Melamine Resin based Wood Plastic Composites for Constructive Application

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Kompetenzzentrum Holz GmbH – Wood K plus

- R&D Institute for Wood Composites & Wood Chemistry with the headquarters in Linz/Austria
- Founded 2001 by the Austrian government
- Network of university (3) and industry (16) partners
- 70 scientific employees (12 WPC), in 35 projects (7 WPC)
- International cooperation with research institutes and universities as well as companies
- 4 technical research areas and a cross sectional market research area
- Budget K plus (2005-2007):12,6 Mio. €; Projects & Services 2006: 1,0 Mio. € (Trend ↑)

Managing Director:

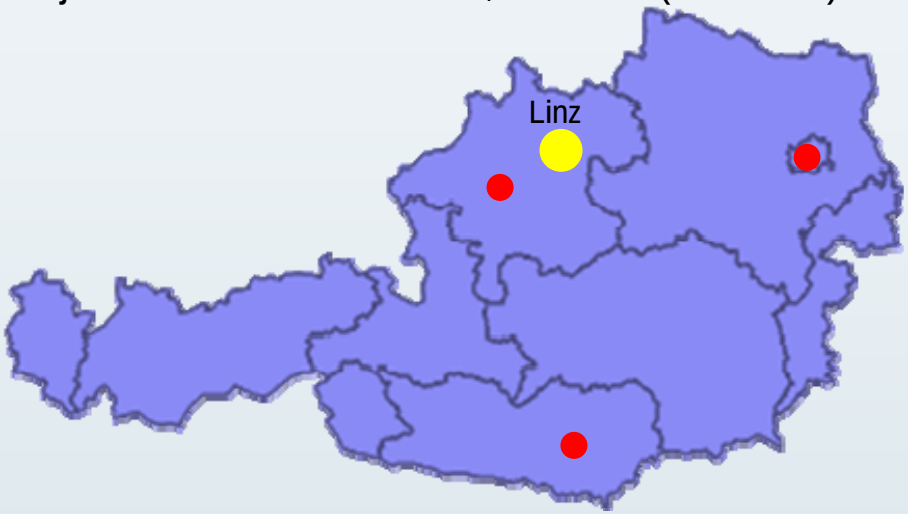
Dipl.-Ing. Boris Hultsch

Scientific Director:

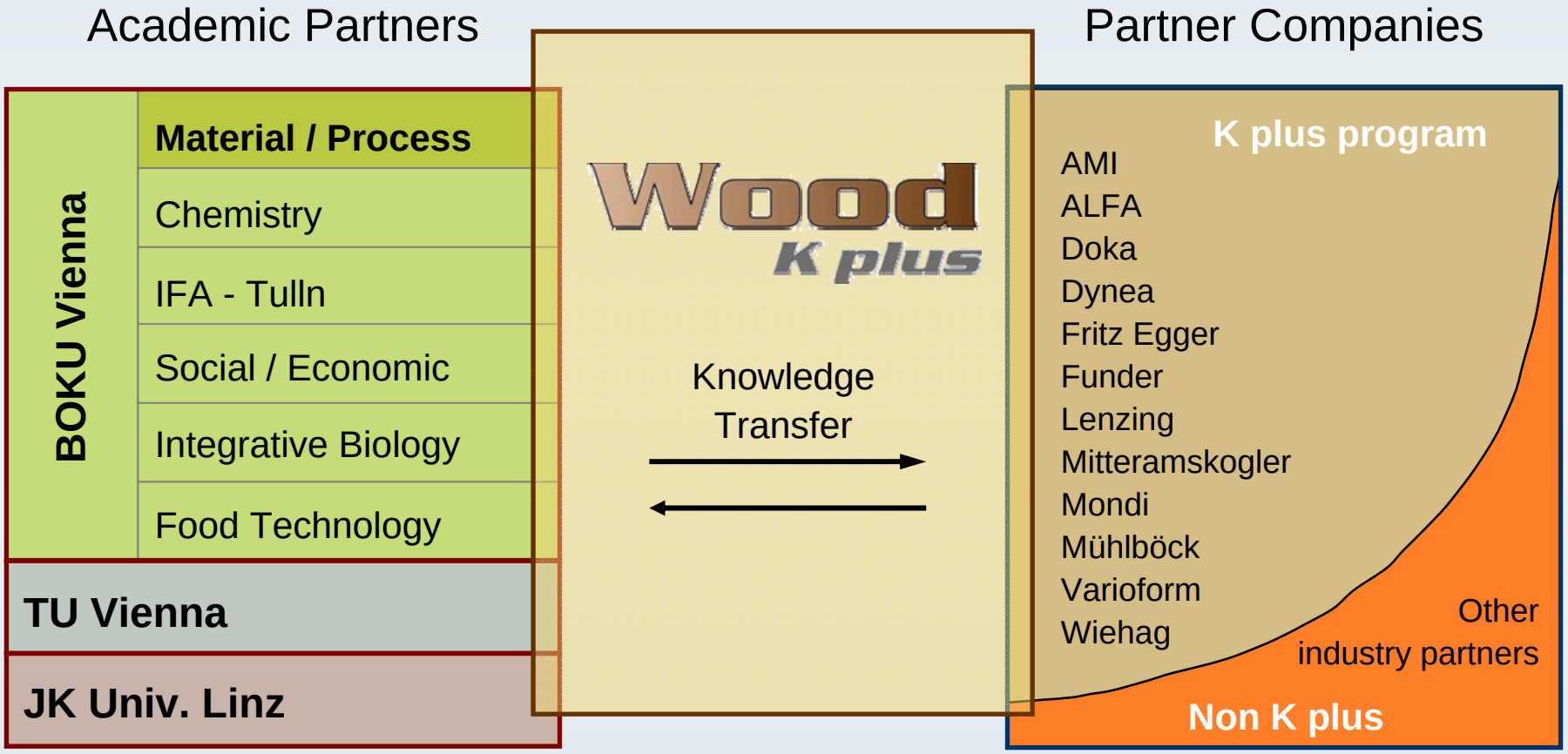
Univ.-Prof. Dr. Alfred Teischinger (BOKU)

Locations:

