



Modified Wood: Sustainable and Durable

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Sustainable Technologies for the
Production of Durable Wood

Restrictions of Wood

- Durability (resistance against biological attack of fungi and insects)
- Shrinkage and swelling
 - anisotropy
 - unequal swelling in greater dimensions
 - adhesion problems with paints
- UV-degradation
- Water adsorption and desorption

“Classical” Wood Preservation

- Mechanism toxicity (f.i. heavy metals)
- Disadvantages:
 - emissions during production
 - emissions during use
 - emissions after use (waste stage)
- New legislation
- Public image

Alternatives to “classical” wp

- Durable tropical hardwood species
 - sustainable forest management
 - quality of plantation grown wood
 - availability
- Shift to other materials
 - pvc
 - steel
 - aluminium
- Alternative treatment methods

Alternative treatment methods

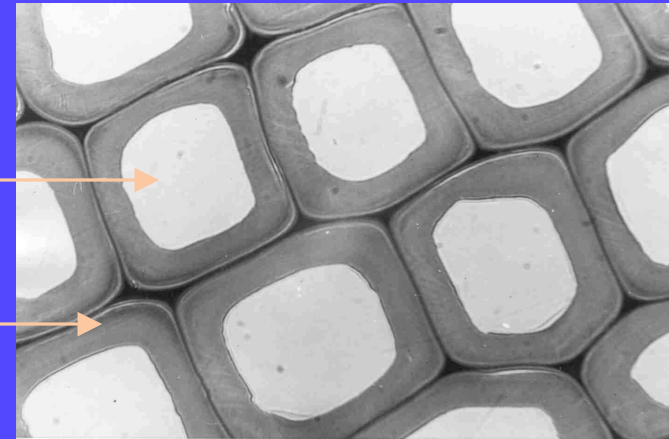
- Lumina filling resin treatments
- Cell wall filling resin treatments
- True modification of the cell wall



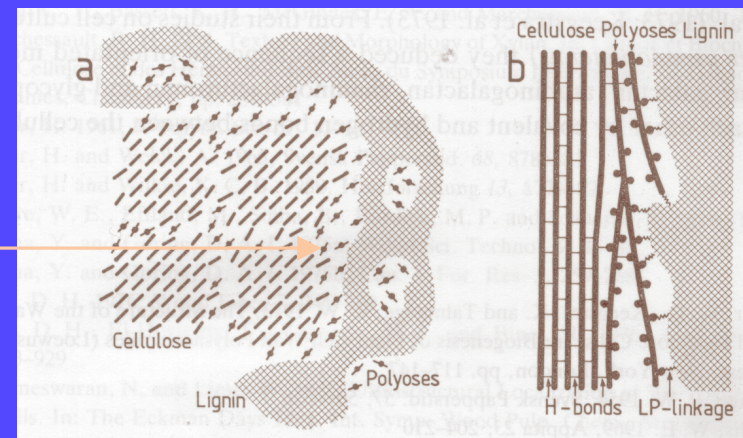
Wood structure and Distribution of the chemical components within the woody cell wall

Cell lumen

Cell wall



Association of cellulose, polyoses and lignin

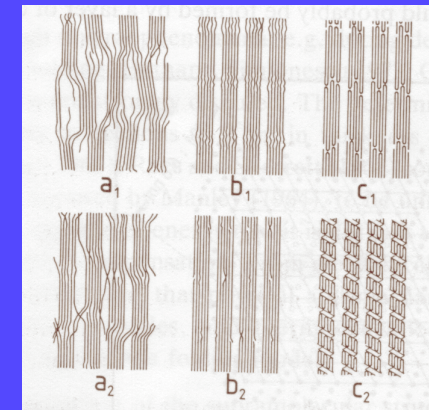
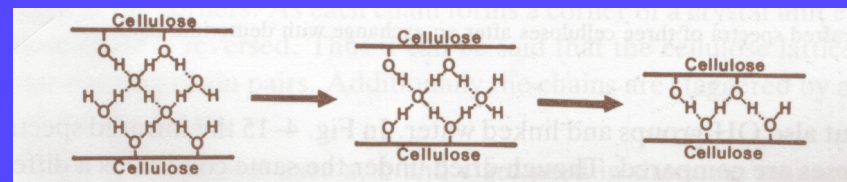
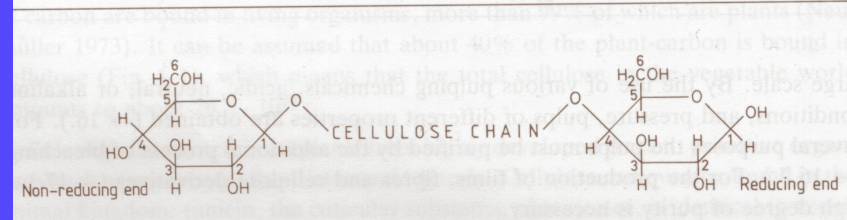
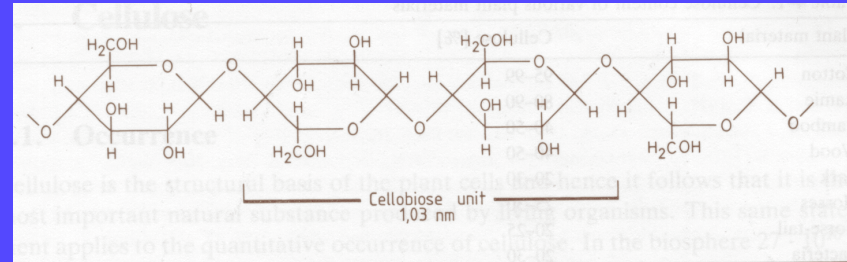




