Wood modification

a brief overview of the technology

presentation by Prof. George Mantanis

Special thanks to Dr. Dennis Jones and Prof. Callum Hill

Why modify wood ?

- **Improving the performance of wood by modifying its molecular structure**

- **Potential property improvements**
  - ✓ ***Durability***
  - ✓ ***Moisture resistance***
  - ✓ ***Dimensional stability***
  - ✓ ***Paint adhesion***
  - ✓ ***Colour and/or resistance to UV radiation***
  - ✓ ***Resistance to weathering***

- **Create new markets for local timber**
  - *Hope to compete against **tropical hardwoods***
  - *Promote sustainable timber sources*

Definition

*'**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 non-toxic 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'*

Range of modification methods

- Based on four wood modification classes:
  - Chemical modification

    Acetylation-Accoya, Furfurylation-Kebony
  - Thermal modification

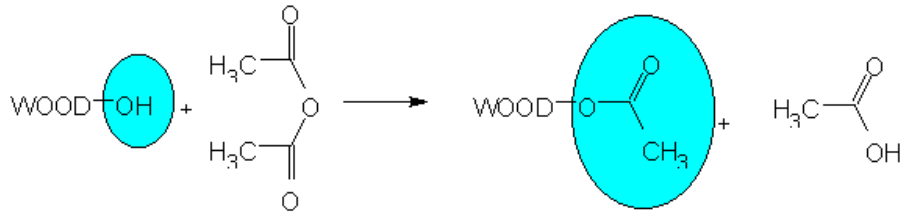
    ThermoWood, Plato Wood, Menz holz, ThermoHolz, Calignum, Retification
  - Impregnation / polymerisation

    Belmadur, Indurite
  - Enzymatic modification

    No commercial method available yet

Acetylation

- Reaction with *acetic anhydride*
- Commercially available
  - Titanwood (**Accoya**)
- Over 20 years of laboratory results

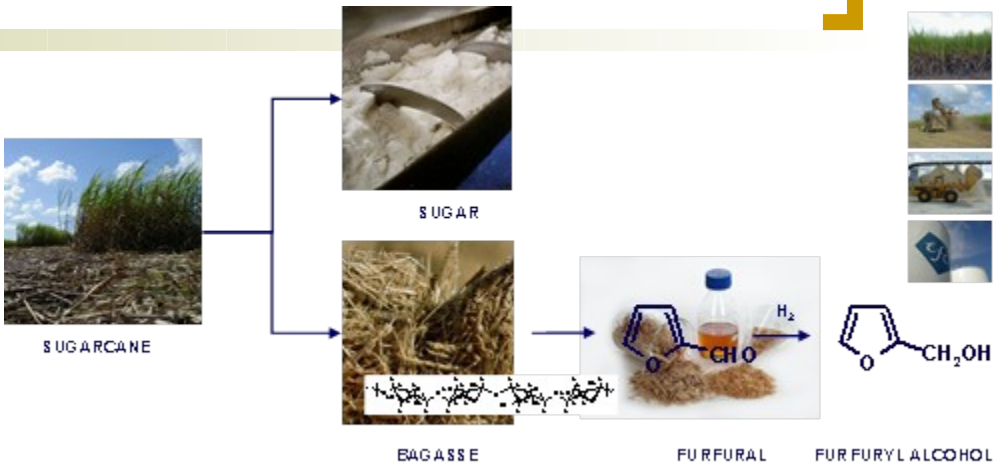


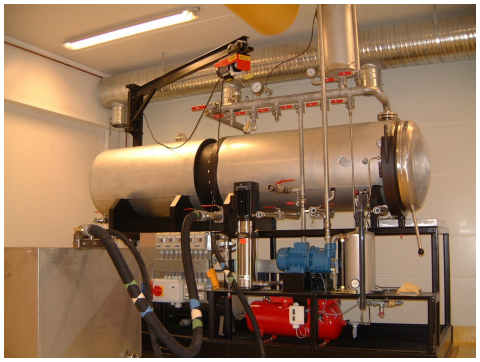
TITAN WOOD

accoya™

Furfurylation

- Treatment with *furfuryl alcohol*
- Recognised as ***environmentally friendly***
- Commercially available ***(Kebony)***