Linz, Lenzing, St. Veit, Wien



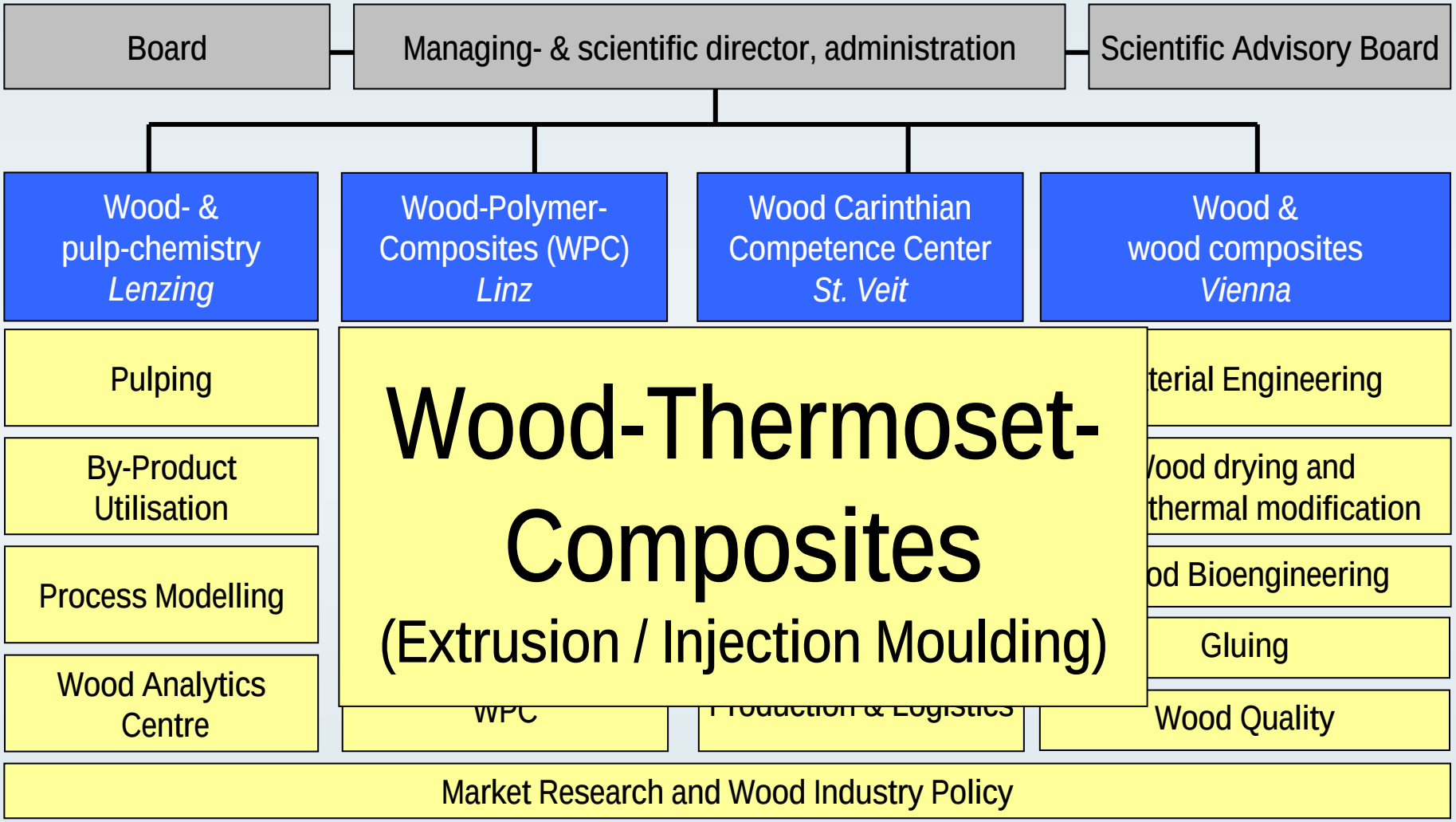
Partners of Wood K plus



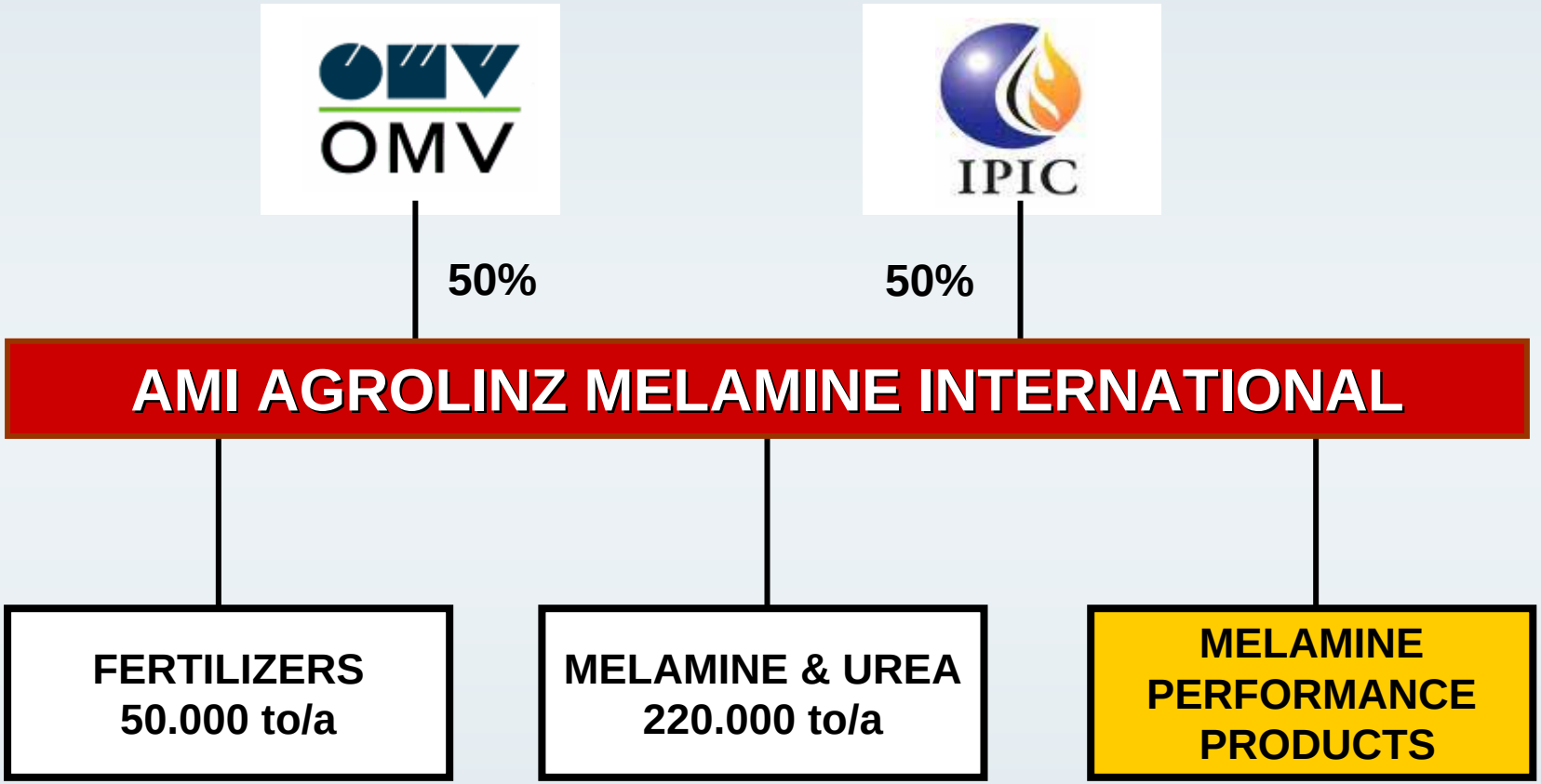
Long-term, strategic cooperation „K plus program“ → 2008 „COMET program“

