Exploring plant protein structures in various food and non-food systems: by X-ray scattering and other techniques

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Outlay

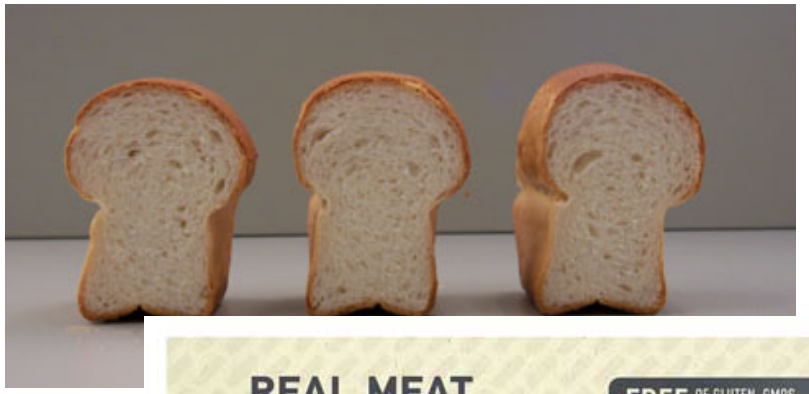
- Introduction to plant protein systems
- Question: structure - function relationship + processing?
- Nano-structure by SAXS/WAXS
- X-ray tomography
- Conclusions

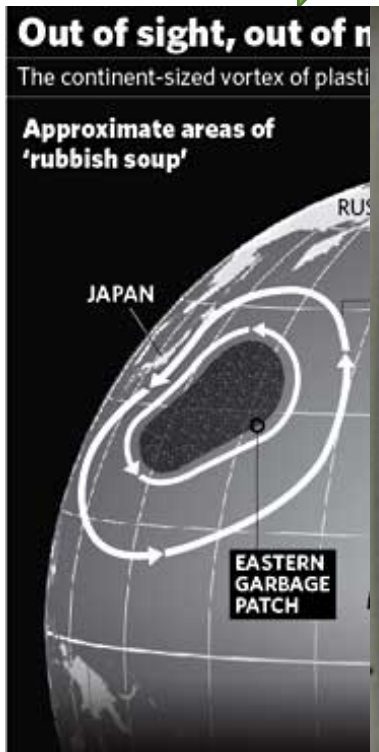
Strategic research needs?

- Food security
- Biodiversity
- Environment
- Bio-economy
- Human health

5 EXAMPLES

PROCESSING





Plant protein systems

PROCESSING

Food

Non-food

Plant protein systems

- Wheat gluten (gliadin and glutenin)
- High protein rich seed crops and legumes (lupin)

EU H2020 project – 18 partners

budget 8.8 mln €- 2015-2020

SLU is a partner in WP1, WP2 and WP3

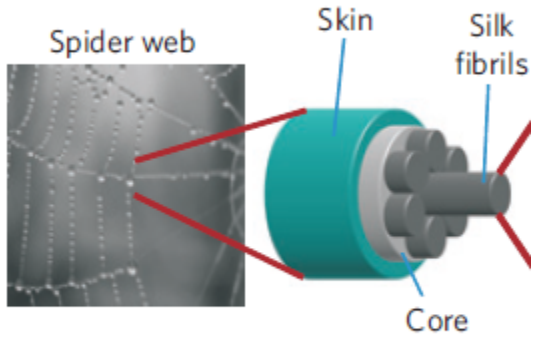
Innovative protein rich foods

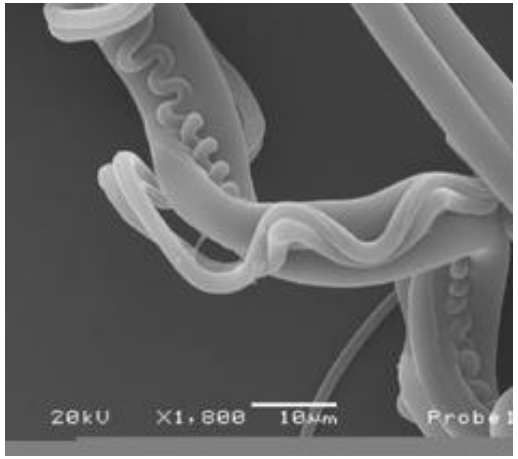
PROTEIN 2FOOD

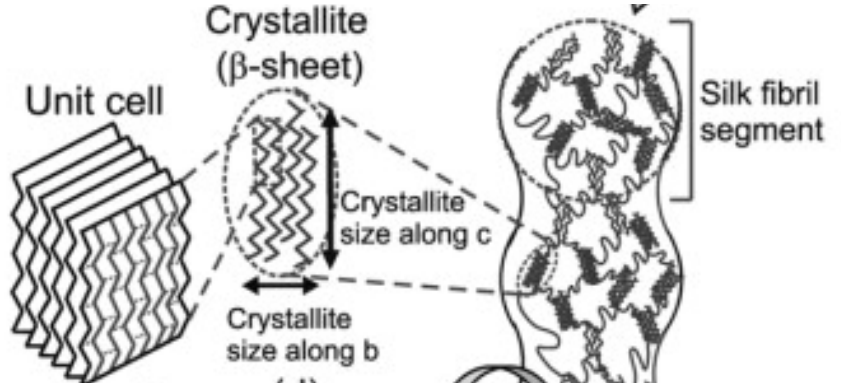
PIONEERING CROPS FOR FUTURE GENERATIONS

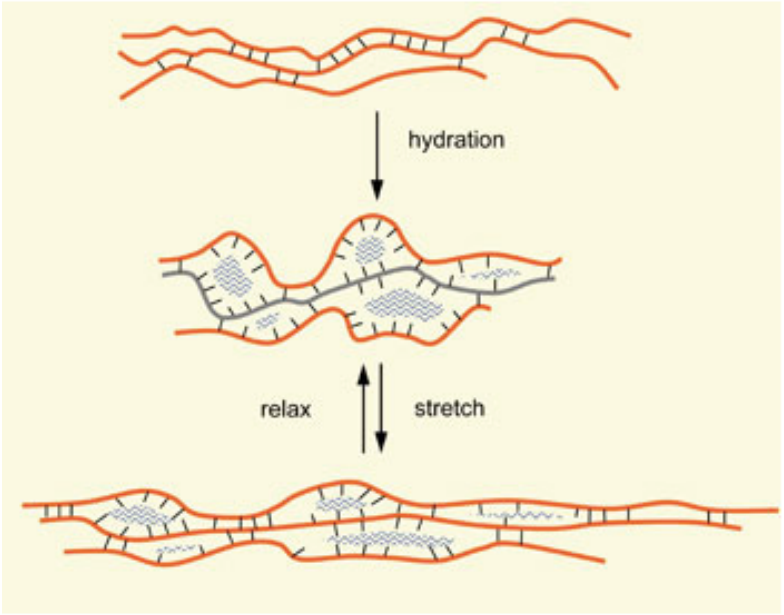
Aim 1: protein structure-mechanical properties

Aim 2: Structure-function relationship



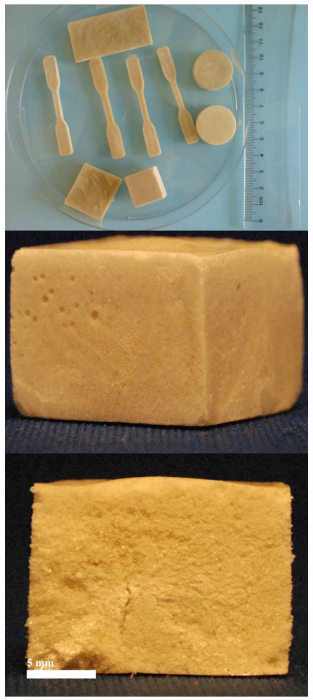


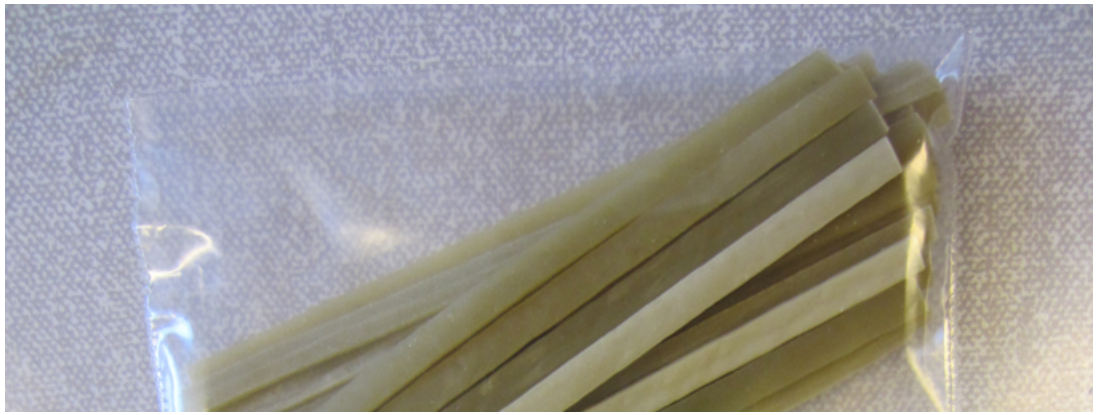




Visco-elastic and mechanical properties

Protein-based non-food uses





SLU

Wheat gluten for targeted products: Example 1

Genotype x **Environment**

2+12 and 5+10

	E treatment	Nitrogen applied (mg per plant) Spike 44–48	Anthesis 65–69	Temperature
High	N1T1	0	0	25/19 °C (T1)
	N2T1	20	0	25/19 °C (T1)
Low	N3T2	20	20	18/14 °C (T2)
	N4T2	0	40	18/14 °C (T2)

E: environment.

