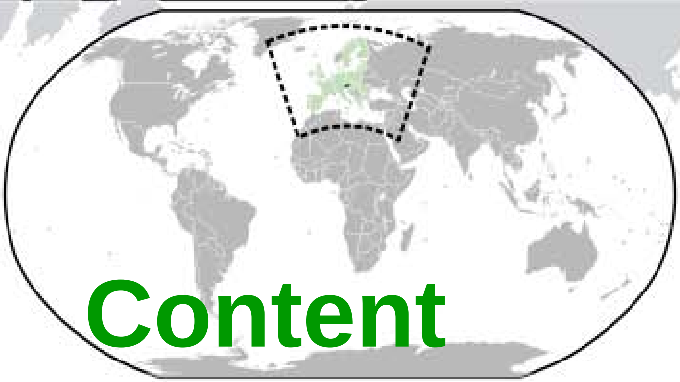
Universität für Bodenkultur Wien

University of Natural Resources and Life Sciences, Vienna

www.boku.ac.at



Content

Universität für Bodenkultur Wien
University of Natural Resources
and Applied Life Sciences, Vienna

- Who am I
- University of Natural Resources and Life Sciences (BOKU)
- Wood Science and Technology
- Visco elastic thermal compression process (thesis)

Who am I

- Graduate from University of Natural Resources and Life Sciences, Vienna
- Visiting student/ assistant at Aalto University, Helsinki and Oregon State University, Oregon
- Traineeship by EGGER, England and Kronostar, Russia (both particle and fibreboard production)
- Graduate from the engineering school in wood and sawmill technology and management, Salzburg
- Carpenter by Holzbau Gesäuse, Styria

University of Natural Resources and Life Sciences, Vienna

Founded:	**1872**
Students:	**10.000**
Scientific staff:	**1.200**
Other staff:	**470**

Universität für Bodenkultur Wien
University of Natural Resources and Applied Life Sciences, Vienna

Departments (15)

- Department of Material Sciences and Engineering
- Department of Biotechnology
- Department of Water, Atmosphere and Environment
- Department of Nanobiotechnology
- Department of Chemistry
- Department of Integrative Biology and Biodiversity Research
- Department of Food Sciences and Technology
- Department of Spatial-, Landscape-, and Infrastructure-Sciences
- Department of Economics and Social Sciences
- Department of Sustainable Agricultural Systems
- Department of Structural Engineering and Natural Hazards
- Department of Forest- and Soil Sciences
- Department of Applied Plant Sciences and Plant Biotechnology
- Department of Agrobiotechnology (IFA Tulln)
- Department of Applied Genetics and Cell Biology

Institute of Wood Science and Technology

University of Natural Resources and Life Sciences, Vienna

Department of Material Sciences and Process Engineering

Wood Kplus

Kompetenzzentrum Holz GmbH

Structure

Wood K plus

IHF

Institute of Wood Science and Technology

Teaching

- Bachelor
  - *Wood and fiber technology*
  - *Forest Science*
- Master
  - *Wood Technology and Management*
  - *Natural fiber composits*
  - *Forest Science*
- Dissertation

Kompetenzzentrum **Wood Kplus** (area BOKU)

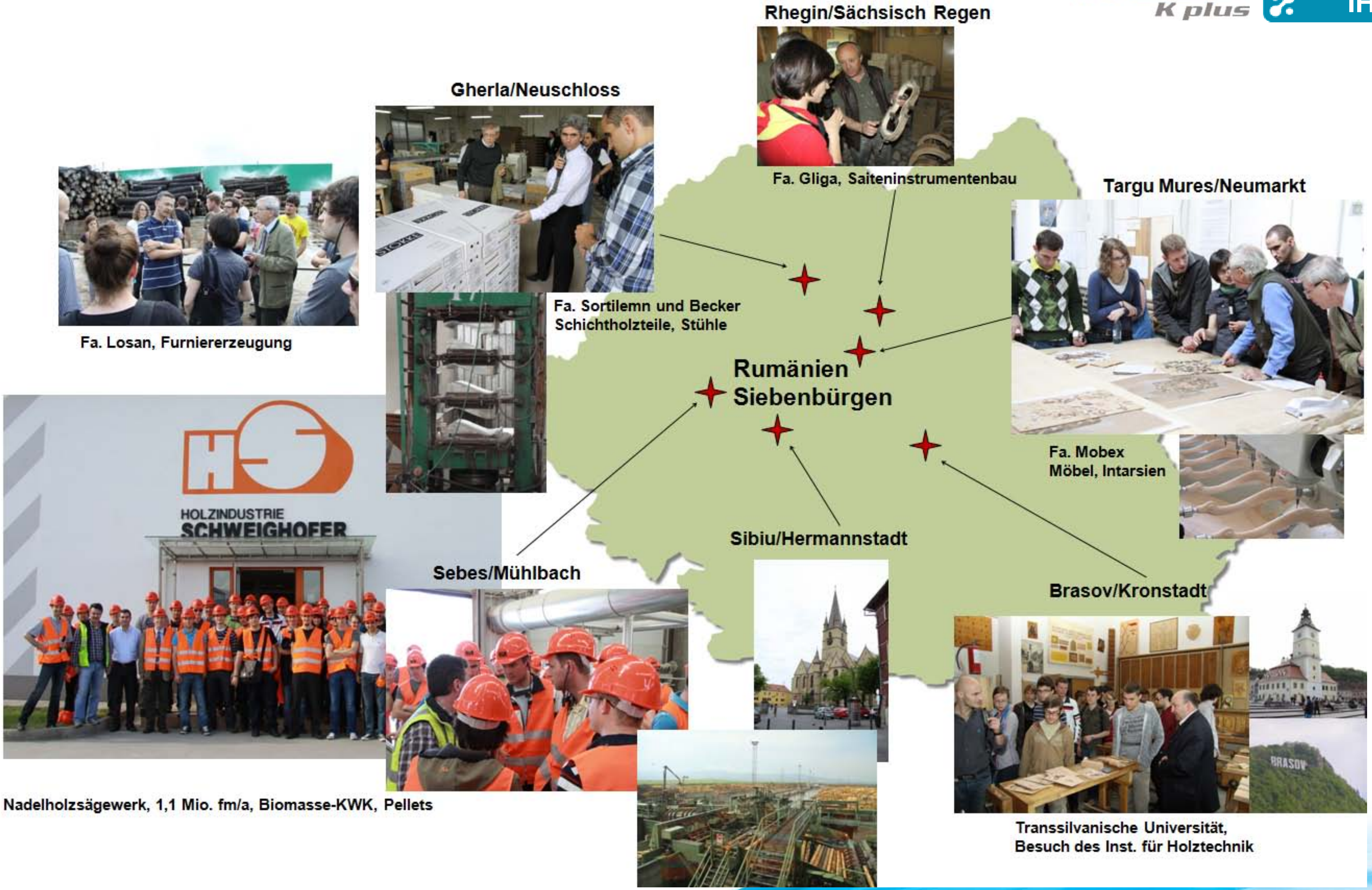
Research areas

- **Wood quality**
- **Wood chemistry**
- **Material engineering**
- **Surface applications**
- **Pulp and Paper**
- **Light weight materials**
- **Wood drying**
- **Wood modifications**
- **Composites**
- **Adhesive bonding**
- **Dendrochronolgy**
- **Technologies for natural fibers**

