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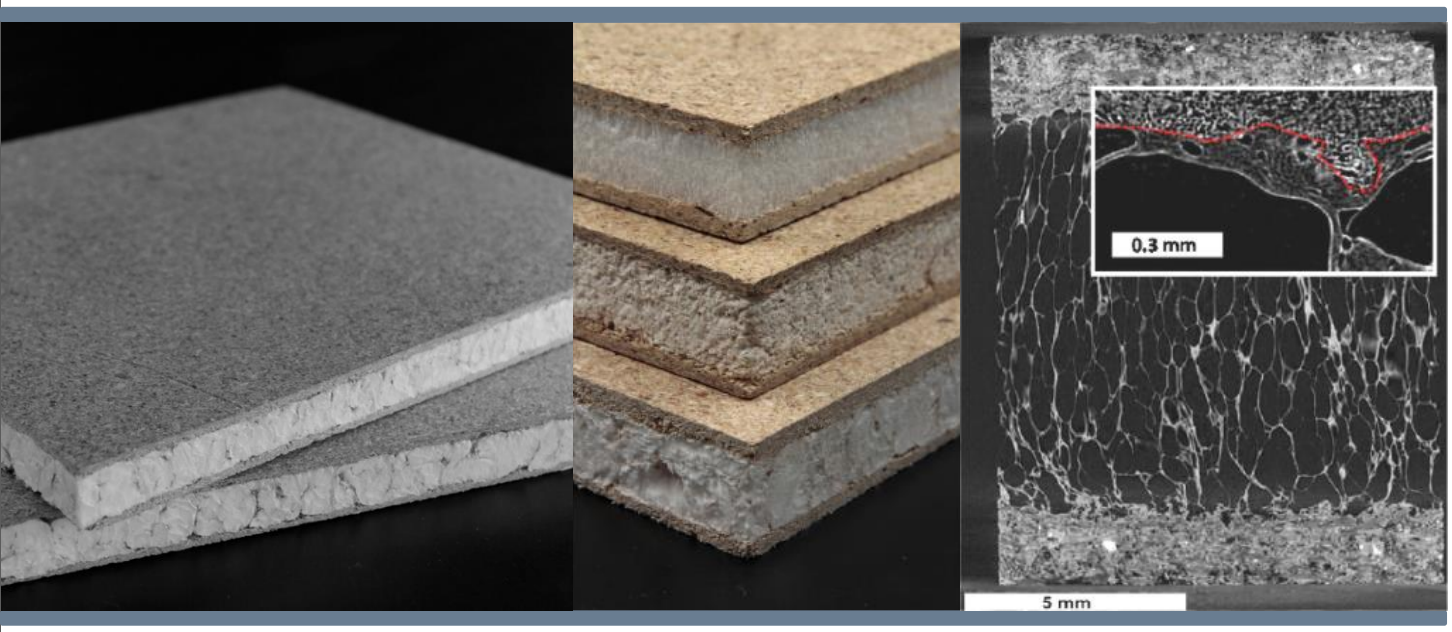
FÉDÉRALE DE LAUSANNE



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Martin Rhême
Heiko Thoemen

Mechanical properties of bio-based foam

COST FP1303 Technical Workshop
24.02.2016
Madrid

Institute for Materials and Wood Technologies

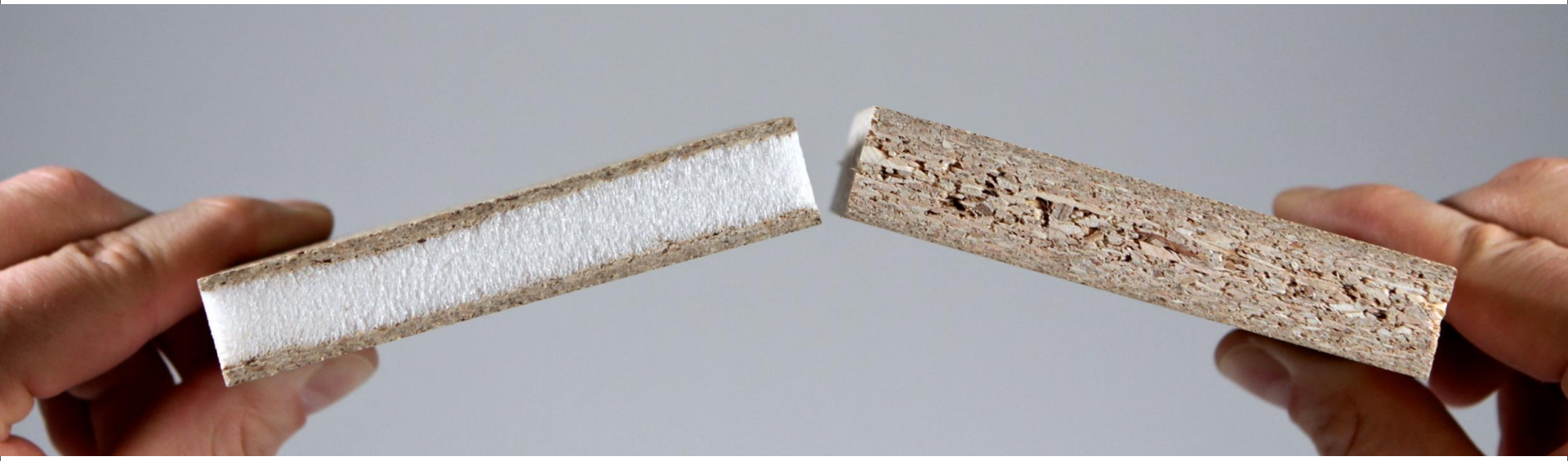
Why panel weight reduction?