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Green Chemistry

PAPER

View Article Online
View Journal

The use of plants as a "green factory" to produce high strength gluten-based materials†

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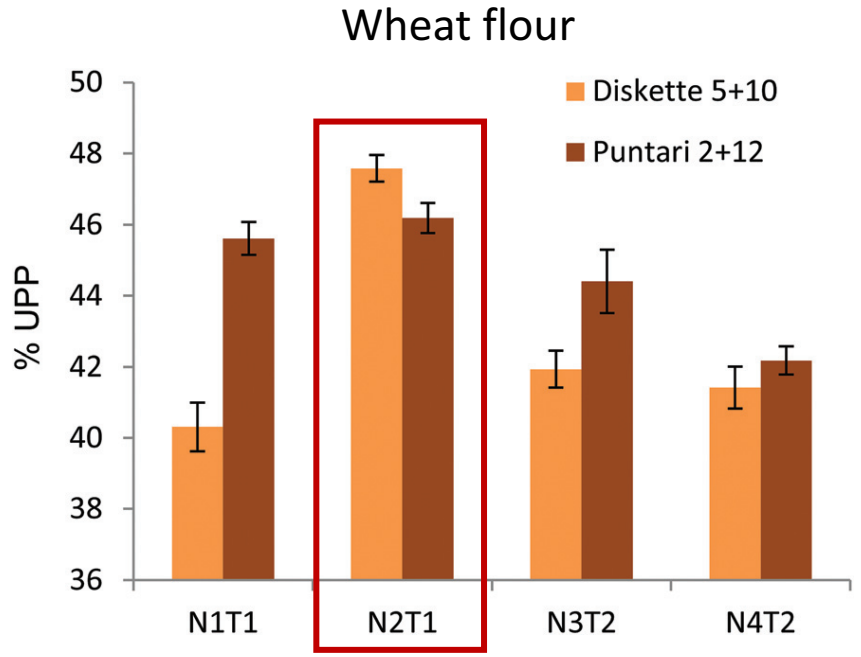
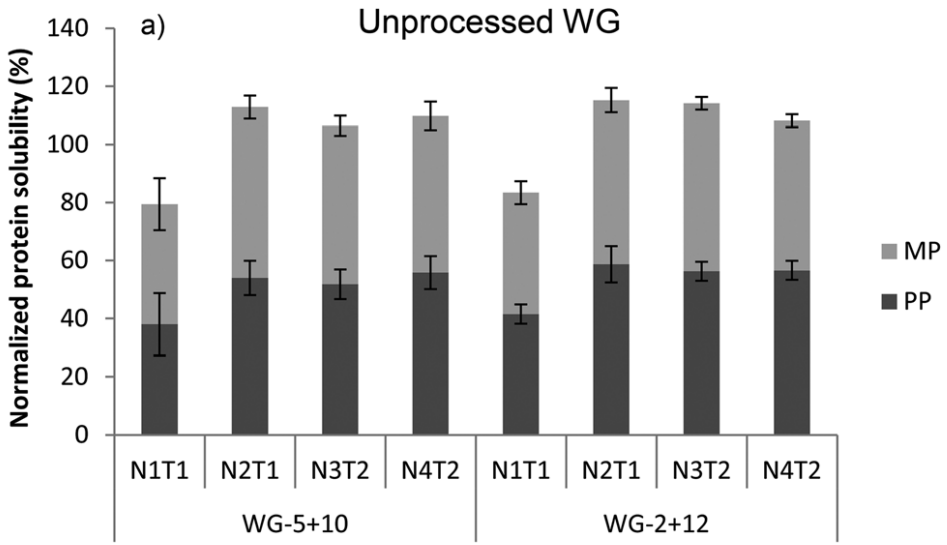
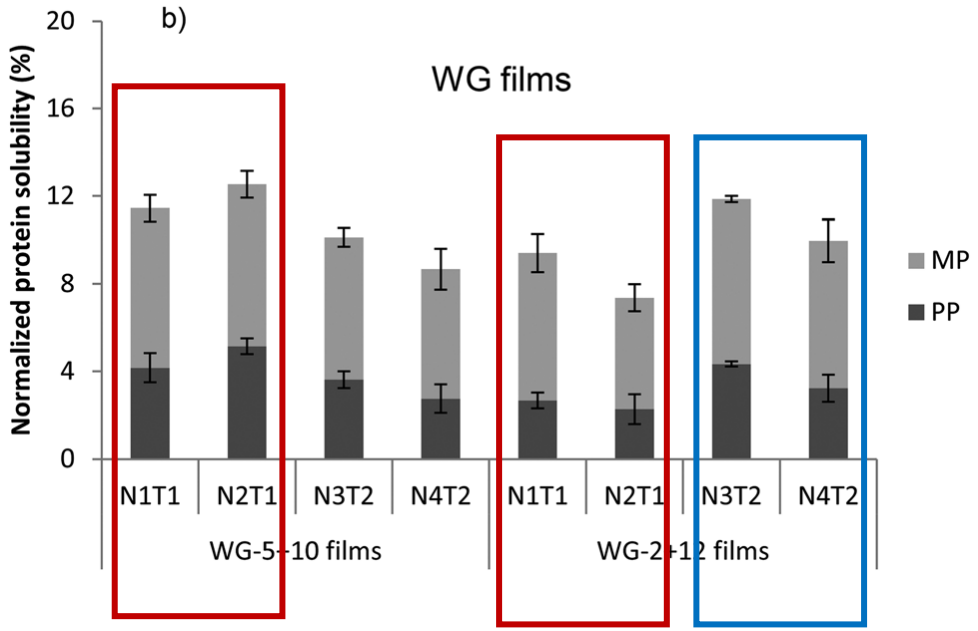
Cite this: DOI: 10.1039/c5gc03111g

