PTFBPI 2010

IMPACT OF HEAT TREATMENT ON THE WETTABILITY OF WOOD

Milan ŠERNEK
Department of Wood Science and Technology, Biotechnical Faculty, University of Ljubljana, SLOVENIA

Philippe GÉRARDIN and Mathieu PETRISSANS

Laboratoire d'Etudes et de Recherches sur le Matériau Bois, Nancy Universités, Faculté des Sciences et Techniques, Vandoeuvre-lès-Nancy, FRANCE

7th-8th October, 2010
Salzburg/Kuchl, Austria

Outline of presentation

- Introduction
- Objectives
- Materials and Methods
  - Heat-treatment of wood
  - Contact angle measurement
- Results
  - Contact angle: heat-treated/untreated wood
  - Contact angle: air/nitrogen
- Conclusions

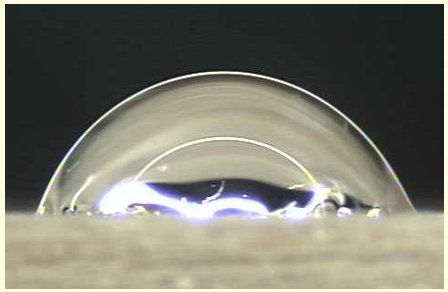
Adhesive bond formation

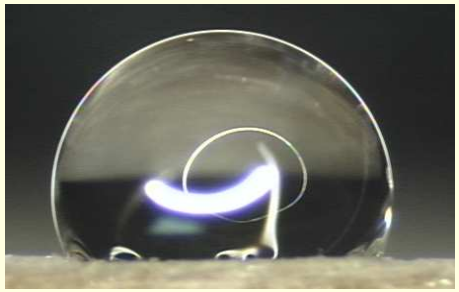
- Bond formation between wood and an adhesive involves five distinct actions (Marra 1992):

1. ***Flowing***
2. ***Transferring***
3. ***Penetrating***
4. ***Wetting***
5. ***Solidifying***

Wetting

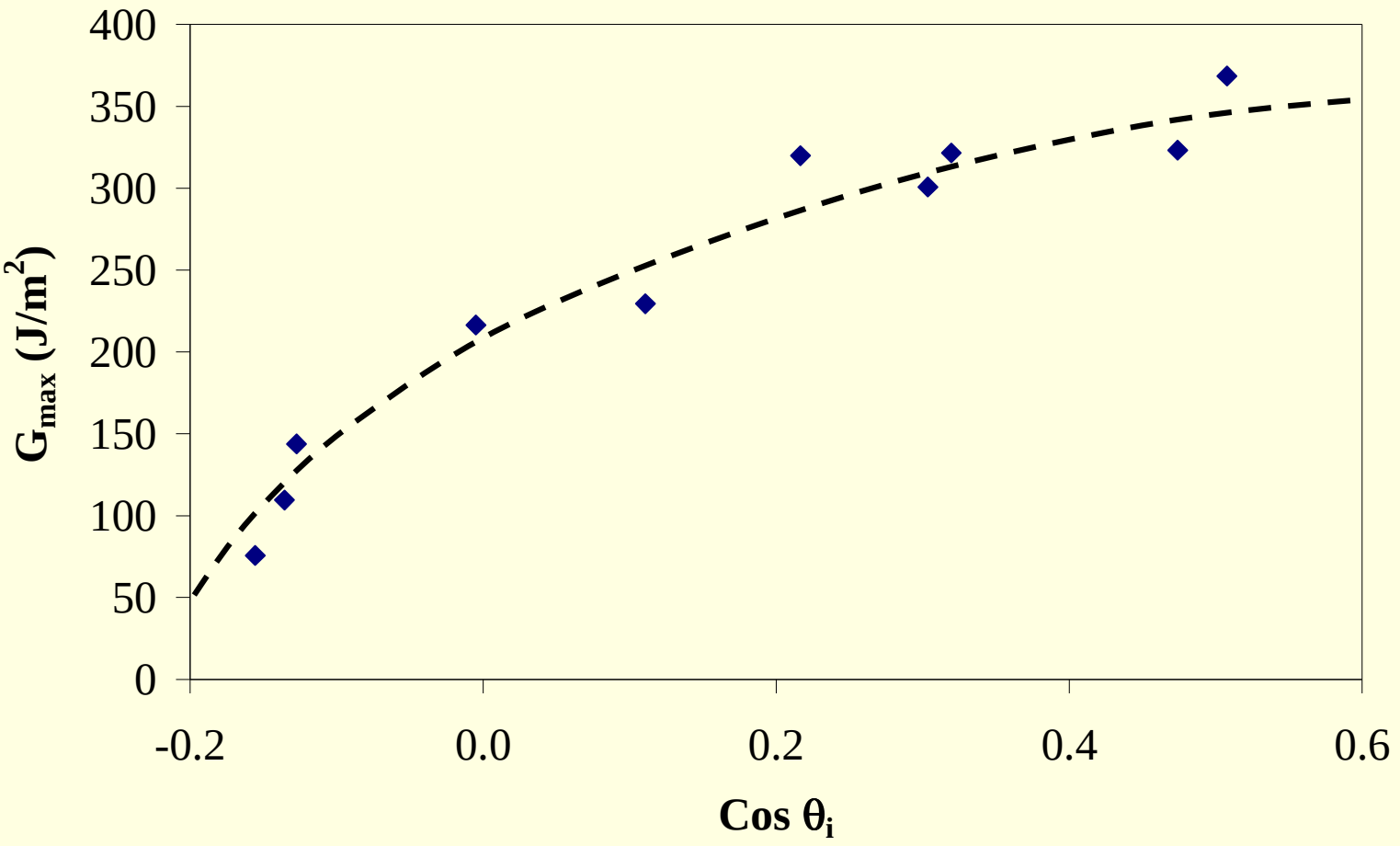
- A condition of a surface that determines how fast a liquid will wet and spread on the surface or if it will be repelled and not spread on the surface.





