Transformation of lignocellulose into aromatic building blocks

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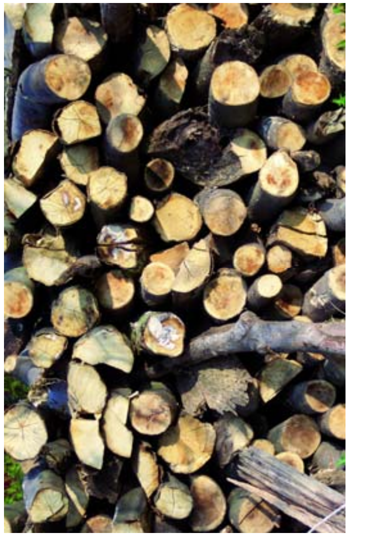
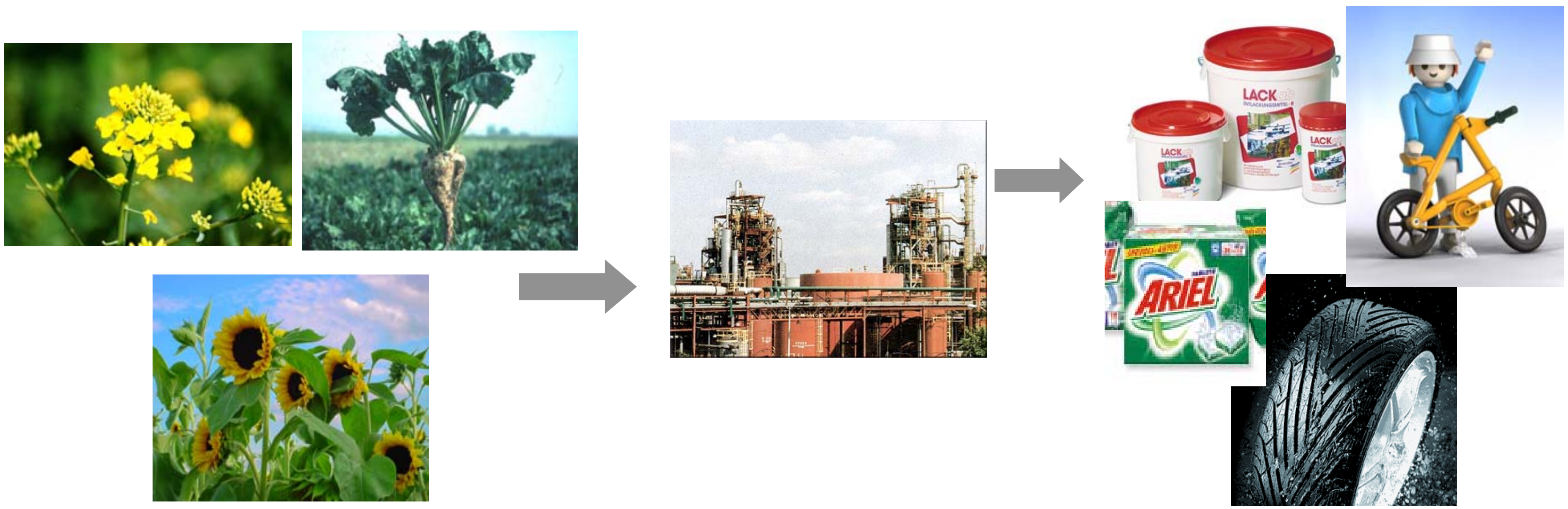
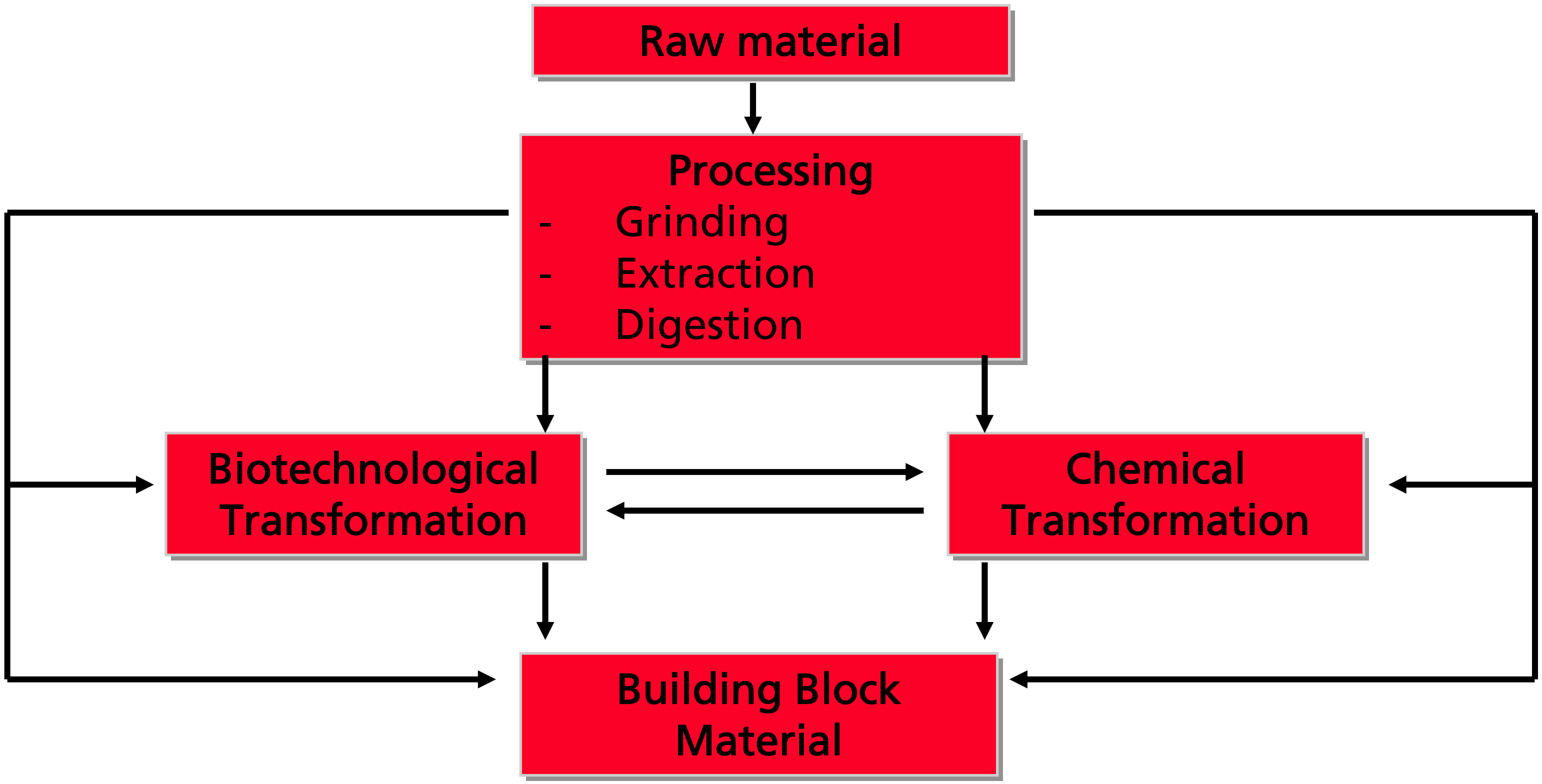