Processing: protein solubility

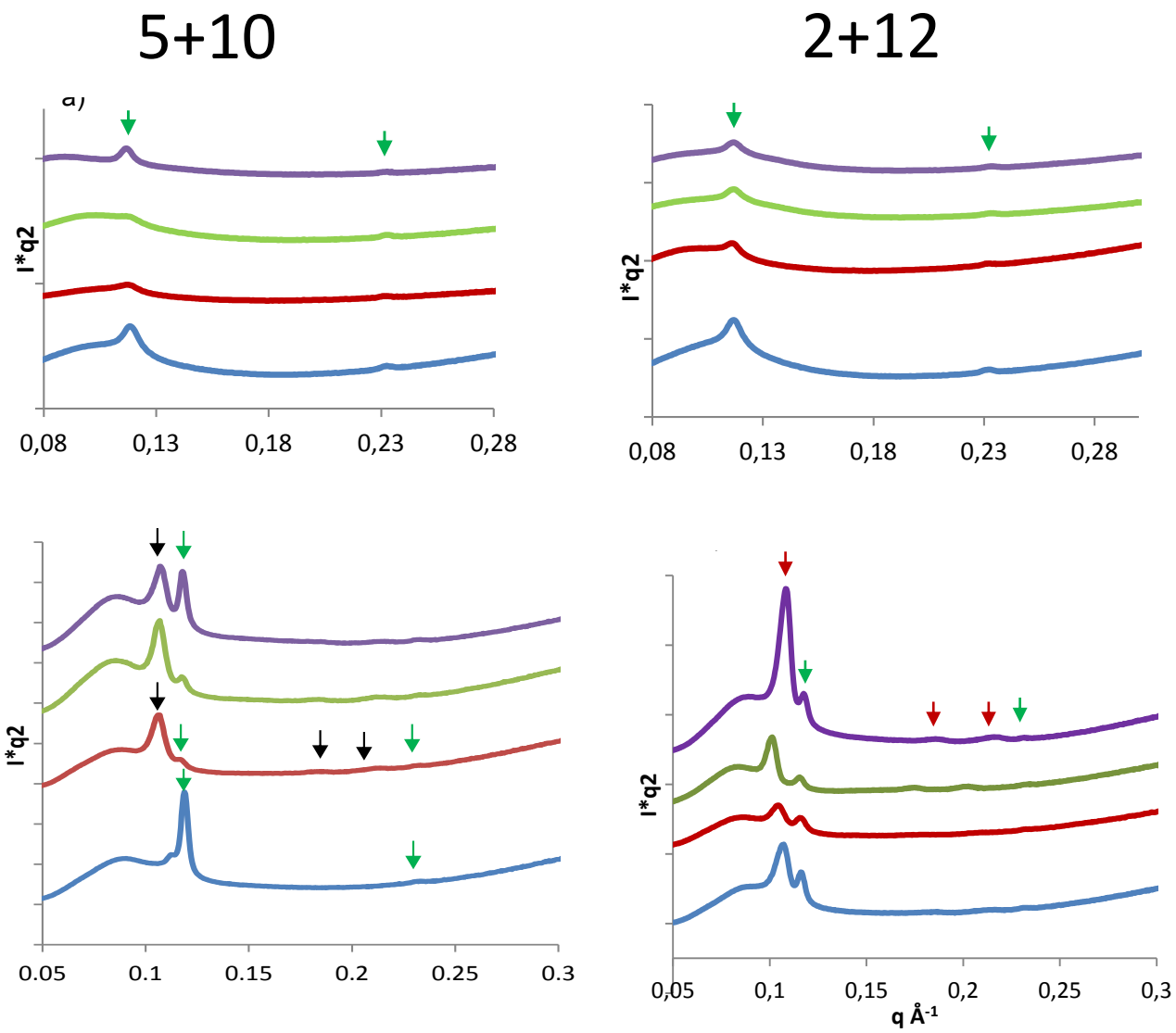


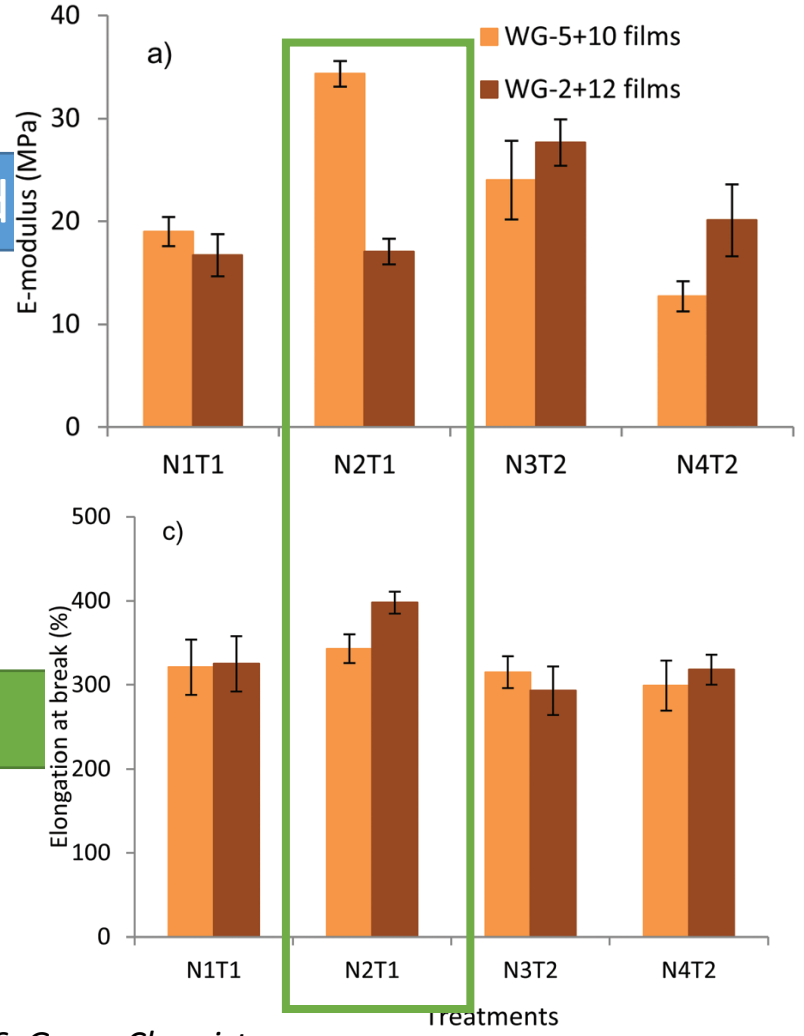




Rasheed et al. 2016, Green Chemistry

Processing: nano-structure and mechanical properties





Rasheed et al. 2016, Green Chemistry

5+10

2+12

Low Nitrogen
High Temperature

High Nitrogen
Low Temperature

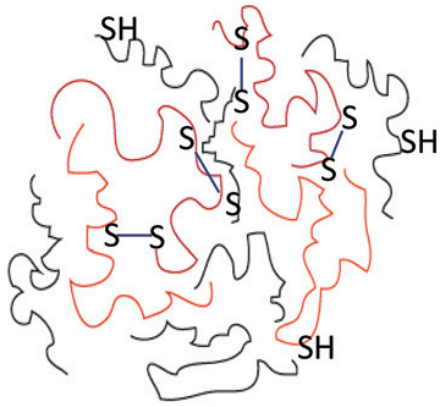
High Protein Conc.
High Gliadin to Glutenin ratio
High %UPP

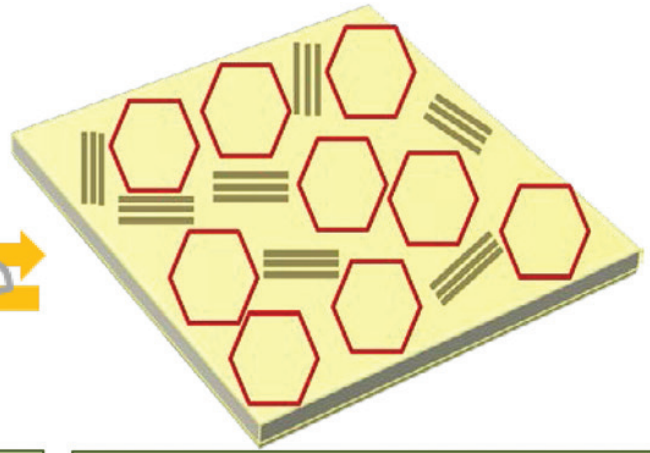
Medium Protein Conc.
~ = Gliadin to Glutenin
Medium %UPP