Customers point of view

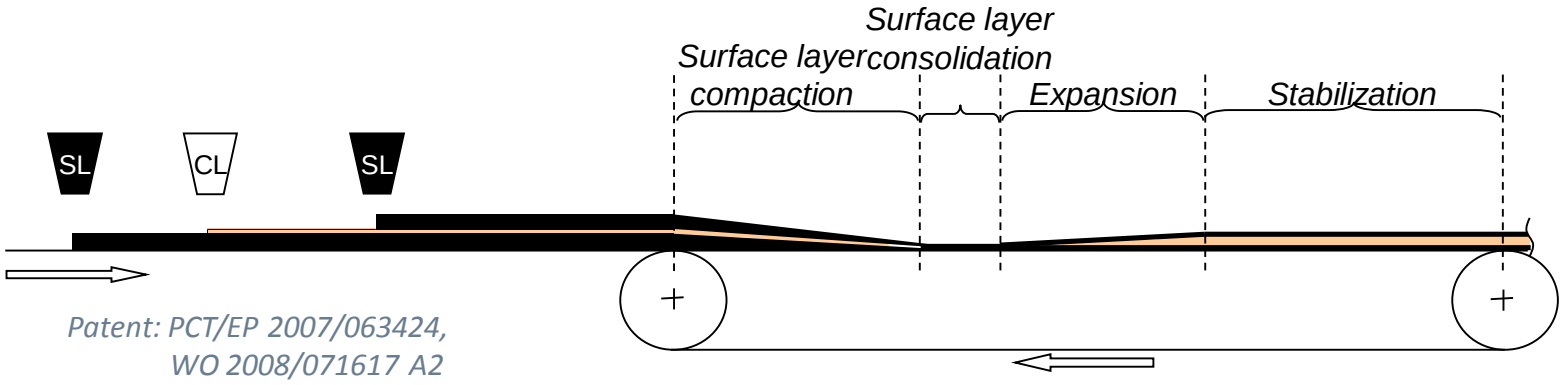
- Design trend
- Transportation cost
- Ease of handling
- Ease of assembly

Application fields

- Furniture
- Interior paneling
- Packaging

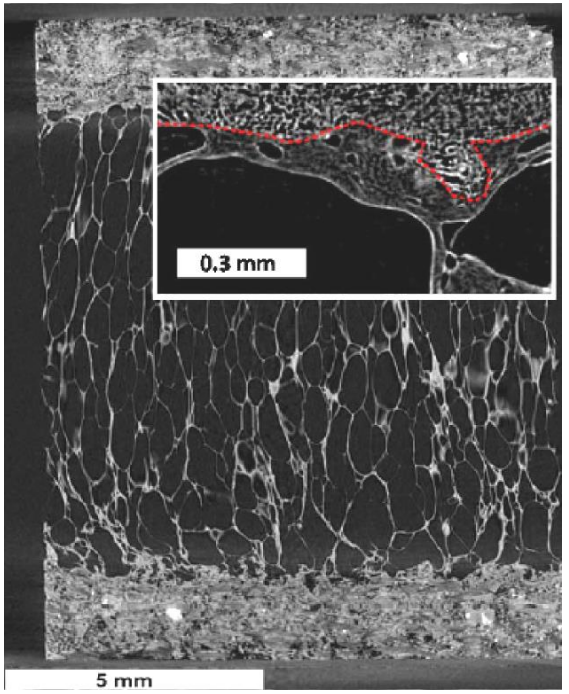


Why a continuous process ?