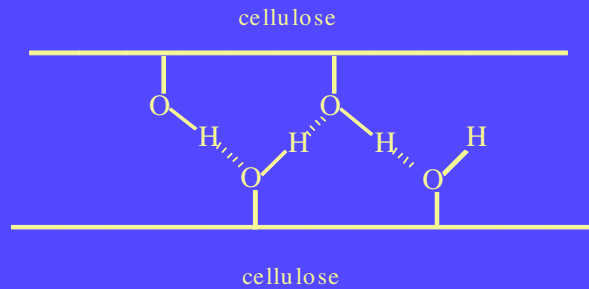
Chemistry of the components

- **Cellulose**

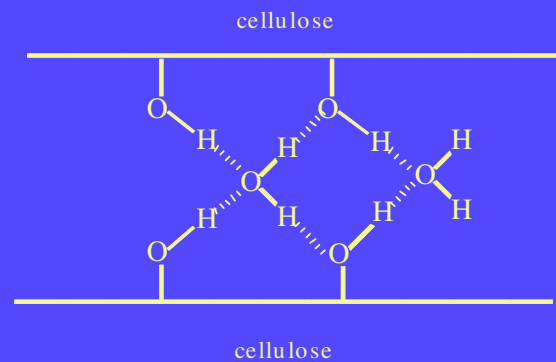
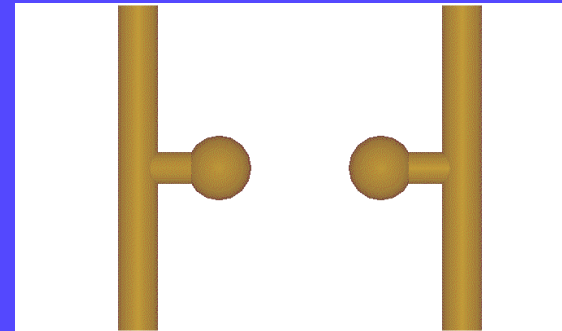
- Long chains of anhydroglucopyranose
- Native cellulose DP 3.500 - 12.000
- Fibrils
- Crystallinity and amorphous zones



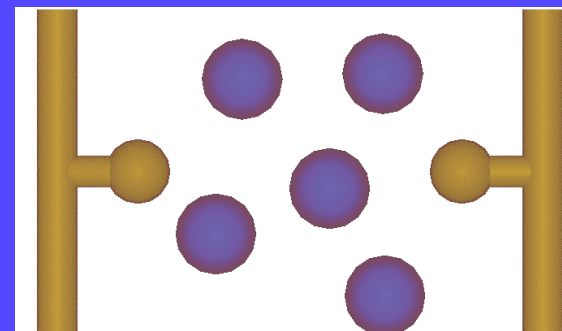
Mechanism of water uptake



hydrogen bonds between two cellulose surfaces

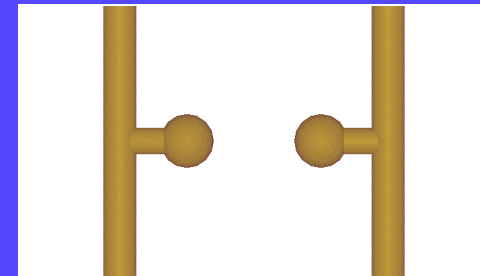
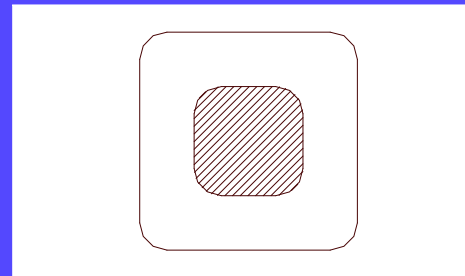