In Plants

Unprocessed

After processing

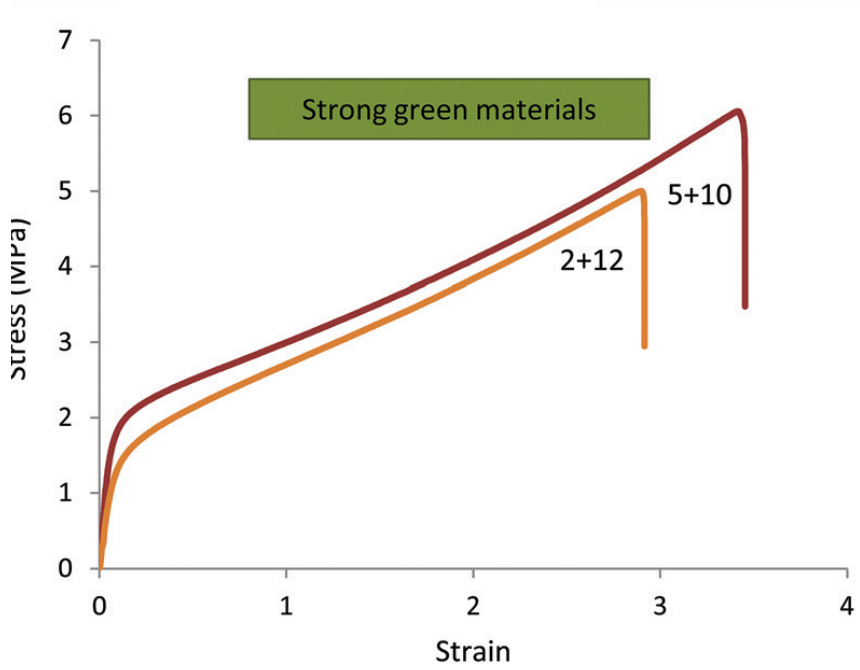




Low aggregation

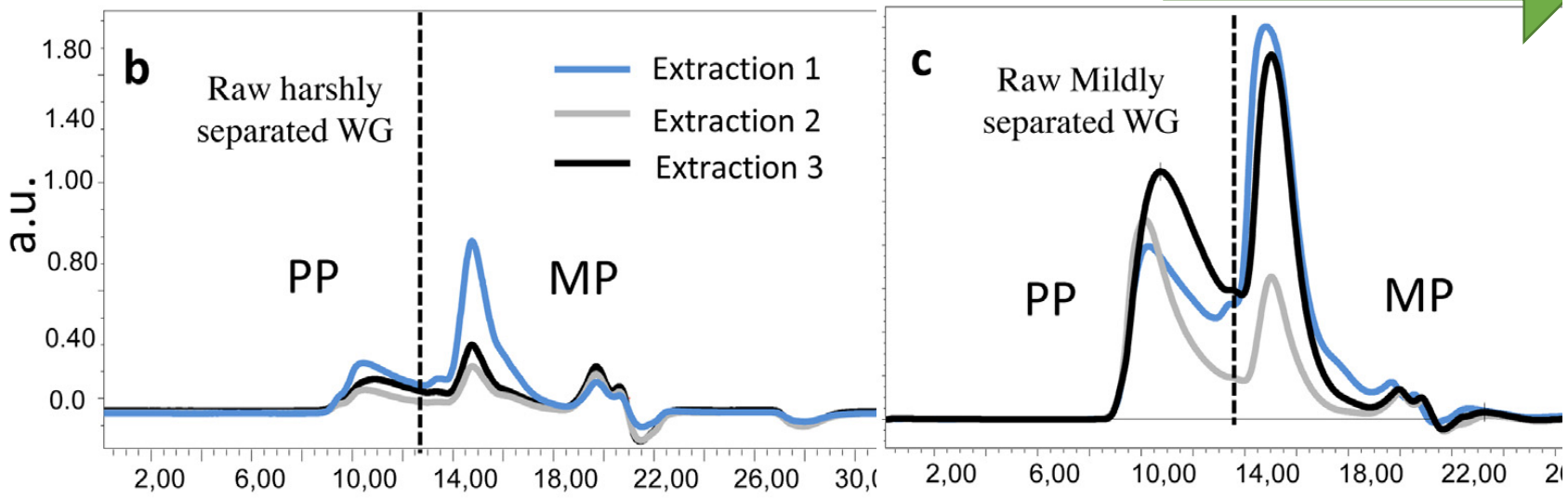
High β-sheet content

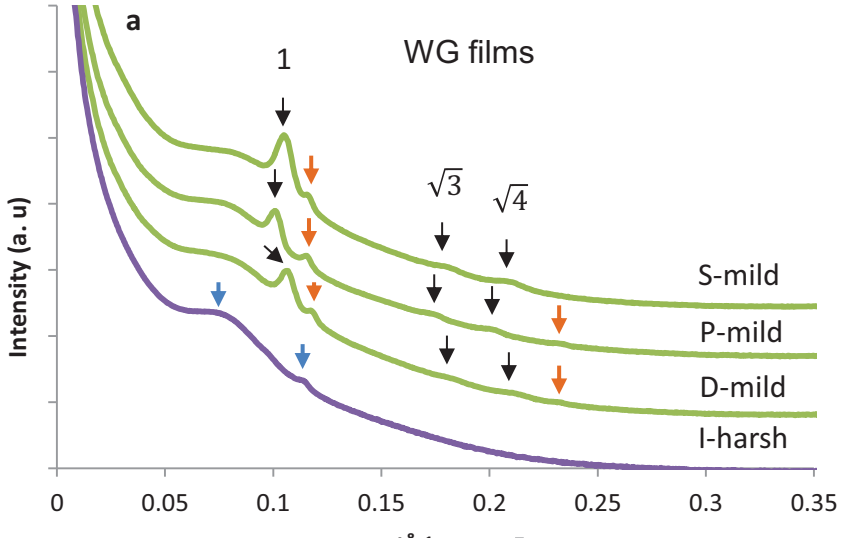
More hexagonal to lamellar

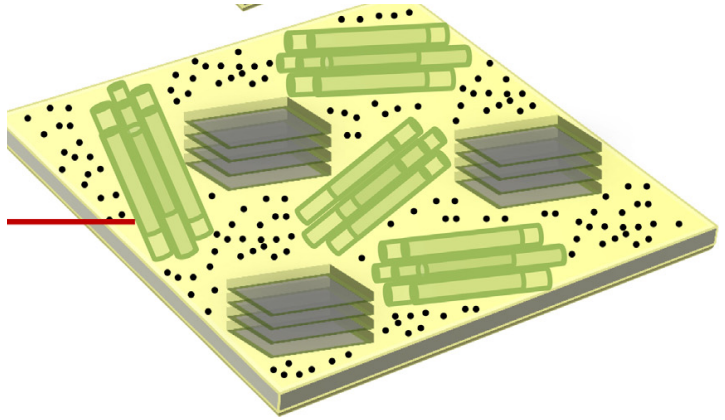


Wheat gluten extraction: Example 2

PROCESSING

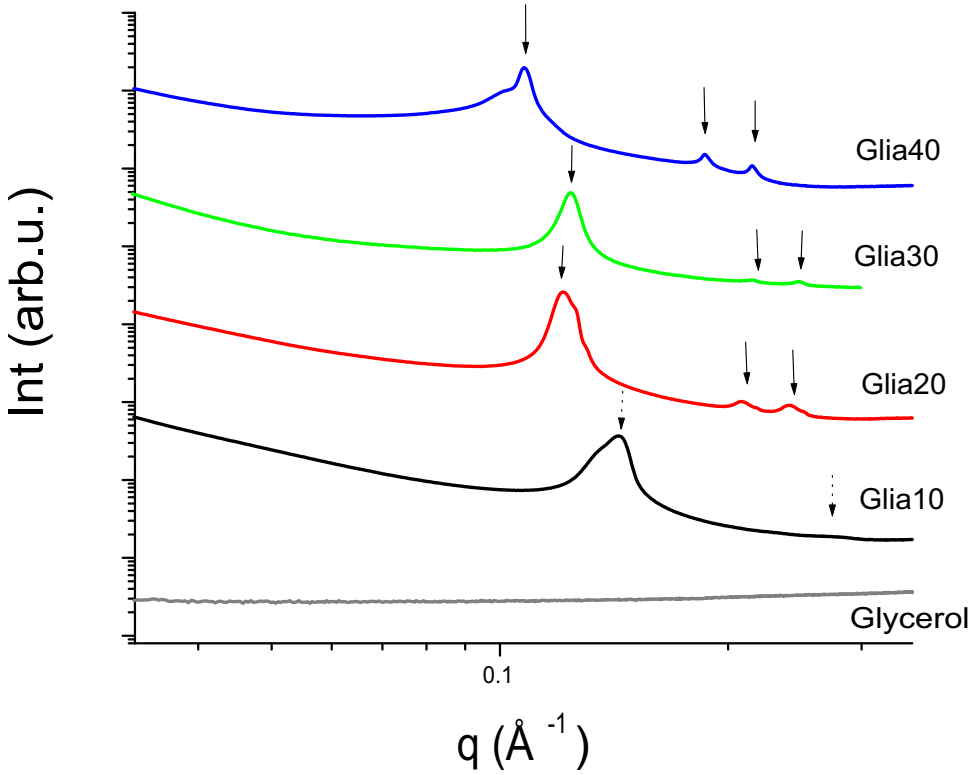


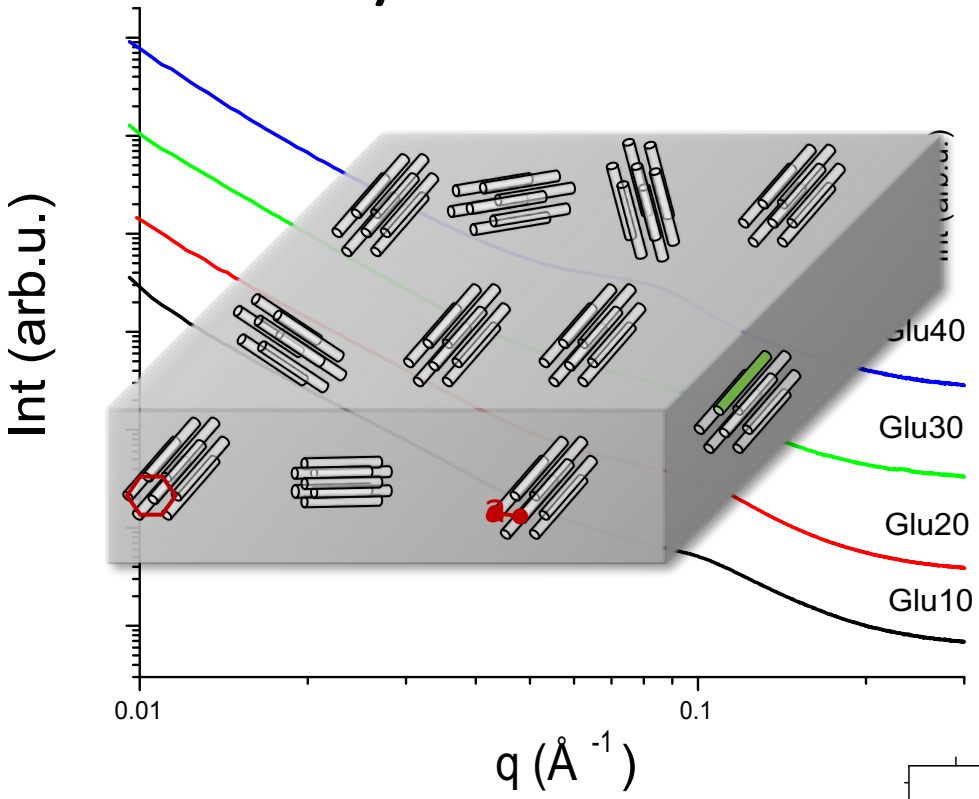


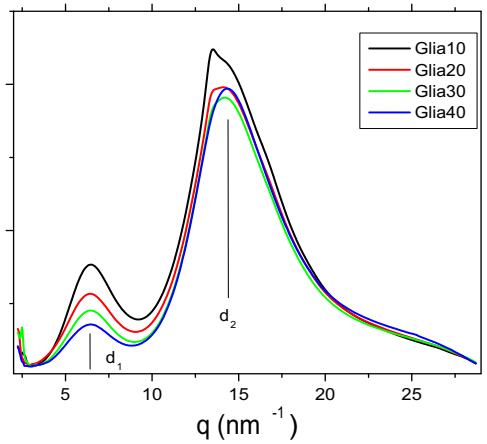


Rasheed et al. 2015, Industrial Crops and products.

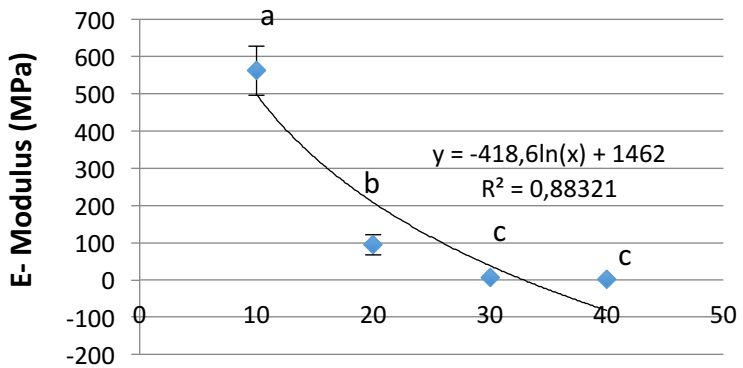
Protein-glycerol structure dynamics: Example 3