Patent: PCT/EP 2007/063424, WO 2008/071617 A2

- Cost-efficient production
- Mechanical interlocking connection between layers, no adhesive needed



Challenges

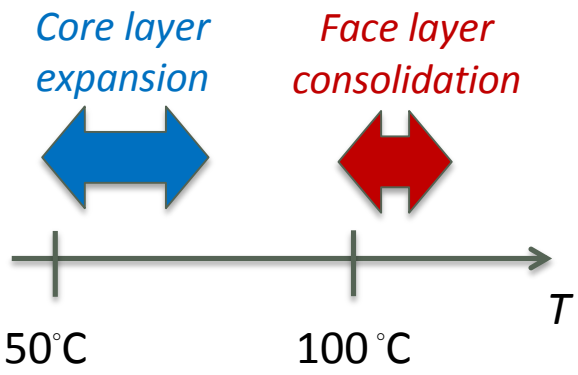
Previous work

- EPS as core material, with pentane as blowing agent
- Alternative: Expancel® microspheres

at University of Hamburg (J. Luedtke, J. Welling, A. Shalbafan, H. Thoemen)

Materials requirement

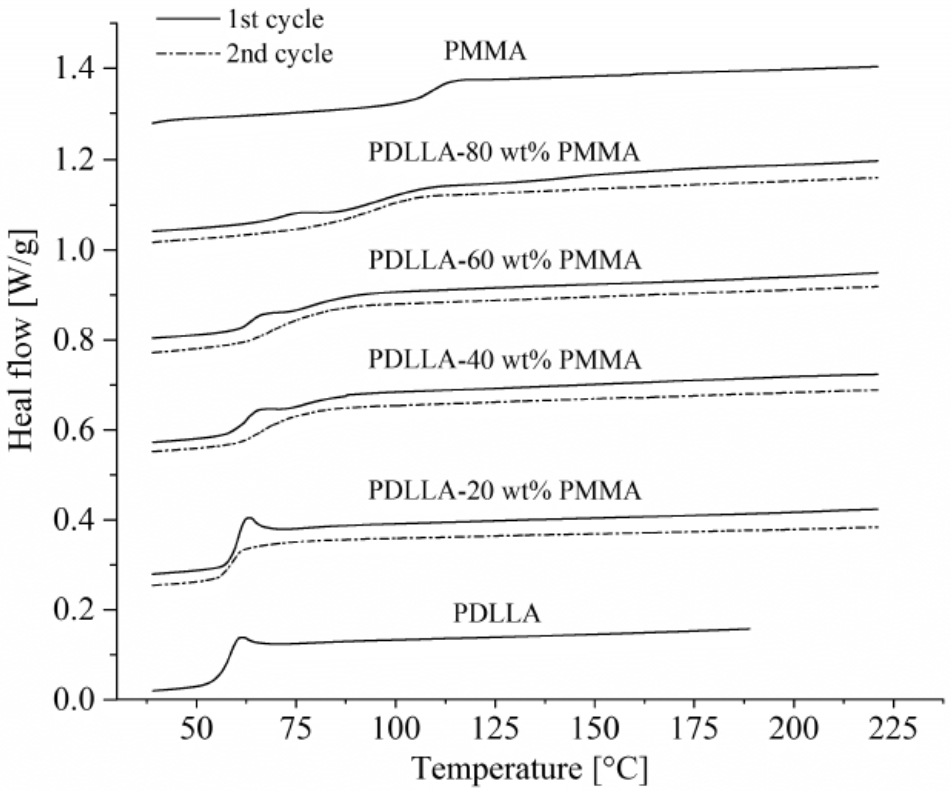
- Application as a dry powder or granulate
- Nonflammable/non-VOC foaming agent
- Bio-based, preferably biodegradable
- Overlaping processing window



Choice of the foam material

- poly(D,L-lactide) (PLA) blended with PMMA (50/50wt%) + talc as nucleating agent
- Impregnation with liquide CO_2 as blowing agent

- Solide foam precursors (granulates), stable at room T
- Foam and coalesce at 80° C – 90° C



Foam core layer

Goal of the study

- Mechanical characterization and comparison of the various foam types
- Investigation of the influence of the processing conditions

