

**Alternative raw materials for  
particlesboards**

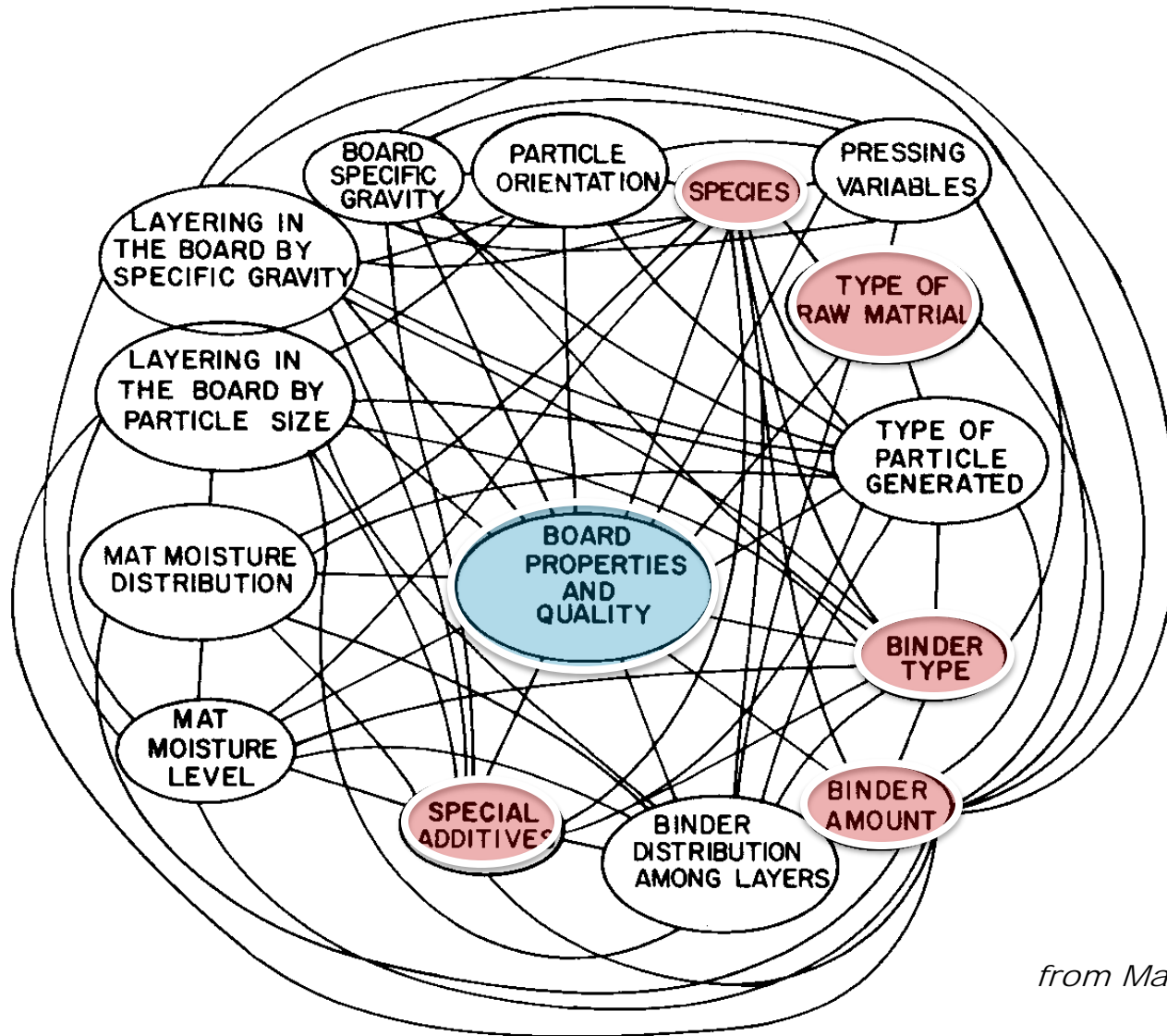
**Rupert Wimmer  
BOKU Wien**

**Brno, 29. September 2016**

# Why alternative raw materials?

- rising **wood prices** – search for alternatives
- **re-goals** (re-new, re-duce, re-cycle,...)
- **ressource efficiency**
- **Altered property profiles** (e.g. lower weight)

# The raw material factor – widely unknown



*from Maloney1993*

# Alternative raw materials

- Alternative **wood species** (e.g. poplar, beech)
- **Fiber plants** (hemp, flax,..)
- **Agricultural wastes** (e.g. topinambour, sunflower)
- **Giant grasses** (z.B.Miscanthus)
- **Biogenic process wastes** (e.g. brewer spent grain)
- **Wastes- / residual materials** (used textiles, PET bottles)