hydrogen bonds between two cellulose surfaces and water

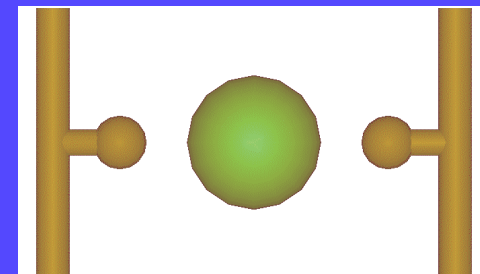
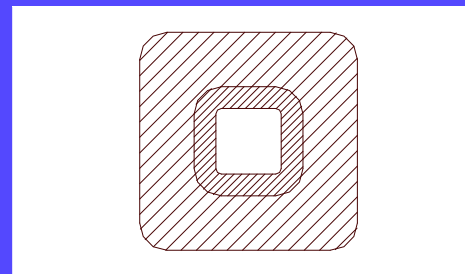


Resin treatments

- Filling lumina
no penetration
of cell wall

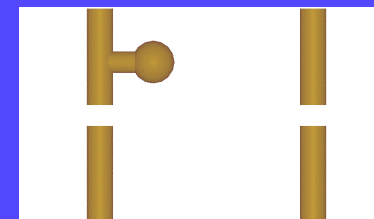
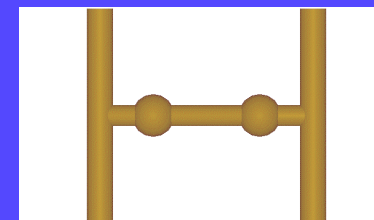
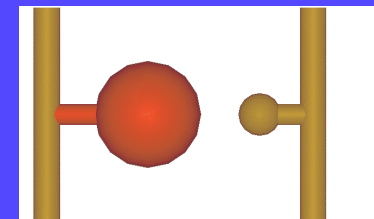
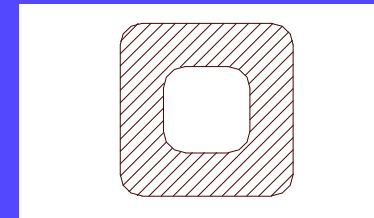


- Bulking
penetration of
cell wall cavities



Modification of Wood

- Chemical alteration of cell wall polymers
 - Substitution of OH-groups
 - Cross linking
 - Degradation of polymers (undesired)

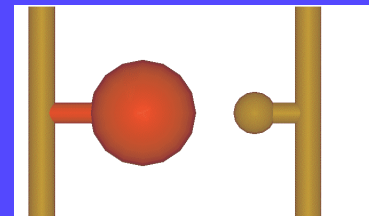


Etherification of wood

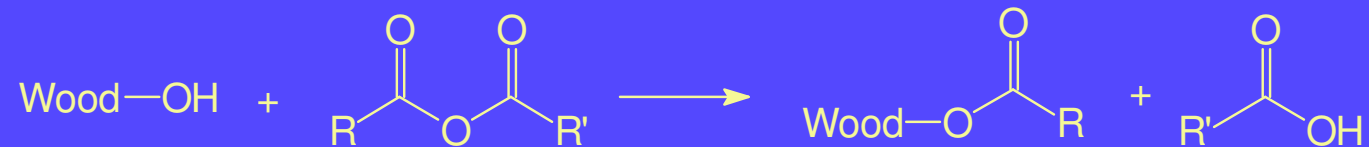
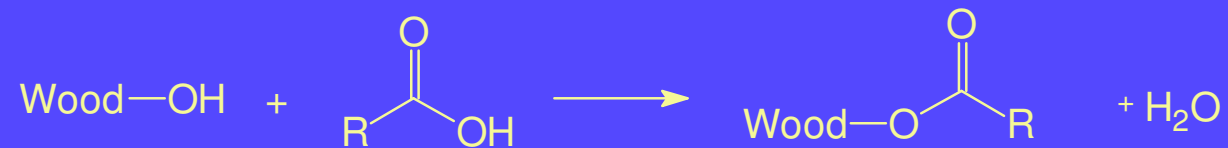


Etherification of wood:

- a. with methylchloride
- b. with an epoxide

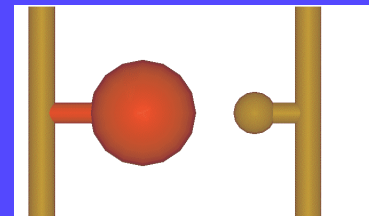


Esterification of wood

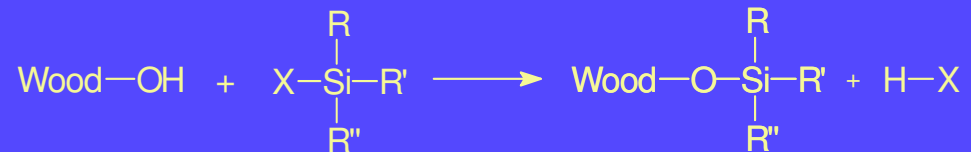


Esterification of wood:

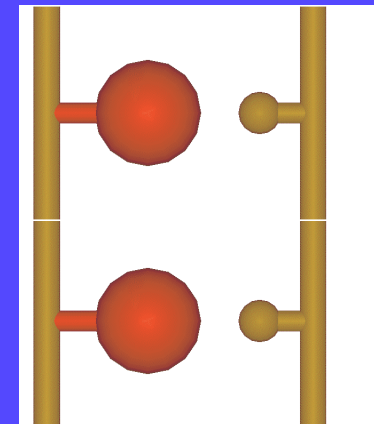
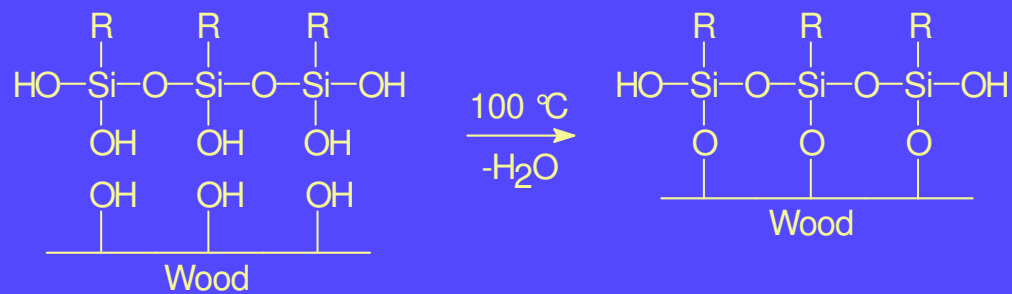
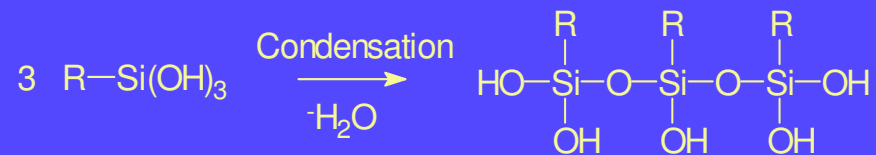
- a. with a carboxylic acid
- b. with an alkylic anhydride



Silanisation of wood

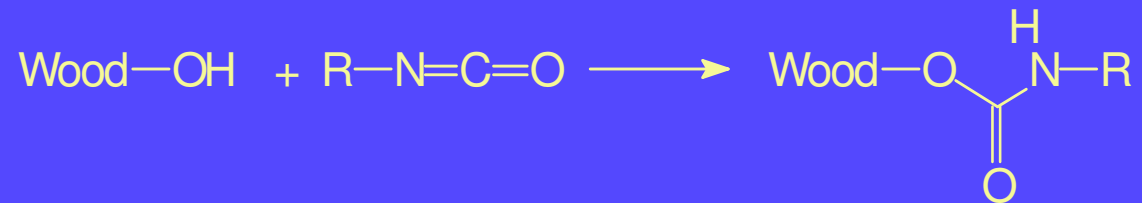


Silylation of wood with an alkylsilane

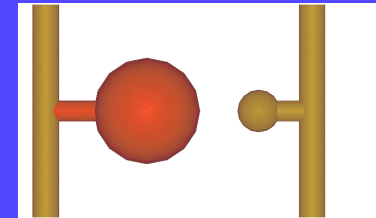


Reaction of wood with an alkoxy silane (according to Goethals et al., 1996)

Urethane treatments



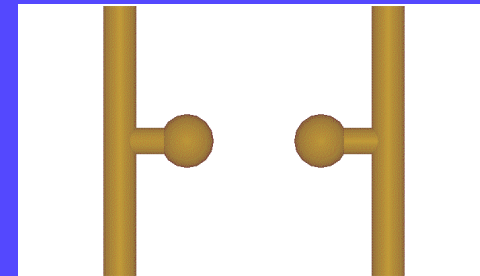
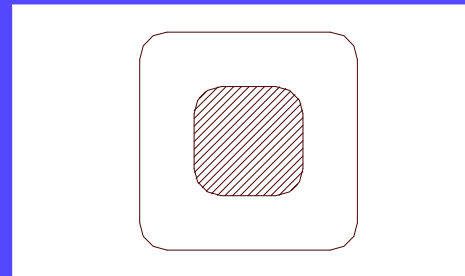
Reaction of wood with a mono-isocyanate