Thermal treatment

- Range of commercial operations
- Heat in absence of oxygen
- Severity of treatment affects appearance and properties

Plato PERDURE

Barkett

ThermoWood®

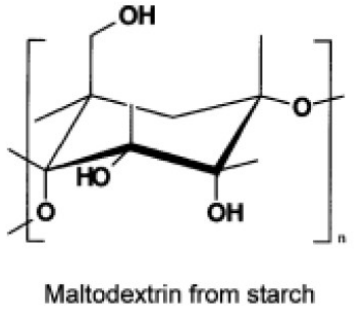
Impregnation / polymerisation

- ***Belmadur***
  - Based on **DMDHEU**
  - Used in textile industry
  - Developed in Germany and commercialised by BASF

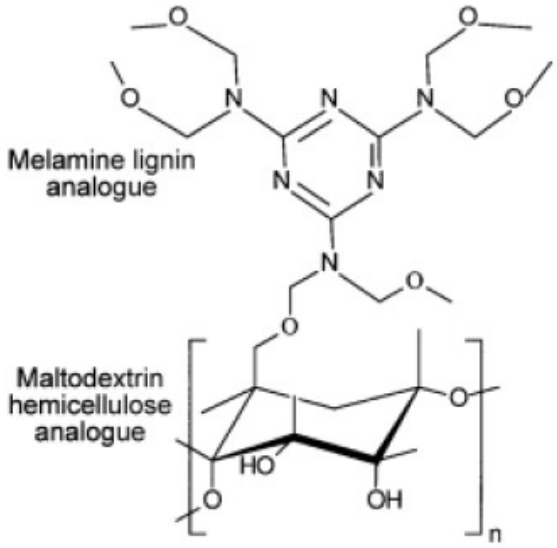
belmadur® Wood

Impregnation / polymerisation

- ***Indurite***
  - Developed in New Zealand
  - **Starch-based** treatment
  - Bought out by **Osmose**
  - Regarded as *"wood into wood"*

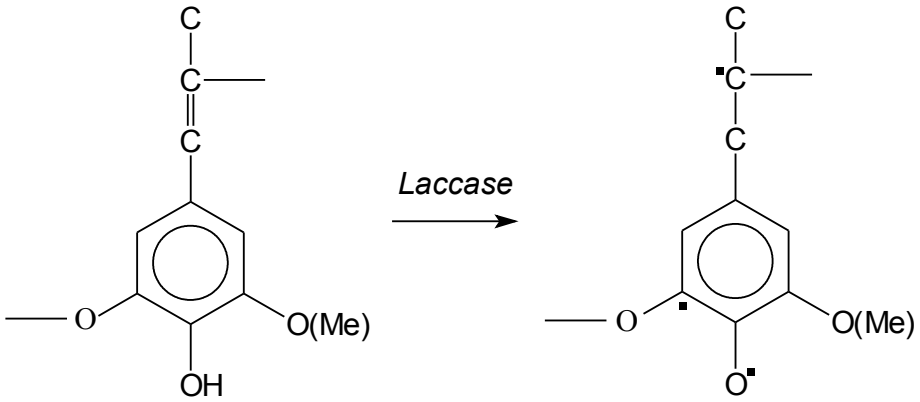


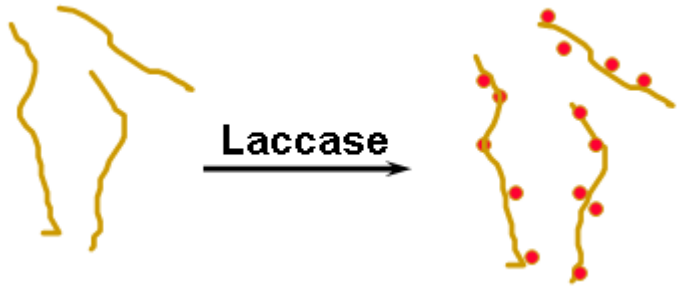
Maltodextrin from starch



Enzymatic treatments

- Mainly based on **laccase**
  - *Activate sites on lignin*
  - *Auto-adhesion of fibres*
  - *Suited to composite manufacture*





