New Wood Modification Technology on its Way to Practical Application

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Wood Biology and Wood Products
Georg-August-University Göttingen
GERMANY
Georg-August-University Göttingen

Science and Academic studies:
- since 1734
- approximately 25,000 students
- 13 faculties
- various Max-Planck-Institutes
Historical Göttingen
“Wood Biology and Wood Products“

(Employeees: ca. 30 persons)

- Wood quality
- Wood modification
- Wood protection
- Biological degradation
- Coatings / Lacquer
- Weathering / UV-Protection
- Wood Polymer Composites
content

- Why modification?
- How (principles)
- Processes
- Products
- Markets
Ecological reasons...

Political/ Society background

- Wish to use “green” products
- Discussion on climate change due CO₂
- Carbon stock in wooded biomass
Wood: material of the future

- Ecological
- Sustainable
- Renewable
- Esthetical
- Technologically diverse
- Modern
Wood: material of the future?

Weak points:

• Moisture sensitive
• UV-stability
• Dimensional unstable
• Resistance against fungi
• Soft surface
How to solve these problems?

- Use wood with high natural quality (as many tropical hardwoods)
  - Availability (mid term, long term)
  - Sustainability
- Use of wood preservatives
  - Toxicity issues
  - New biocides with low impact
  - Only durability item solved
- Use of new technologies for wood treatment!!
What is “wood modification“?
What is wood modification?

Softwood structure
(Mod. J. Harrington)

Tree (0.1-10 m)

Plank (10-100 mm)

Annual ring (1-15 mm)

(20-40 µm)

(2-10 µm)

Macrofibril = cellulose aggregate > 4-60 nm

Reaction with cell wall

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- Heat treatment
- Acetylation (Accoya)
- DMDHEU (Belmadur)
- Furfurylation (Kebony)
- Silicone/Silane
- oil / wax/ parafins

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- Melamine resin
- chitosan/ extractives etc.

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- On the market/ production capacity

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- Production capacity built
- ??
Thermo treatment (TMT, Thermowood)

Process:
- no chemicals
- temperature 180°C to 220°C
- many wood species used
- difference between producers: technology used
Producers (Europe)

- Finland
- The Netherlands
- France
- Austria
- Germany
- Russia
- ...

Production (2010): approx. 200,000 m³
Other wood modification: Treatment steps

- liquid, catalyst
- vacuum-pressure impregnation
- drying and reaction
- drying temp: above 100 °C
Process:
- impregnation with acetic anhydride
- reaction at elevated temperatures
- post treatment (acetic acid)
Accsys Chemicals PLC (UK)  
Seit April 2003  

Quelle: www.titanwood.com
Furfurylation
silicon based compounds

Hydrophilic and potentially reactive

Protection of masonry

Clothes (dyeing agents fixation)

Coupling agents (electrical circuit)

Hydrophobation of glass

Hydrophobic
Silanes, silicones

“water shade effects”

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Polymerisable chemicals
Wrinkle free wood?

- Dimensionally stable
- Crease resistant
- "Easy care" "Non-iron"
Belmadur® Technology

Wood → Treatment → Curing → Belmadur® Wood

Belmadur®

Solution

Room temperature

Temperature > 100°C

© = patent and registered trademark of BASF
First application in Germany: Fa. Becker/Brakel
Becker Brakel: veneers for shaped products
Material properties
Water uptake

(Tingaut et al., 2005)
Bulking Effect and Crosslinking Effect

Tangential swelling and shrinking after modification

- Max swelling after impregnation
- Max shrinking after curing/drying
- Swelling at 33% r. h.
- Swelling at 65% r. h.
- Swelling at 91% r. h.
- Max swelling after water saturation

Bulking effect
Crosslinking effect

- Untreated control
- Interlace Treatment "A"
- Interlace Treatment "B"
Swelling and shrinking of wood species

Relative swelling of wood species from 0% moisture content to fibre saturation point

- Interlace Treatment
- teak
- pine heartwood
- pine sapwood
- oak
- beech

Swelling [%]
- radiale swelling
- tangentiale swelling

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EN 113 (Coriolus versicolor) beech

Graph showing mass loss versus weight gain after reaction for Interlace Treatments A, B, and C.
Degradation of beech wood after 32 weeks in soil contact (ENv 807)

- Interlaced treatment "A"
- Interlaced treatment "B"
- Interlaced treatment "C"

Mass loss vs. weight gain after reaction:
- Class I: 0% mass loss, 0% weight gain
- Class II: 5% mass loss, 5% weight gain
- Class III: 15% mass loss, 15% weight gain
- Class IV: 25% mass loss, 25% weight gain
- Class V: 35% mass loss, 35% weight gain

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Brinell hardness (parket flooring)

![Graph showing Brinell hardness for different concentrations of DMDHEU and species of wood.](image)
Production and markets
* Production heat treated wood in Europe: approx. 200,000 m³

* Production other wood modification treatments: approx. 150,000 m³
• Biocide treated wood
  – Costs!!
  – Special products

• Markets of tropical hardwoods
  – Hazard classes 1-5
  – “high quality“

• Special products
Other applications

Outdoor
- Decking
- Roofing
- Utility poles
- Rail ties
- Fences
- Garden furniture
- Bridges
- Marine applications
- And more...

Indoor
- Flooring
- Windows
- Doors
- Furniture
- Mouldings
- And more...

Floor, Kebony  Bridge, Accoya  Decking, Accoya
esthetics

Foto Parkett: Hamberger, Ro
Products/ markets: use class 1
(Photos by Mitteramskogler/ Austria)
Products/ markets: use class 2

(Photos by Mitteramskogler/ Austria)
Products/ markets: use class 3

(Photos by Mitteramskogler/ Austria)
Products/ markets: use class 3
(Photos by Thermowood Association, Finland)
products: hazard classes 1-5
New products from BECKER belmadur®
- garden furniture

Fa. SIFAS, Frankreich
Modell Kolorado
Examples for products BECKER
Basis materials for wood modification

- Fast growing
- Easy “treatable“
- Large quantities
Basis materials for wood modification

- Pines
- Poplars
- Beech?
- Eucalypts?
- Other fast growing wood species!
Other factors of concern to clients...

- Environmental concern
  - Emissions to air
  - Emissions to water
  - Human tox
  - Eco tox

- Machinability / further processing
  - Tools
  - Material homogeneity
  - Working environment

- Disposal / recycling
  - Reuse of fibres?
  - Energy – burning
  - Land fill
Outlook “modified wood“

- New methods will get to market
- Will get larger market share
- Will be introduced in high quality/ special products
- Should be marketed as “new material“
- New type of industry will develop (“wood modifiers“) between chemical industry and wood industry
Thank you for your attention!