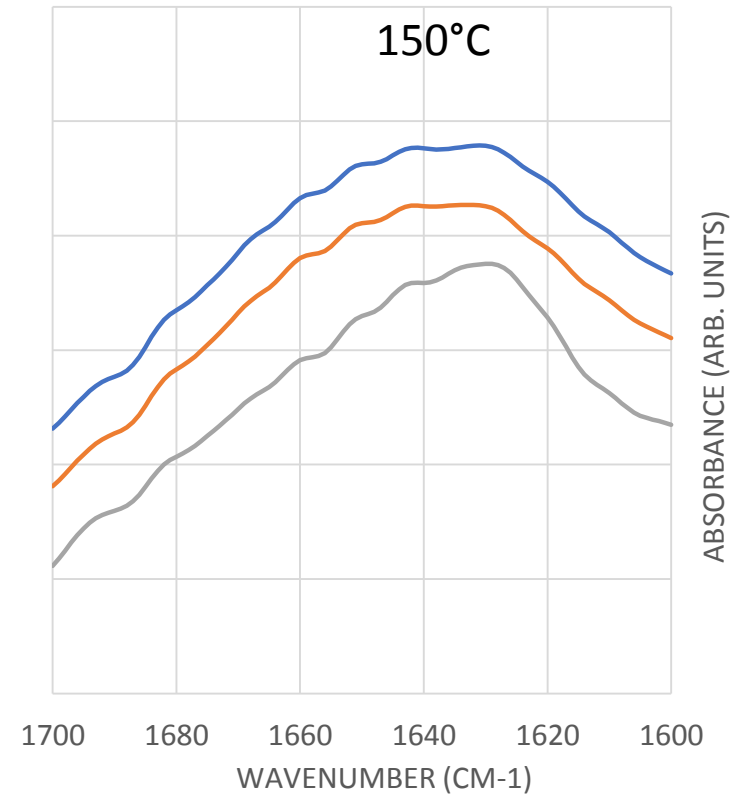
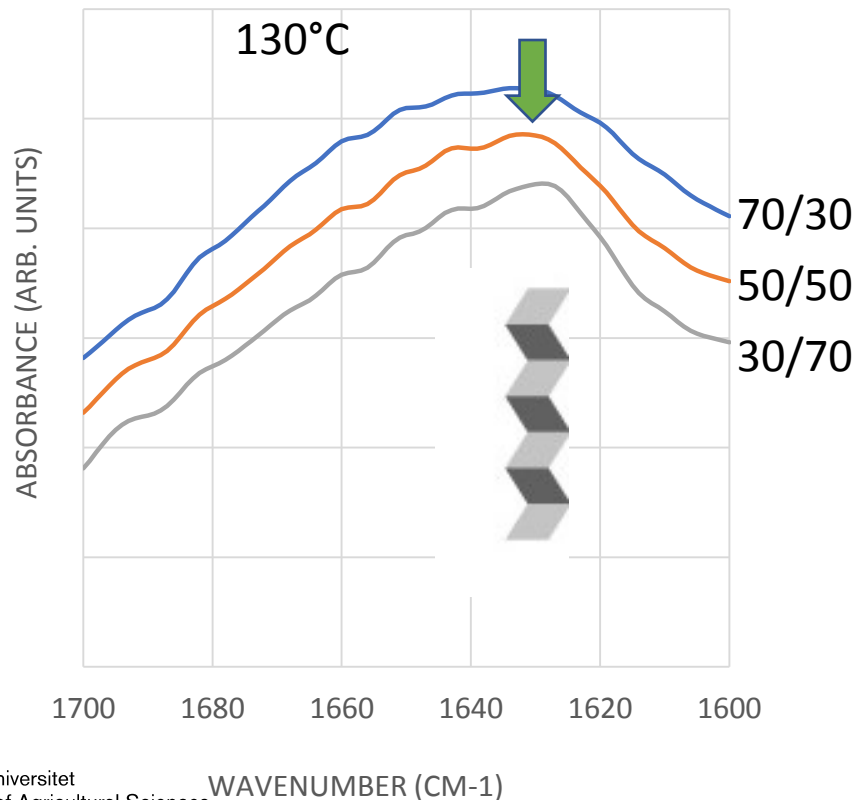


# Composites: a “new” approach to explore new functional properties

- Materials made from few constituents with different physical or chemical properties.