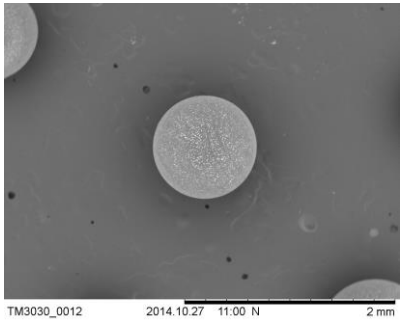
Methods

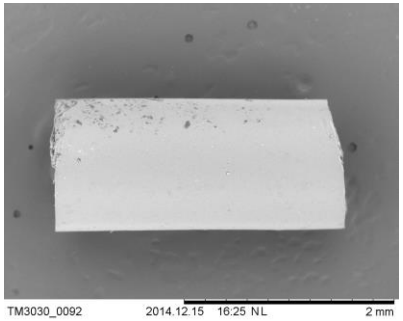
- Production of ULPB with various foam core layer (target density : 100 kg/m^3)
  - EPS
  - Microsphere
  - PLA/PMMA
- Production of reference molded PLA/PMMA
- Extraction of specimens
- Mechanical testing

Materials

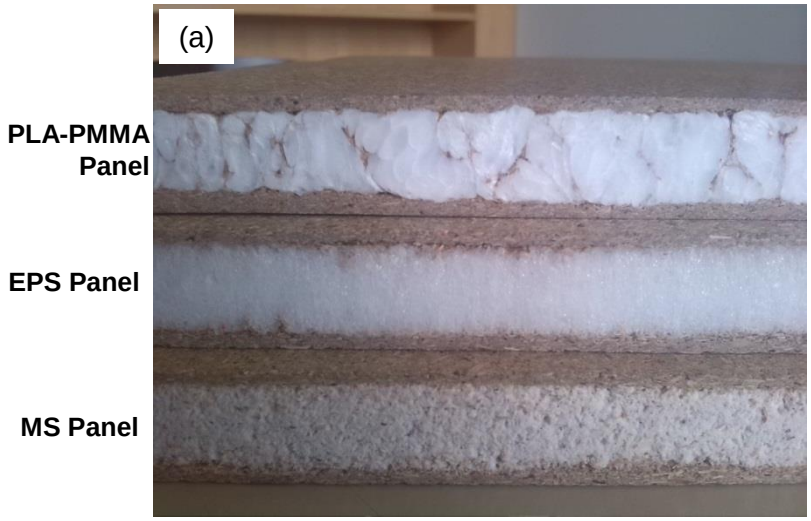
Property	MS	EPS	PLA-PMMA
Particle size	15 µm	0.3 – 0.8 mm	2 – 2.5 mm
Particle shape	Spherical	Spherical	Cylinder
Blowing agent	Isobutane	Pentane	CO_2
Glass transition temperature	80°C	103°C	75°C