# Alternative wood species

1958

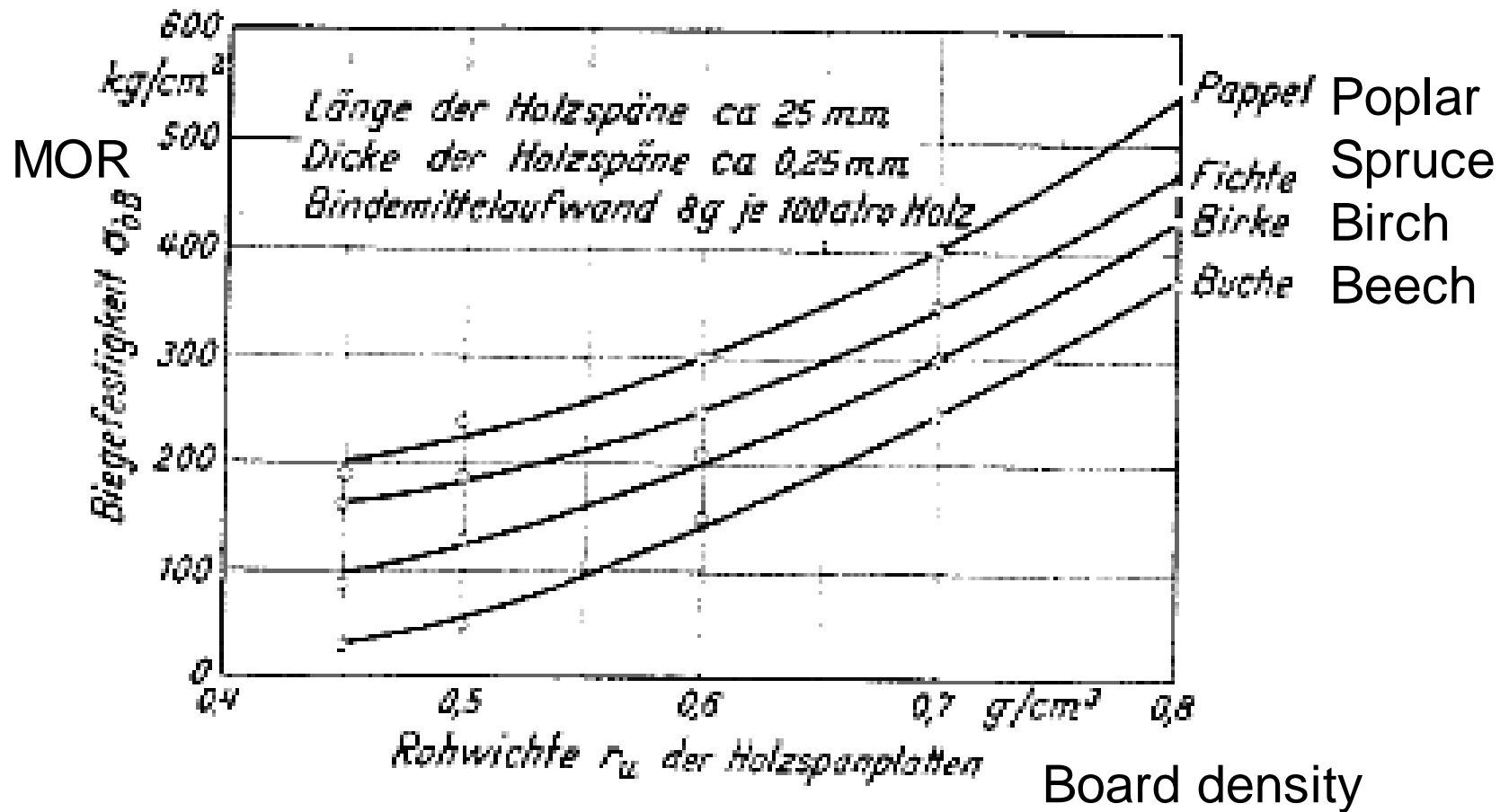


Abb. 2. Biegefestigkeit von Holzspanplatten in Abhängigkeit von der Rohwichte der Holzarten Pappel, Fichte, Birke und Buche bei verschiedener Rohwichte der Platten

aus: Stegmann/Klauditz (1958), Holzf.

# Project – Alternative Wood species (Uni Göttingen)

- Five species: (1) **White oak**, (2) **European beech**, (3) **Poplar**, (4) **Norway spruce**, (5) **Scots pine**

- - Resin types and amounts

- \* Urea-formaldehyde (Kaurit 350, BASF)

- 5.5% for „low“

- 12% for „high“

- \* Polymeric Diphenylmethane-Diisocyanate (PMDI)  
(I-BOND PBEM 4352, HUNTSMAN)

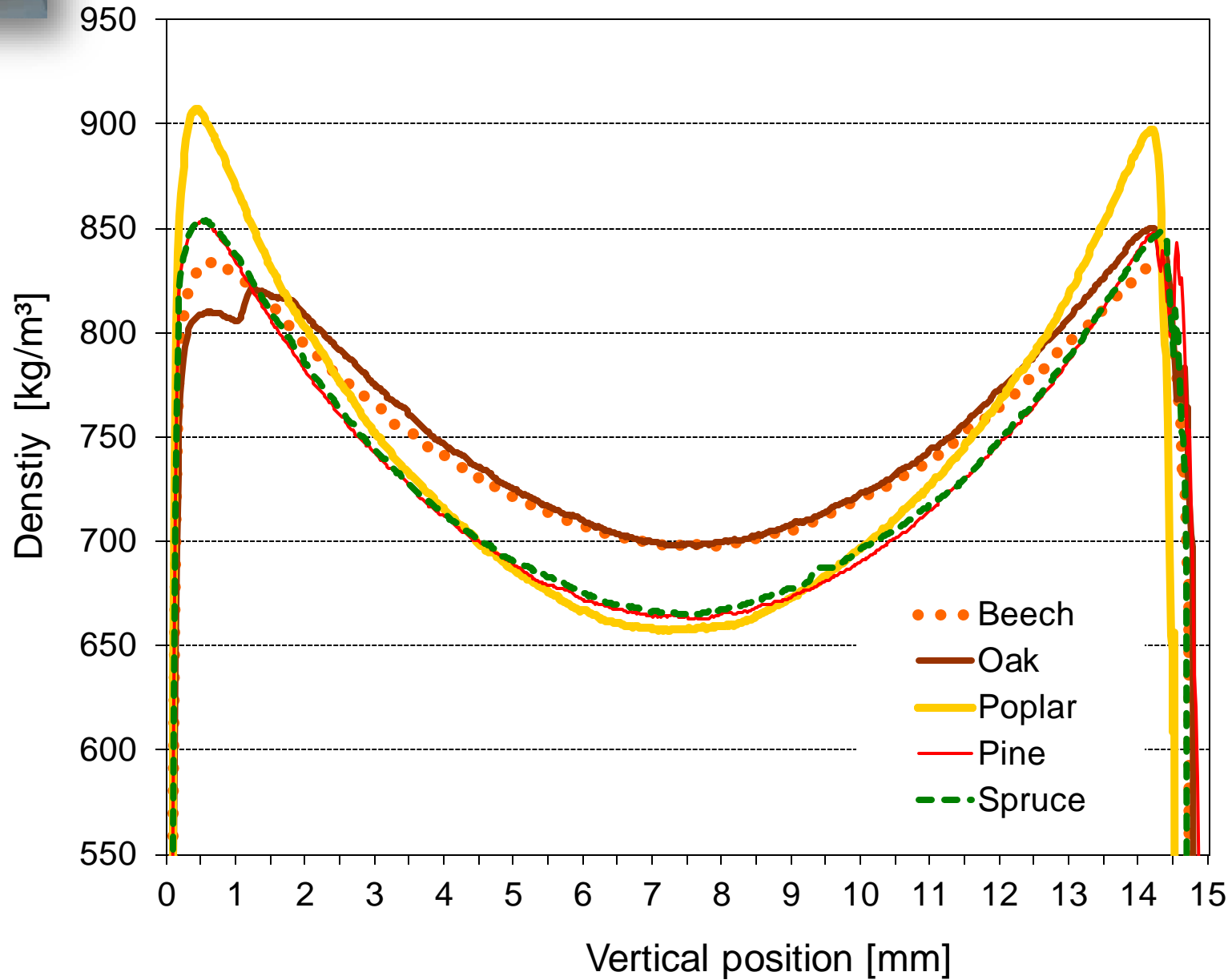
- 2% for „low“

- 4% for „high“

- Pre-treatment using melamine resin (Madurit MW 840, 12%)