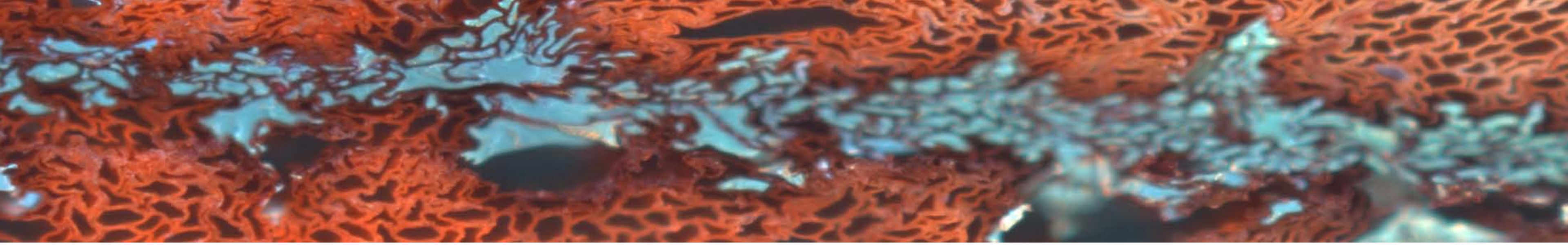
Research Center

Wood K plus BOKU IHF

Excursiones



Student organisations



EXAMINATION OF OPERATIONAL PARAMETERS FOR VTC WOOD PRODUCTION

Master Thesis
Josef Weissensteiner
University of Natural Resources and Life Sciences
BOKU – Vienna

Oregon State University
Corvallis- USA

August 2010- January 2011

Content

- Wood modification in general
- Densification methods
- VTC
  - Main facts
  - Schematic
  - Project goals and equipment
  - Testing
  - Results
  - Conclusions
  - Future projects

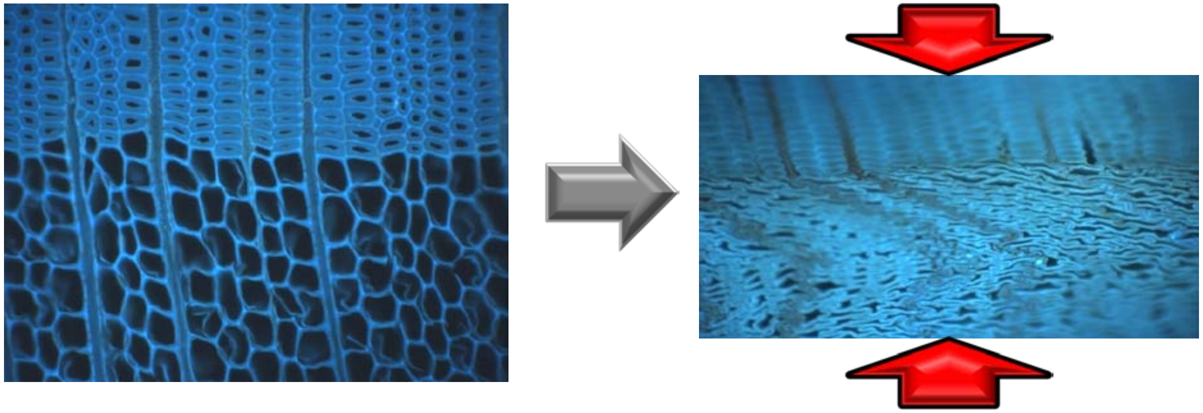
Wood modification in general

Definition given by (Hill, 2006):

"*Wood modification involves the action of a **chemical**, **biological**, or **physical agent** upon the material resulting in a **permanent change** to the polymeric chemical composition; with such a change leading to a desired **property enhancement**. The modified wood should itself be **nontoxic** under service conditions and furthermore, there should be **no release of any toxic substances** during service, or at end of life following disposal or recycling of the modified wood*."

Mechanical densification processes

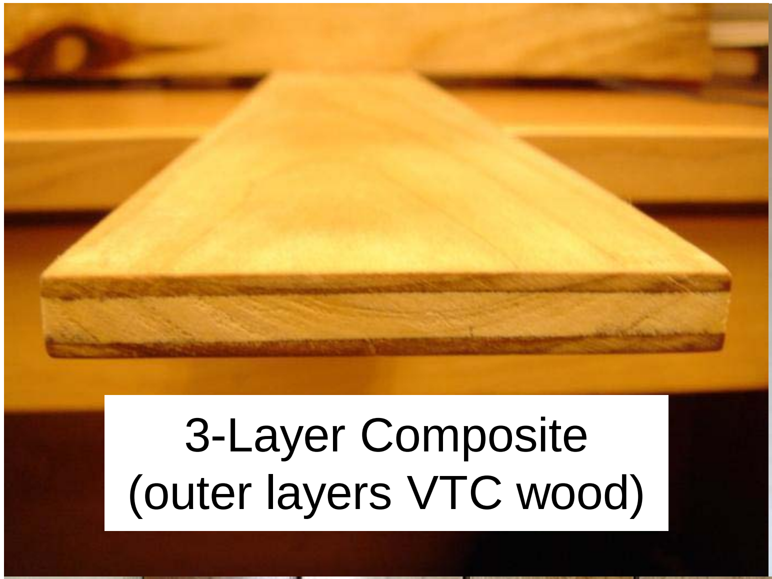
- Thermo-mechanical compression
- Thermo-hydro-mechanical (THM) compression
- **Viscoelastic thermal compression (VTC)**



Viscoelastic Thermal Compression (VTC)

- Mechanical compression of thin wood up to 10 mm perpendicular to the grain under conditions of elevated and dynamic steam pressure and temperature.
- Strength, stiffness, hardness, and moisture resistance improved.
- No chemical treatments.
- Has been demonstrated with many wood species.
- Intended as feedstock for composite products.

What does it look like?