Resin treatments

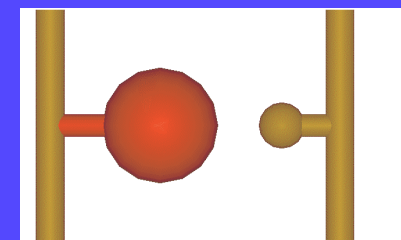
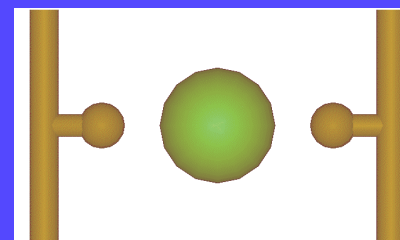
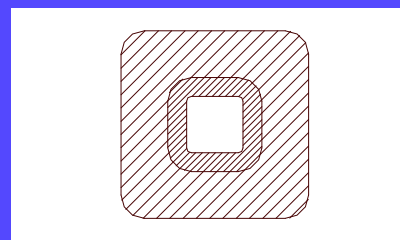
- Non modifying

- alkyds
- acrylates
- epoxides *
- melamine

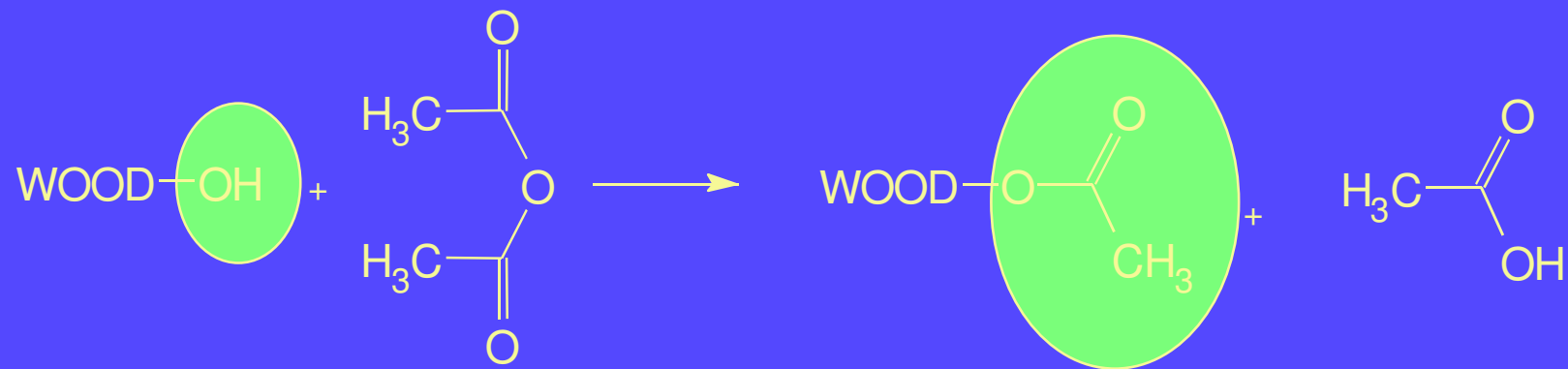


- Modifying

- DMDHEU
- epoxides *

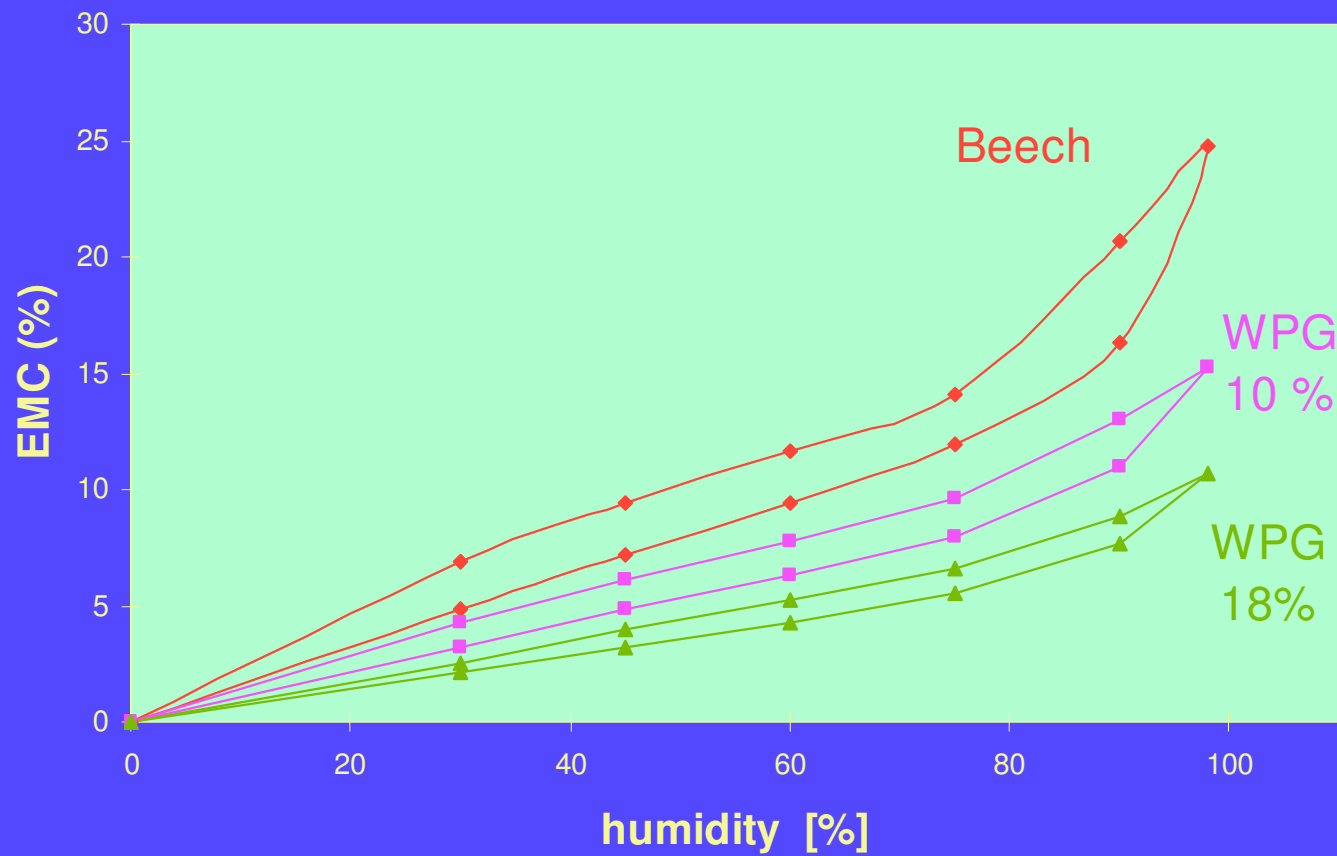


Acetylation

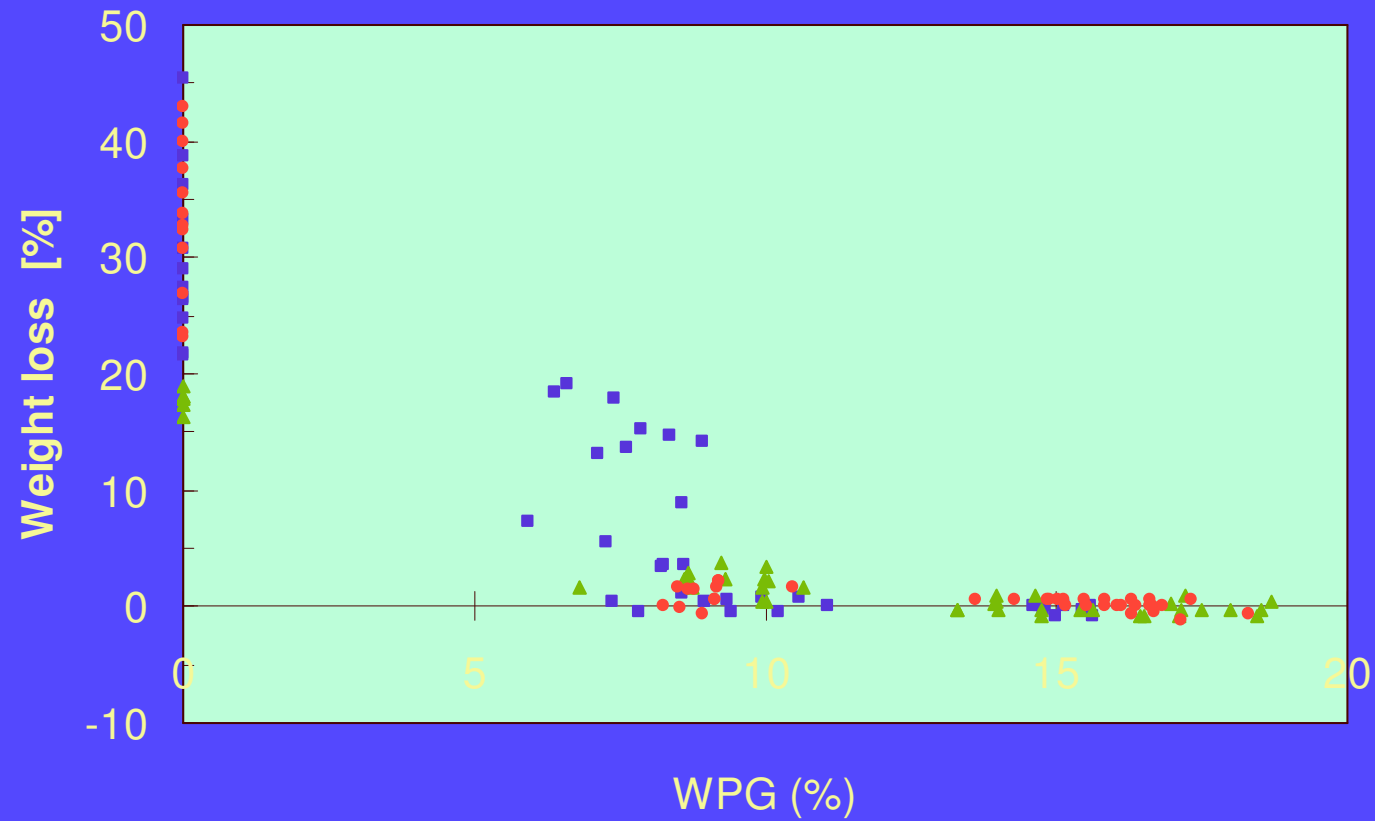




Sorption curves of acetylated wood