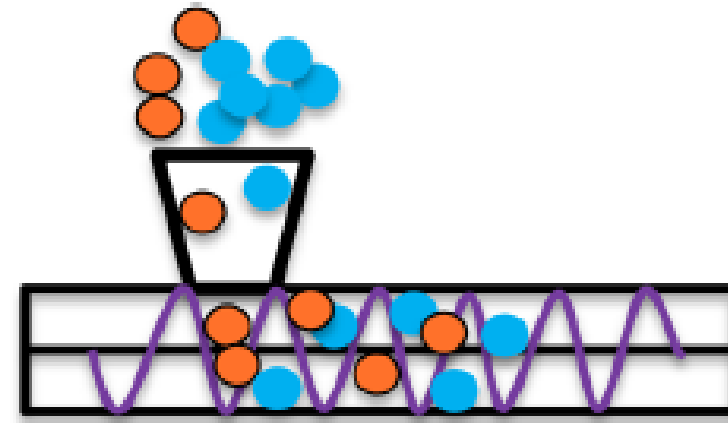
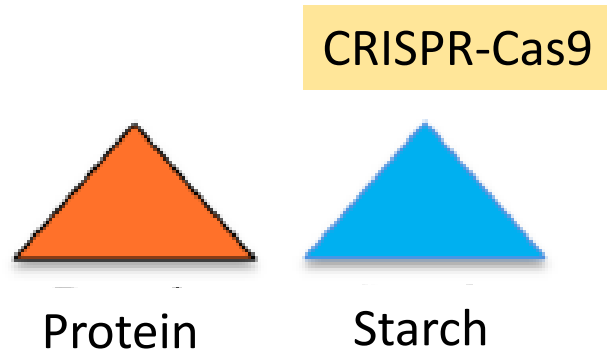
Wheat gluten + potato protein by FT-IR

## Example 3

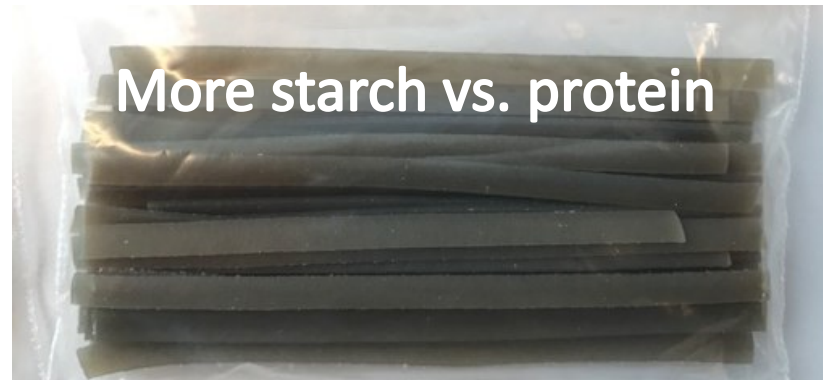
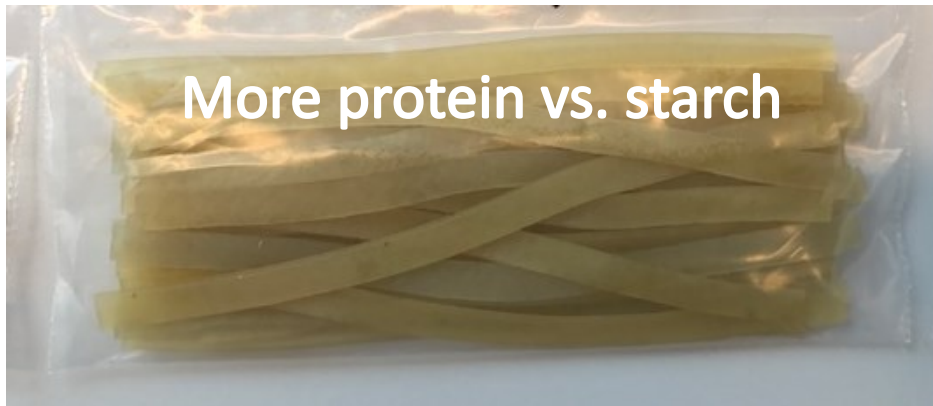