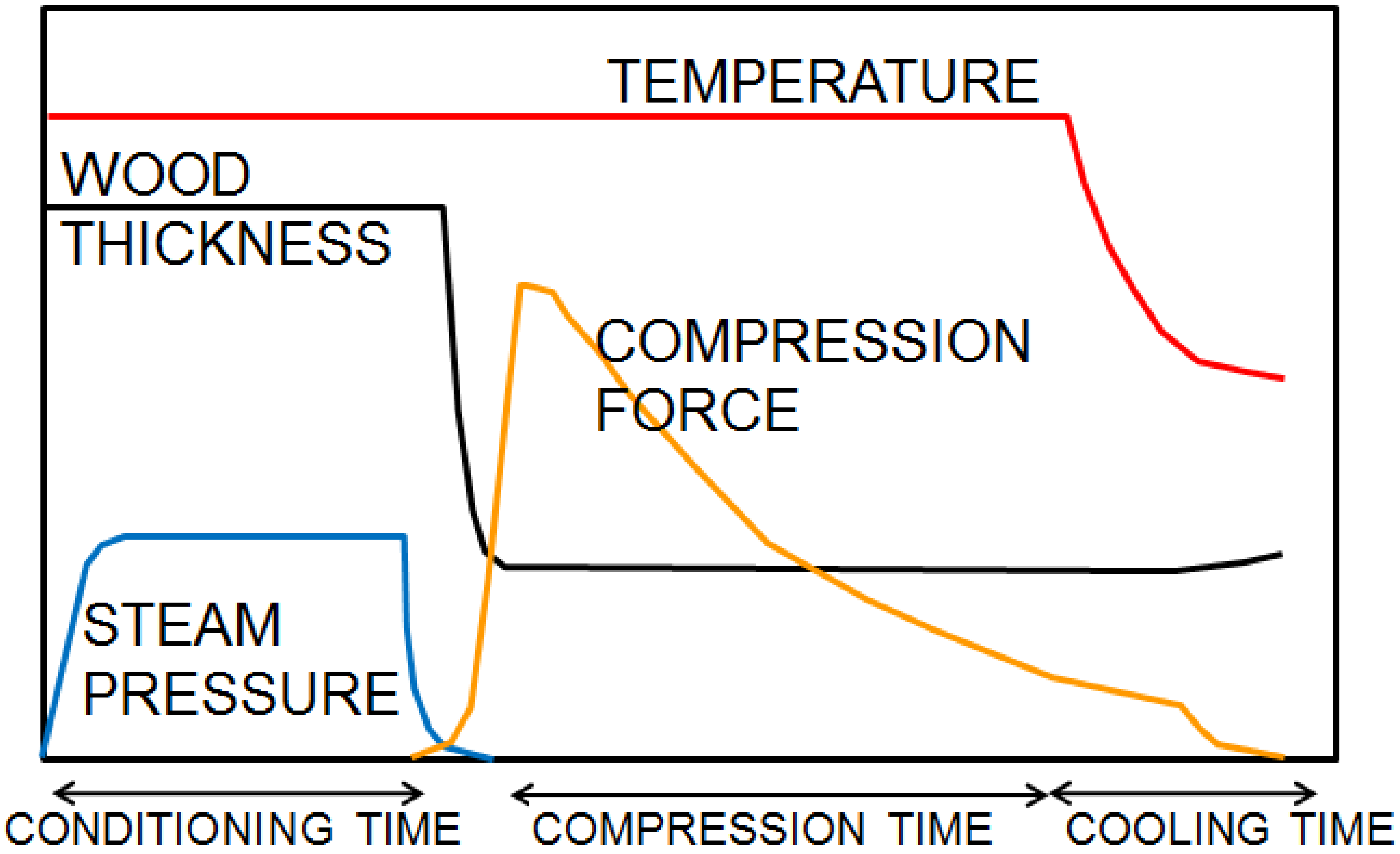


3-Layer Composite
(outer layers VTC wood)

6-layer VTC Composite

Flooring components

VTC- schematic



Research objectives

- Understanding the effects on final VTC properties as a function of process parameters such as:
  - Conditioning time prior to compression
  - Rate of compression
  - Compression time
  - Amount of adhesive (laminated VTC composites)
- Laminated composites were produced and tested in bending as well as glueline shear strength.

Experimental Design

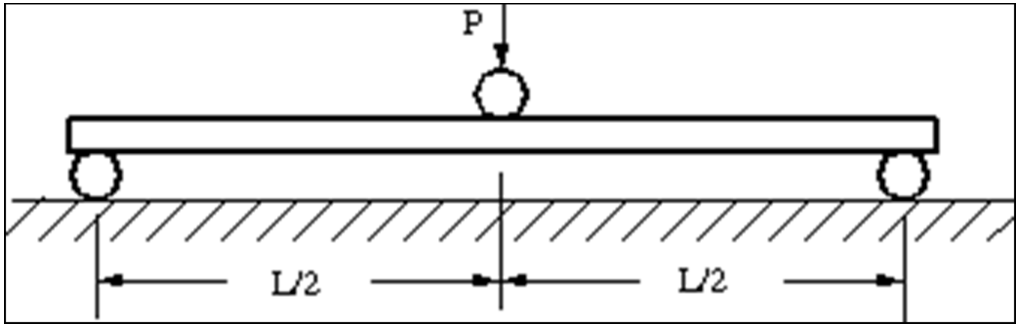
Partial factorial design

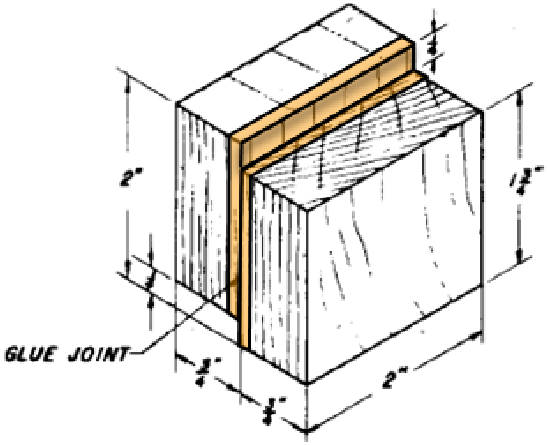
- 5 levels of each parameter
  - conditioning time
  - rate of compression
  - compression time
- 10 replications of each treatment combination
- control specimens (no treatment)

Conditioning prior to compression	sec	Rate (speed) of compression	Compression speed (mm/ min)	Compression time level	sec
A	90	1	61	A	120
B	120	2	40	B	150
C	180	3	29	C	180
D	240	4	14	D	210
E	30	5	7	E	240

Experimental Design

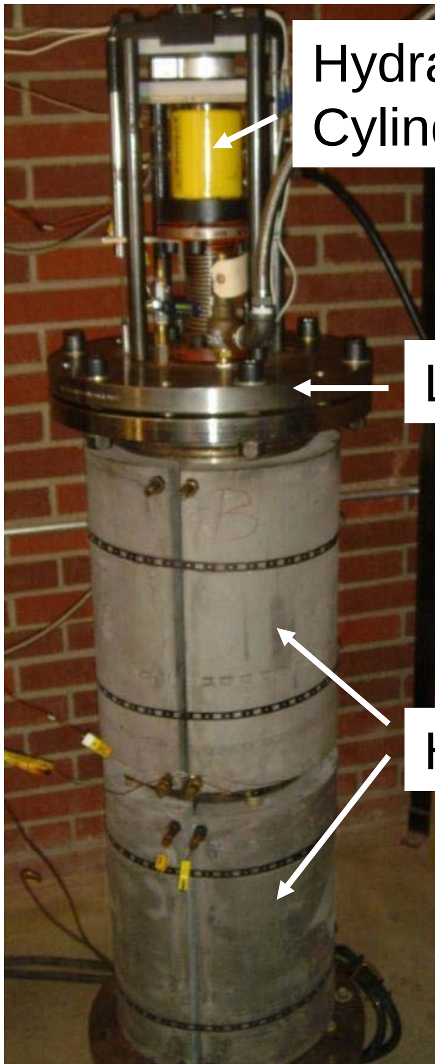
- Initial hybrid poplar specimen dimensions and MC were 600 mm x 230 mm x 5 mm, and 8 - 12%, respectively.
- Density and modulus of elasticity of the control specimens were evaluated.
- After processing, the samples were cut to the dimensions 50 mm x 200 mm for bending test and 50mm x 50mm for the shear block test.