Fundamental research → precompetitive research → industrial development

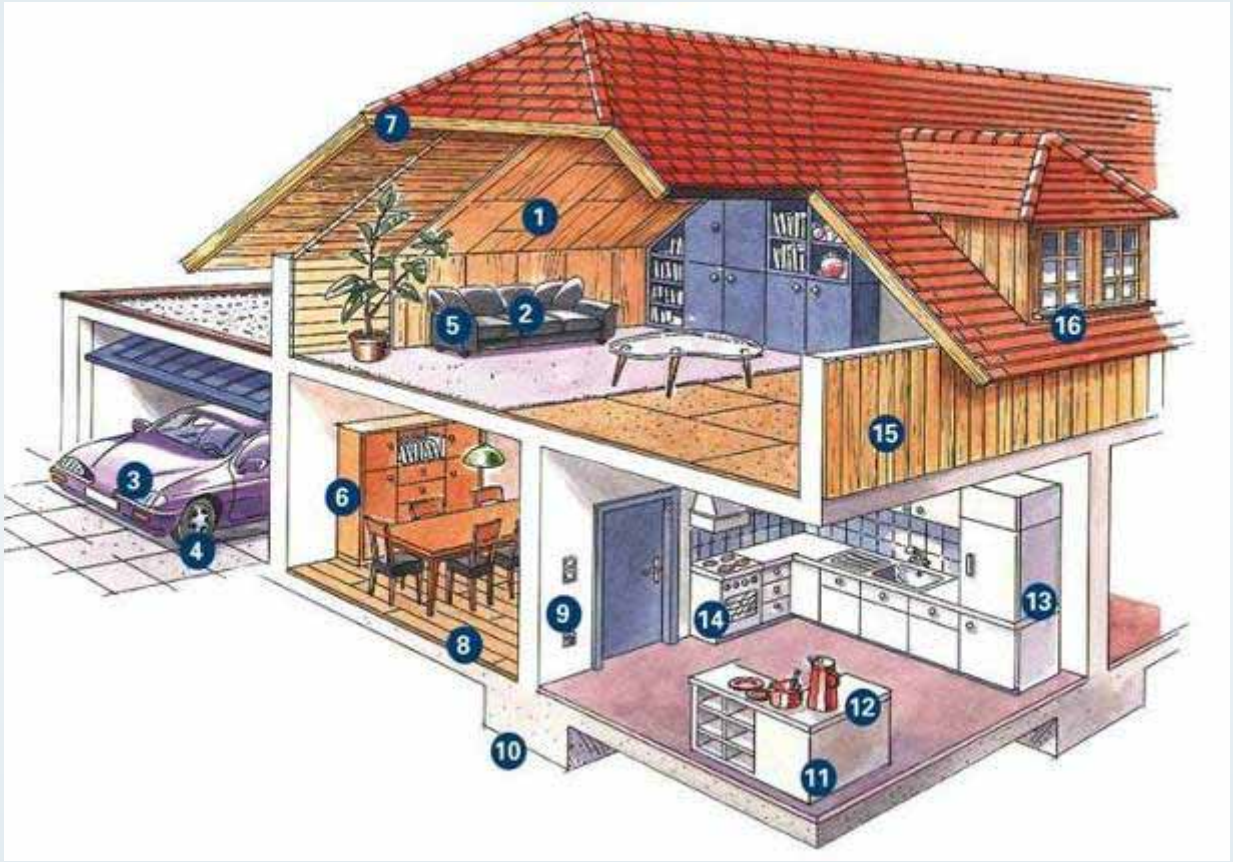
Organization



AMI Shareholders and Product Portfolio



Applications of Melamine Resins



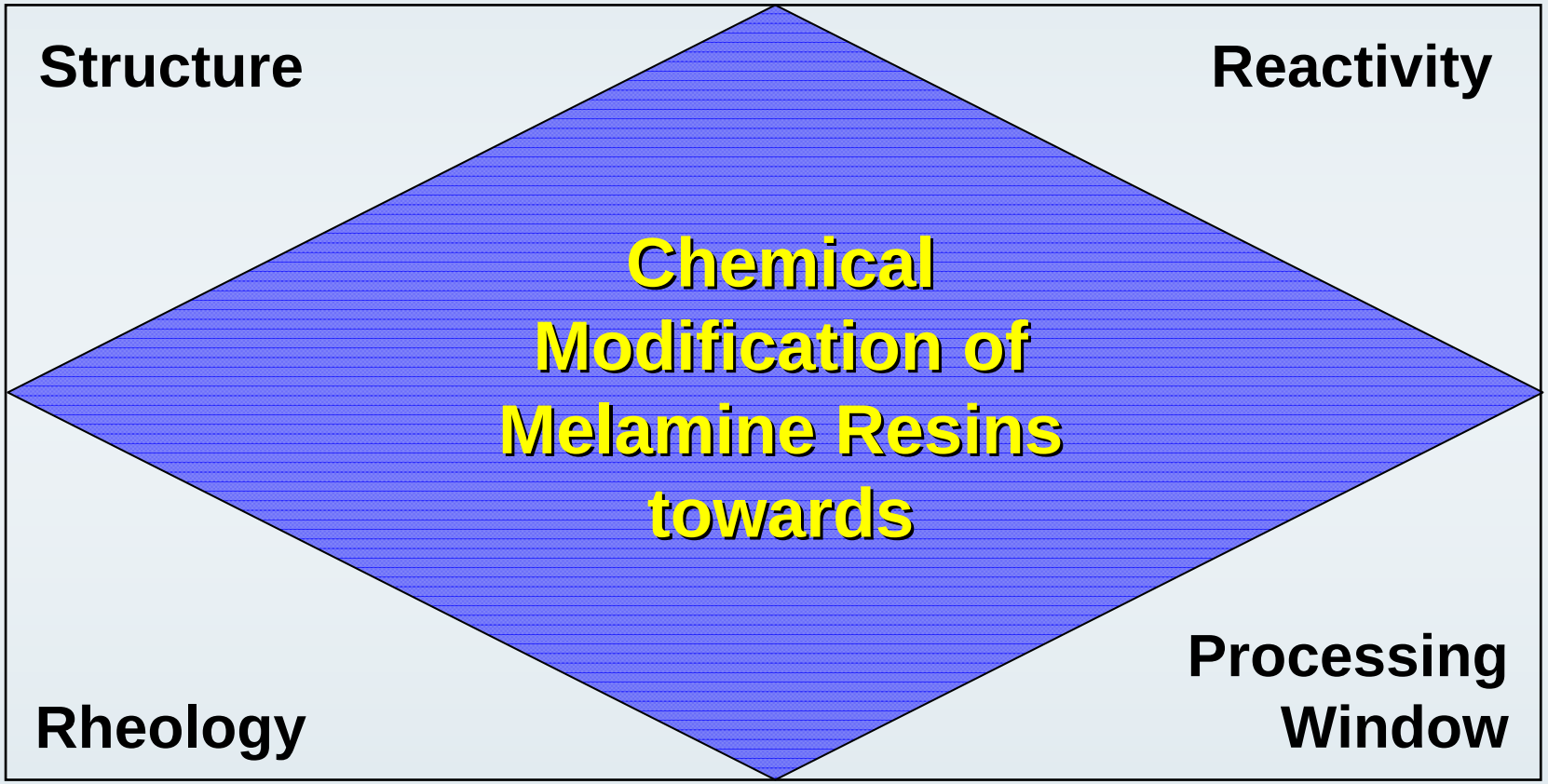
1 Panels and cladding
2 Leather and textile finishing
3 Paints and coatings
4 Tire cord
5 Upholstery flame retardants
6 Laminate sheets
7 Laminated particle boards
8 Flooring laminates
9 Switches, sockets
10 Concrete additives
11 Kitchenware
12 Surfaces
13 Resin-coated fiberboards
14 Coatings for household equipment
15 Outdoor panels
16 Window sills

Why not use it in WPC?

Challenge for Melamine Resins

	Thermoplastics PE, PP, PVC	Thermosets Melamine Resins
WPC Processing:		
- Extrusion	☺	☹
- Injection Moulding	☺	☹
Final Product Performance:		
- Thermomechanics	☹	☺
- Creep, Dimensional Stability	☹	☺
- FR, Flammability	☹	☺

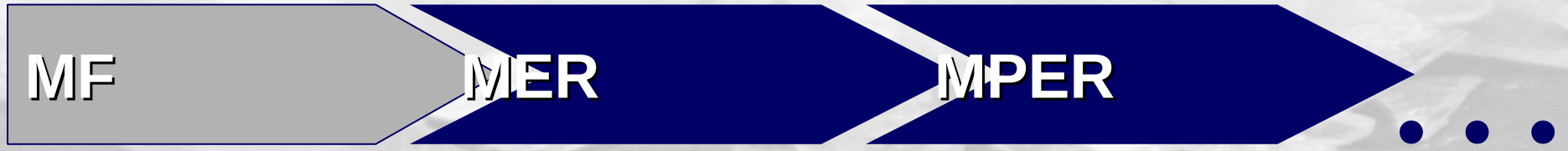
Basic Idea


Structure
Reactivity
Chemical Modification of Melamine Resins towards
Rheology
Processing Window