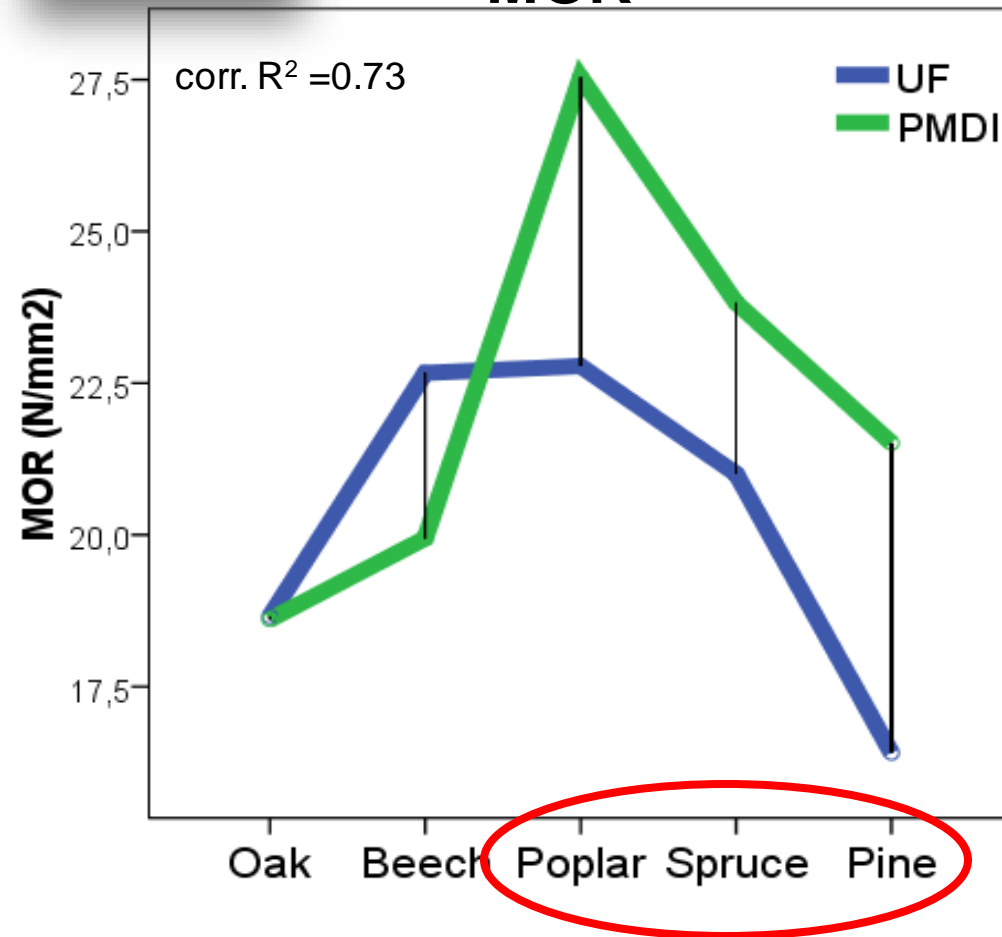
# Density profiles of different species



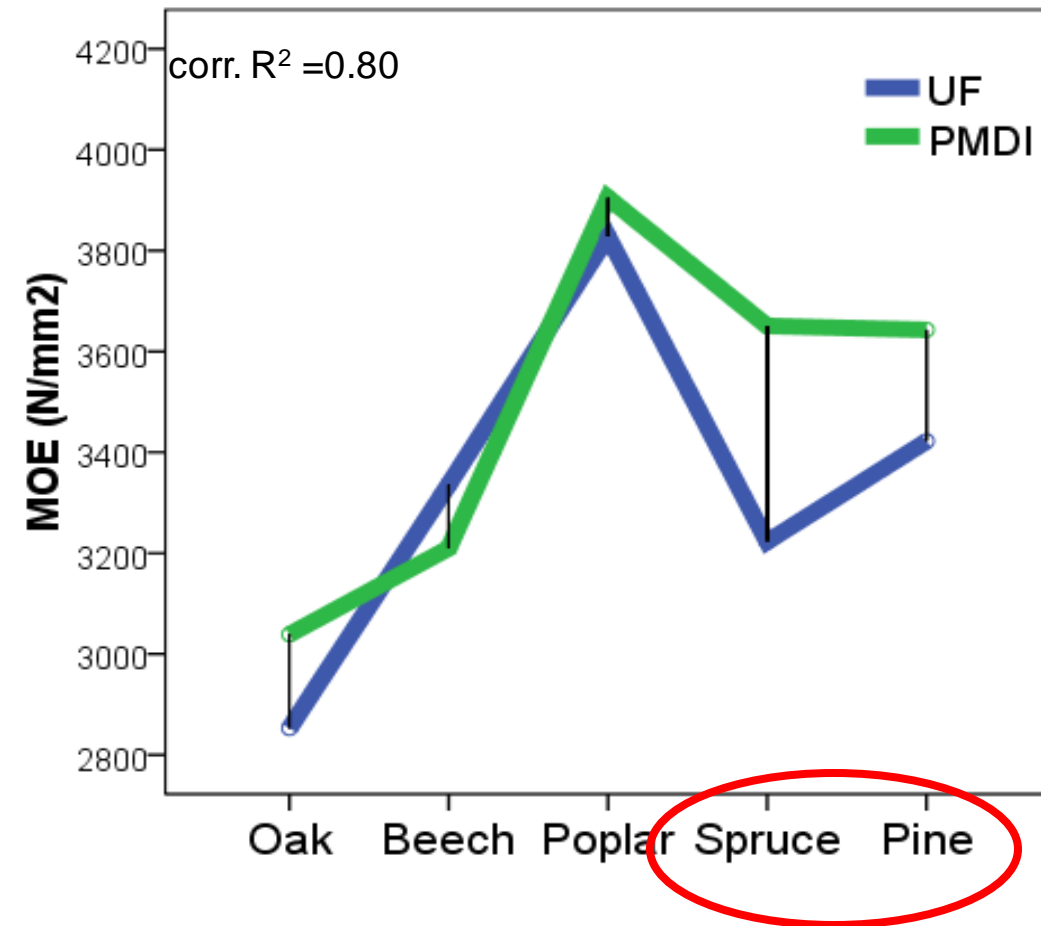


# UF vs. PMDI

## MOR



## MOE



- Spruce, pine (and poplar) respond to **resin type**
- Highest values for **poplar**