## Example 4

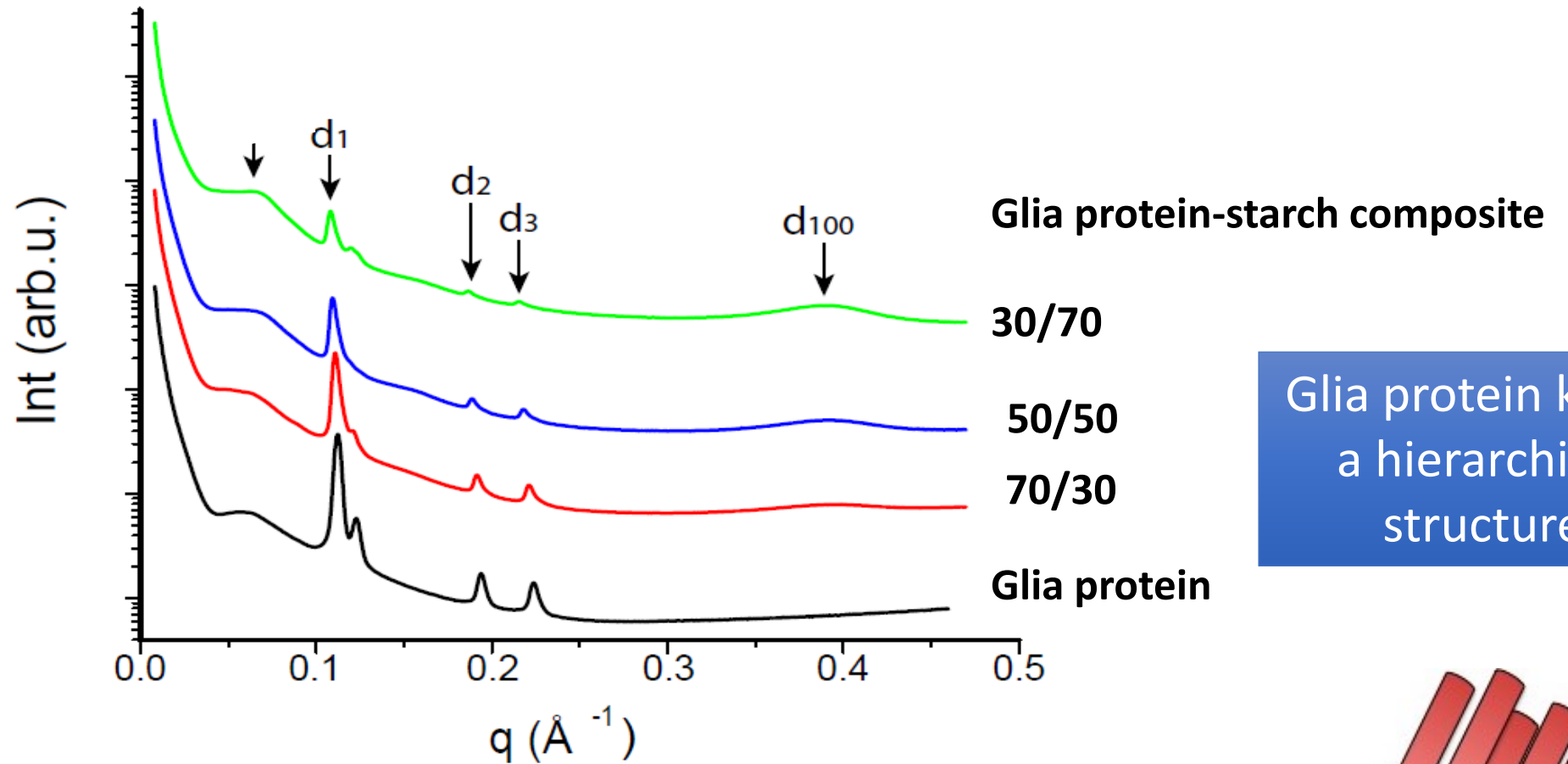
# Composites from novel potato starch and wheat proteins