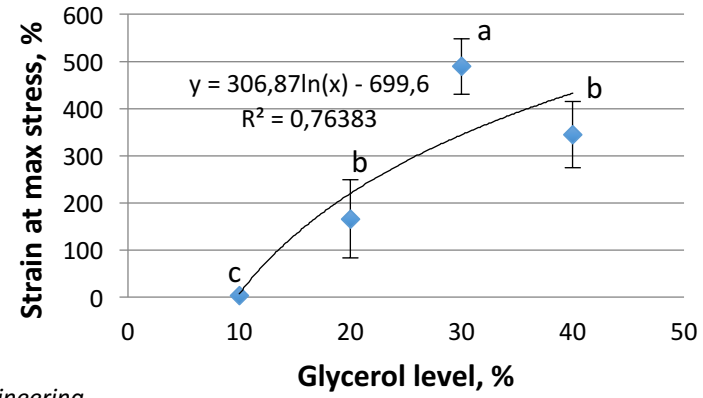




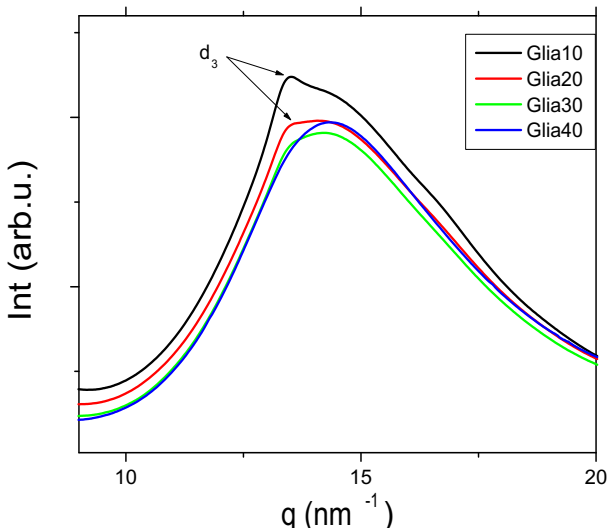


Gliadin glycerol films

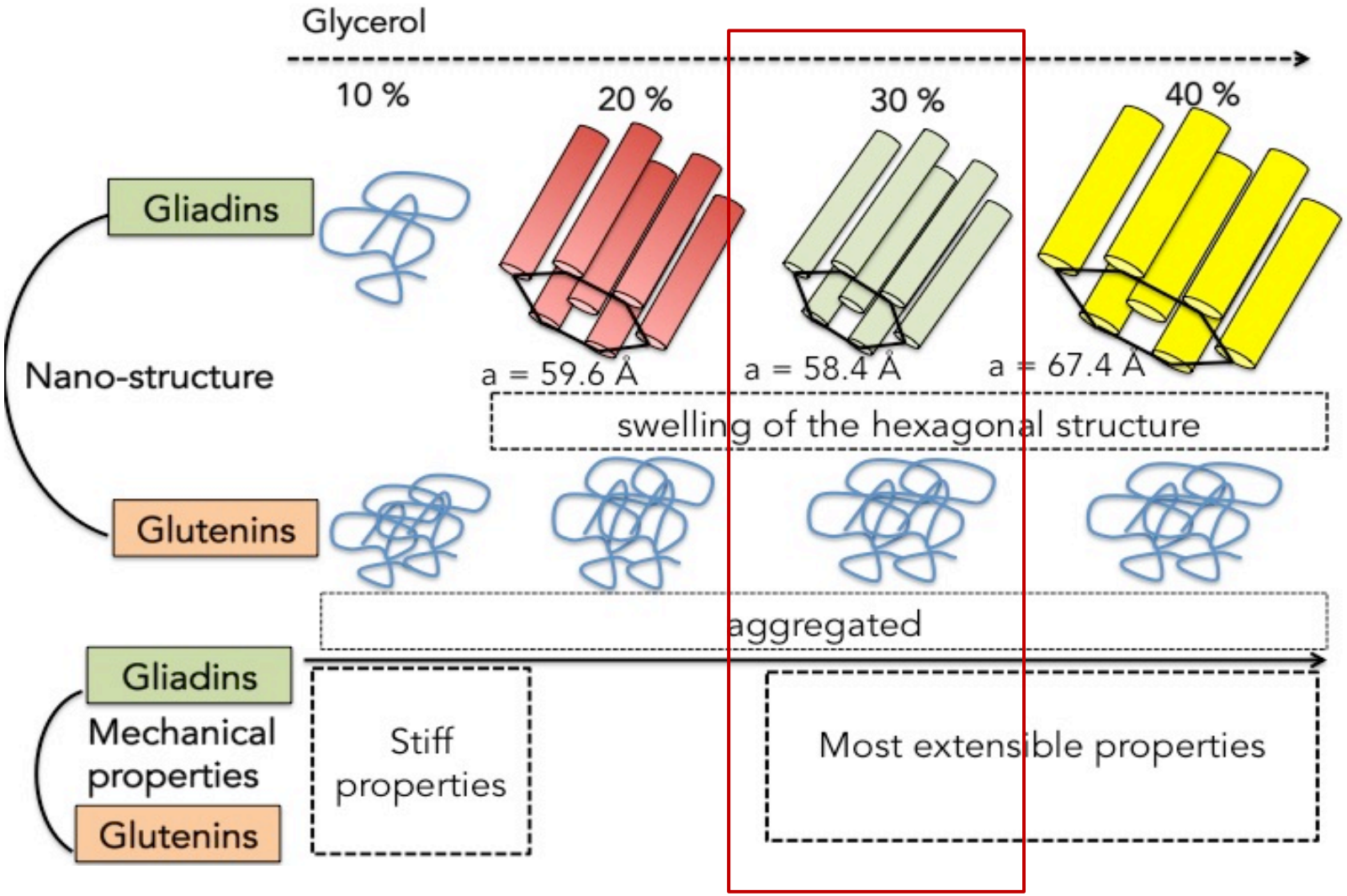




Kuktaite et al. 2016, ACS Sustainable Chemistry and Engineering

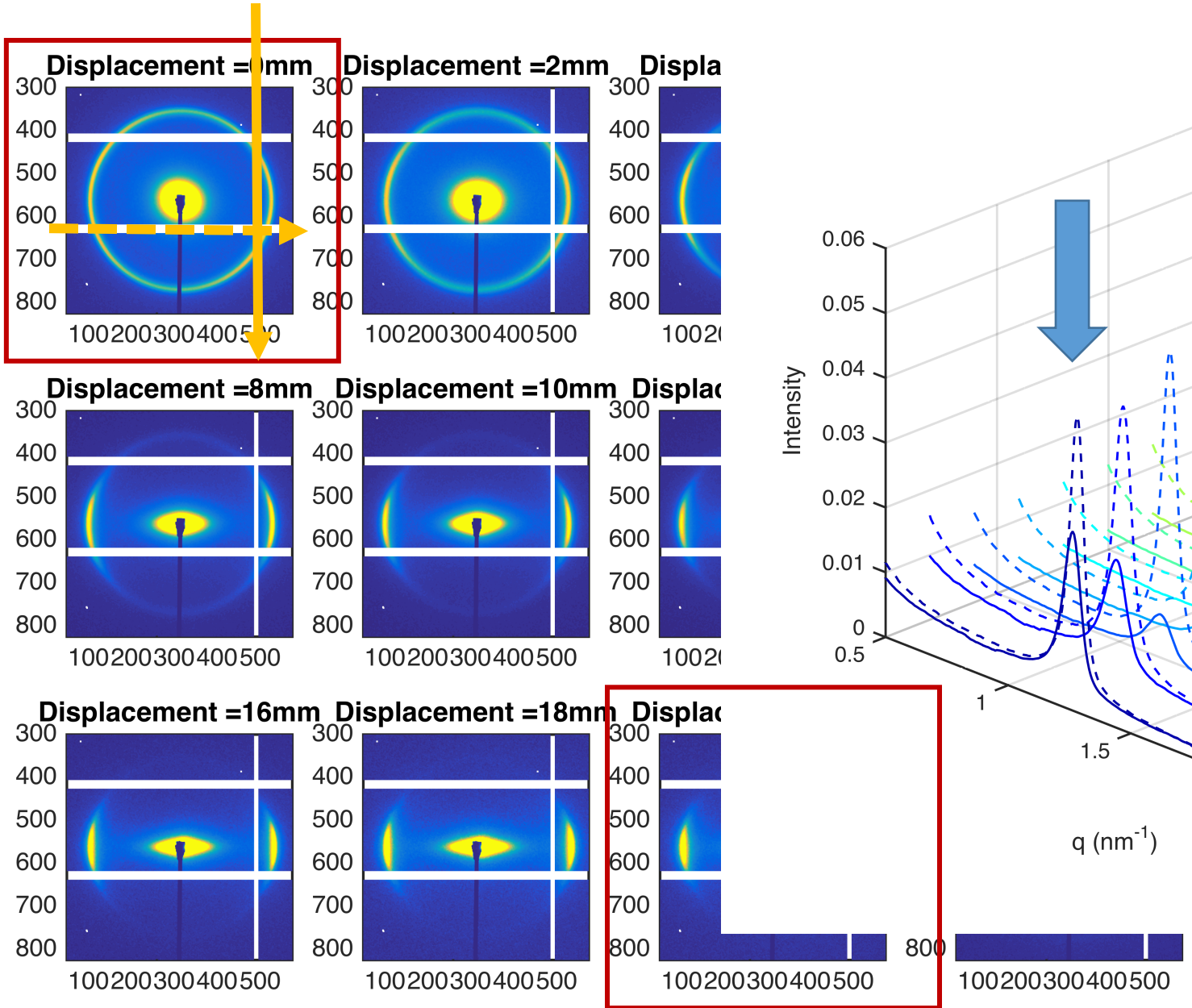