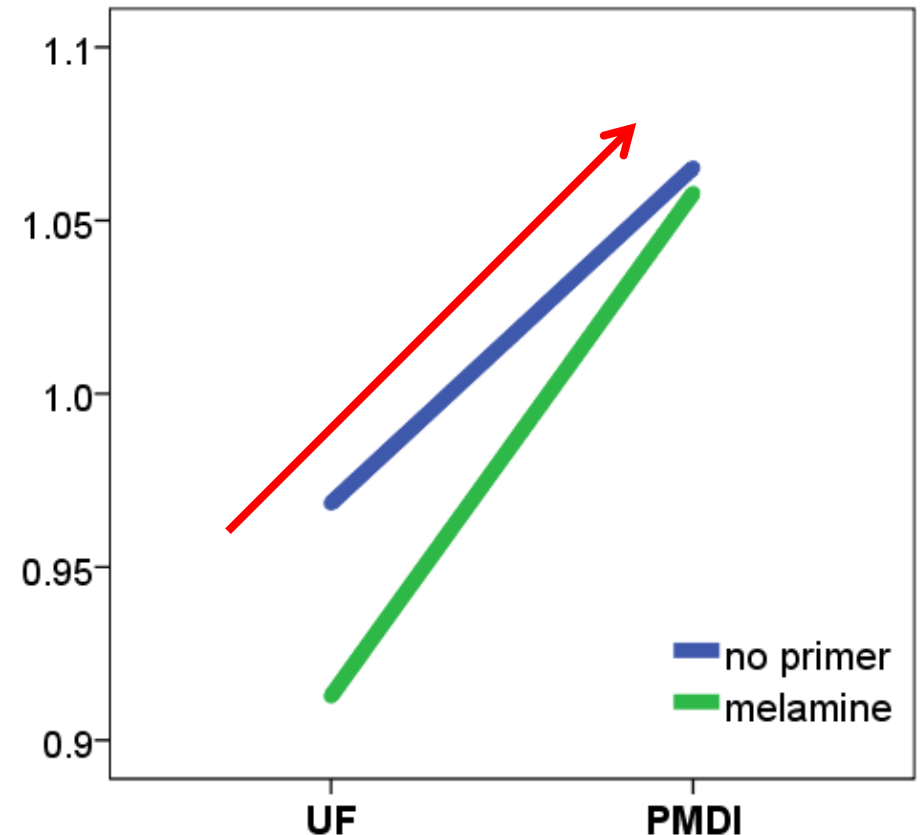
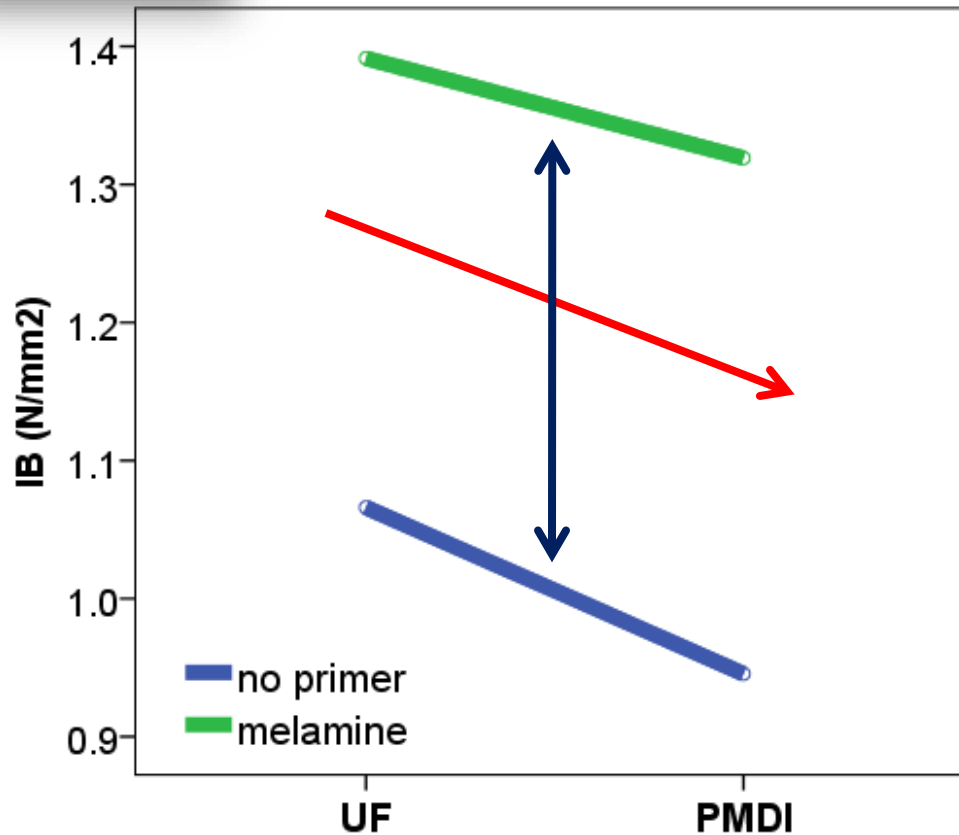


# Melamine primer – resins – species

IB – oak

corr.  $R^2 = 0.93$

IB - spruce



- IB: fundamental species differences
- Greater effects seen for hardwoods

# Species ranking

highest

lowest

Species	MOR	MOE	IB	Swell 2h	Swell 24	WA 2h	WA 24h	Sum	Ranking
Oak	1	1	5	3	5	3	4	22	3
Beech	3	2	4	4	4	4	5	26	1
Poplar	5	5	1	5	2	2	2	22	3
Spruce	4	3	3	2	3	5	3	23	2
Pine	2	4	2	1	1	1	1	12	4

High priority

Low priority



Oak: best IB and low thickness swell

Beech: overall best

Poplar: best bending properties

Spruce: lowest water uptake

Pine: good in stiffness

(Wimmer et al. 2011)