Soft rot resistance of acetylated wood





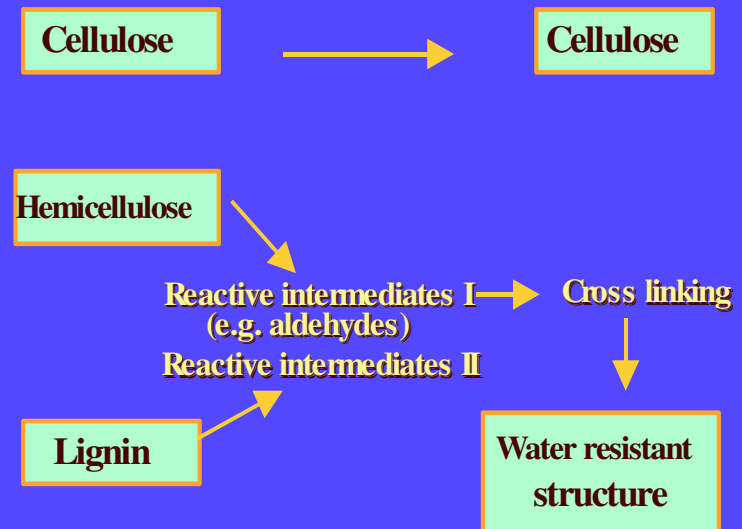
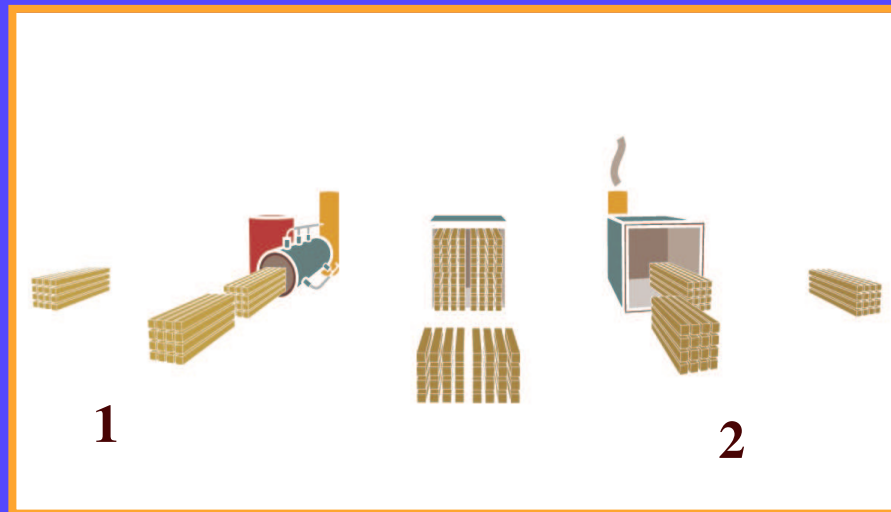
(hydro) Thermal treatment

The Process Principle of the “Plato process”