- Potential of Lignocellulose-Feedstock's (LCF) -

Vision

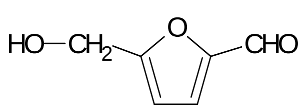
Exploration of new synthesis strategies and development of new production sites for the partial substitution of fossil to renewable resources within the middle of the 21 century.



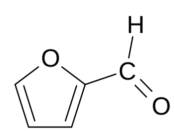


From feedstock to product

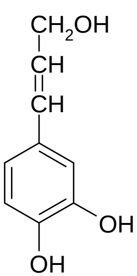
Cellulose → **Glucose** → Hydroxymethyl-Furfural (5-HMF)

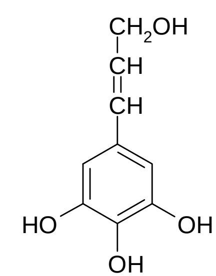


Hemicellulose → **Xylose** → **Furfural**



Lignin → “Oligo-phenol“ → **Monophenol**





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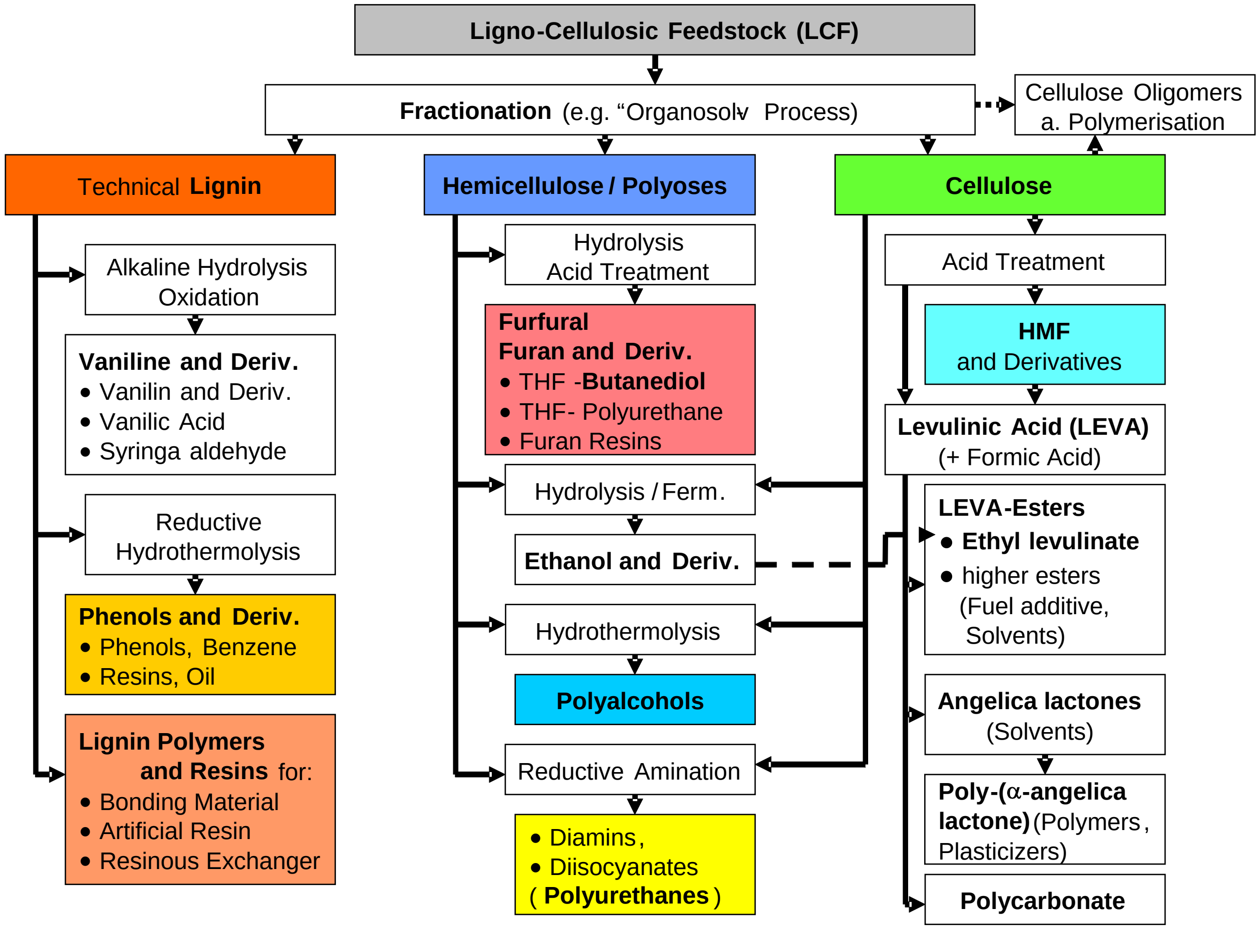
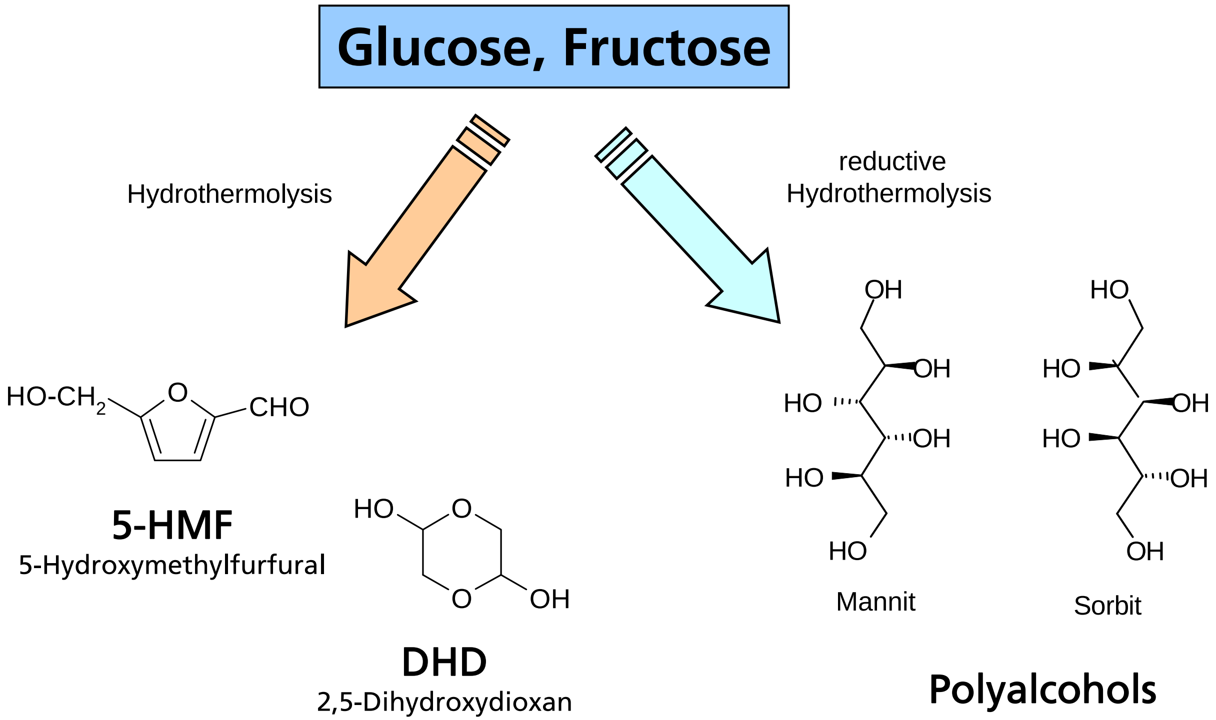
Transformation of Lignocellulose into aromatic building blocks

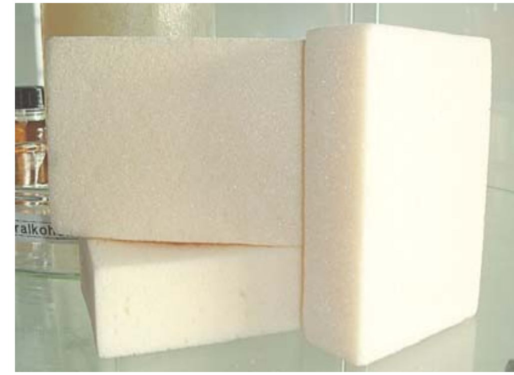


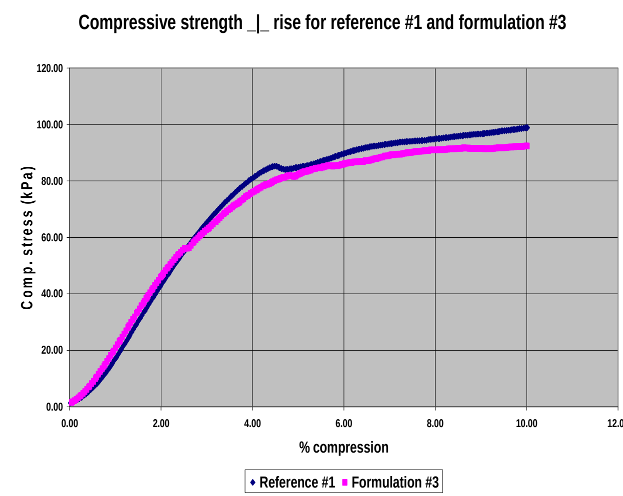
Source: DOW

Sugar based aromatics



Glucose, Fructose
Hydrothermolysis
reductive Hydrothermolysis
HO-CH2
O
CHO
5-HMF
5-Hydroxymethylfurfural
HO
O
O
OH
DHD
2,5-Dihydroxydioxan
OH
OH
HO
OH
HO
HO
Mannit
HO
HO
OH
HO
OH
OH
Sorbit
Polyalcohols