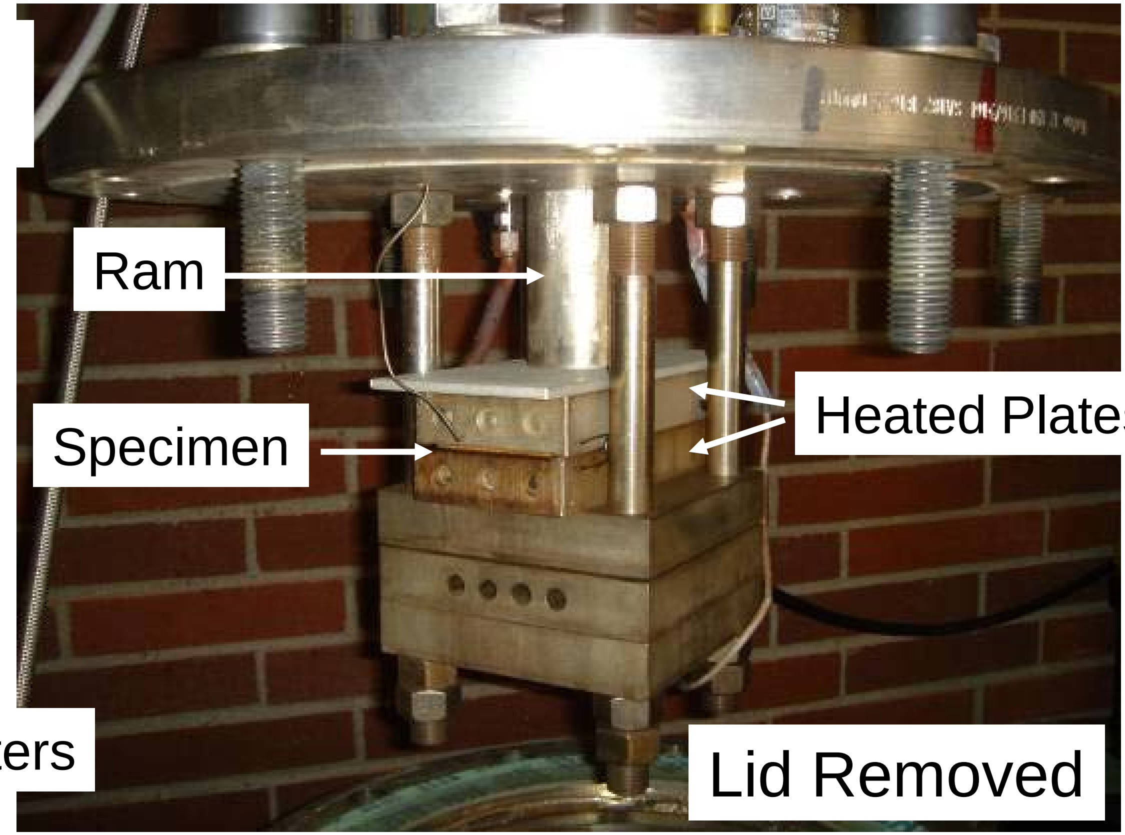




Research equipment

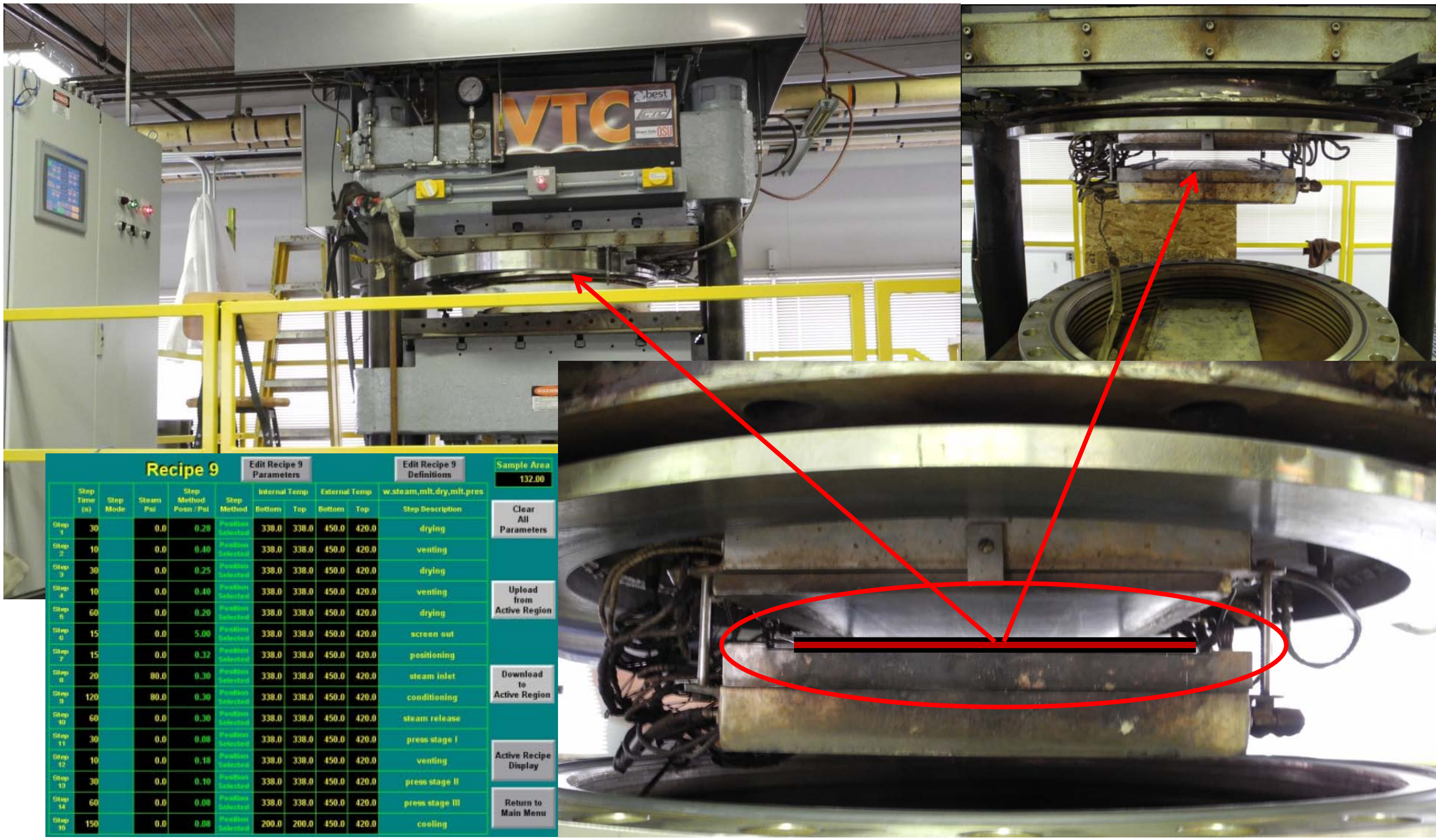
Small VTC Device





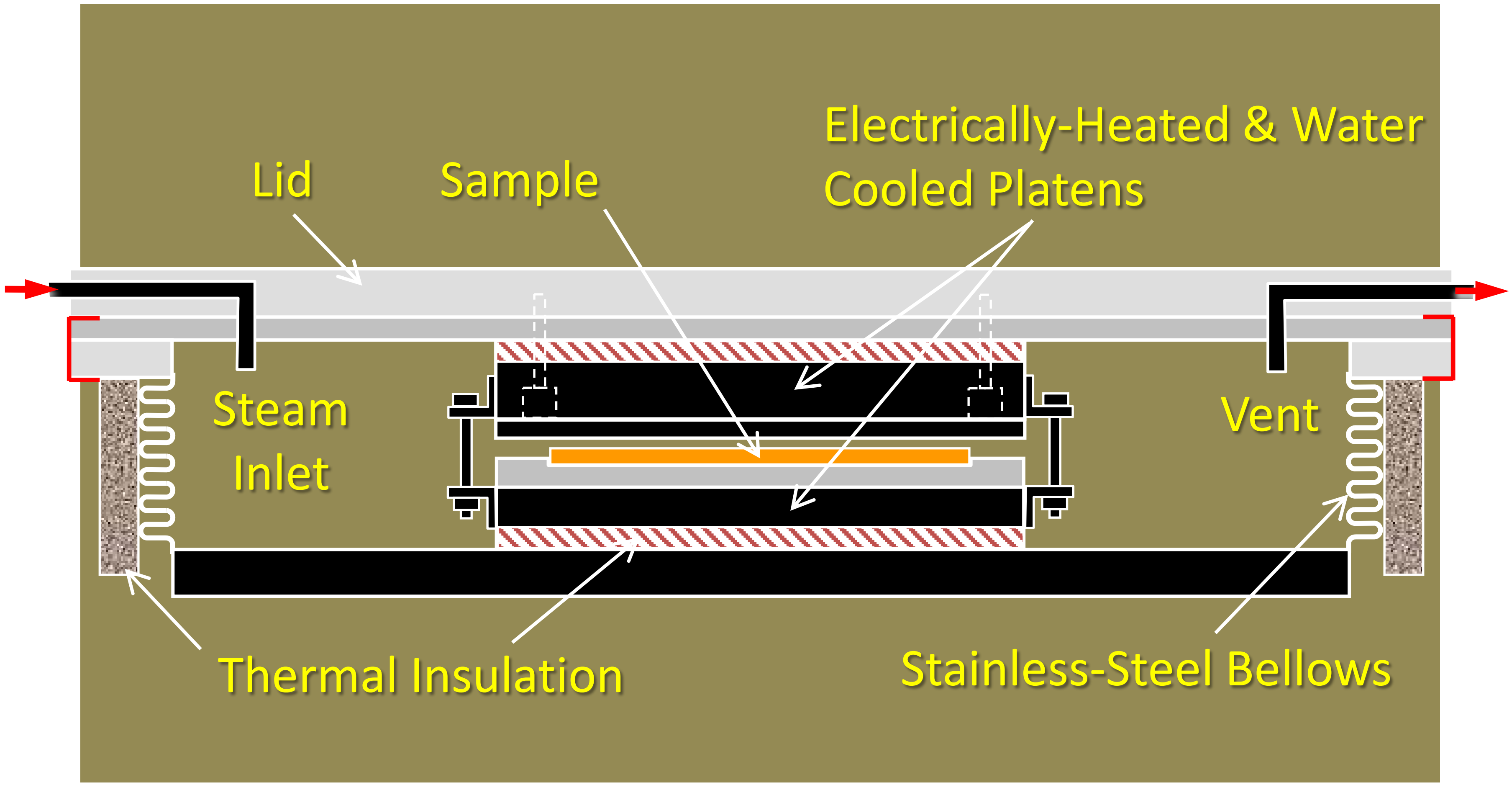
- Specimens up to 15 cm length

Research equipment
New press unit



	Step Time (s)	Step Mode	Steam Psi	Step Method Posn / Psi	Step Method	Internal Temp Bottom	Internal Temp Top	External Temp Bottom	External Temp Top	w.steam,mlt.dry,mlt.pres Step Description
Step 1	30		0.0	0.28	Position Selected	338.0	338.0	450.0	420.0	drying
Step 2	10		0.0	0.40	Position Selected	338.0	338.0	450.0	420.0	venting
Step 3	30		0.0	0.25	Position Selected	338.0	338.0	450.0	420.0	drying
Step 4	10		0.0	0.40	Position Selected	338.0	338.0	450.0	420.0	venting
Step 5	60		0.0	0.20	Position Selected	338.0	338.0	450.0	420.0	drying