Adhesive properties

- Several test programmes
  - *Mainly across Europe*
- Need to assess suitability of adhesives
- Possible new product ranges and uses

Acetylation

- Delamination test
  - **PU adhesives**
    - *Purbond HB181 / HB230*
  - Tested according to EN 391:2001
  - 0% opening
  - Pass according to EN 386

Acetylation

- Variety of adhesives tested
  - Fulfil requirements for laminated beams in exterior use (climate class III) according to EN386

Resin Type	*Code*	*Open glueline (mm)*	*Wood failure (%)*
PRF	Aerodux 185	0	87
	Aerodux 185	2	75
	Aerodux 185	0	92
	Enocol RL490	29	13
PU	Purbond HB181	1	89
	Purbond HB181	0	93

Source: Tjeerdsma et al. Proc. ECWM3, 2007

Thermal treatment summary

- Wide range of adhesives tested (DIN 68603, EN392 block shear, EN302-2 delamination)
  - *1- and 2-component PVAc adhesives*
  - *1- and 2-component polyurethane adhesives (PU)*
  - *Resorcinol phenol adhesives (RF)*
  - *emulsion-polymer-isocyanate adhesives (EPI)*

- Glueability linked to severity of treatment
  - *Greater wood failure at high temperatures*
  - *Longer cure times required to allow absorption of glue into wood*

Glulam / Finger Jointing

- Glulam works well for heat treated pine
  - ***MUF***
  - ***Resorcinol***
- **Normal production parameters**
- Finger jointing also gave good results
  - ***MUF, PVAc, 2 x PU***
- The joints were firm with all tested parameters
  - *Maximum pressure was 22 N/mm2, (>10x the pressure needed for a firm glue line)*

Furfurylated timber

- Very little reported on adhesive properties *(under question)*
  - Similar properties to tropical timbers
- ***Kebony*** has been used as intermediate *boat-decking & parquet*
- Likely to be strong interaction to furfural-based adhesives
  - *Phenol-resorcinol-furfural*
  - *Tannin-resorcinol-furfural*

Kebony applications

Impregnation / polymerisation

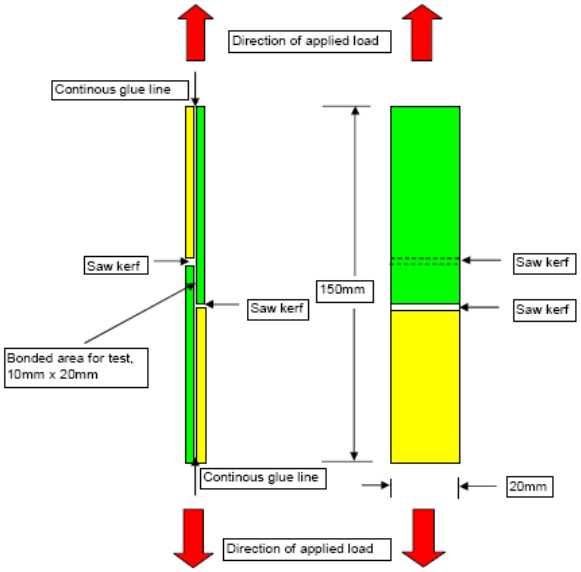
- ***Belmadur*** – can be glued as any other timber

  Veneers bonded with hot melt PF *(Dynosol S-576)*

- ***Indurite*** – range of adhesives tested

  No determinable difference in performance when compared using the EN302:1 lap shear test

  - *Mainly timber failure before bond failure*



Conclusions

- **Adhesive bonding of modified wood is possible**
  - *Wide range of examples*
- Only limited effect of modification
  - *Water-based adhesive systems*
- New products entering the market
- **Possibility of tailoring adhesives to properties of modification**

Special thanks to

NAPIER UNIVERSITY
EDINBURGH

Thanks for your attention