- Solid foam precursors
- Resinated Wood particles

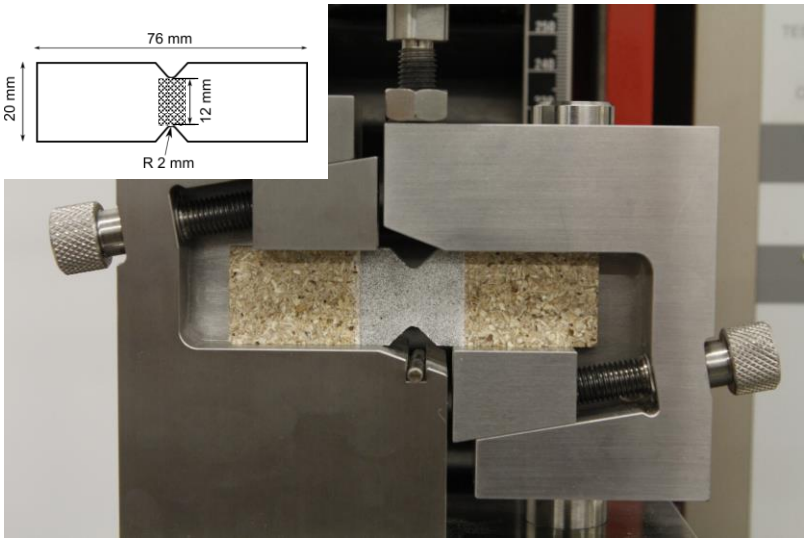




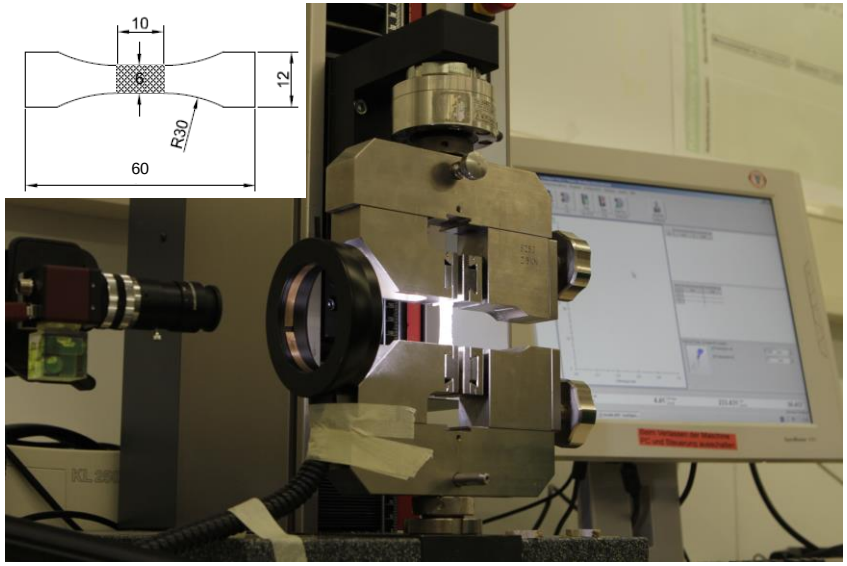
Experimental methods



Shear

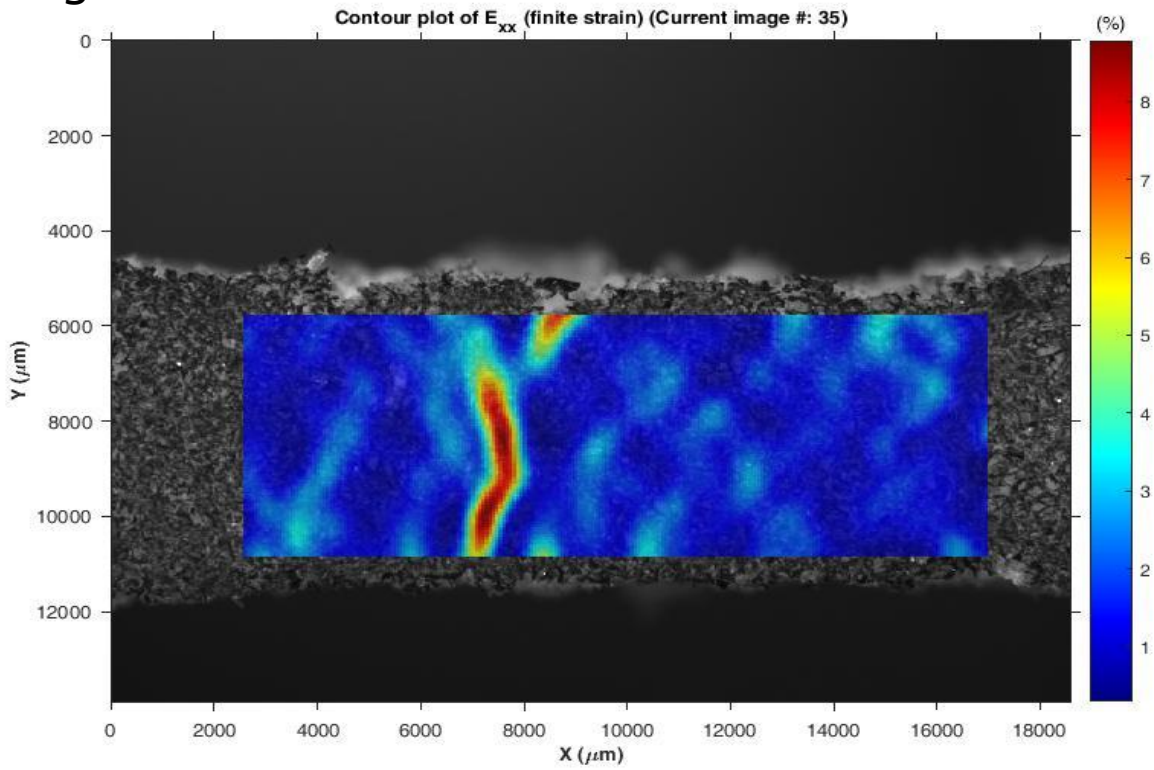


Tension - Compression



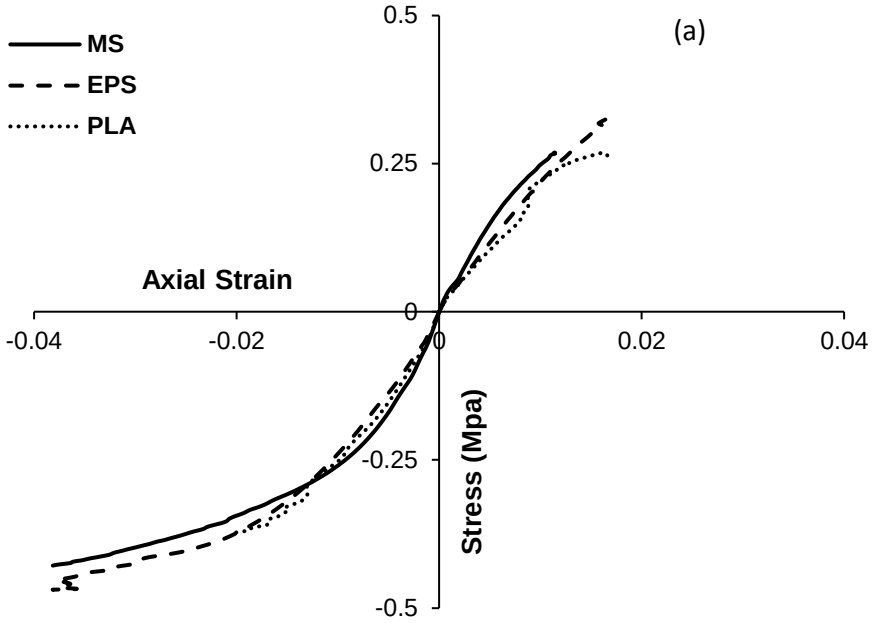
Evaluation of the results