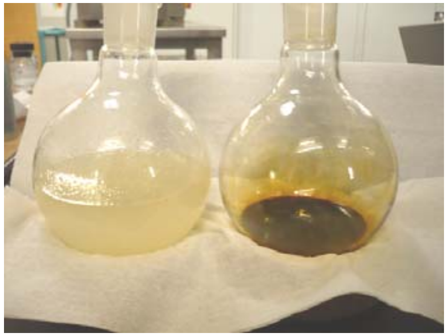




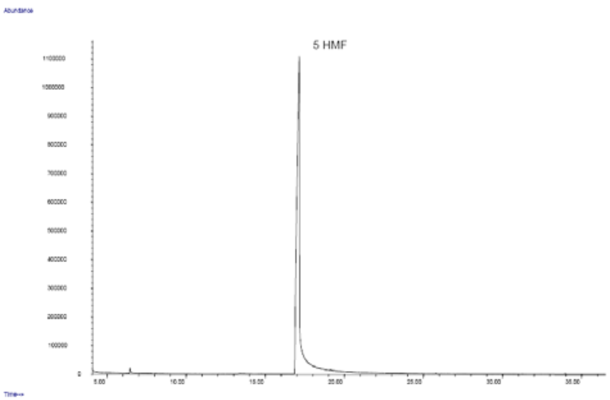
Compressive strength _|_ rise for reference #1 and formulation #3
Comp. stress (kPa)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
% compression
Reference #1
Formulation #3

Purification of 5-Hydroxymethylfurfural via distillation

5-HMF (raw) **5-HMF** (purified) residue



HMF (raw material) residue



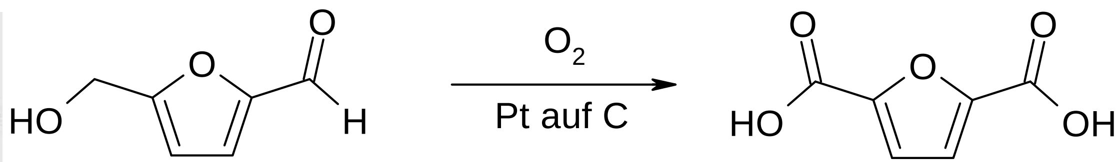
DBU-Vorhaben

„Synthesebausteine aus nachwachsenden Rohstoffen„

Aktenzeichen: 24621

Deutsche Bundesstiftung Umwelt

ICT Synthesis of 2,5-Furanedicarboxylic acid (FDCA)



Oxidation of 5-Hydroxymethylfurfural in water

Batch size max. 2,5 kg 5-HMF

Yield FDCA > 98 %

5-Hydroxymethylfurfural

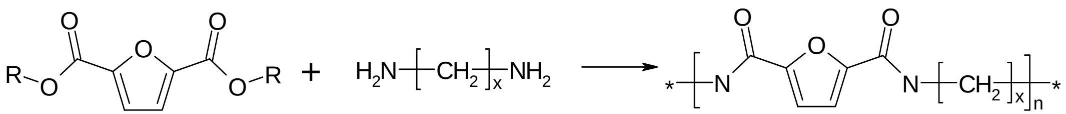
Furandicarboxylic Acid
→ **Polyesters, Polyamides, Thermoplastic Elastomers**

2,5-Dihydroxymethylfurane
→ **Polyesters, Polyurethanes**

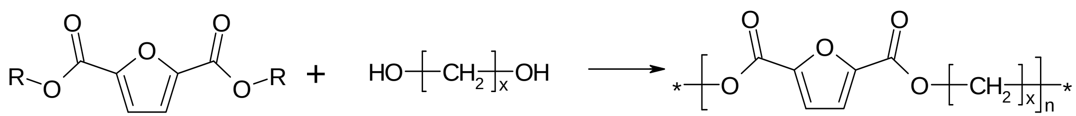
2,5-Diaminomethylfurane
→ **Polyamides, Polyurethanes**

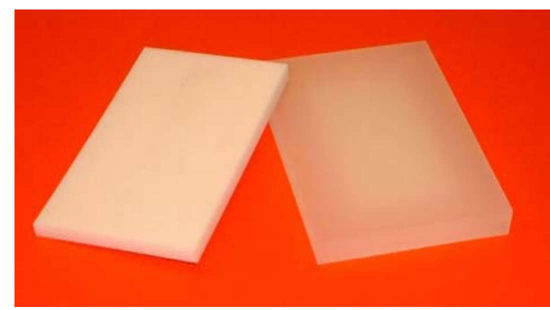
Biopolymers based on Furanedicarboxylic acid

Polyamides

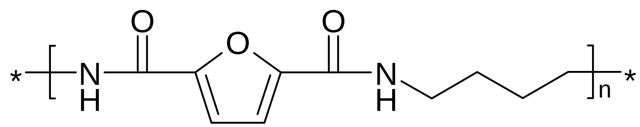
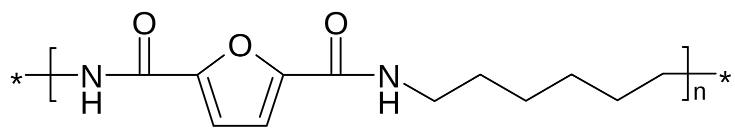
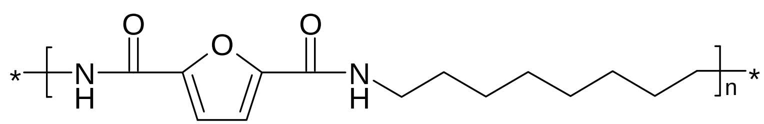