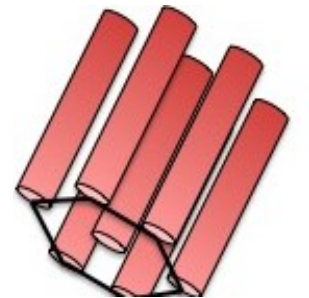
Extrusion processing



# Gliadin-potato starch nano-structure



Gliadin protein keeps a hierarchical structure



## Example 5

Gliadin nano-  
fibers  
by  
electrospinning  
and extrusion  
melting

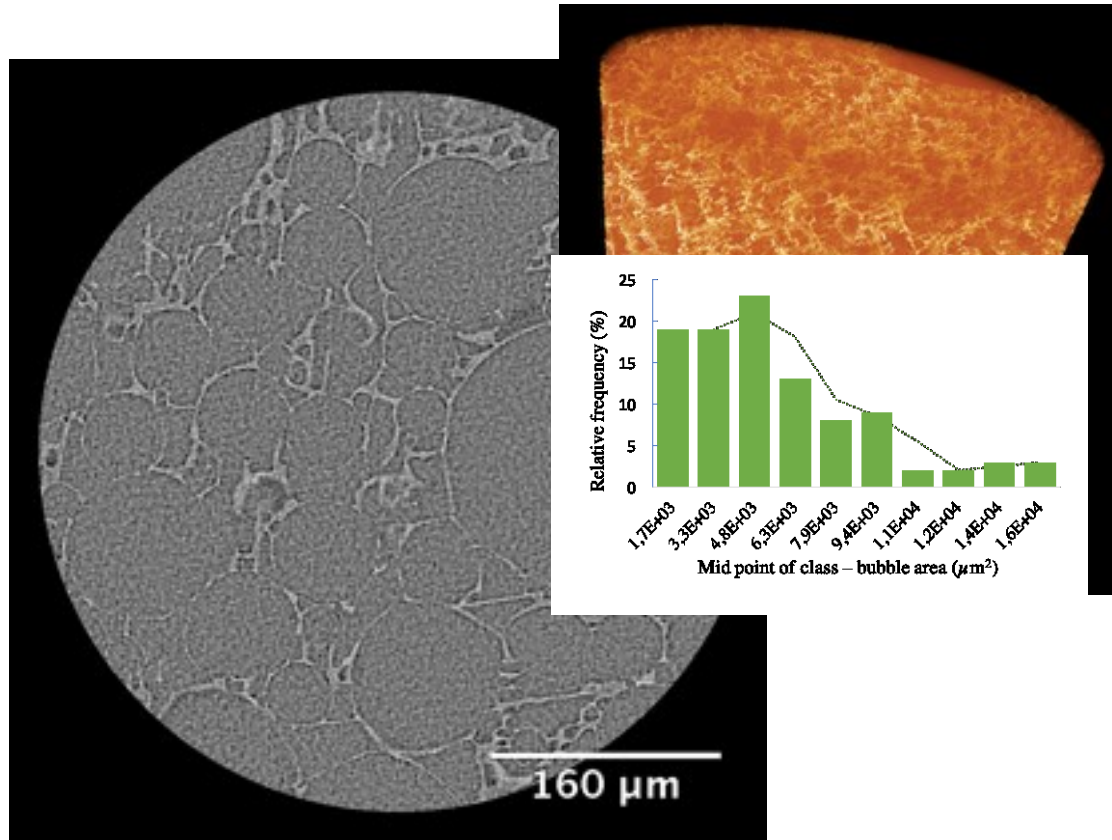




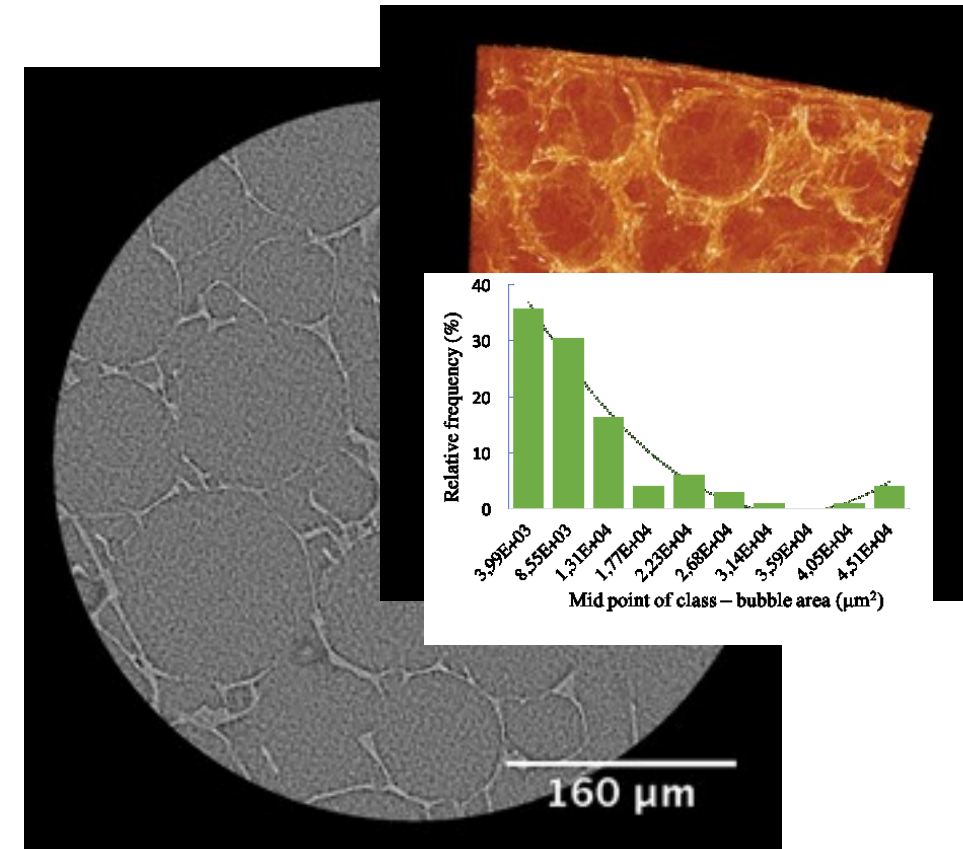
## Example 6

# Food: Gliadin snack macro-structure

No enzyme



Enzyme treated



*Ceresino et al. (unpublished results)*

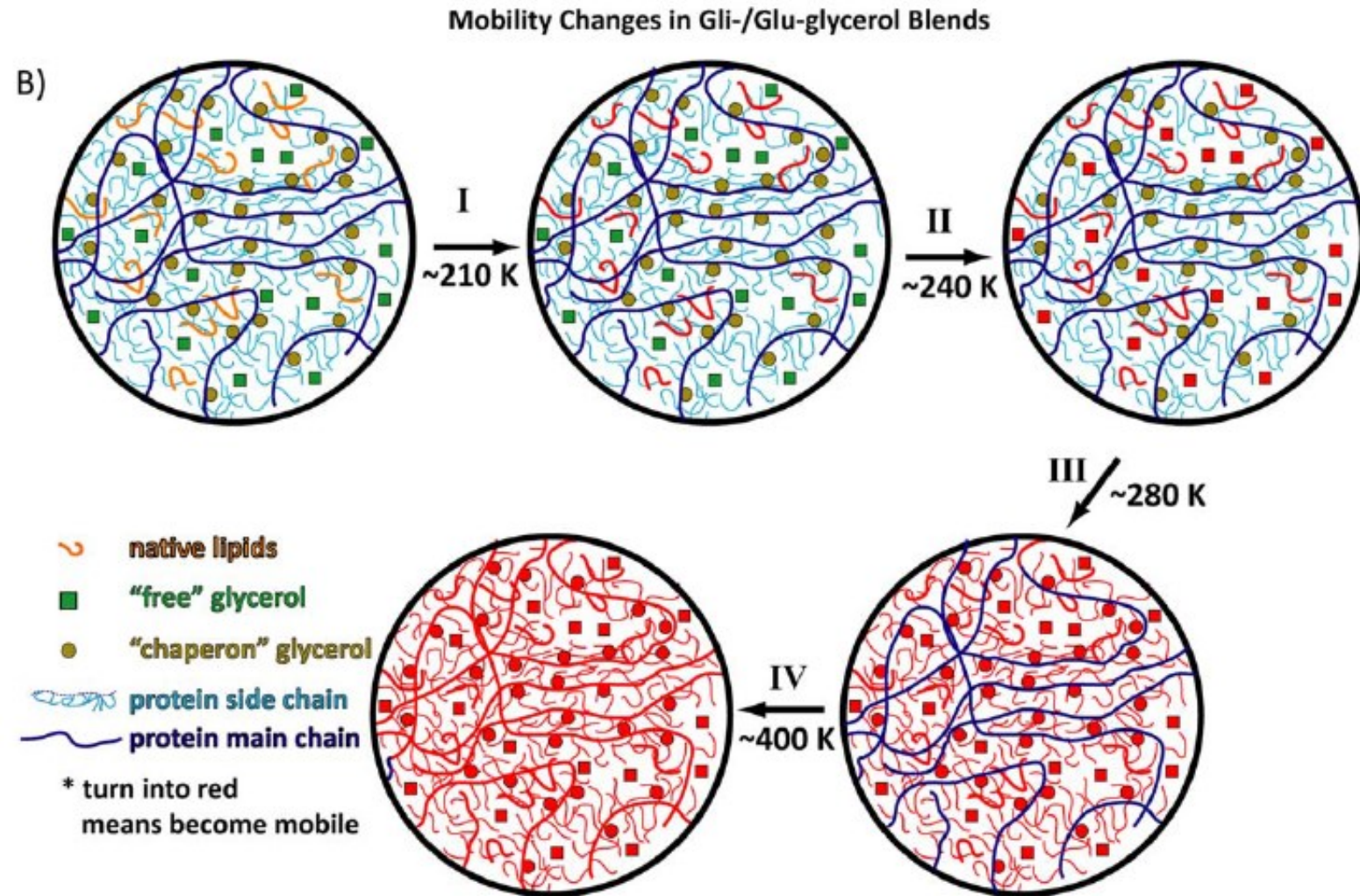


# Example 7 Non-Food: Molecular motions Gli/Glu processed films by $^{13}\text{C}$ Solid State and $^1\text{H}$ Time-Domain NMR

**TABLE 1** Relative Intensities of the C=O  $^{13}\text{C}$  Signal Associated