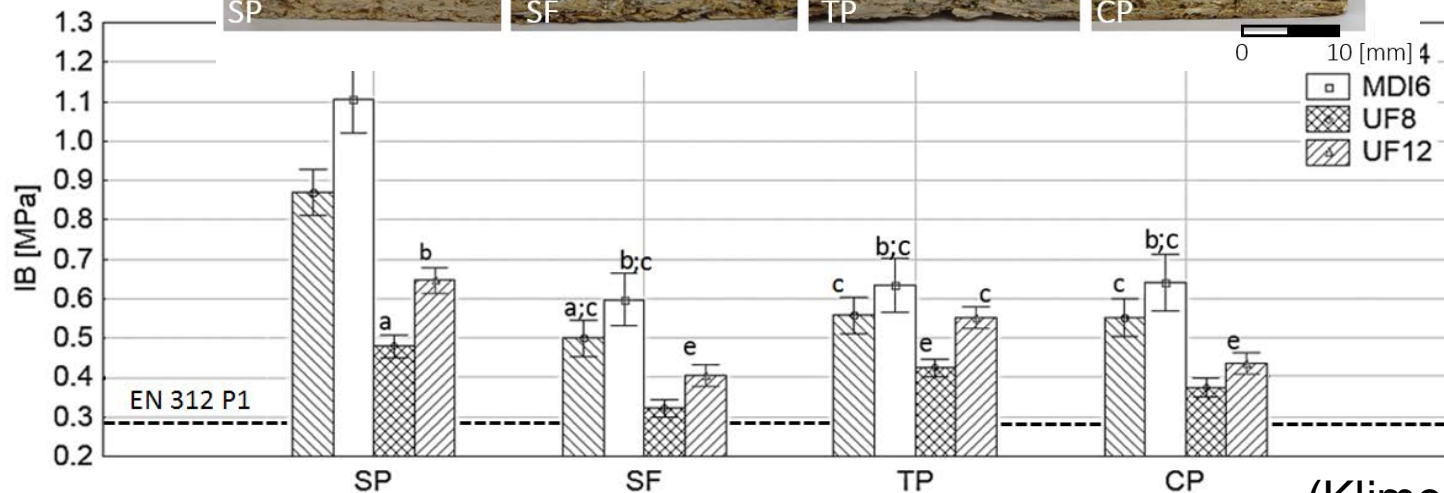
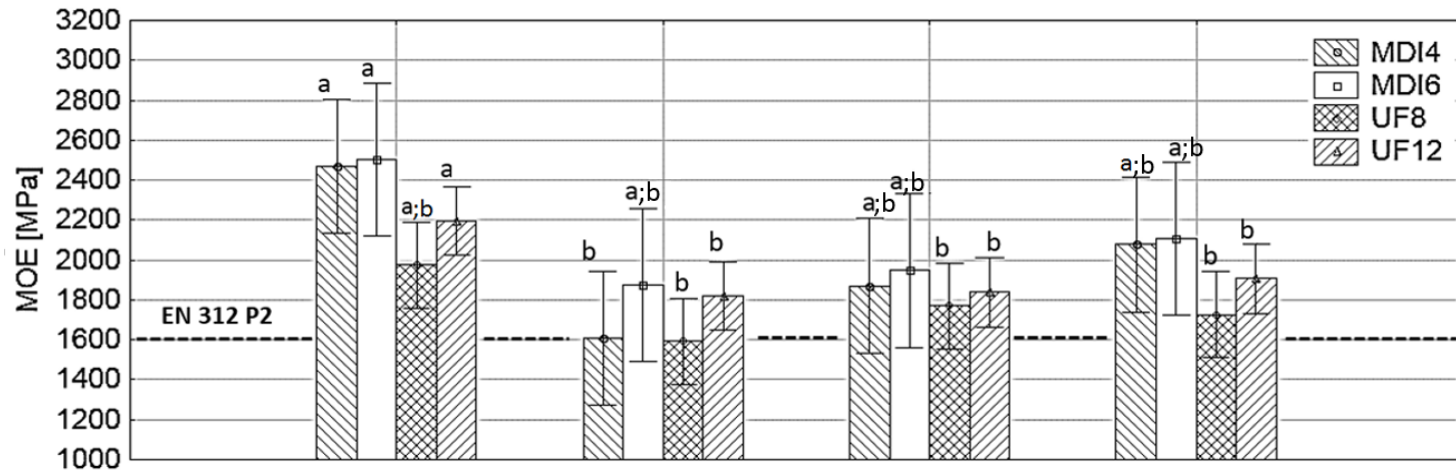
# Klimek dissertation – Agricultural residues

(Mendel Uni, WKI)



(from Klimek 2016)