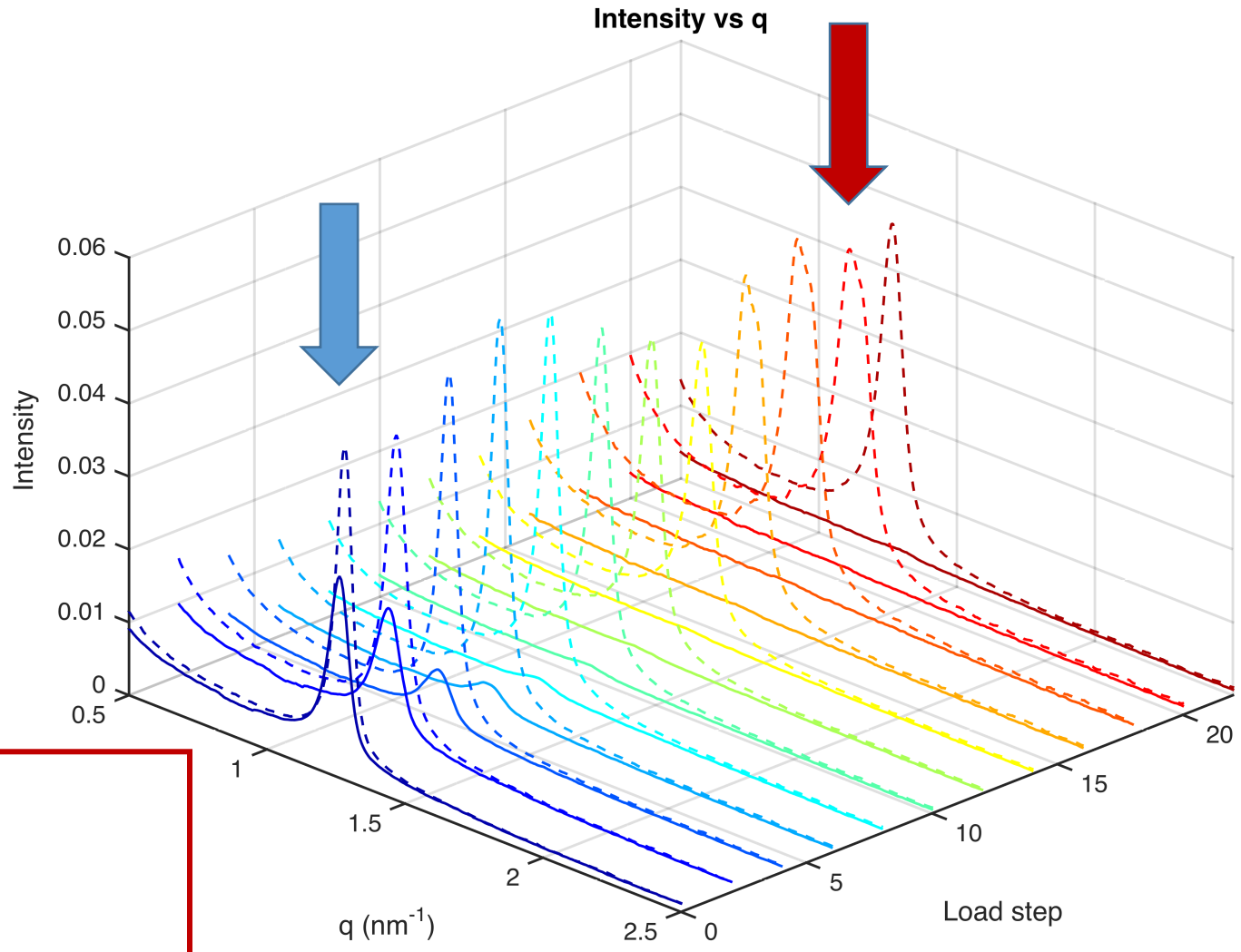
Nano-structure and mechanical properties



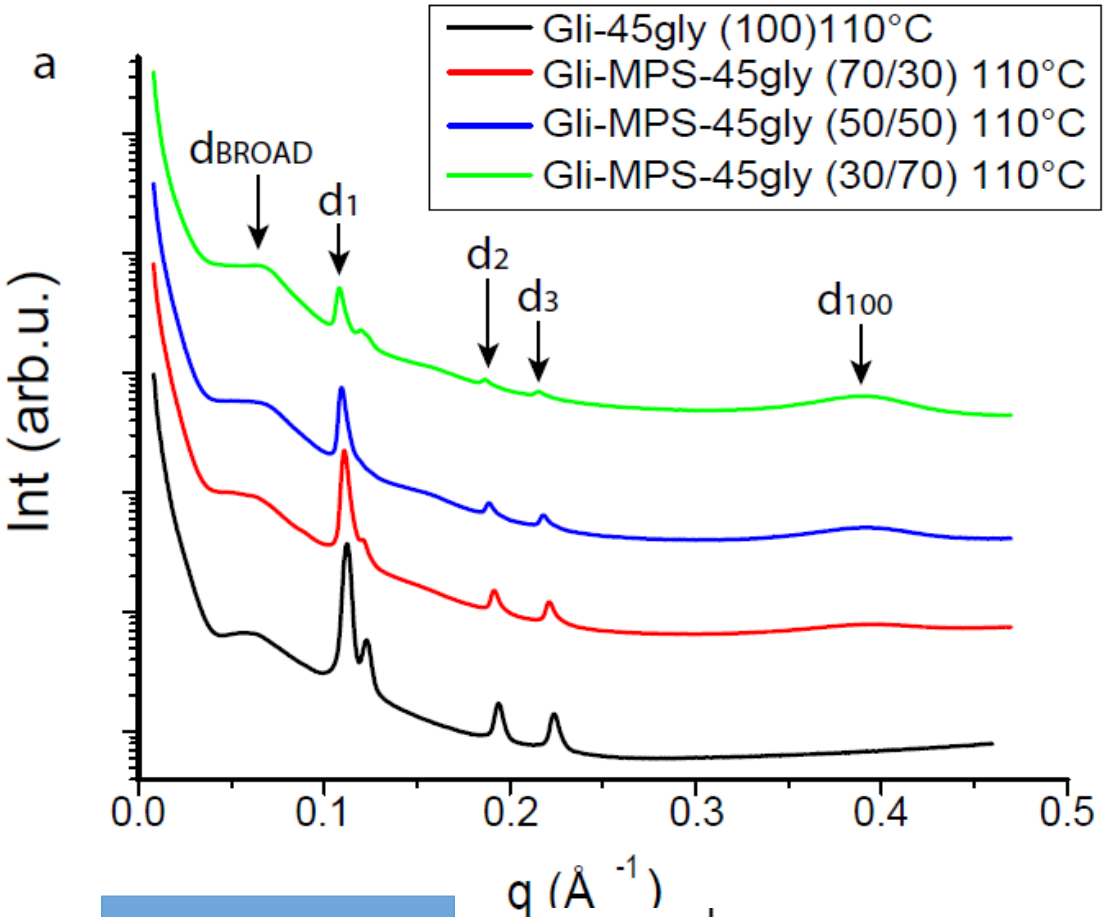
Kuktaite et al. 2016, ACS Sustainable Chemistry and Engineering

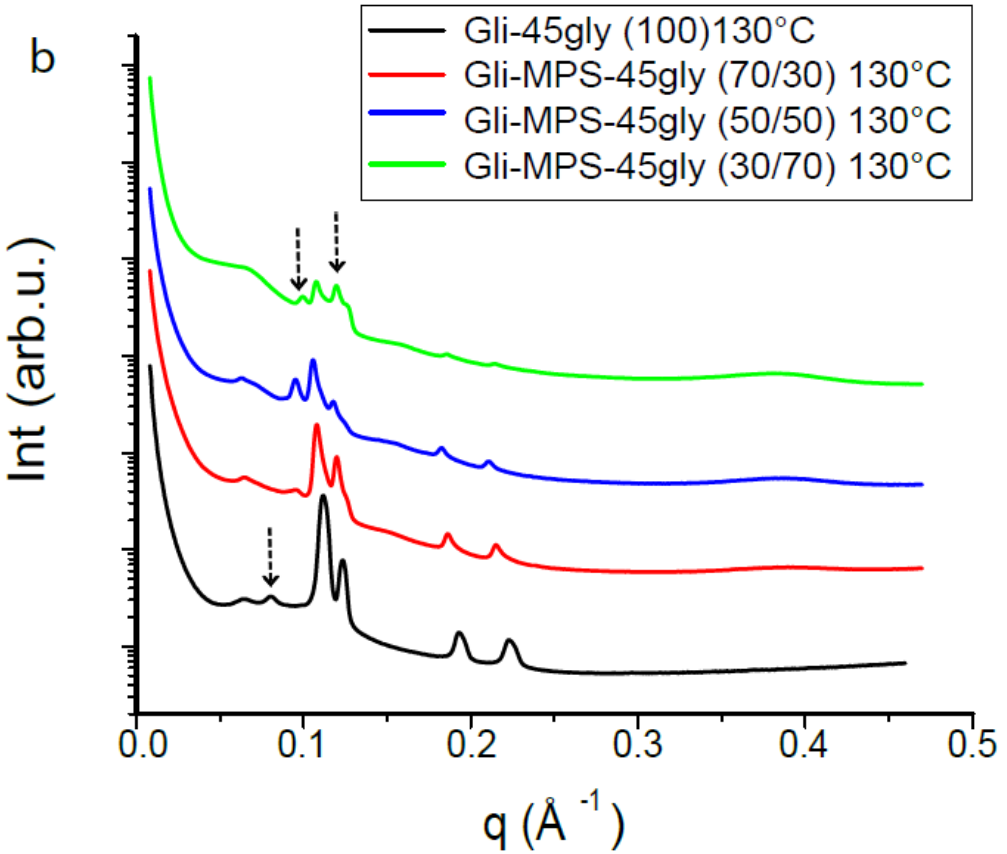
In-situ Glia-glycerol structure dynamics