New Melamine Resins for Extrusion

CHEMICAL PATHWAY

HIPE®ESIN



Melamine
Formaldehyde
Resins

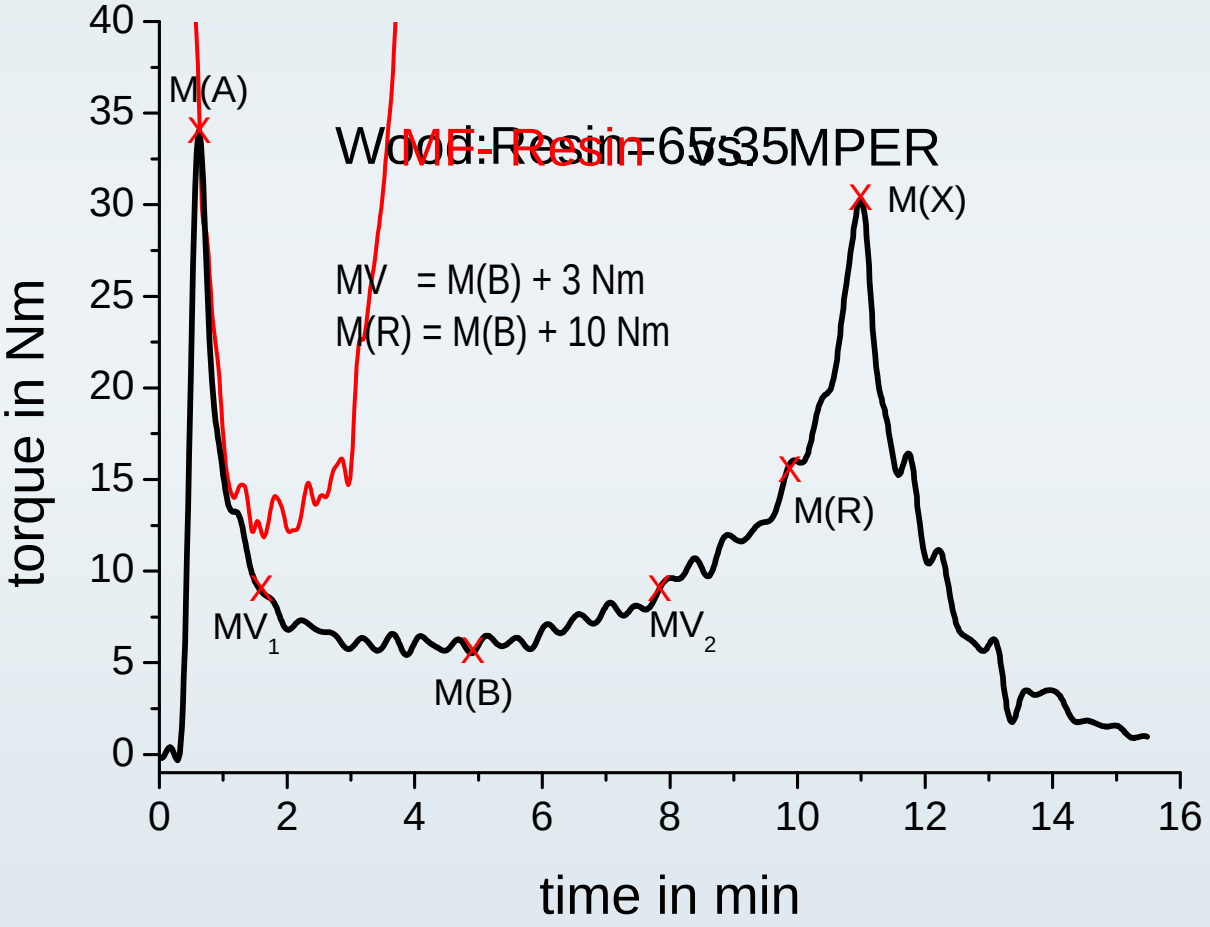
Melamine
Etherified
Resins

Melamine
Plastified
Etherified
Resins

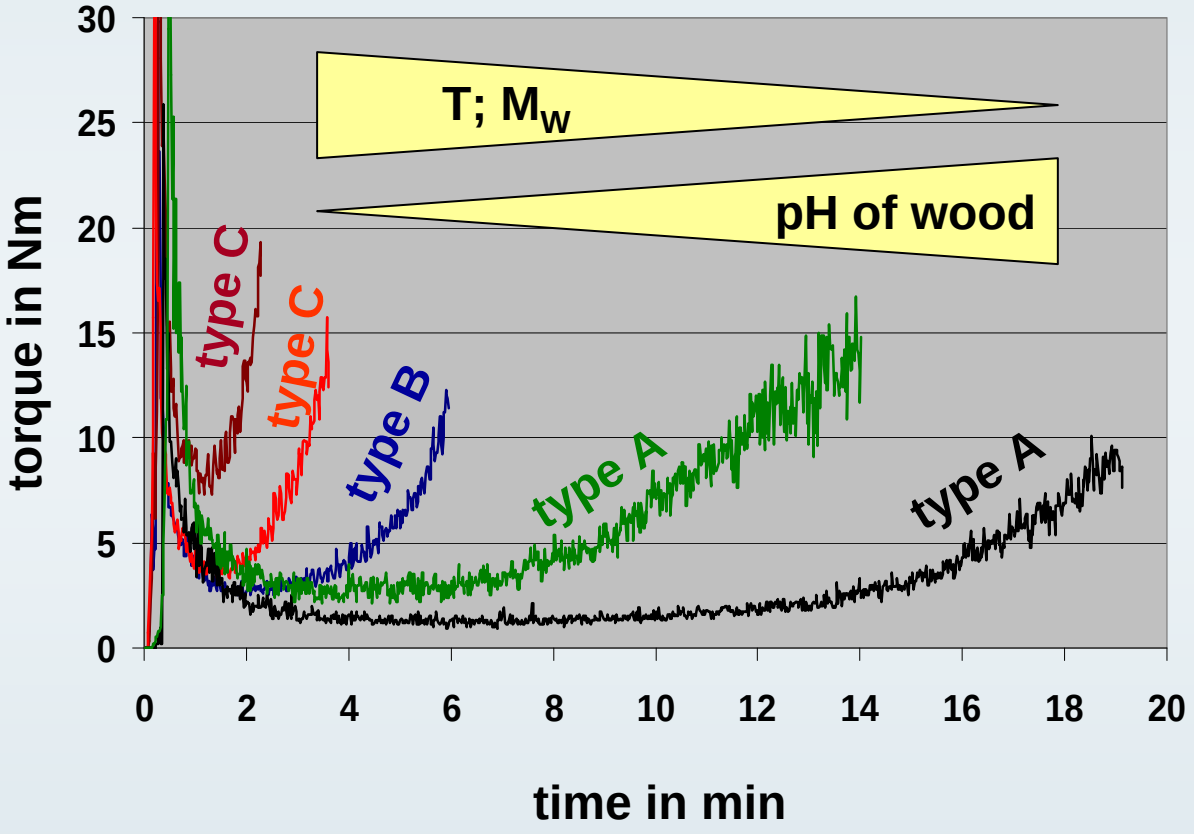
- "Linearization"
- Controlled Reactivity
- Rheology

Brabender Test

simulating plastification in twin-screw extruder



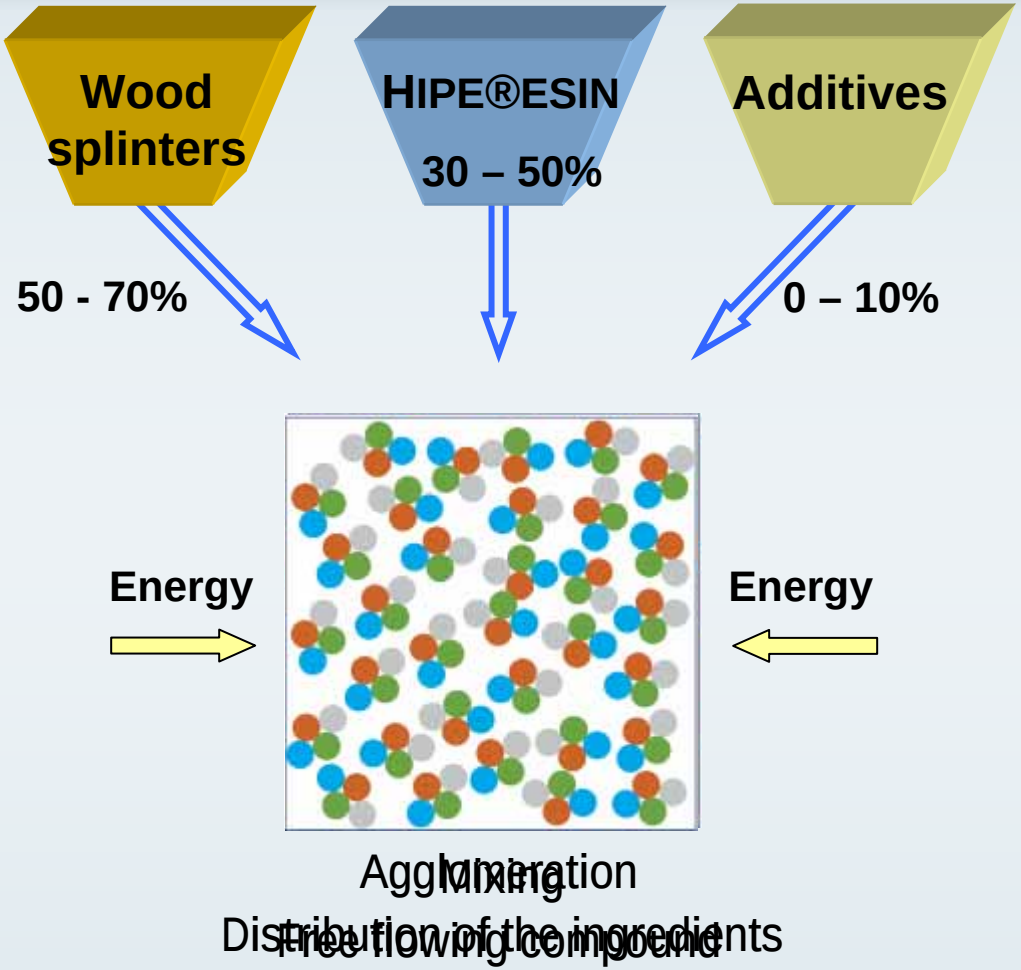
Melamine Resins / Wood



REACTIVITY

- Control of crosslinking kinetics in HIPE®WOOD
- Influence of HIPE®ESIN type (modifier; M_W; **...**)
- Process window depends on the temperature, M_W, wood type)
- Optimization according to wood type and amount

Processing – Pre-Mixturing

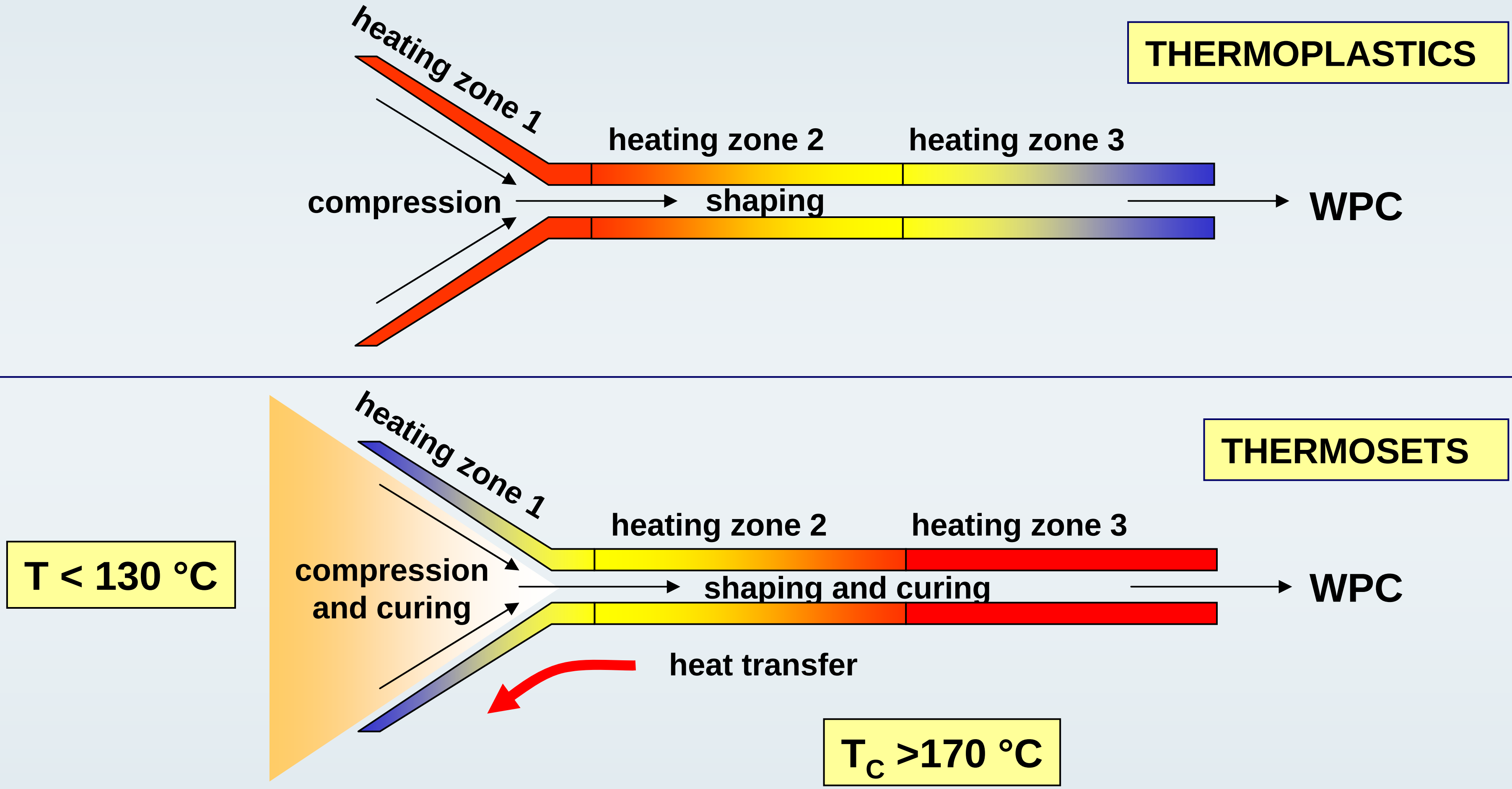


trouble-free subsequent processing in extruder or injection moulding

Processing – Extrusion equipment

- Fiberex Titan 58 (Cincinnati, with force feeder)
- Conical twin screw extruder with 4 heating- / cooling zones
- Used in PVC and WPC extrusion (PP, PE, PVC)
- **Different (“inverse”) temperature profile !**
- **Cool** in the extruder (thermoplastic window)
- **Hot** in the die (profile fixing → crosslinking)