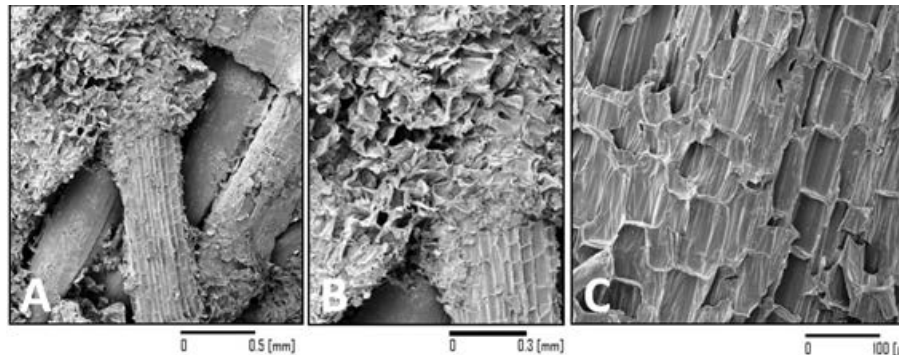
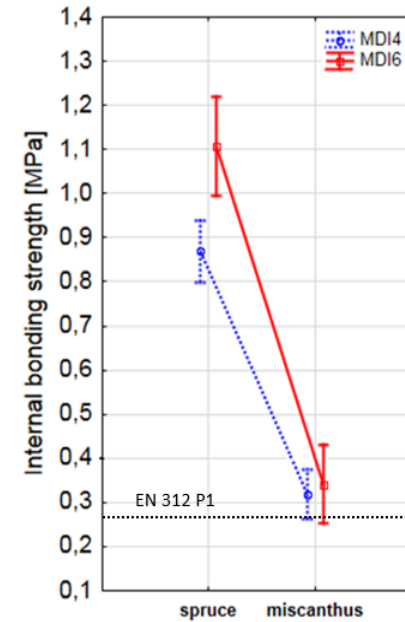
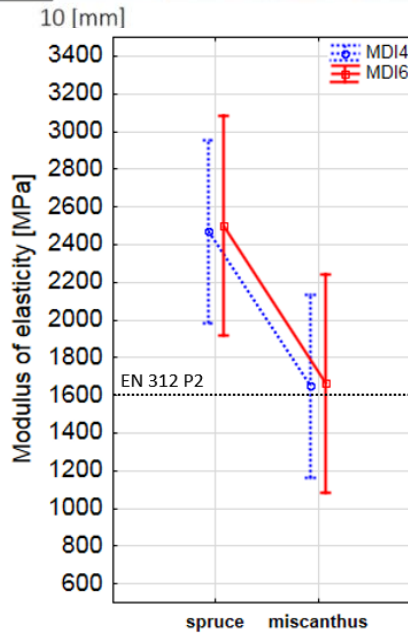
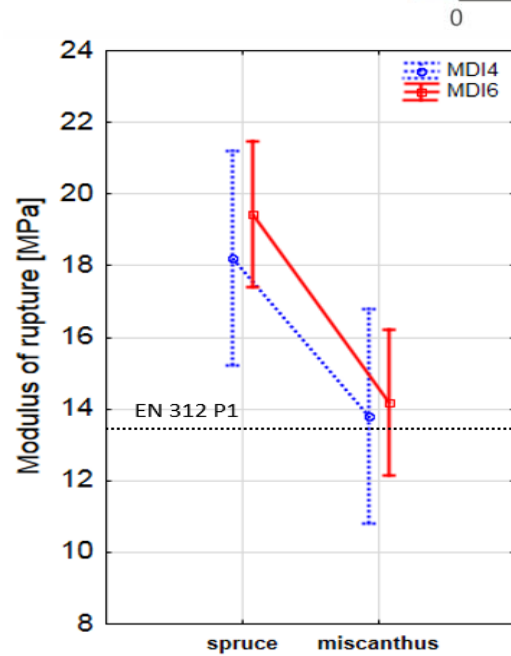
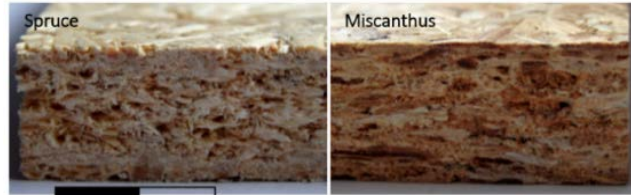
# Agricultural residues (sunflower, topinambour, silphie)



(Klimek et al. 2016a,c)

SP-spruce particleboards, SF-Sunflower, TP-topinambour, CP – cup-plant

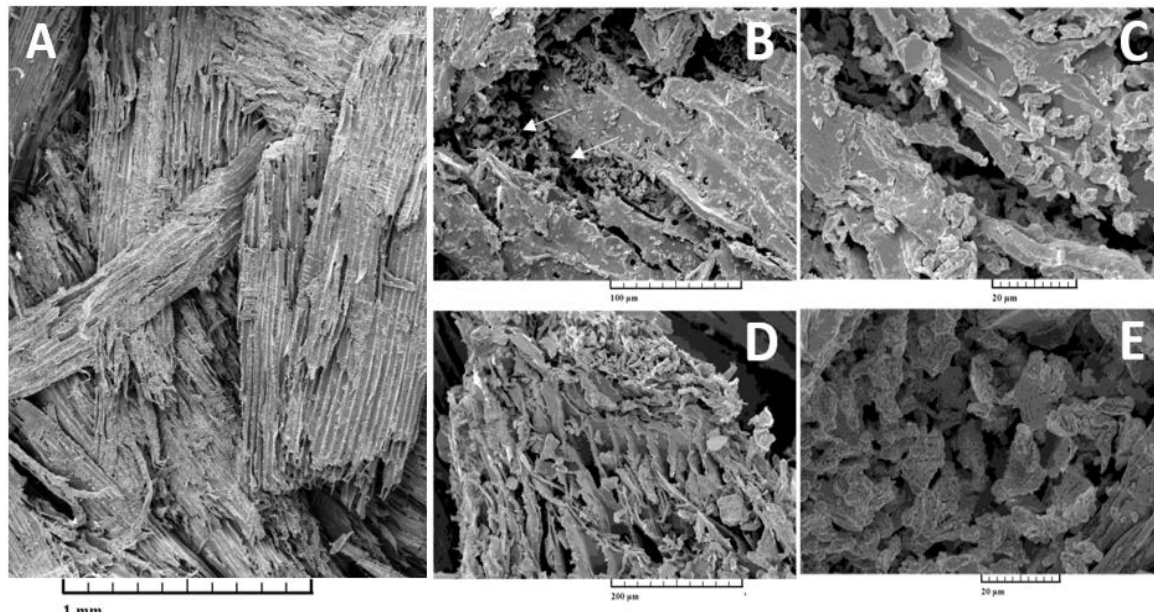
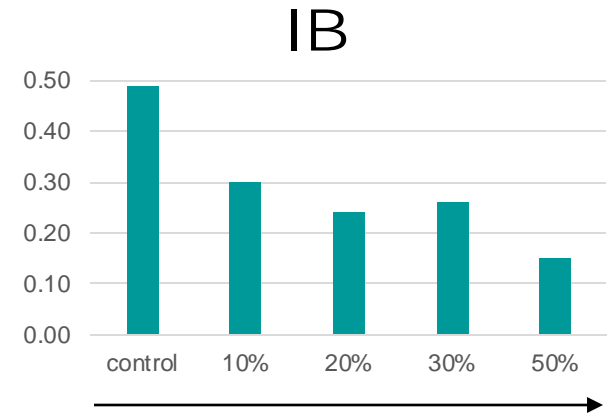
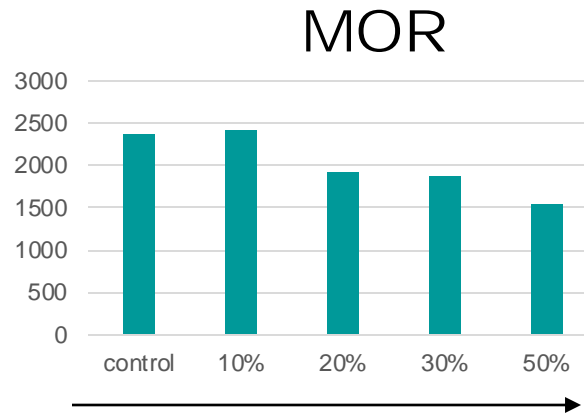
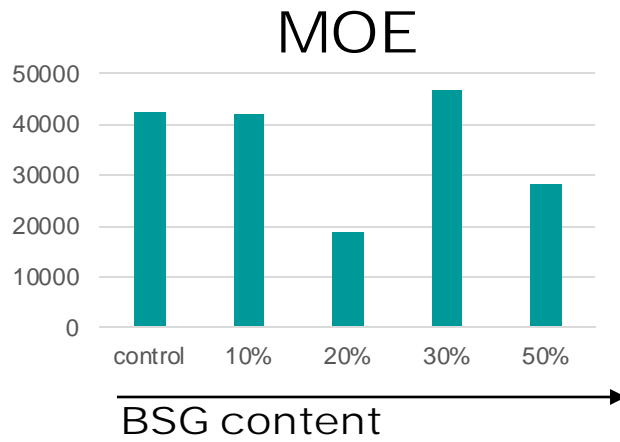
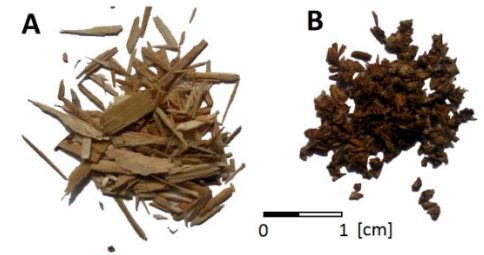
# Giant grasses (Miscanthus) (Mendel Uni, WKI)