to  $\alpha$ -Helices,  $\beta$ -Sheets and Disordered Chains in the Gli/Glu–Glycerol Blends

Glycerol Percentage (%)	Relative Intensity (%)					
	Gli-Glycerol Blend			Glu-Glycerol Blend		
	$\alpha$ -Helix	$\beta$ -Sheet	Disordered	$\alpha$ -Helix	$\beta$ -Sheet	Disordered
0	43	32	25	26	40	44
10	26	51	23	21	43	36
20	22	49	29	16	42	42
30	26	28	46 <sup>a</sup>	13	36	51
40	25	33	42 <sup>a</sup>	11	37	52

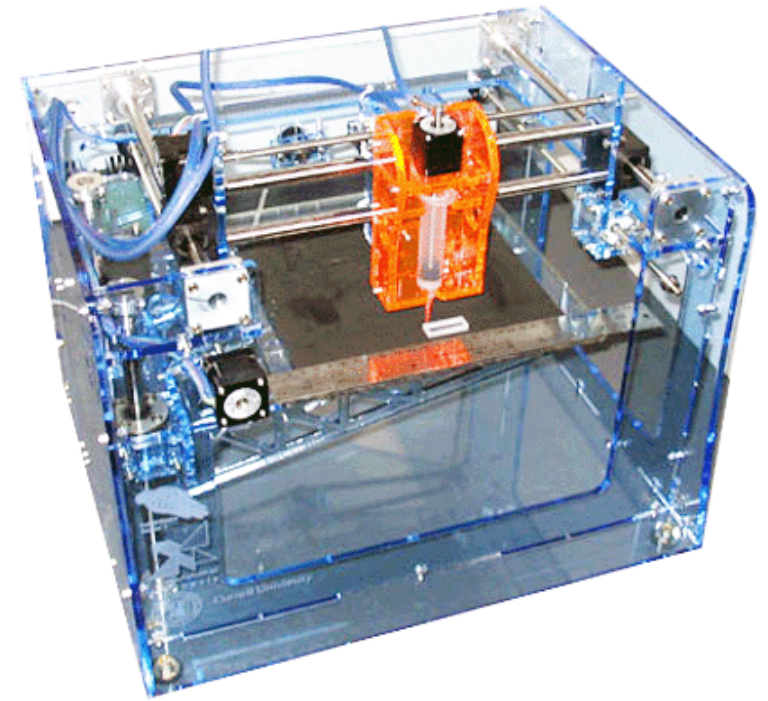
# Gliadin and glutenin molecular dynamics



# Conclusions and future prospects

- WG proteins are THE sustainable alternative.
- Protein structure-function understanding will offer improved bio-products.
- The new techniques bring a novel approach to explore protein food and bio-based materials.
- Addressing sustainability, lower consumption of meat etc., wheat protein can become even more attractive source (caution: for celiac people) for innovative food and bio-based plastics – benefits to society and the planet.

## 3D printed protein materials



# Acknowledgements

- Colleagues from the Plant Product Quality group
- PhD students: Faraz Muneer and Elaine Anderssen
- PostDocs: Bill Newson, Faiza Rasheed; Prof. Eva Johansson & Marisa
- Colleagues at the Department of Plant Breeding
- Horizon 2020, Partnerskap Alnarp, TC4F and FORMAS





- Reality leaves a lot to the imagination (*John Lennon*)  
....and *to act*

*Thank you for your attention!*