Processing – Special Tool Features

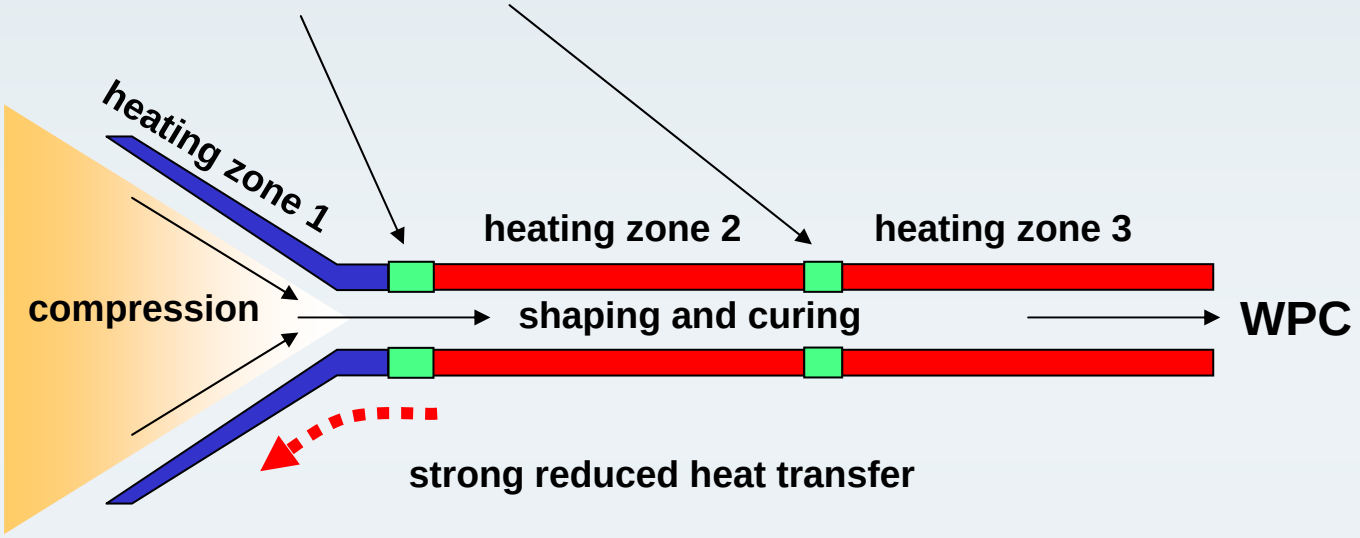


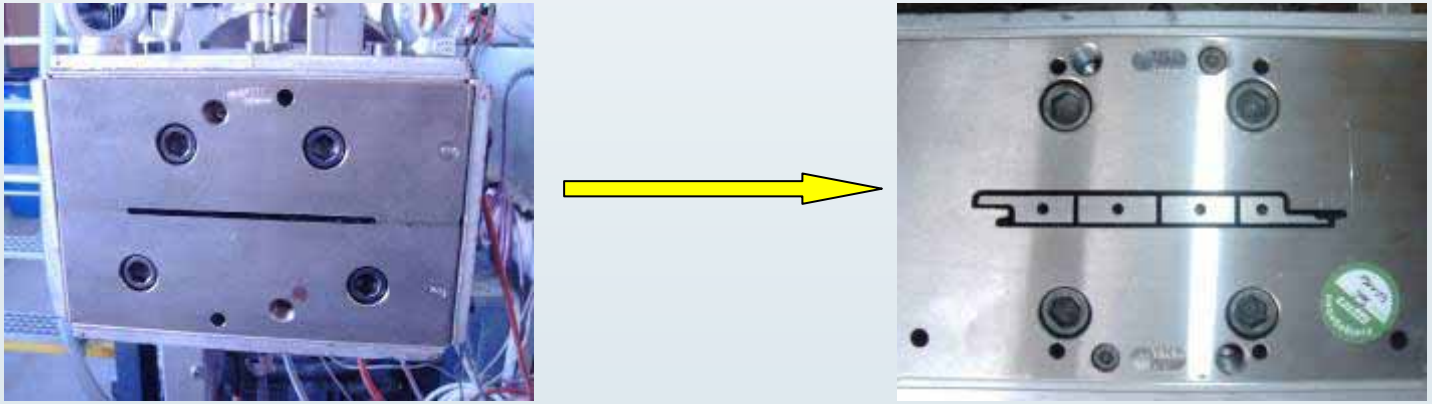
The extrusion of wood melamine resin compound requires a special tool – the tool was developed in cooperation with GREINER Extrusionstechnik GmbH, Austria

The heat transfer in the compression part influences the flow of the melt and forbids a strong temperature jump which is necessary for the curing

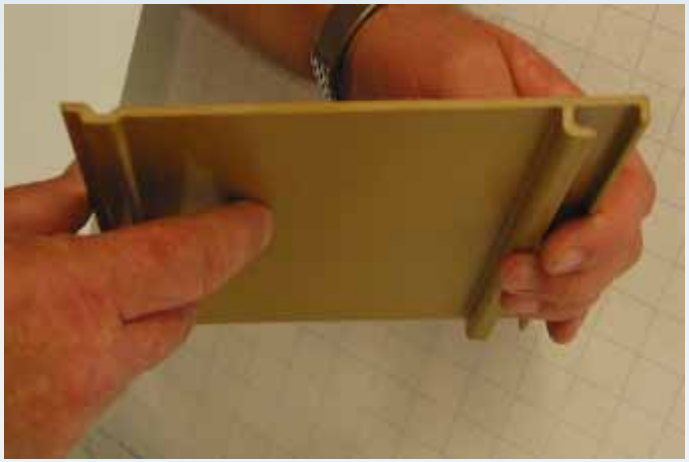
Tool for Thermoset Extrusion

thermal separation to reduce the heat transfer!





HIPE®WOOD



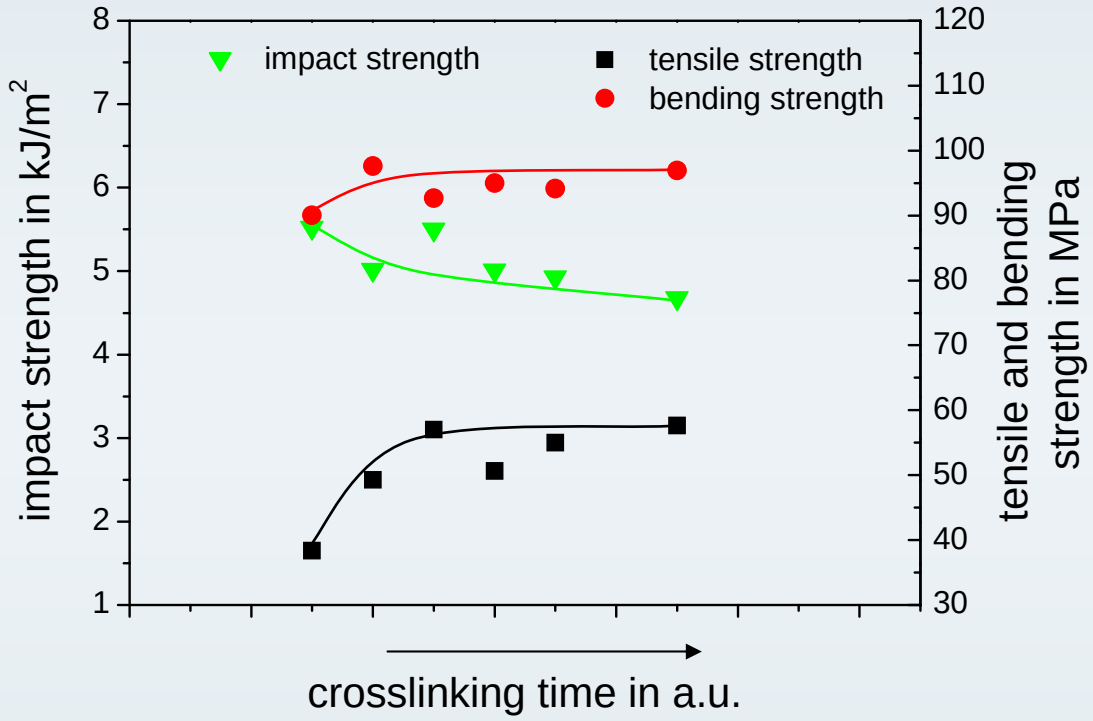
- The special tool enables a high temperature jump, which is essential for a complete crosslinking and a successful extrusion
- The obtained panels show excellent mechanical properties, can be brushed and colored

Comparison

	Density [g/cm³]	flexural strength [MPa]	Young's modulus [GPa]	Tensile stregth [MPa]	Young's modulus [GPa]	Water absorption (24 h) [%]	Impact strength* [J/m²]
HIPE®WOOD							
3rd generation (at present)	1,3	80	7,0	45	7,0	< 3	3,0
HIPE®WOOD - objective	1,2-1,3	100	10,0	60	10,0	< 3	5,0

* producer information (data sheets or web pages), ** P. D. Smith, Wood-Plastic Composites, Vienna, 2002