Step 6	15		0.0	5.00	Position Selected	338.0	338.0	450.0	420.0	screen out
Step 7	15		0.0	0.32	Position Selected	338.0	338.0	450.0	420.0	positioning
Step 8	20		80.0	0.30	Position Selected	338.0	338.0	450.0	420.0	steam inlet
Step 9	120		80.0	0.30	Position Selected	338.0	338.0	450.0	420.0	conditioning
Step 10	60		0.0	0.30	Position Selected	338.0	338.0	450.0	420.0	steam release
Step 11	30		0.0	0.08	Position Selected	338.0	338.0	450.0	420.0	press stage I
Step 12	10		0.0	0.18	Position Selected	338.0	338.0	450.0	420.0	venting
Step 13	30		0.0	0.10	Position Selected	338.0	338.0	450.0	420.0	press stage II
Step 14	60		0.0	0.08	Position Selected	338.0	338.0	450.0	420.0	press stage III
Step 15	150		0.0	0.08	Position Selected	200.0	200.0	450.0	420.0	cooling

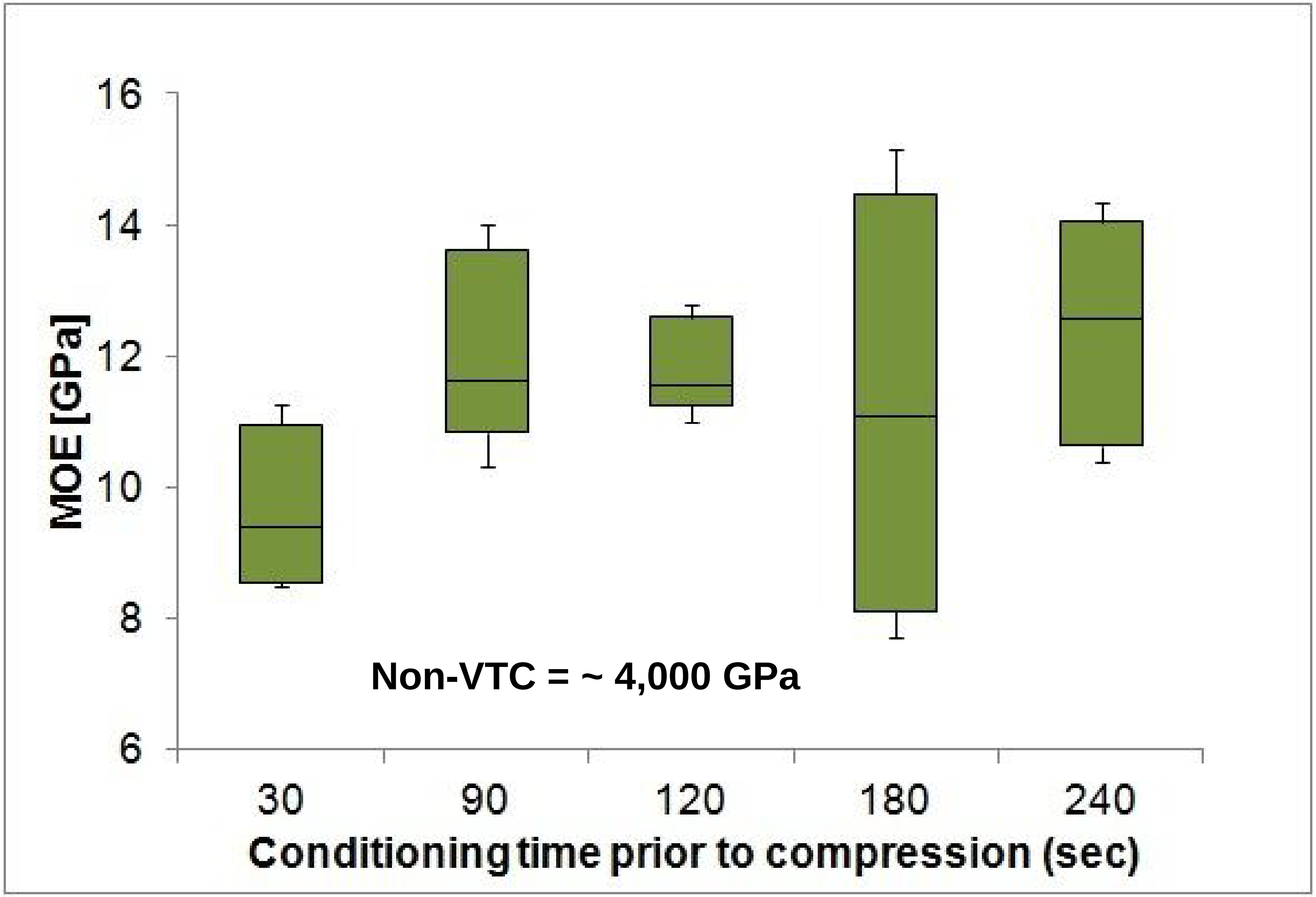
Research equipment
Densification chamber