Polyesters

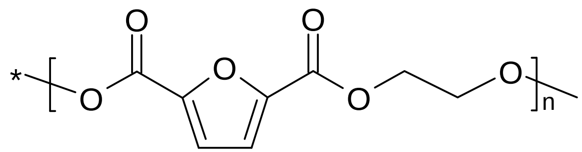
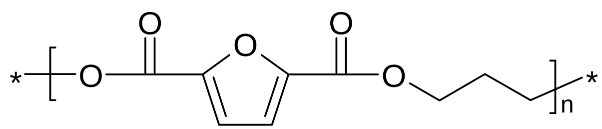
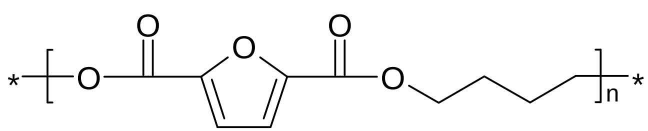
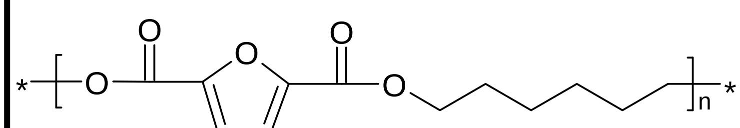




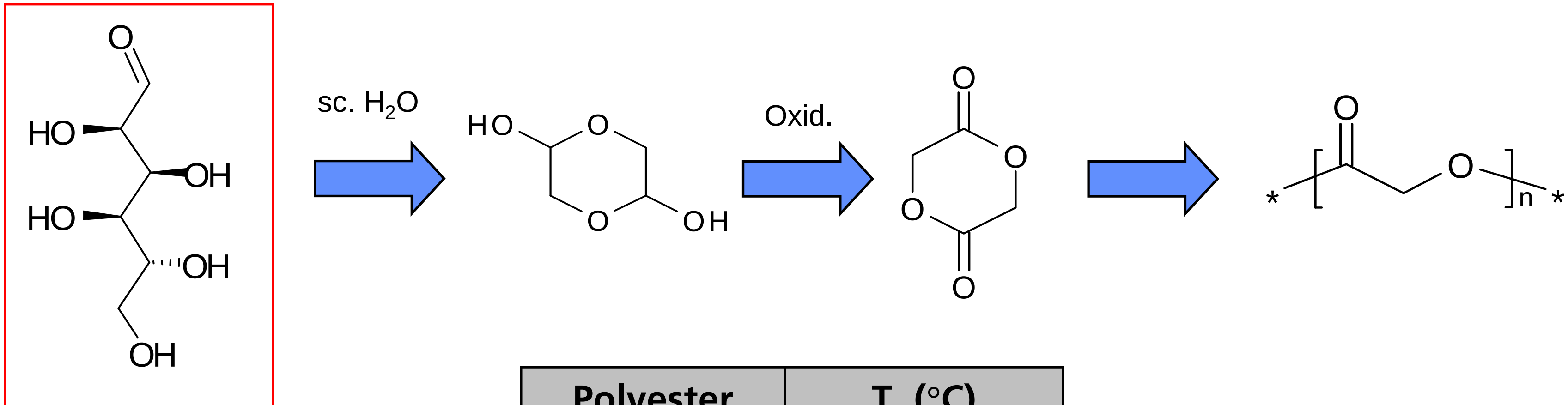
Thermal properties polyamides of glucose based polyamides

	Tm = 250 °C
	Tm = 175 °C Fibres
	Tm = 125 °C

Thermal properties of glucose based polyesters

	Tm = 205-210 °C Fibres from melt
	Tm = 120 °C
	Tm = 163 – 165 °C
	Tm = 143 – 146 °C