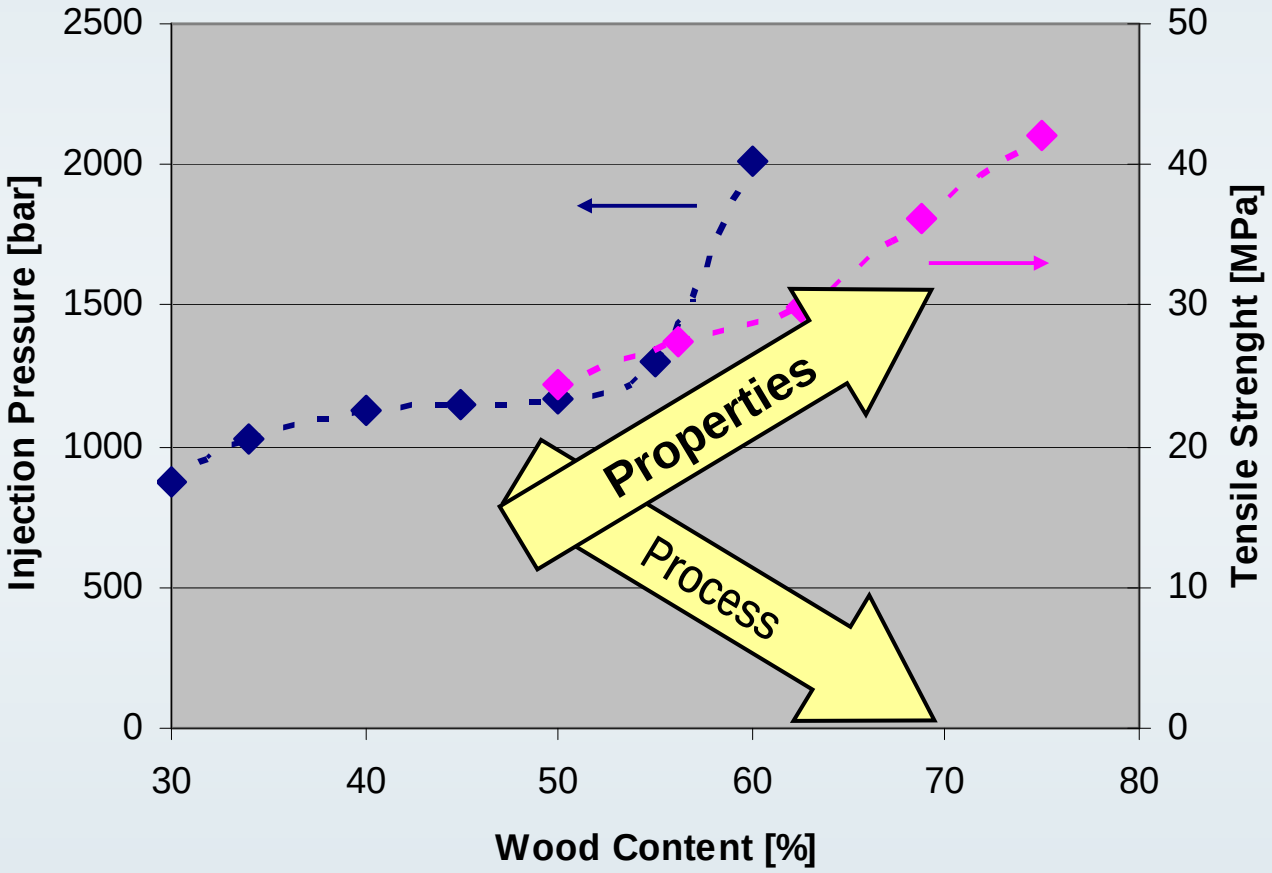
Injection Moulding



Injection molding experiments show the performance of wood/melamine resin compounds

Flow Behaviour – Influence of Processing Condition

Processibility vs. Properties



Higher wood content means …

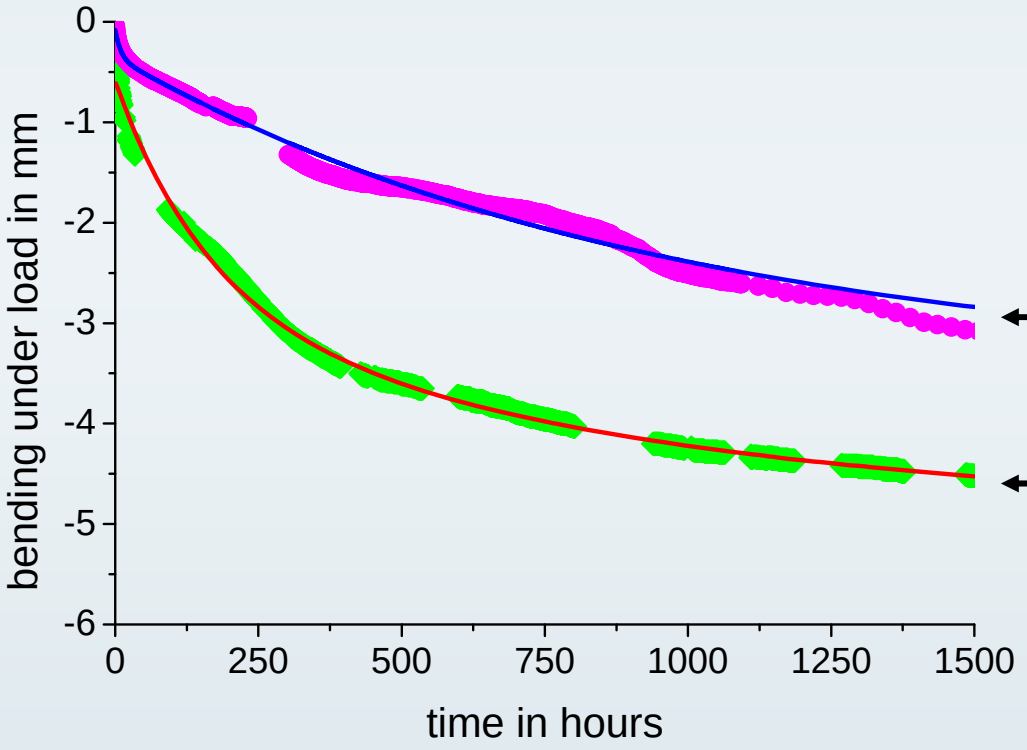
… higher mechanical product performance

… diminished processibility

→ Optimization is necessary

Creep – EN 1156

CREEP TEST: LESS SENSITIVITY TO HIGH TEMPERATURES !



First results:

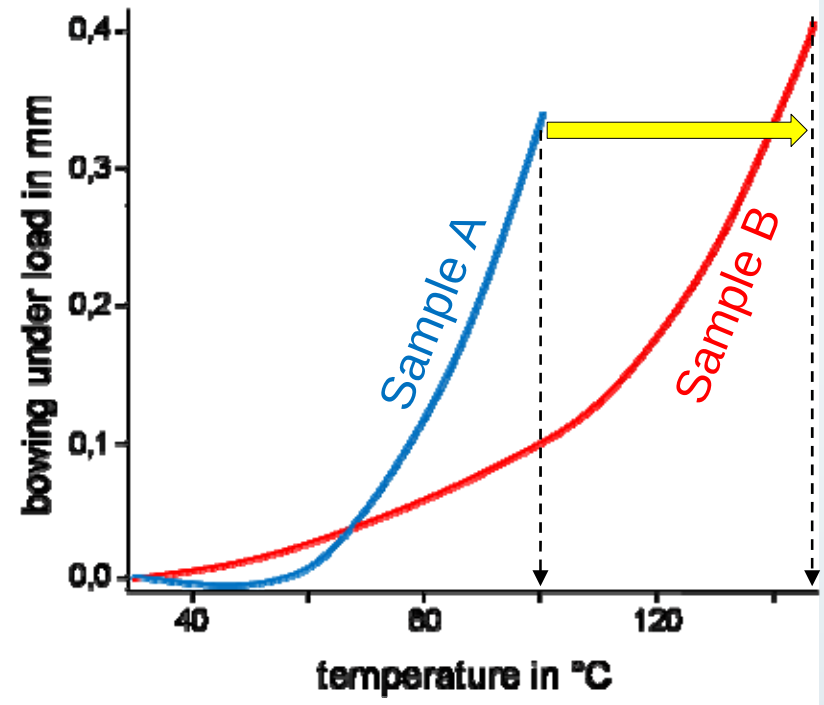
Room temperature
Force 150N; 128 days

HIPE®WOOD
(Wood/Melamine resin)

WOOD/PP

Product Performance of HIPE®WOOD

THERMOMECHANICS: IMPROVED HEAT DISTORTION TEMPERATURE



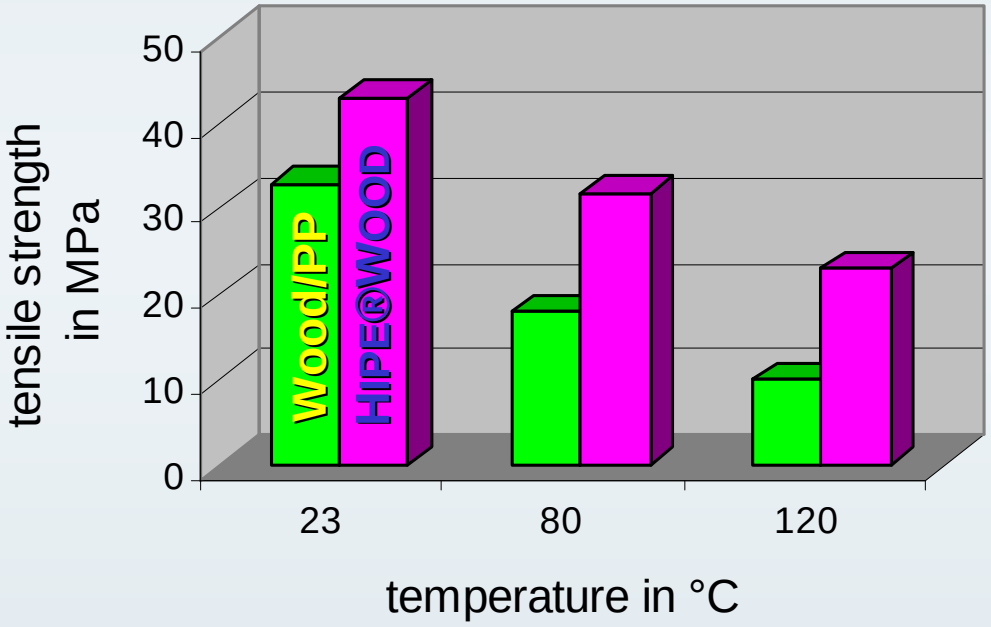
Higher degree of crosslinking (catalyst)