Results

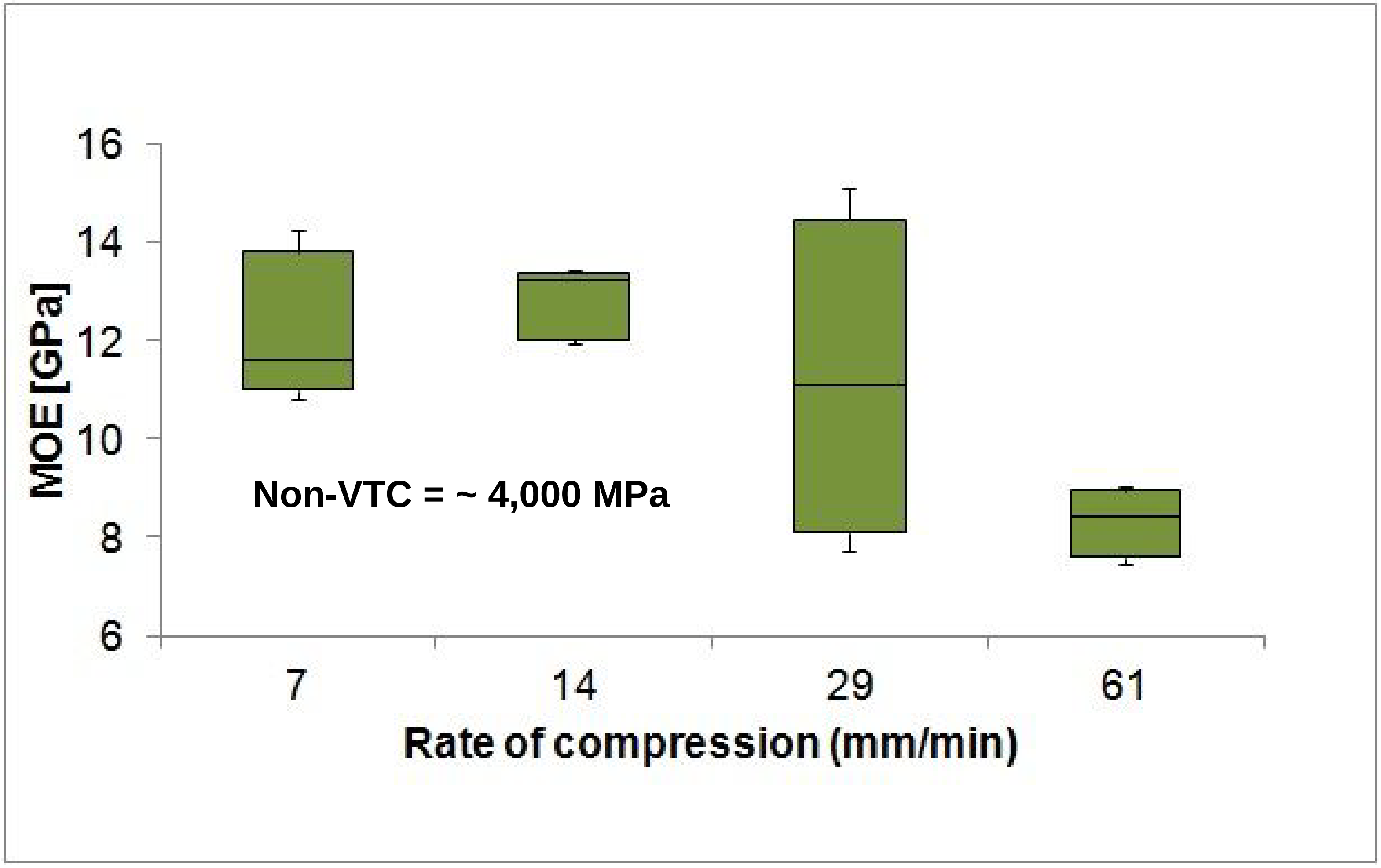
MOE as a function of conditioning time

(prior to compression)