Glucose **DHD** **Glykolide** **Polyglykolide**

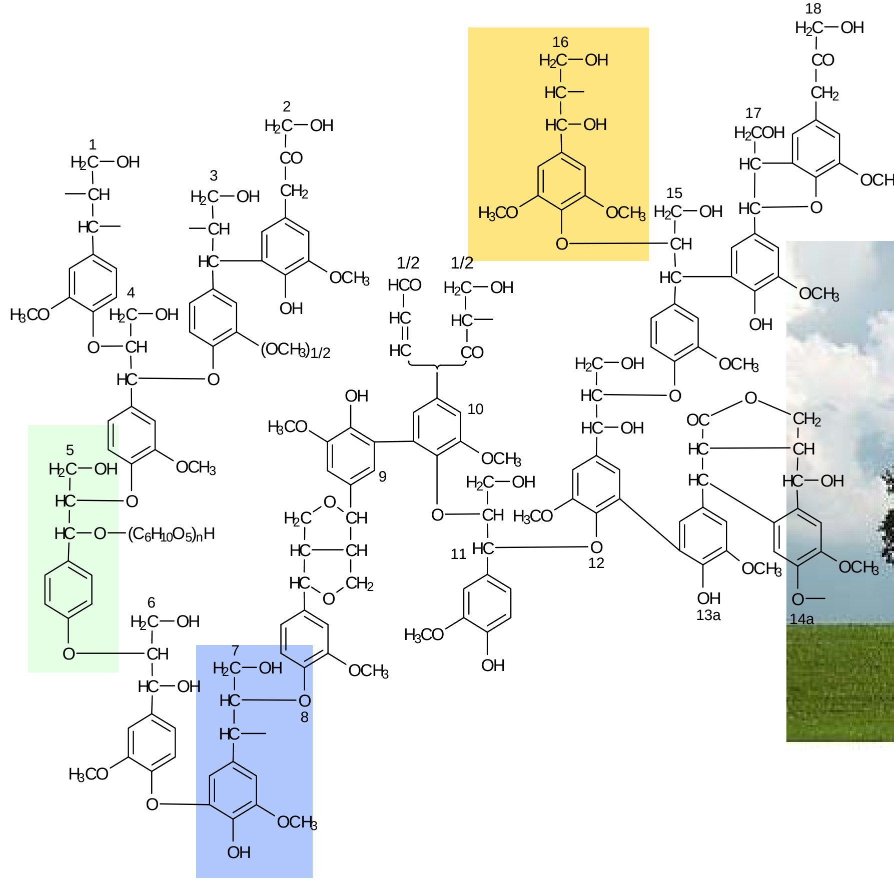


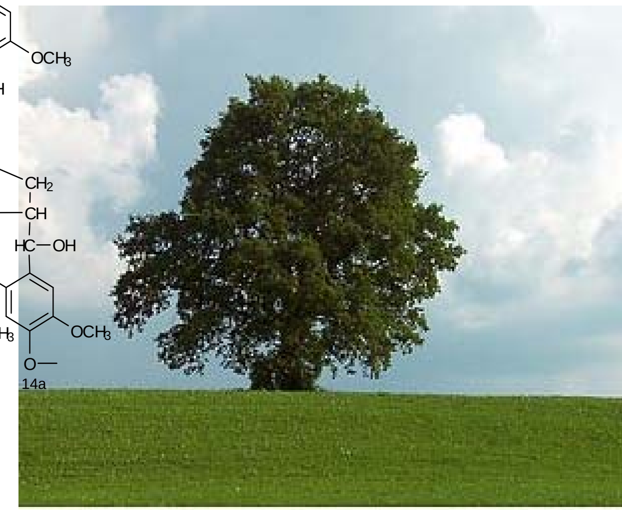
Polyester	T_m(°C)
Poly(3HB)	178
Poly(3HV)	110
Poly(L-lactid)	185
Poly(glycolid)	223-228

Lignin separation

and transformation

Lignin





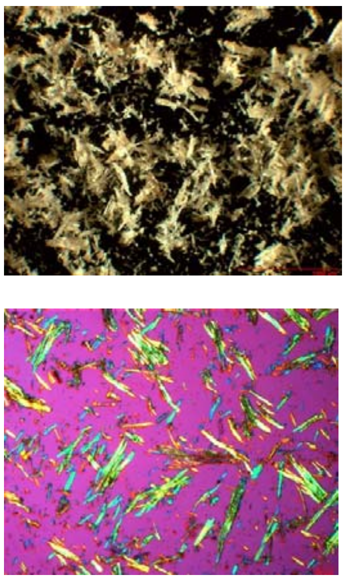
Lignin release from wood

- Sulfate or sulfite process
- Acid wood digestion
- Ionic liquids
- Hydrothermal Treatment (Aquasolv-Process)
- **Organosolv-process (Ethanol, …)**
- Enzymatic cleavage (+ Fraunhofer IGB)

Lignin production:

The ORGANOSOLV-Process

Temperature:	150 – 250°C
Exraction time:	1 hour
Solvens:	Ethanol/Water



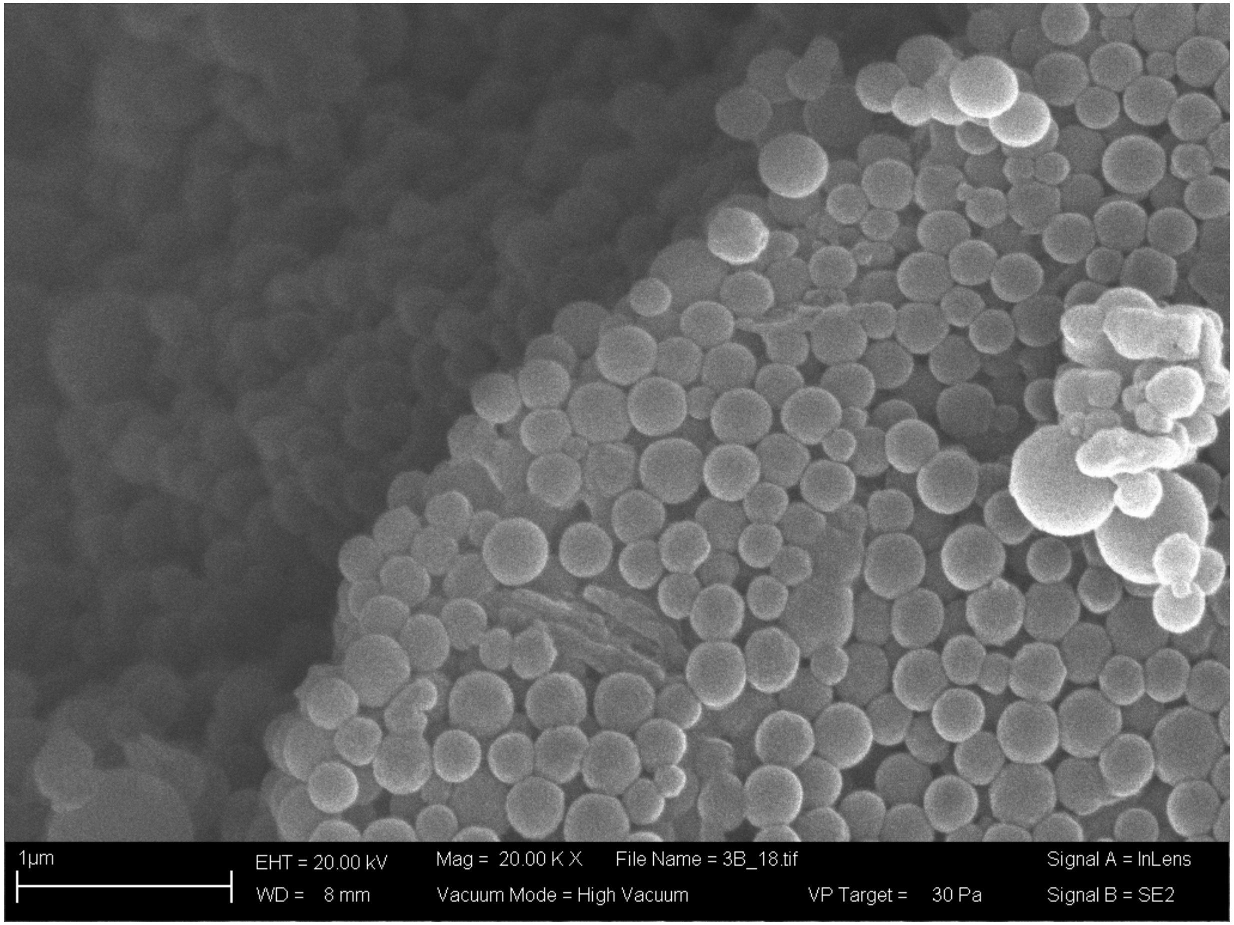
Beech wood

Autoclave (13 L)

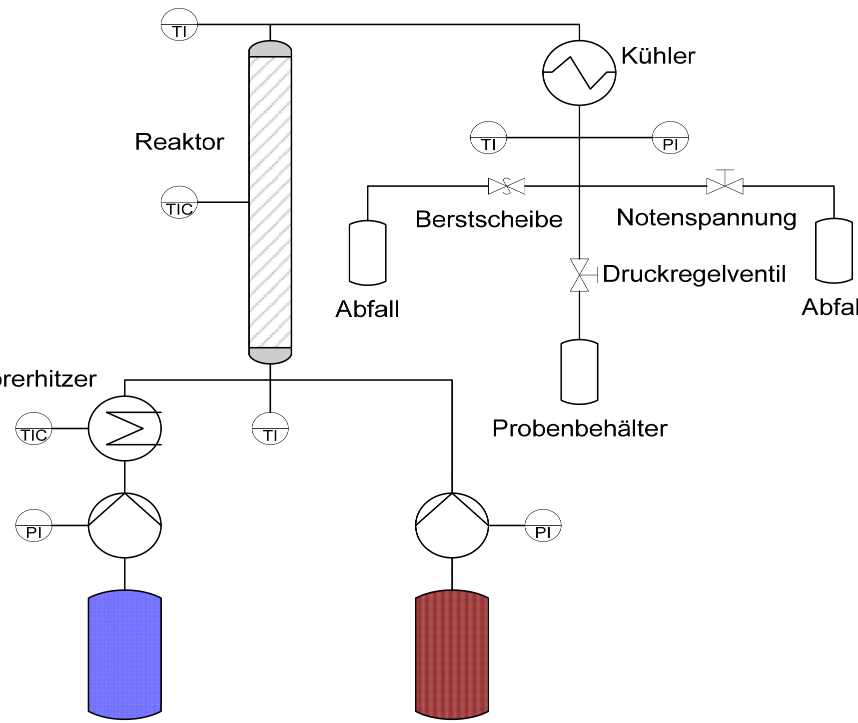
Separation
Solvent Regeneration

Nanosized

Organosolv-Lignin



Lignin Transformation:
Hydrothermolysis

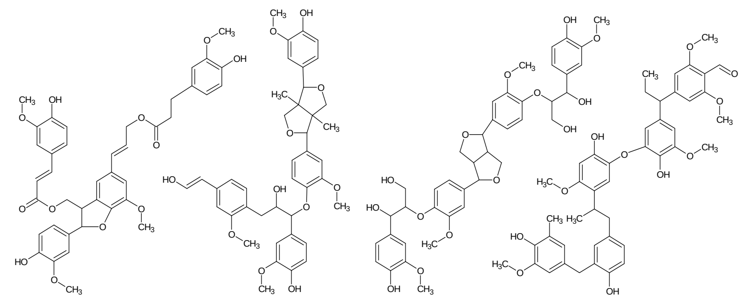


<u>Process parameter</u>

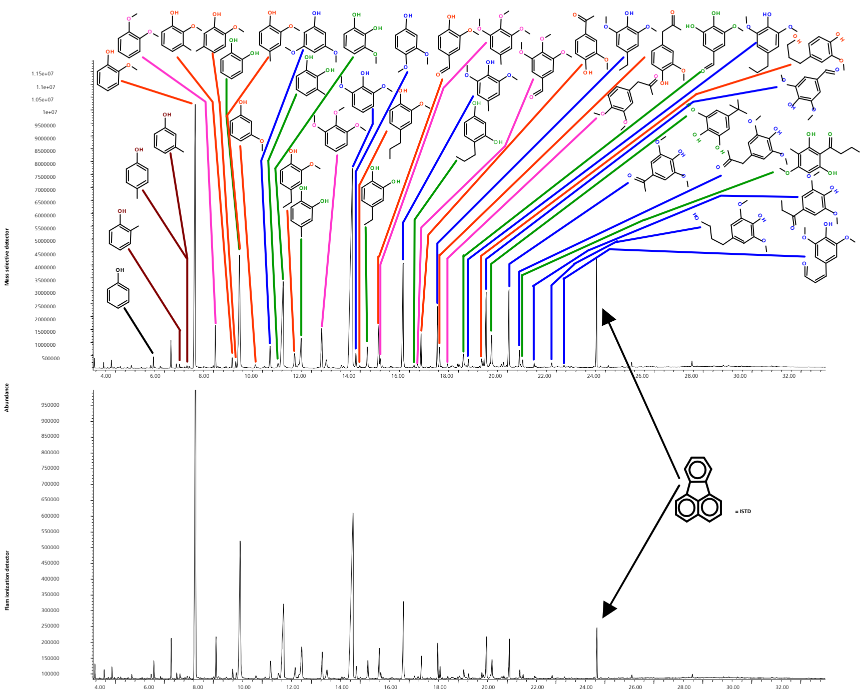
max. temperature:	400°C
max. pressure:	250 bar
max. flow rate:	7,3 L/h
Reactor length:	8- 12 m
Reactor diameter:	9 mm
Residence time:	15 min