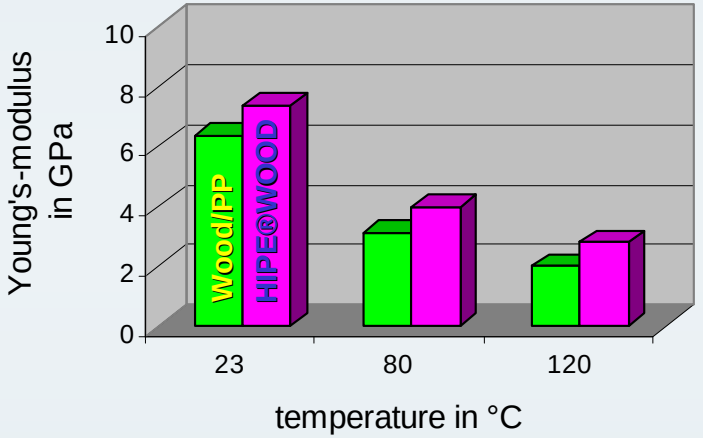
	Sample A in °C	Sample B in °C	Wood/PP in °C
HDT/A	100	147	-
HDT/C	80 141*	90 157*	57 -

*values after tempering

Product Performance

TENSILE STRENGTH: REDUCED THERMAL SENSITIVITY!

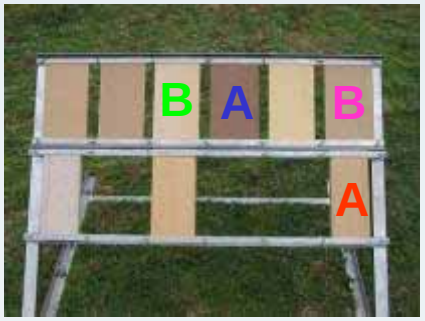


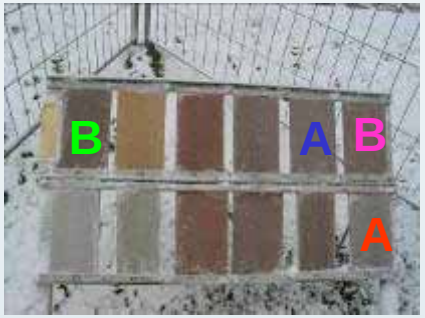


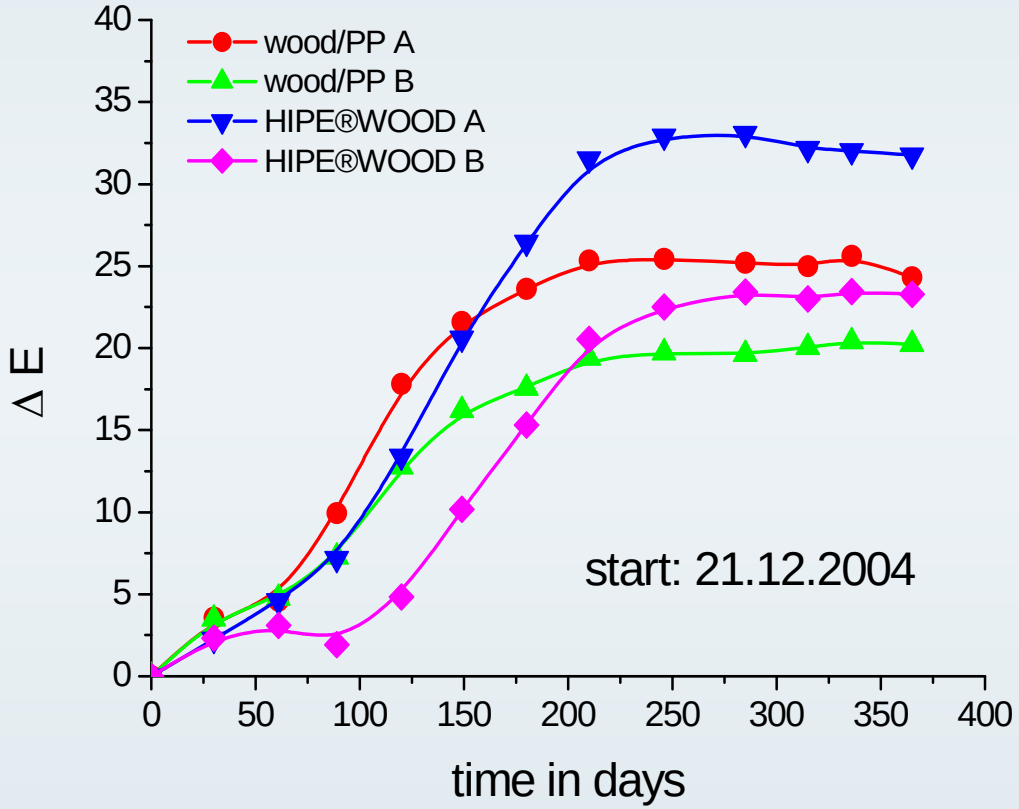
- Tensile strength and modulus show the same trend.
- Product performance of HIPE®WOOD is higher than of classical WPC

Outdoor – Weathering

FIRST RESULTS: ALL COMPOSITES ARE UV-STABILIZER-FREE



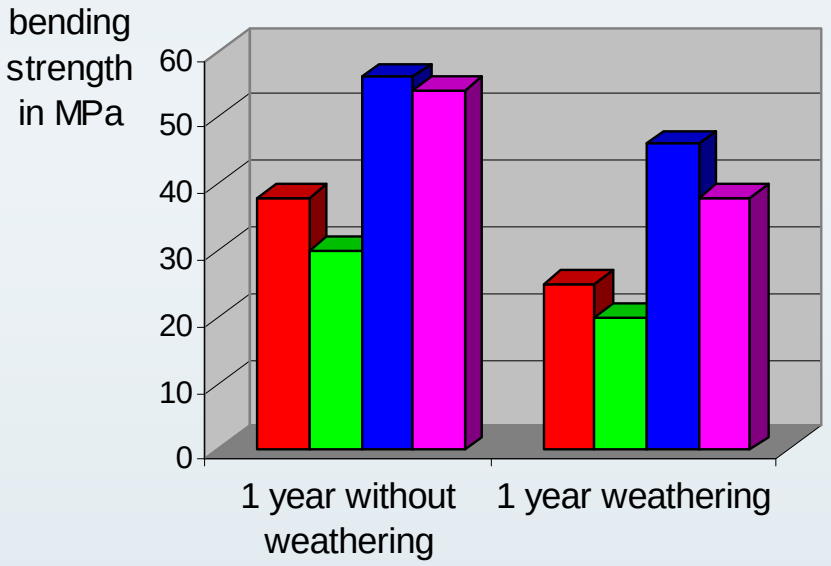


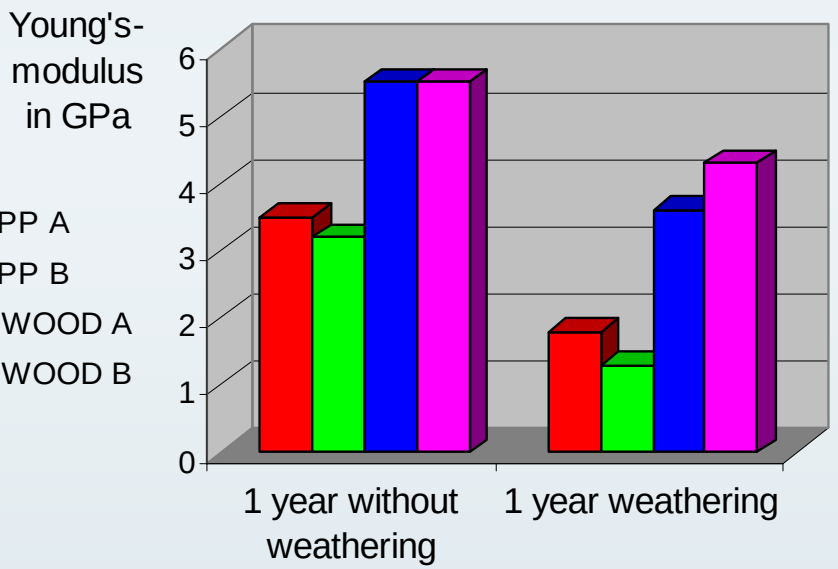


Yellowing of wood/PP-WPC and HIPE®WOOD as result of outdoor weathering (wood content: B > A)

Weathering – II

BENDING STRENGTH: REDUCED WHEATHERING SENSITIVITY!