- An intimate contact on a molecular level is assumed to be necessary for bond formation to achieve good adhesion between materials.

Adhesion vs. wettability

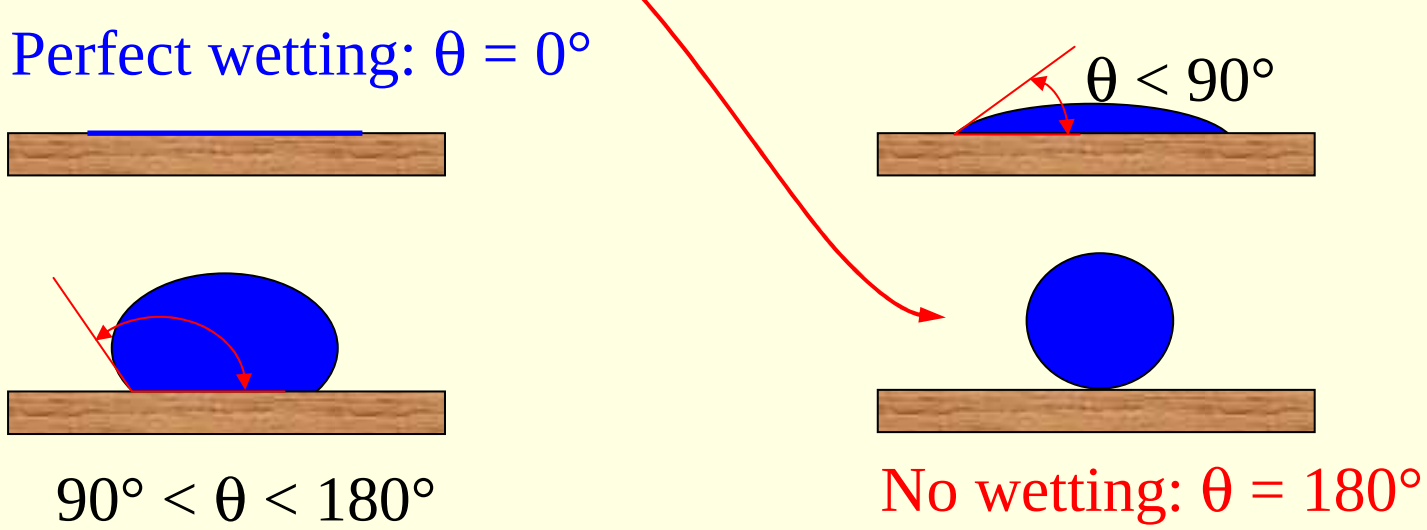


Wettability

- The molecular nature of the adhesive
- The molecular mobility in the adhesive
- The pressure and temperature of the adhesive
- The time available before hardening of the adhesive
- The quality of the wood surface
- The wood characteristics:
  - wood species and composition, extractives ,
  - wood anatomy, wood surface sections,
  - wood seasoning, moisture content, temperature.

Nature of solid surfaces

- Hydrophilic surface; affinity for water, “likes water”
- Hydrophobic surface; repels water, “hates water”



Heat treatment of wood

- Reduces hygroscopicity of wood
- Improves dimensional stability
- Increases durability of wood
- Improves resistance to decay
- Diminishes strength and toughness
- **Reduces wettability**

Plato® heat treatment process

- Improves the dimensional stability and durability of wood while maintaining its mechanical properties.
- Plato®Wood is mainly utilized in exterior applications, such as garden furniture, fencing, claddings, window frames and doors.
- Adhesive bonding is often involved in the production of such products.

The aim of the study

- To determine the **impact of heat treatment** using the Plato® process **on the wettability** of several wood species.
- To evaluate the **effect of aging**, in **different environments**, on the **wettability** of untreated and heat-treated Norway spruce.

Materials

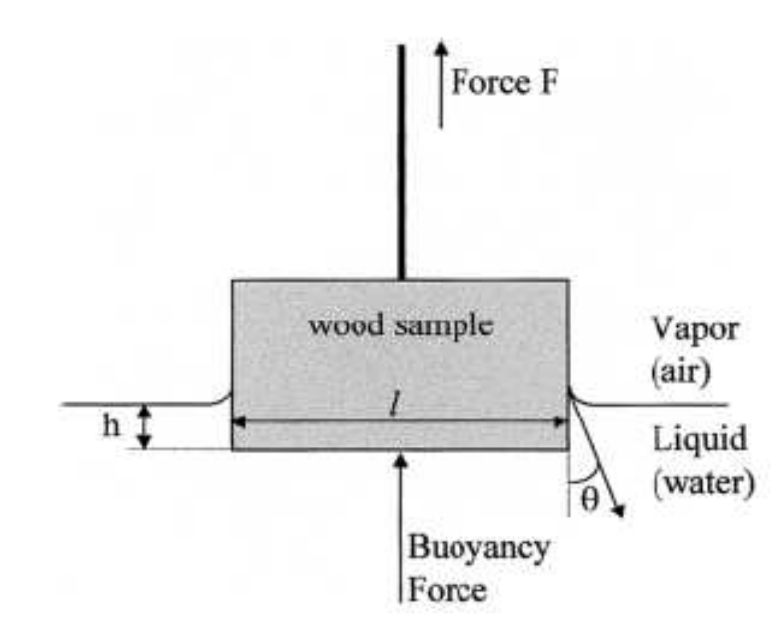
Specimen	Wood species	Treatment
B-C	Birch	Untreated (control)
B-PHT		Heat-treated
P-C	Poplar	Untreated (control)
P-PHT		Heat-treated
DF-C	Douglas fir	Untreated (control)
DF-PHT		Heat-treated
NS-C	Norway spruce	Untreated (control)
NS-HyT		Hydro-thermolysed (intermediate)
NS-PHT		Heat-treated