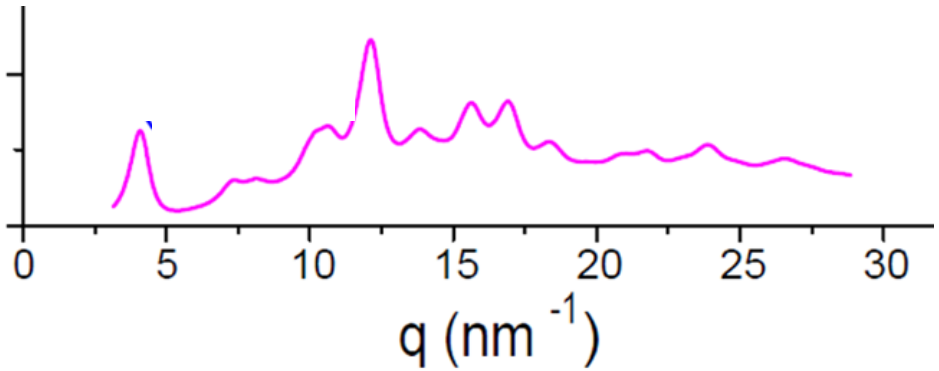


Gliadin-starch nano-structure: Example 4





More complex hierarchical structure



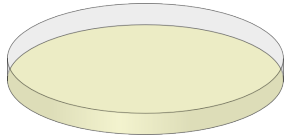
Potato starch -WAXS

Gliadin/Lupin protein PROCESSING Example 5

Foaming – aerating process

protein

30 s

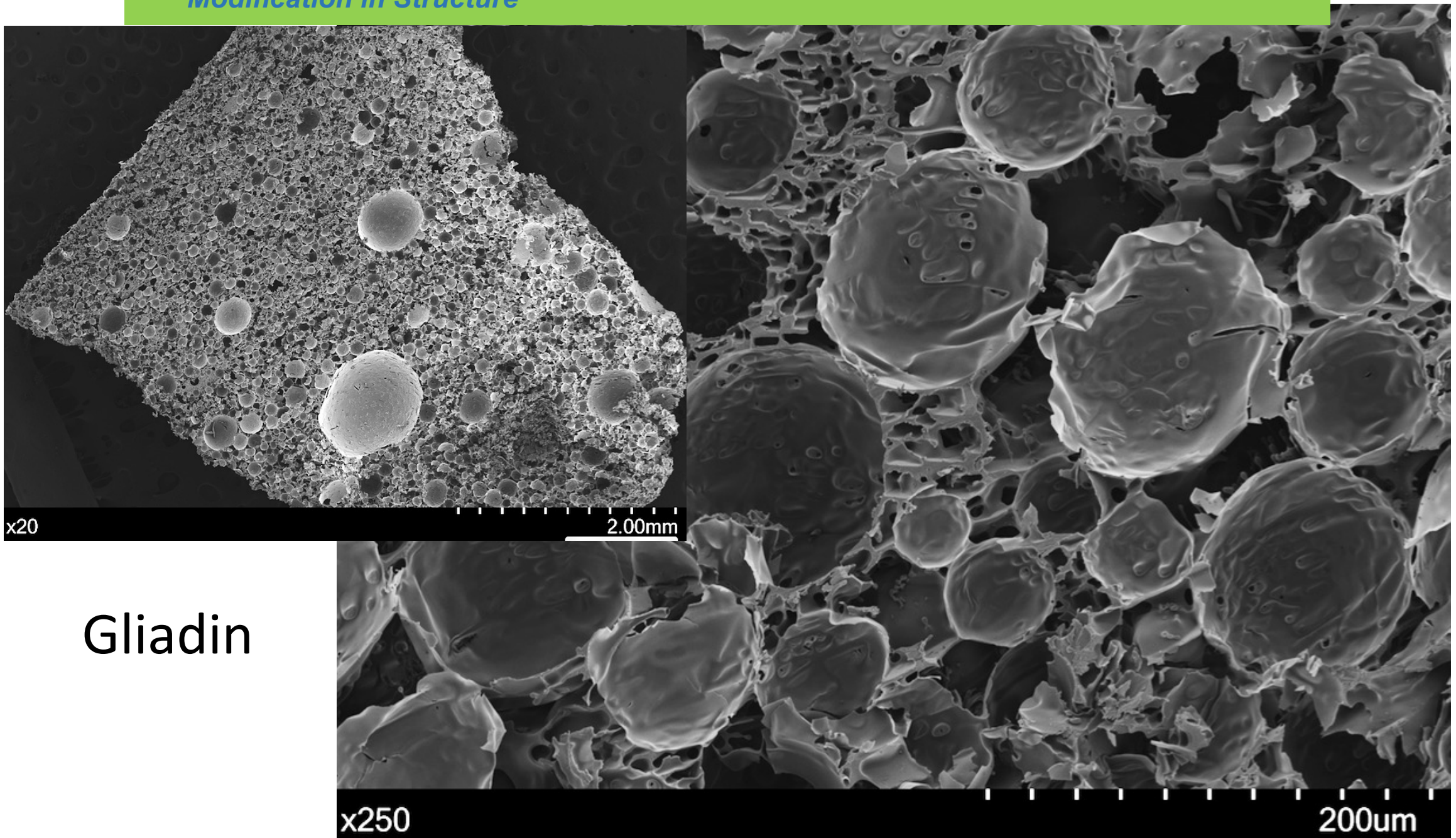


- 80 °C

48 h

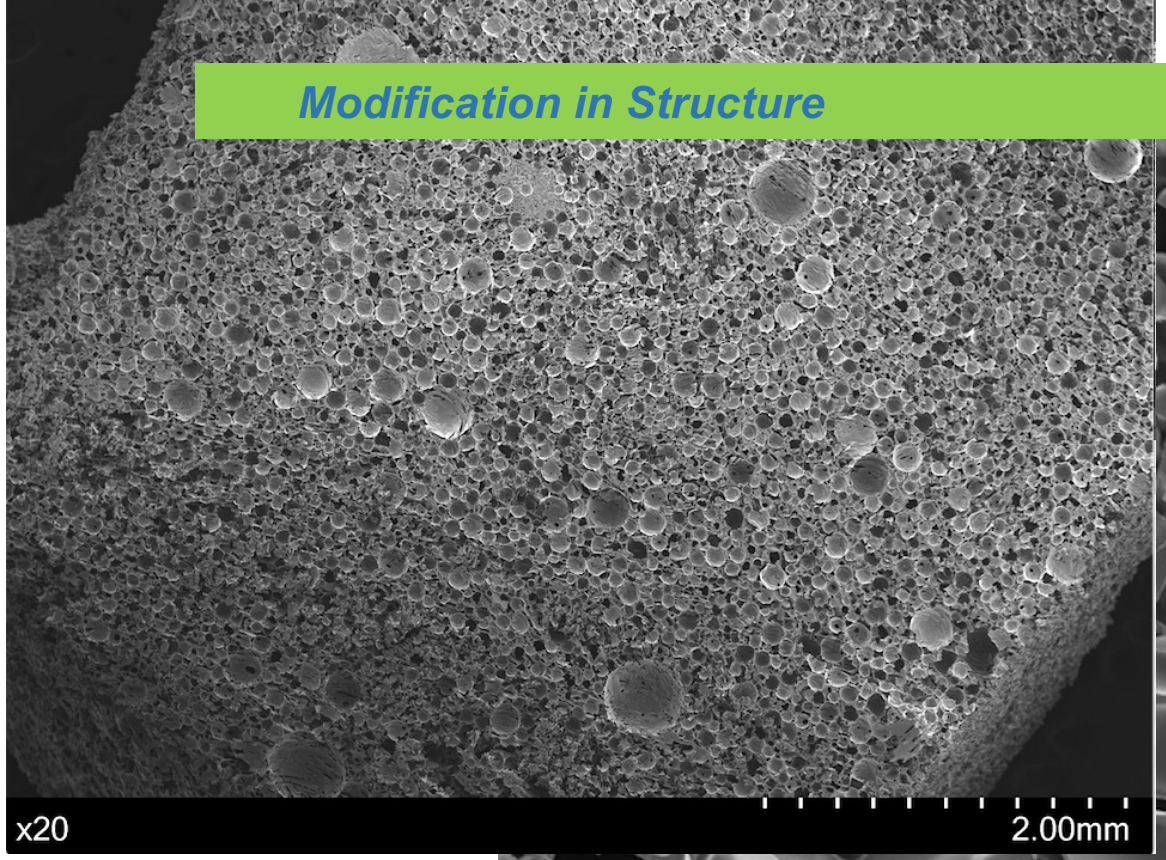
1 cm

Modification in Structure



Gliadin

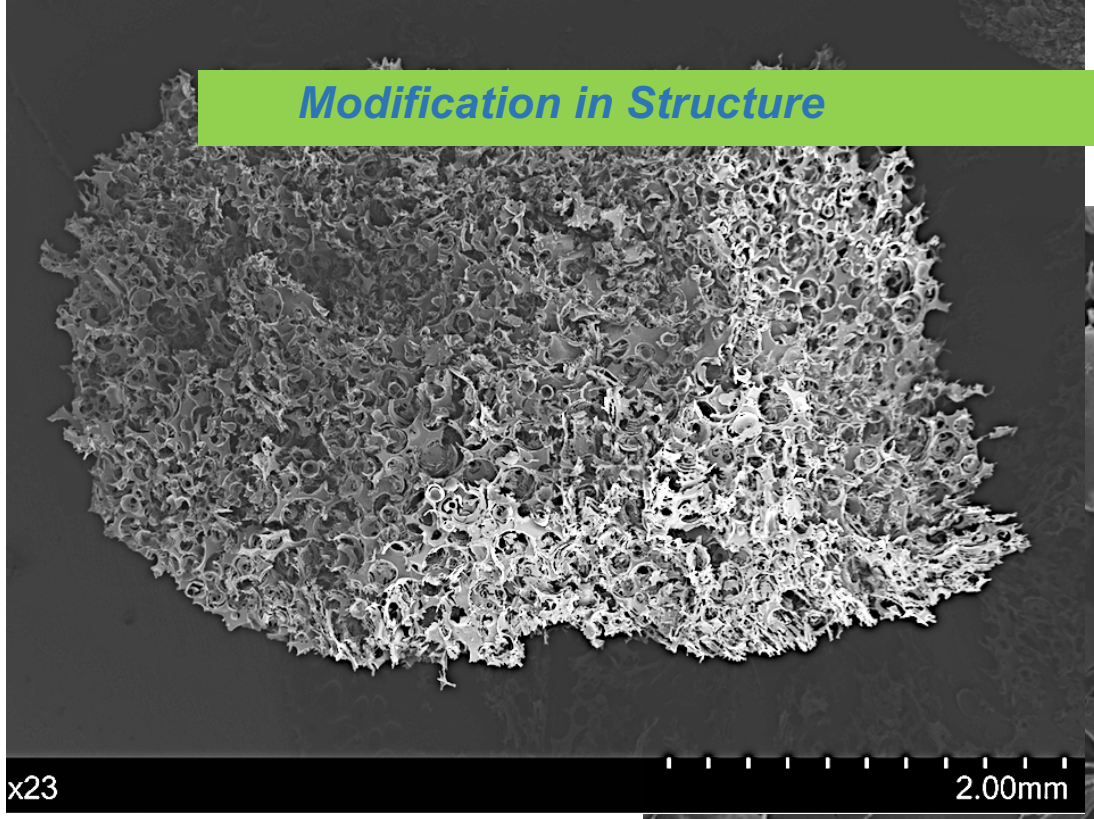
Modification in Structure

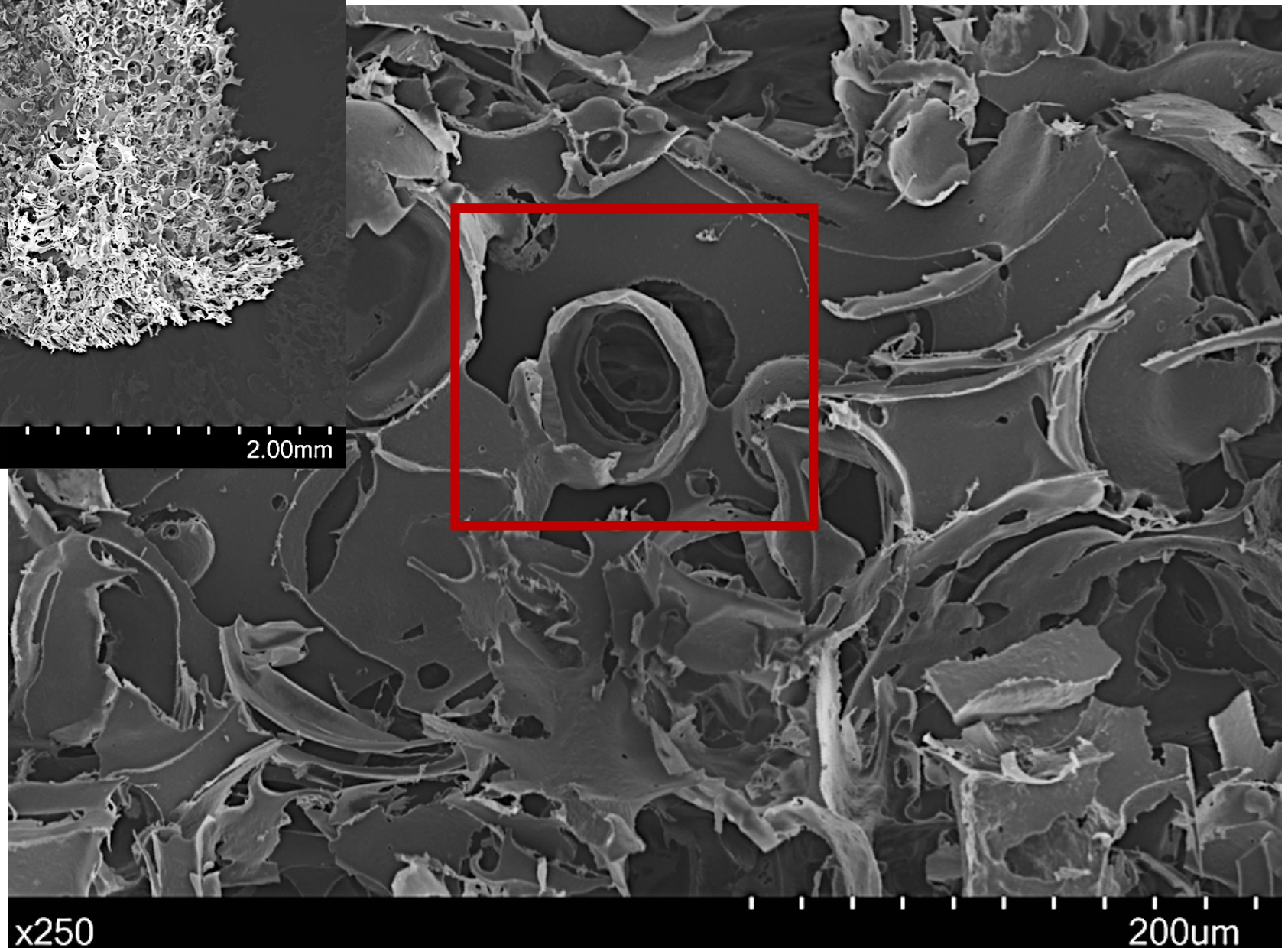


Gliadin + SB6

Bubbles are bigger, more uniform in size and closer to each other

Modification in Structure

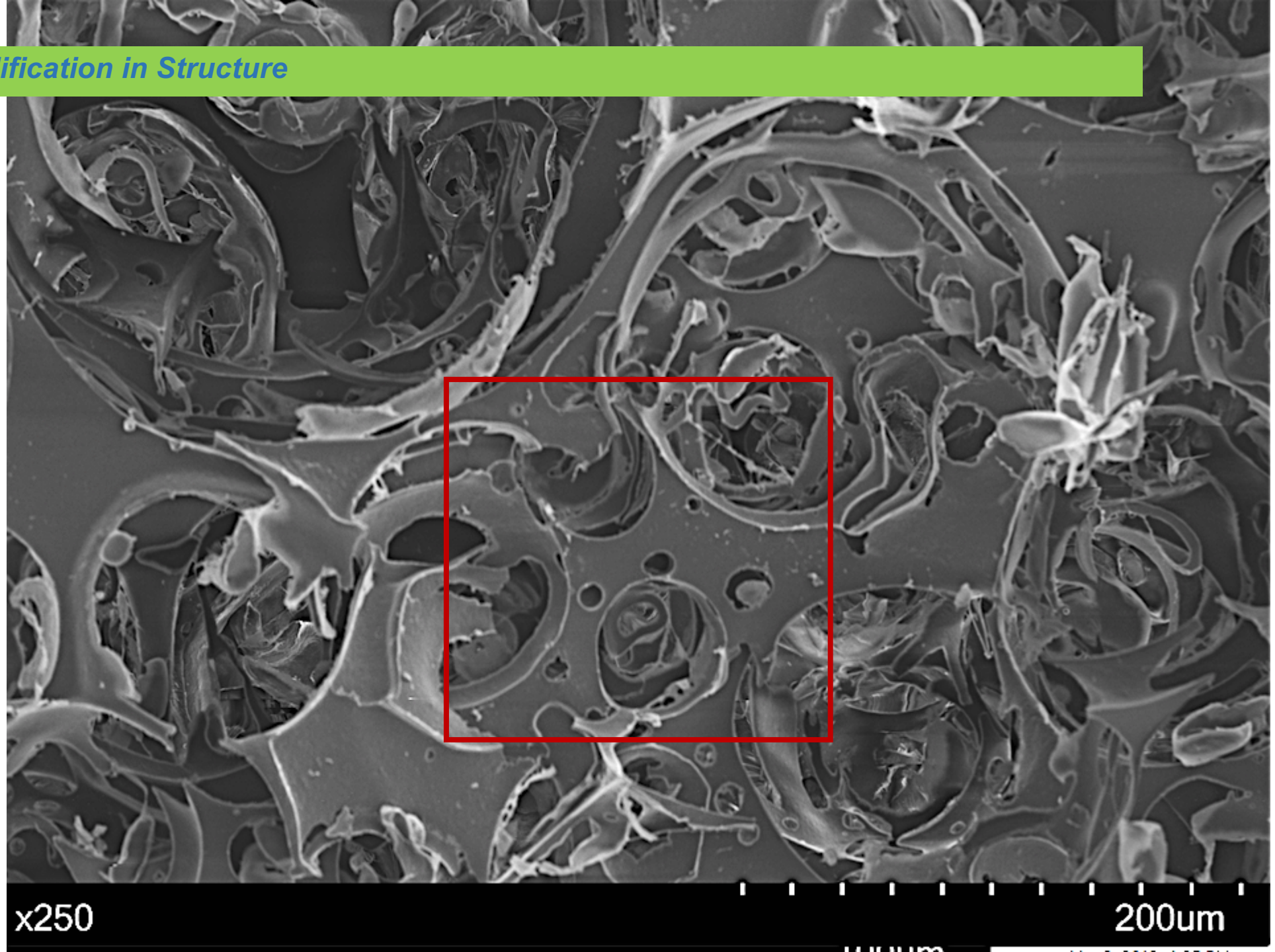




Lupin

Modification in Structure

Lupin + SB6



Conclusions

STRUCTURE + FUNCTION + PROCESSING

- Example 1: The structure-functional properties of wheat gluten products can be modulated in a green way by tuning G X E in plants.
- Example 2: Wheat separation processing is important: structure and quality can be positively impacted.
- Example 3: Designing of the novel food structures (e.g. meat replacers) and properties through innovative processing is possible.
- Example 4: Tuning gliadin-glycerol structure-function properties is possible.
- Example 5: Structure modification with the use of enzyme brings innovative possibilities for development of new food products.

Acknowledgements

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