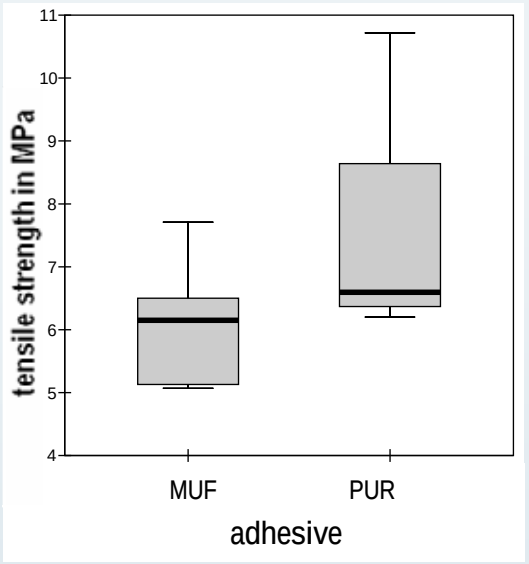


Bonding Strength

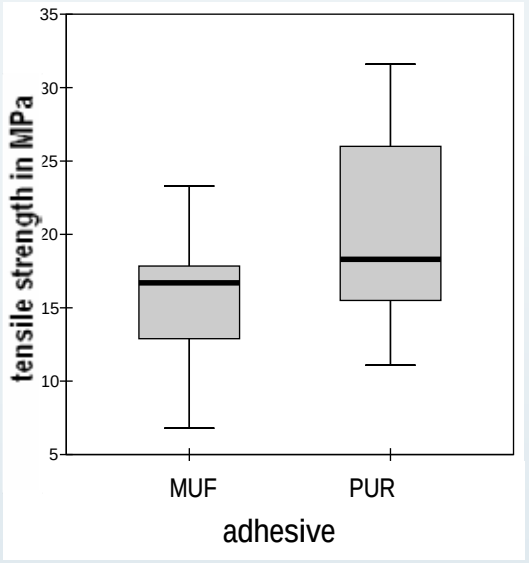
lap joint (EN 302-1:2004)

test piece (tensile strength)

scarf joint (DIN 53 253)



tensile transverse resistance

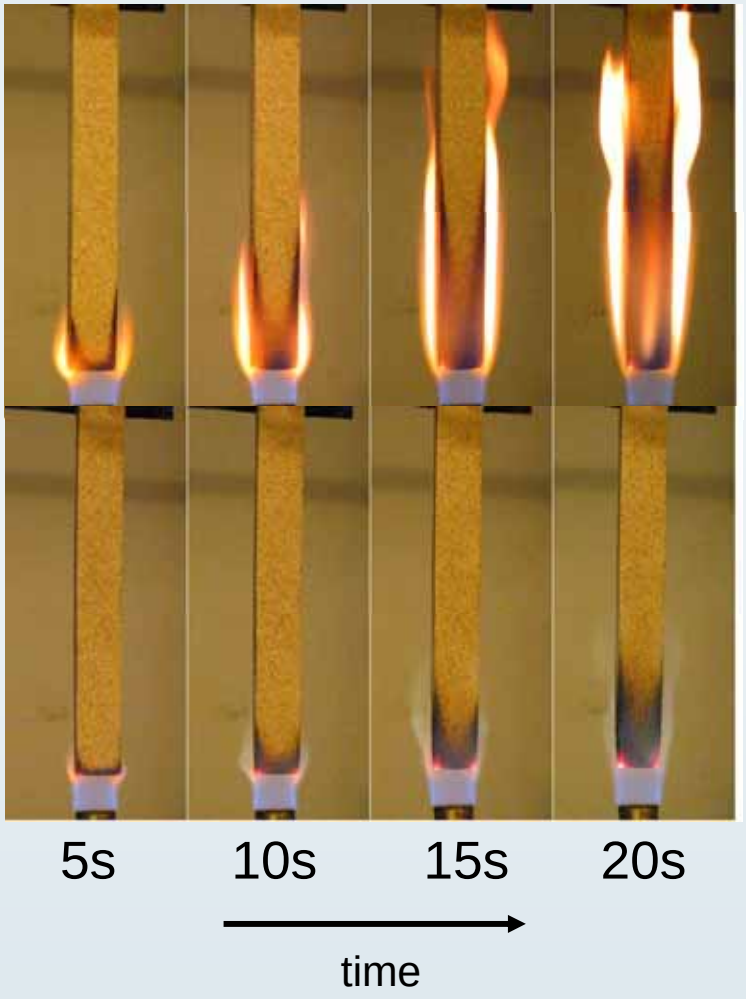


tensile strength of scarf joint

- tesile strength of pure material: 37 MPa
- tensile transverse resistance (spruce): 5.9 MPa (MUF), 7.9 MPa (PUR)
- tensile strength of scarf joint (spruce): 7.5 MPa (MUF), 10.5 MPa (PUR)

Extended Applications

- Special designed, halogen-free flame-retardant formulation has been developed (also applicable on other wood composites)
- Impregnation resin for reduced water uptake and improved dimensional stability can be used
- Property modification (in development): e.g. impact modifier, adapted UV stabilisation and resistance to fungi and insects



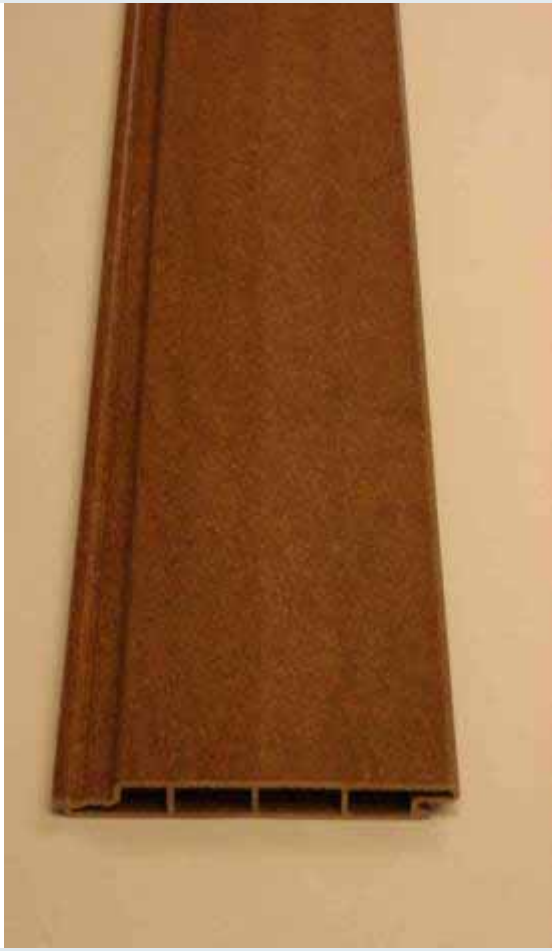
Summary of HIPE®WOOD Development

- Unique new melamine resins with thermoplastic processing window: HIPE®ESIN
- Controlled rheology and reactivity of resin and composition
- Extrusion of thermosetting WPC on commercial equipment
- Processing conditions: invertedd temperature profiles → special tool design (crosslinking)
- Outstanding performance of HIPE®WOOD
- Advantages in existing applications
- Providing access to new applications and markets

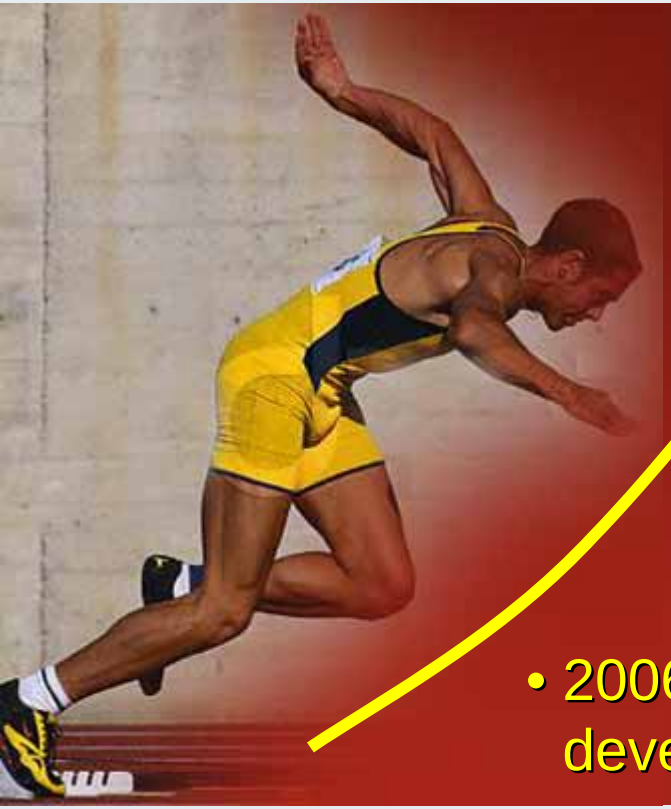
Focused Applications

- MARKET TRENDS
- Tremendous growth in European market will continue
- New applications under development, esp. in Building & Construction
- Low weight & value-added products → hollow profiles

- HIPE®WOOD FOR ADVANCED WPC
- Advantages in existing + Access to new applications
- Lightweight boards, fencing, railing, cladding
- Doors, door frames, decorative profiles, furniture



Outlook



- Providing access to new applications and markets
- Advantages in existing applications
- 2007: Upscaling HIPE®ESIN → Premarketing
- 2006: Basic development of HIPE®WOOD package for profile extrusion in pilot scale
- 2006: Cooperation for product and market development

WPC – R&D Projects

- Extrudable wood melamine resin composites (HIPE®WOOD)
- Biopolymers for high quality profile extrusion
- Modified wood particles for WPC
- Rheolex – melt flow rheology of extruded wood plastic composites
- Market research
- Customer projects

Acknowledgement

Thank You for your attention

Kompetenzzentrum Holz GmbH