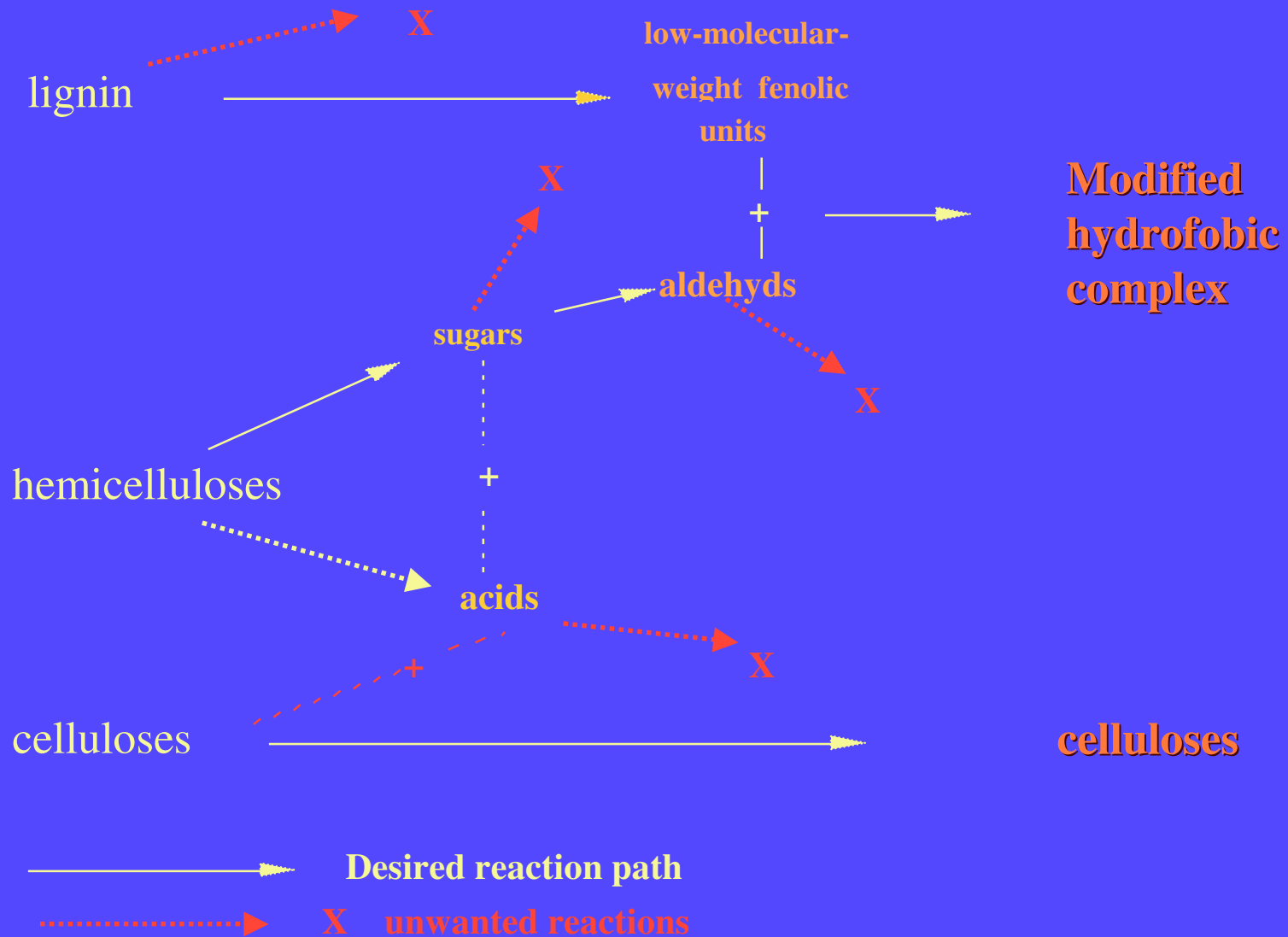
A two steps process:

- 1 hydro-thermolysis *165 °C - 185 °C*
drying *conventional*
- 2 curing *170 °C - 190 °C*

→ **Selectively reorganizing the chemistry of wood**



The Plato process chemically



Improved wood properties

- High durability (fungi, insects)
- Reduced shrinkage and swelling
- UV-stability
- Strength properties (both + and -)
- Reduced EMC

⇒ LOWER MAINTENANCE

State of the Art 2002

- Laboratory research
 - reaction kinetics
 - mechanism of activity
 - ultrastructural research
 - adaptation of test methods

State of the Art 2002

- Search for chemicals / processes
 - complexity
 - by products / co products
 - toxicity (human / eco)
 - price
 - technological feasibility

State of the Art Europe 2002

- Commercial treatment plants:
 - Thermowood (SF, > 10 production sites)
 - Plato (NL, constructed, restart)
 - NOW, Perdure (F, producing)
 - Acetylation plant (NL, blue print)
 - Other processes (NL, 3 plants in 2003)

Future of modification

- New research networks
- New networks with industry
 - EU Network “wood modification”

www.woodmodification-network.org

- From technology push to market pull

Challenges

- Up-scaling
- Commercialisation:
 - co-operation chemical process industry and wood industry

Production of high quality and durable wood products with wood harvested from sustainable managed forests of the moderate zones

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