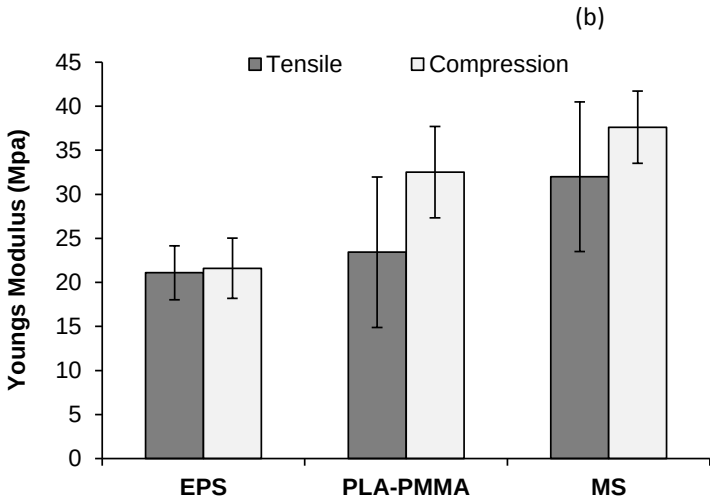
- Digital image correlation
- Strain field computing
- Strain-stress curve drawing
- Elastic properties computing



Results

Foam materials comparison



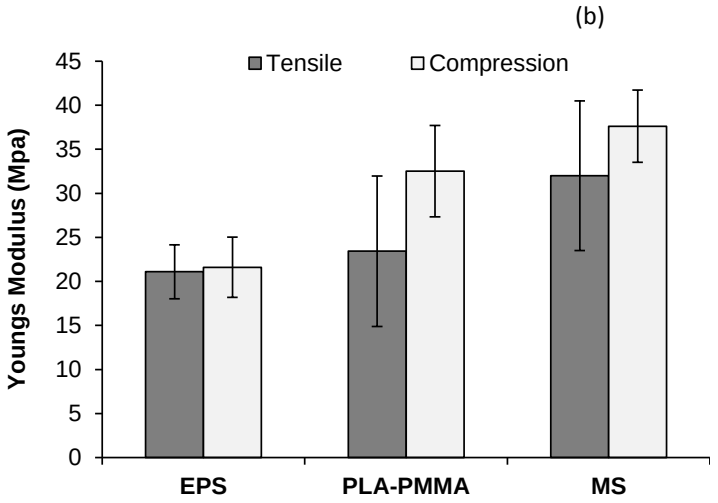


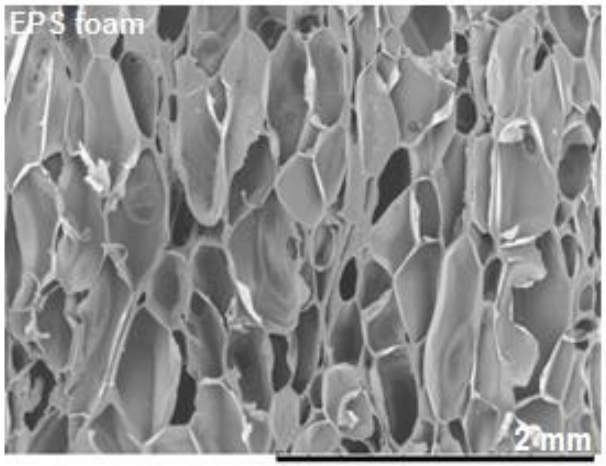
Pre- and post-yield beahvior can be easily observed