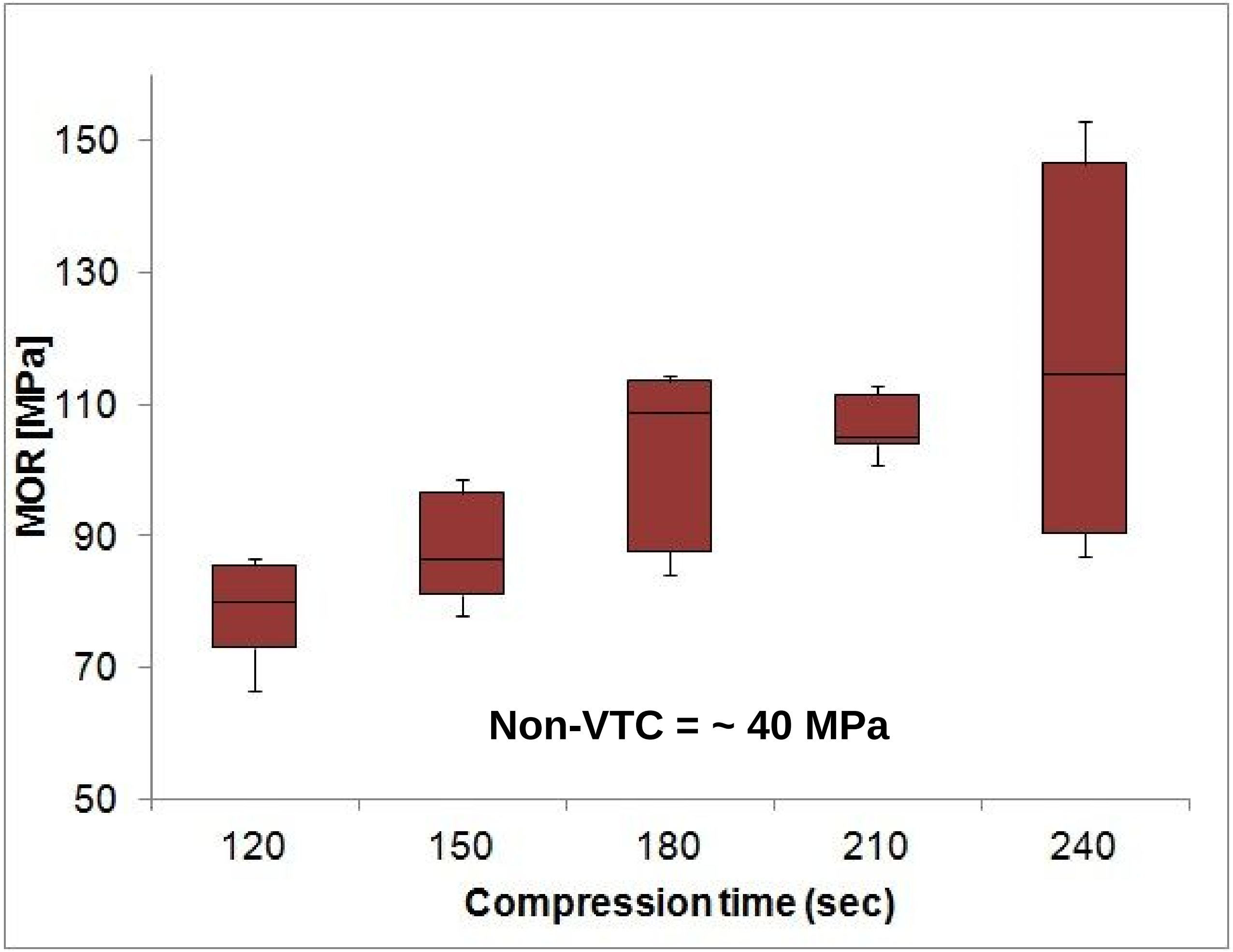
Results

MOE as a function of rate of compression



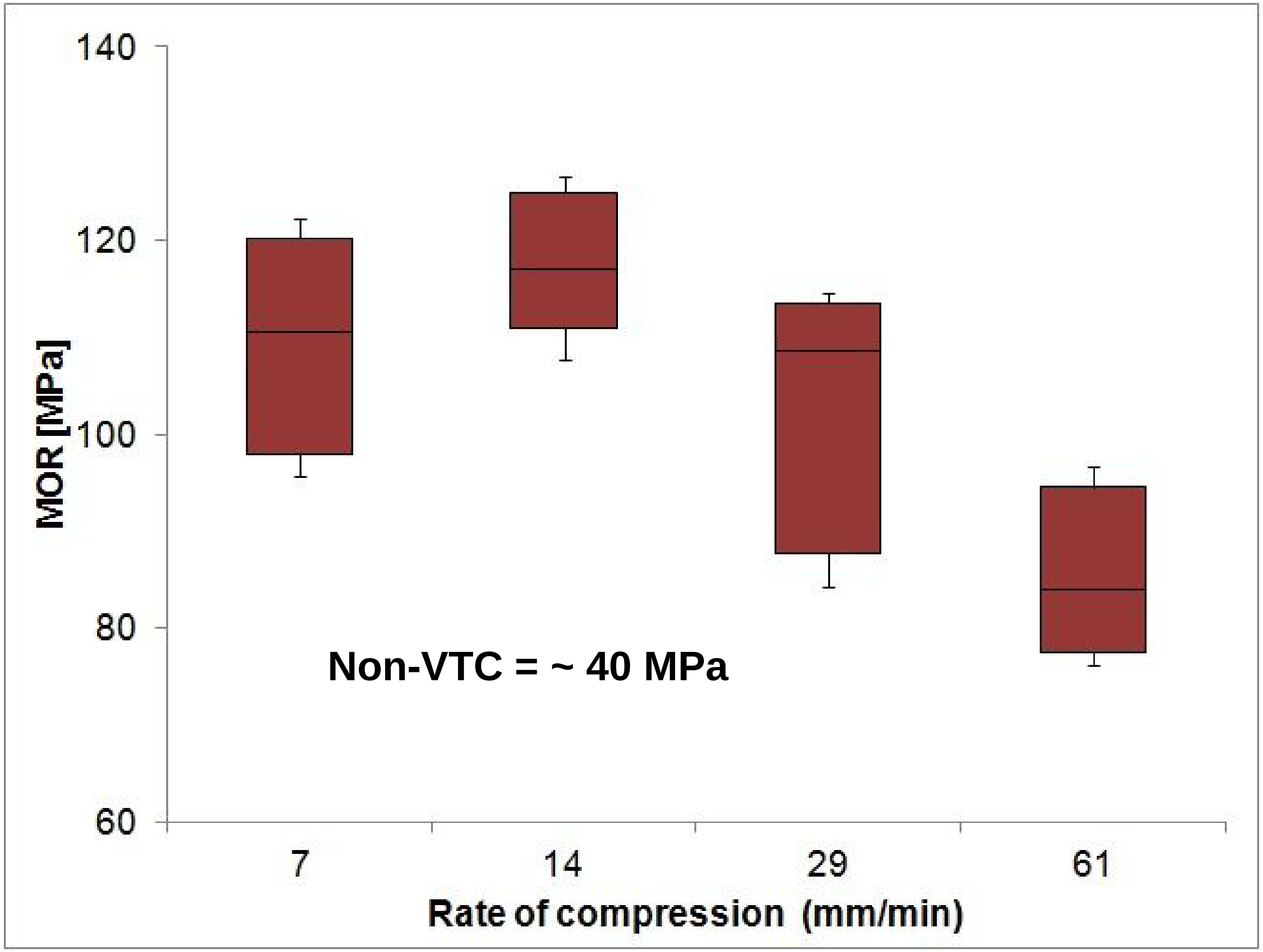
Results

MOR as a function of compression time



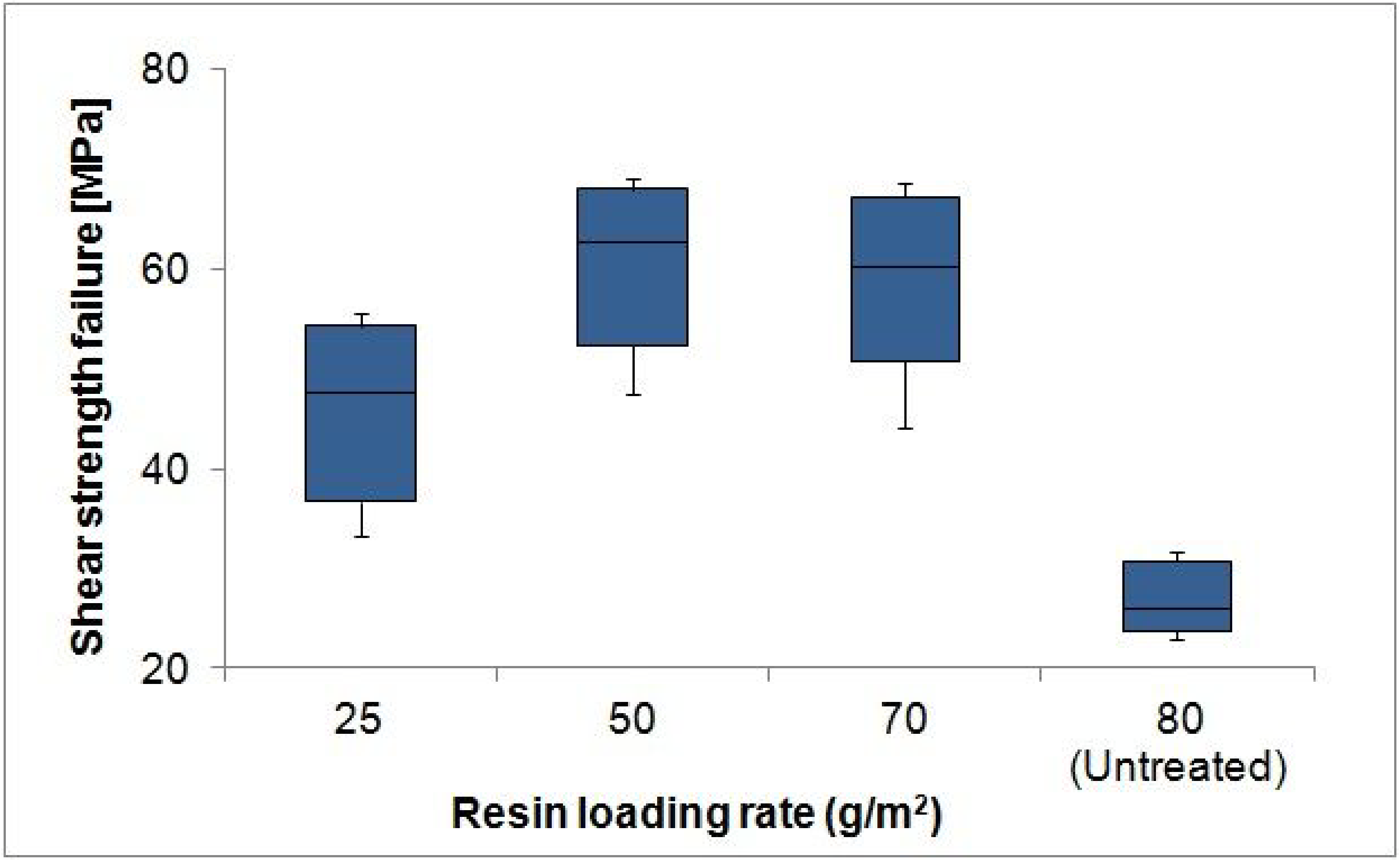
Results

MOR as a function of rate of compression



Results

Shear strength failure as a function of resin loading rate

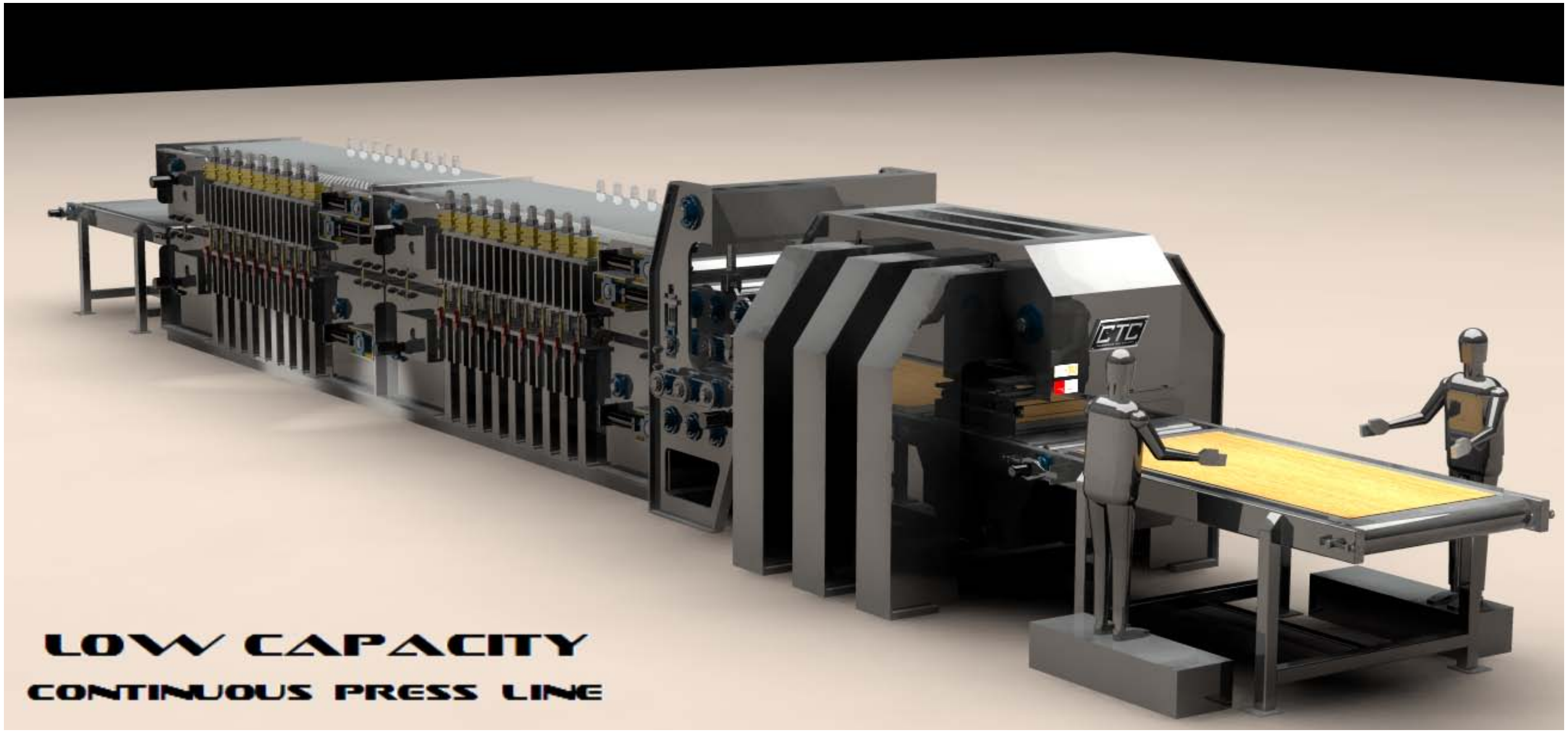


Conclusions

- Densification of hybrid poplar wood with viscoelastic thermal compression:
  - Enhancement of modulus of elasticity, modulus of rupture and shear glueline strength.
  - In general, MOE, MOR, and the shear strength increase almost in a linear correlation with the degree of densification.
- Conditioning time up to 180 seconds increases the MOE.
- Significant decline of the shear strength values after a conditioning time of 180s
- Rate of compression improves the MOE gradually to the 3rd level (29 mm/min) then decreases
- Higher rates of compression lowered the MOR which might be caused by cell wall fracture.
- No trend could be found between compression time and MOE
- Neither the rate of compression nor the compression time influences the shear strength significantly.
- The resin coverage of 25 g/m^2 (PF resin solids) yields lower glue line stress failure strength compared to 50 and 70 g/m^2, optimum between 25 and 50 g/m^2.

Future project

- Low capacity continuous press line



Future research

- **Material**
  - Data set from various species and treatment combinations
    - Gaining general knowledge about the behavior of wood under such treatment conditions
    - Evaluation of the influence of different sizes of the samples
- **Tests**
  - Swelling test