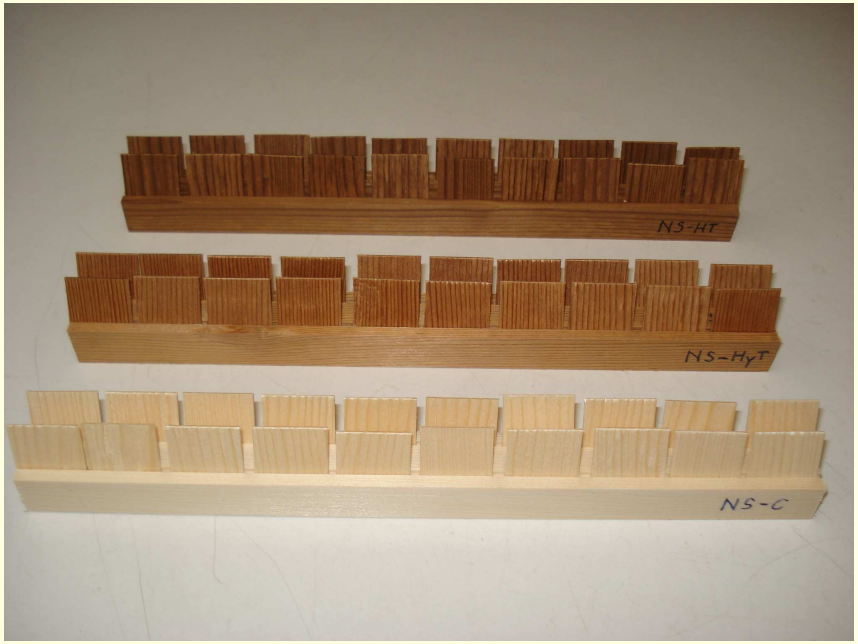
Methods

- The industrial Plato® process
- Wettability - contact angle measurements
- 2 experiments:
  1. Untreated-control and heat-treated specimens made from Birch, Poplar, Douglas fir, and Norway spruce
  2. Norway spruce (untreated and heat-treated)
     - ½ in the surrounding air
     - ½ in the nitrogen environment
     - The effect of aging (immediately after surface preparation, and after 1, 7, and 14 days)

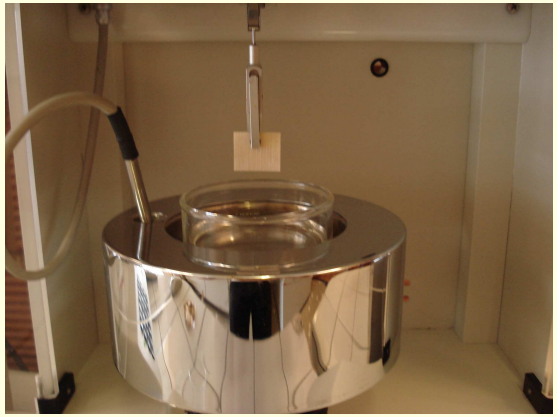
Wilhelmy plate method

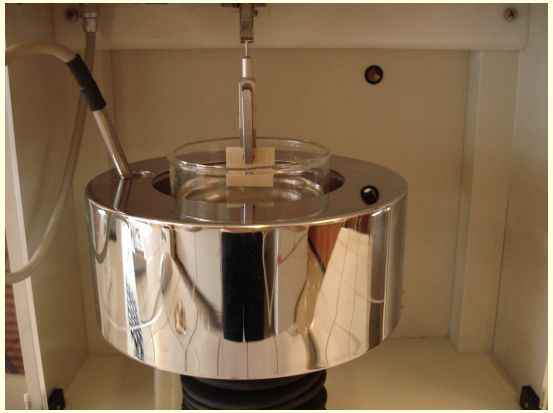
- Krüss K12 Tensiometer
- 16 mm x 20 mm x 1 mm (L x R x T)