(Klimek et al. 2016b)

# Brewer's Spent Grain

(Mendel Uni / Food Science Department)



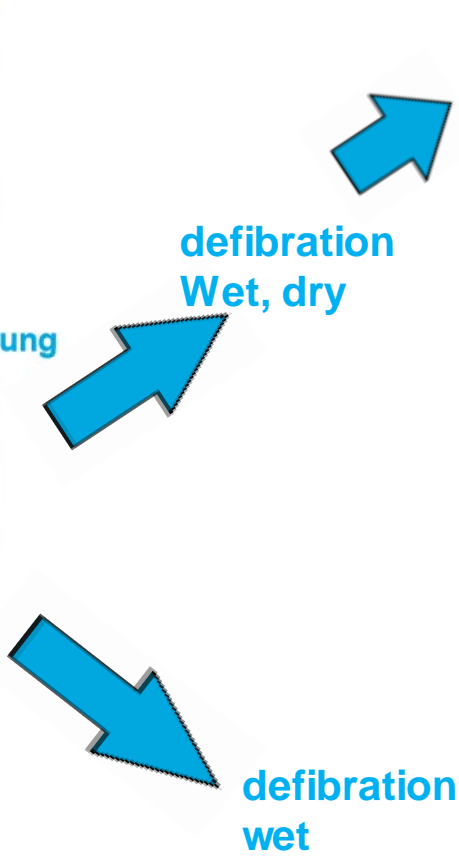
(Klimek et al. 2016d)

# Used-textiles-wood materials (BOKU)

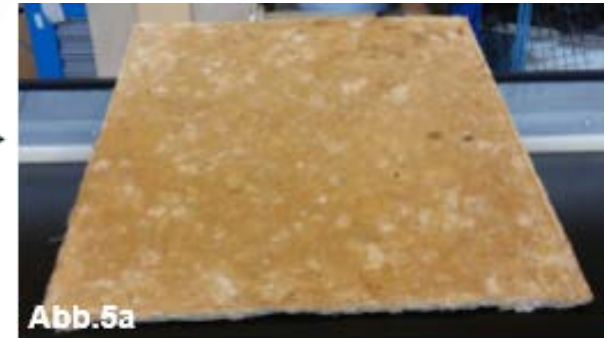
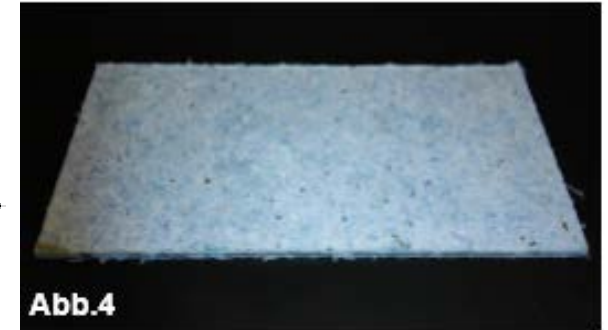
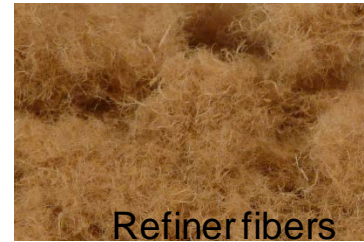
## Used clothes