  - Analytical/ chemical discussion of the densified wood
    - Determination of the degree of degradation at certain process parameters
    - Surface structure after the treatment

References

- Master thesis of J. Weissensteiner (2011): Examination of operational parameters for VTC wood productions. University of Natural Resources and Life Sciences (BOKU), supervised by Prof. A. Teischinger, BOKU & Prof. F.A. Kamke, Department of Wood Science and Engineering, Corvallis, USA.

- Conference Posters:
  - Joint International Symposium on Wood Composites & Veneer Processing and Products, Seattle, Washington, April 5 to 7th, 2011
  - COST Action FP0904 Thermo-Hydro-Mechanical Wood Behavior and Processing Biel, Switzerland, February 16-18, 2011

Acknowledgement

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Institute of Wood Science and Technology
Department of Material Sciences and Process Engineering
University of Natural Resources and Life Sciences

BOKU – Vienna

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Department of Wood Science and Engineering
Oregon State University

Corvallis- USA

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MARSHALL PLAN
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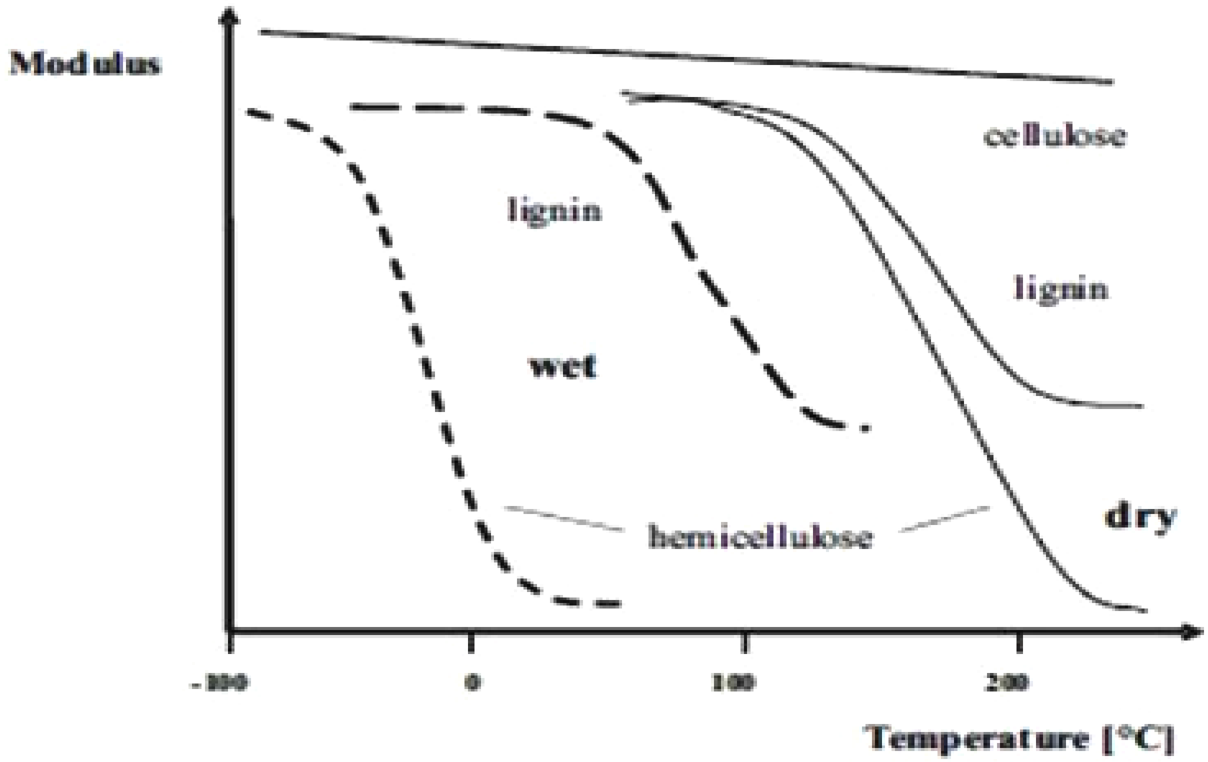
.

Thank you for your attention

Josef Weissensteiner
University of Natural Resources and Life Sciences
BOKU – Vienna

Modulus elasticity vs. Temperature



Resin solids loading rates (g/m2) for bending and shear test laminates

Resin solids loading rates (g/m^2) for bending and shear test laminates			
VTC- shear	VTC- bending	Control- beding	Control- shear
25	-	-	-
50	-	50	50
-	60	-	60
70		-	70
-	-	80	80
-	-	-	90
-	-	100	100