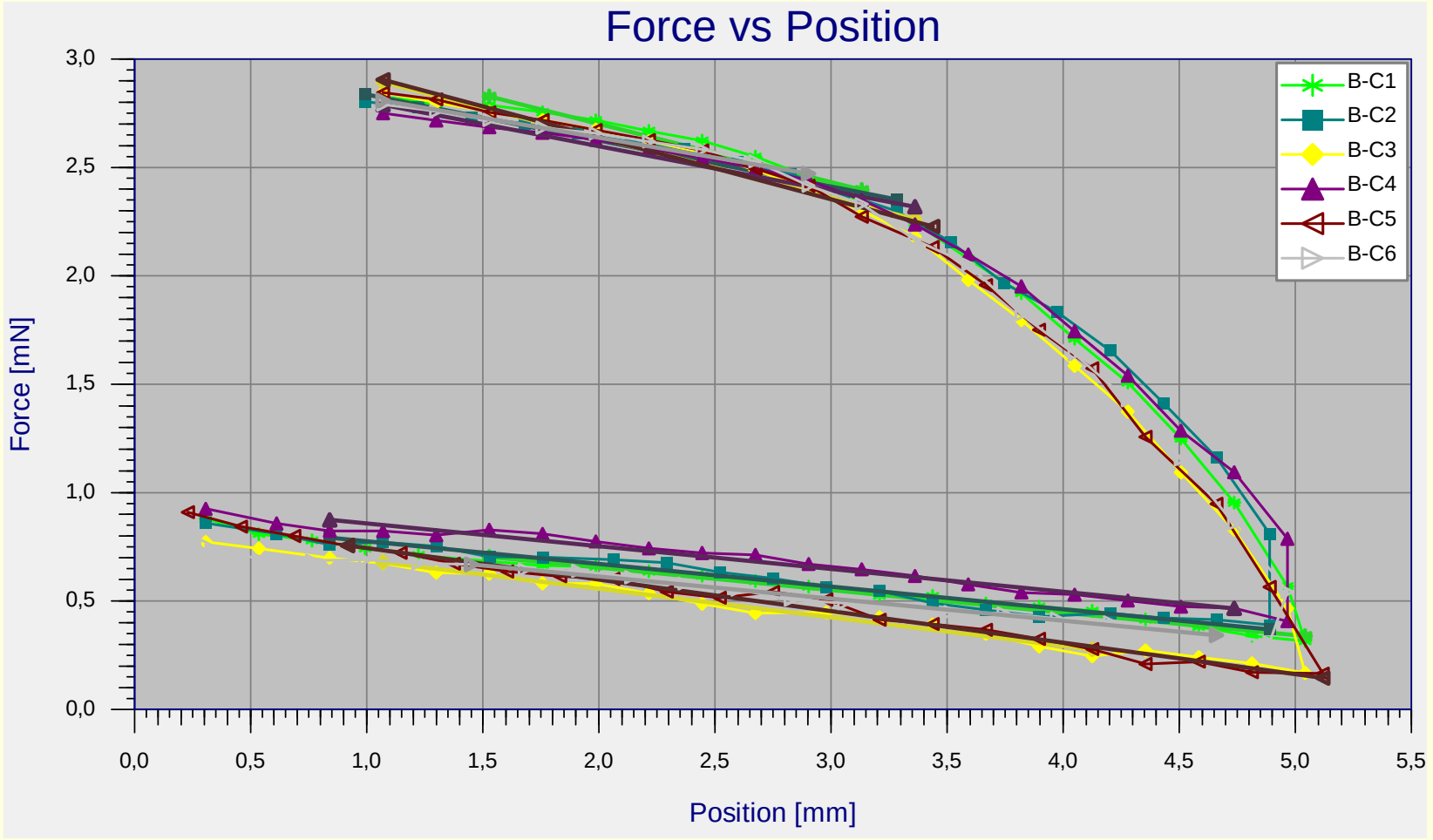


Krüss K12 Tensiometer

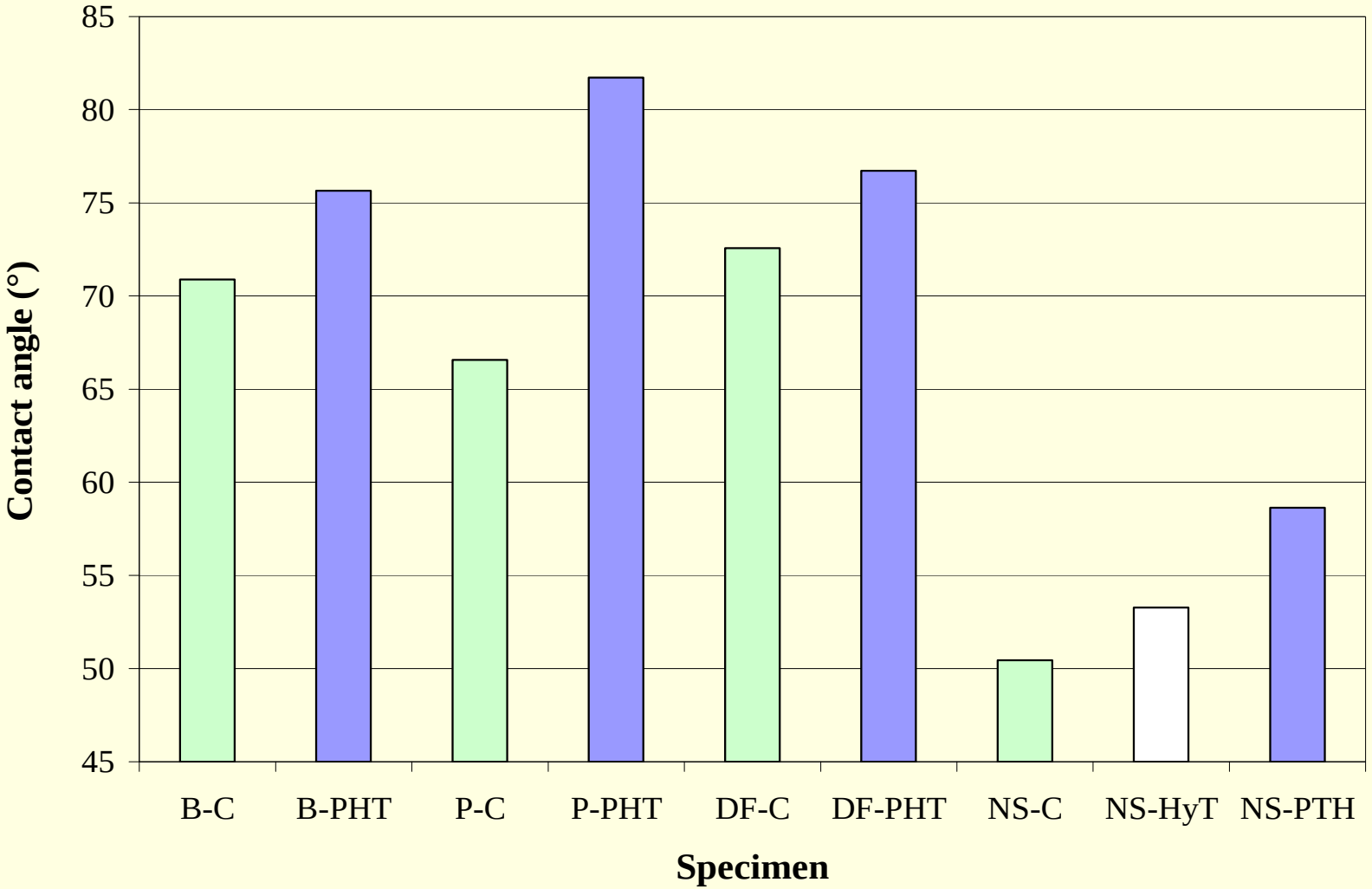




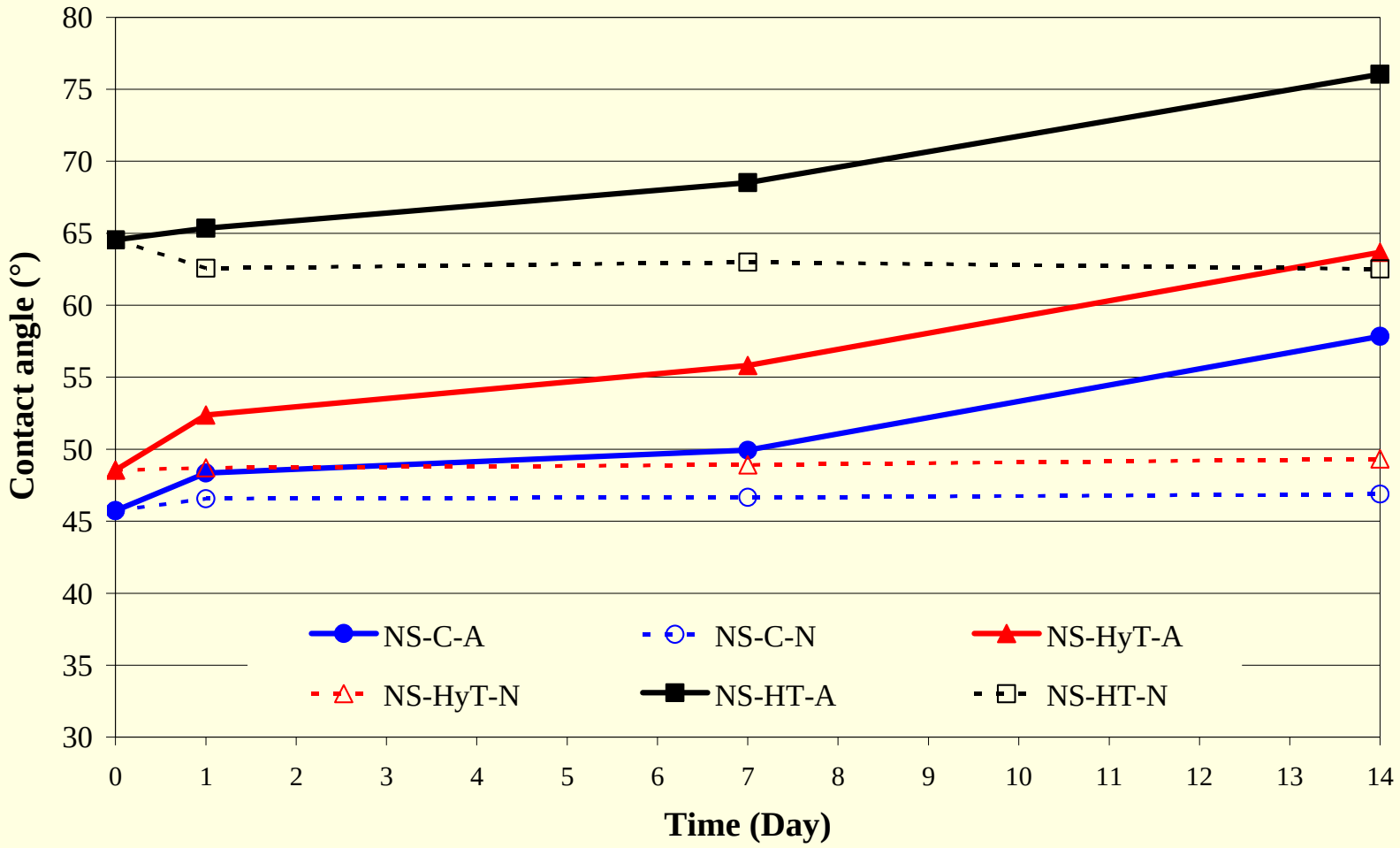
Results: Force vs. position



Contact angle:
Untreated and heat-treated wood



Contact angle:
Aging in air and nitrogen



Physical and mechanical properties

Specimen	MOE (N/mm^2)	MOR (N/mm^2)	MC (%)
NS-C	10825	75.3	12.7
NS-HyT	12528	74.5	10.4
NS-PHT	9376	29.5	6.0

Conclusions

- Plato® heat treatment **reduced the wettability** of the investigated wood species.
- The contact angle was always larger in the case of the heat-treated specimens when compared to that of the untreated-control specimens.
- The effect of aging in air was clearly evident – the contact angle increased with time exposure, whereas aging in a nitrogen atmosphere did not impact the wettability of the wood.

Acknowledgements

- COST E34 “Bonding of Timber”
  - STSM-E34-1924 (October / November 2007)
- The Slovenian Research Agency
  - Research Program P4-0015
- Nancy Universités, Faculté des Sciences et Techniques
- Plato International BV, The Netherlands