Mechanische Zerkleinerung

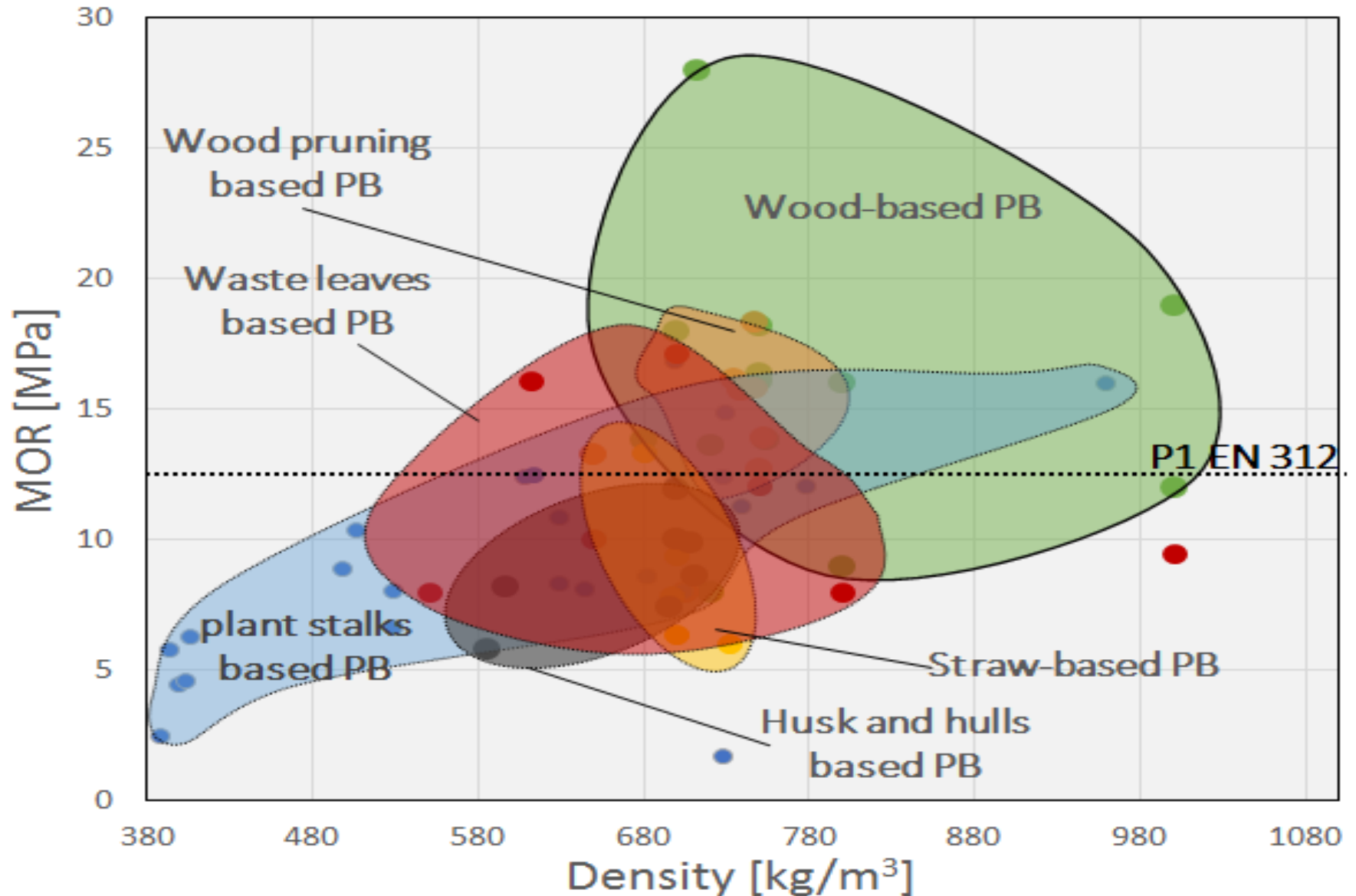


defibration  
Wet, dry



(Gasser et al. 2016)

# Ashby Plot - extended property profiles





# Risks

- Agrar-based particleboards: reduced mechanical properties
- no logistics – missing raw material management
- Availability discontinuous
- storage problem
- variable / missing market prices
- Odor ?
- processibility

# Chances

- Independency from wood
- Weight reduction! (-20%)
- Sandwich constructions
- textile wastes – continuously available
- opportunity for „wet-process“ (self-bonding)
- cost reduction
- Mixing with other raw materials (wood,..)
- Higher resource efficiency

# Publications

- Klímek P., Meinschmidt P., Plinke B., Wimmer R., Schirp A. (2016a) *Utilization of cup plant (Silphium perfoliatum L.), sunflower (Helianthus annuus L.) and topinambour (Helianthus tuberosus L.) stalks as a raw material for particleboard production. Industrial Crops and Products* 92: 157-164
- Klímek P., Meinschmidt P., Kúdela J., Wimmer R. (2016b) *Study of Miscanthus (Miscanthus x giganteus) stalks as a material for particleboard production. (Industrial Crops and Products, to be submitted)*
- Klímek P., Meinschmidt P., Wimmer R. (2016c) *Production and characterization of one layer and three layer particleboard from cup plant (Silphium perfoliatum) stalks. Industrial Crops and Production, to be submitted)*
- Klímek P., Kumar K, P., Wimmer R., Kúdela J. (2016d) *Utilization of brewer's spent-grains as a material for wood-based particleboard manufacturing. Journal of Cleaner Production* (accepted)
- Klímek P. (2016): Bio-based composites from agricultural residues and other waste materials. Dissertation submitted to the Faculty of Forestry and Wood Technology, Department of Wood Science, Mendel University in Brno, CZ, 148p.
- Král P., Ráhel' J., Stupavská M., Šrajer J., Klímek P., Kumar M. P., Wimmer R. (2014) *XPS depth profile of plasma-activated surface of beech wood (Fagus sylvatica) and its impact on polyvinyl acetate tensile shear bond strength.* 49(2)319-330, **Wood Science and Technology**, DOI: 10.1007/s00226-014-0691-7
- Klímek P., Morávek T., Ráhel' J., Stupavská M., Děcký, D., Král P., Kúdela J., Wimmer R. (2016e) *Air-plasma treated waste polyethylene terephthalate particles as a raw material for particleboard production. Composites part B: Engineering*, 90(2016) 188-194
- Klímek P., Meinschmidt P., Wimmer R. (2015) *Microscopic swelling of wood based panels: First trials.* Proceeding: **InWood2015: Innovations in wood materials and processes**, 19-22.5, 2015, Brno, Czech Republic
- Wimmer, R., Weigl, M., Schöneberg, S. (2011) Particle boards made from hardwoods – what is the significance? Peer-Review **Proceedings of the International Scientific Conference on Hardwood Processing**, Blacksburg, Virginia, October 2011

# Kontakt:

**Dr. Rupert Wimmer, Professor  
Universität für Bodenkultur Wien  
Institut für Naturstofftechnik, IFA Tulln  
Konrad Lorenz Strasse 20, 3430 Tulln/Austria  
and**

**Institut für Holztechnologie und Nachwachsende Rohstoffe, UFT  
Konrad Lorenz Strasse 24, 3430 Tulln/Austria**

**Phone +432272/66280-97203**

**Web: [www.naturstofftechnik.at](http://www.naturstofftechnik.at)**

**Email: [Rupert.Wimmer@boku.ac.at](mailto:Rupert.Wimmer@boku.ac.at)**

**Publications & Projects: [www.researchgate.net/profile/Rupert\\_Wimmer](http://www.researchgate.net/profile/Rupert_Wimmer)**

**Facebook: [tinyurl.com/naturstofftechnik](https://www.facebook.com/naturstofftechnik)**