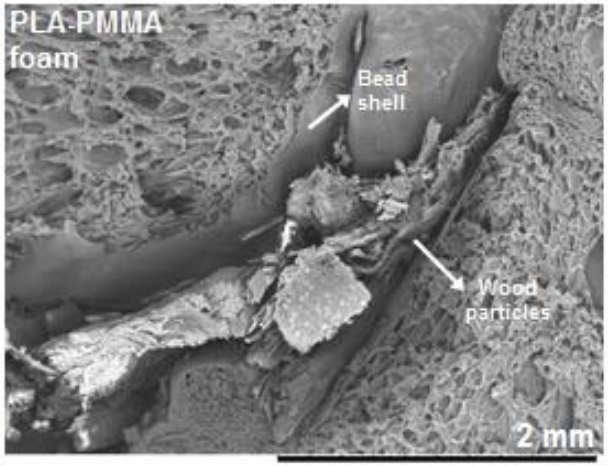
Results

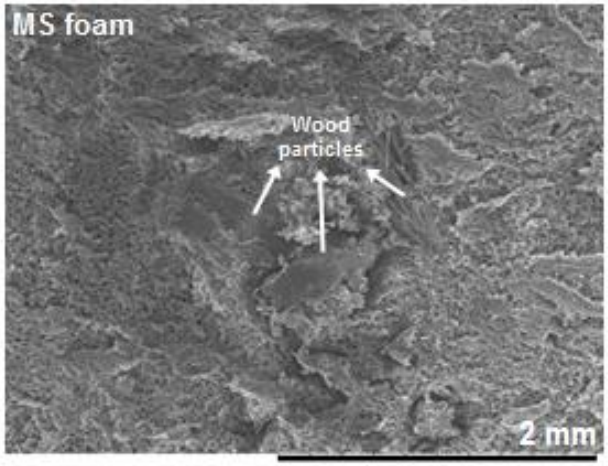
Material comparison

- Strong influence of the microstructure (cell density, …)



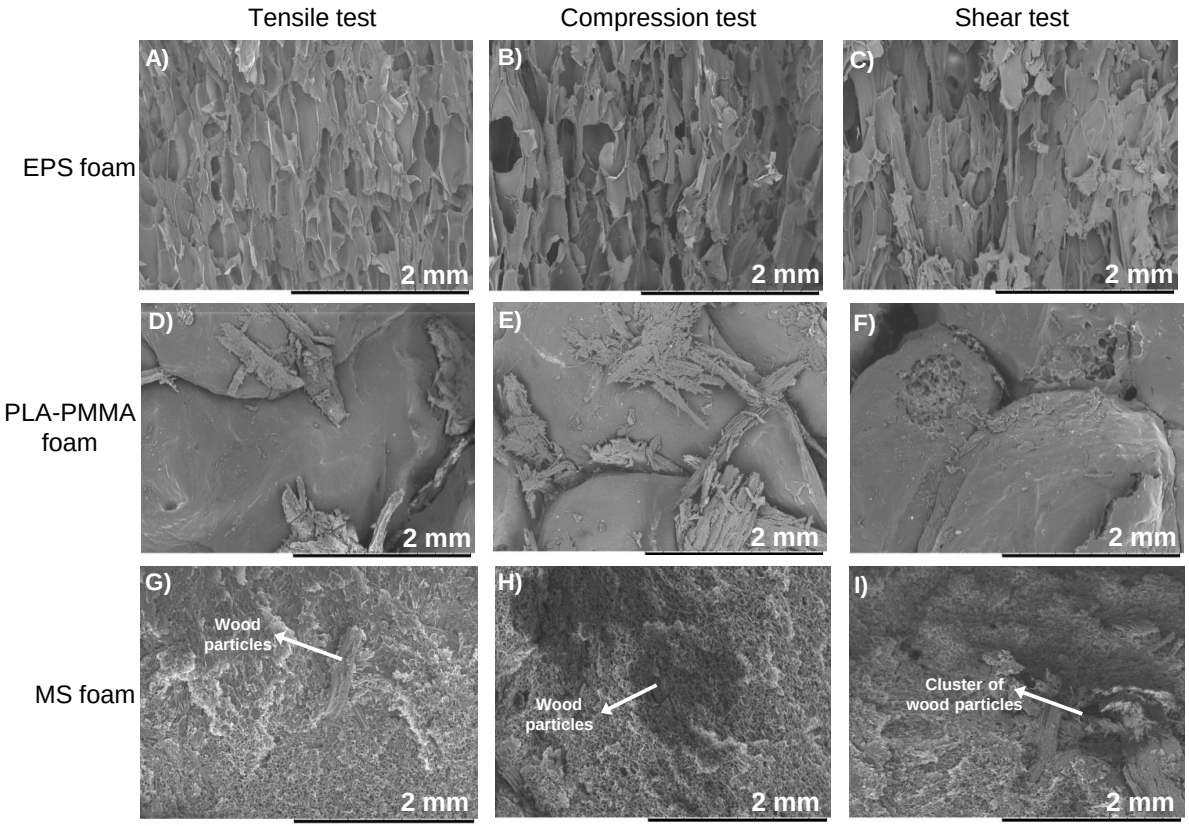






Results

Microscopy

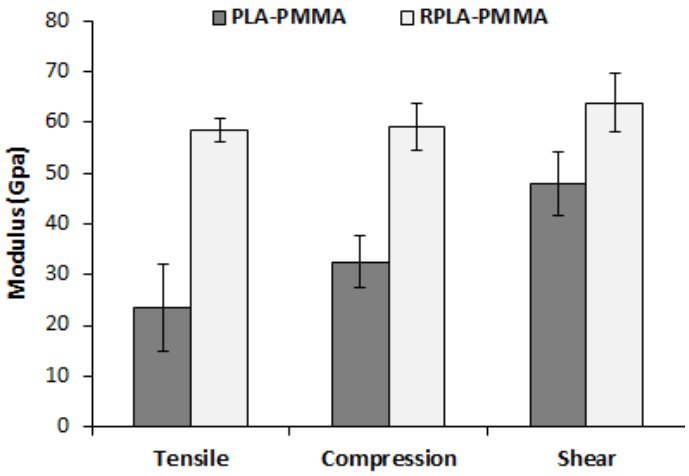


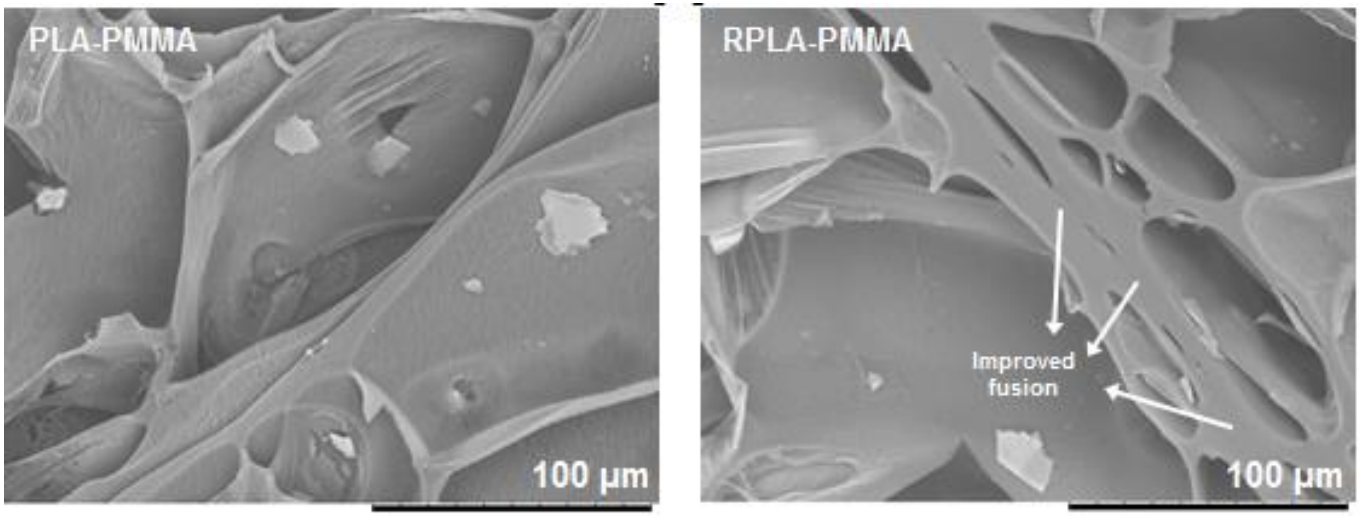
- For PLA-PMMA, the fracture occurs in-between precursors

Results

PLA in ULPB and reference PLA

- Better coalescence leads to better properties
- Process condition are crucial





Conclusion and Futur work

- PLA based polymer can be used as solid foam precursor when impregnated with liquid CO_2
- Bio based foam has similar properties as the standards oil based foams

- Better understanding and control of the production process
  - The foamability of the precursors
  - Investigate the influence of the environmental conditions (T, RH)
  - Improve the interface
- Use of a 100% bio based foam core layer
  - Precursor particles with embedded wood fibres
  - Precursor particles with embedded cellulose nanofibrils

Thank you