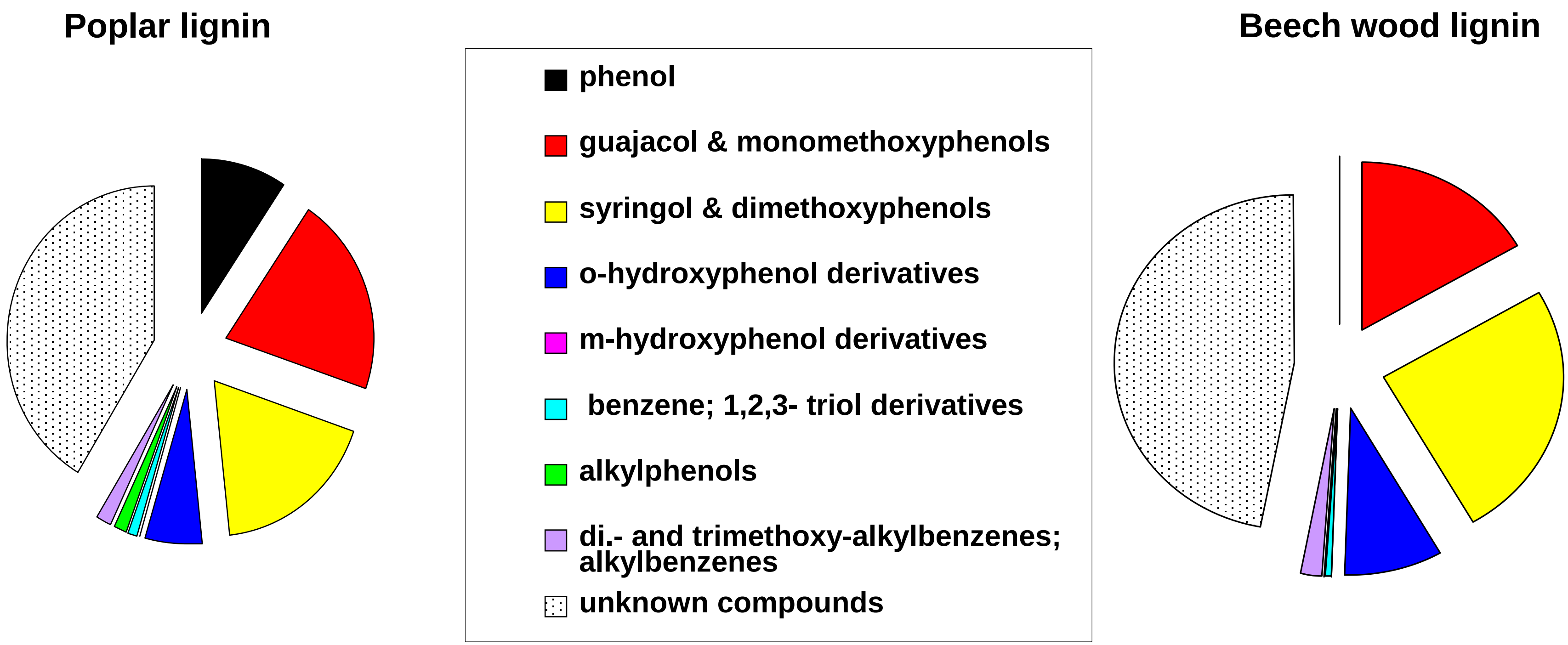
Chemical composition of the products

Fraction of oligomers



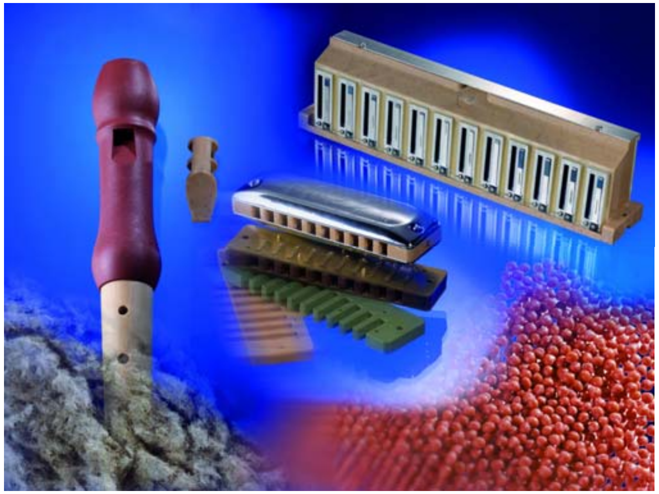
Fraction of monomers





Oil composition after hydrothermal treatment

Lignin in composites



Summary and conclusions

- Cellulose, Hemicellulose und Lignin are already used in industrial scales
- Increasing use of Lignocellulose is detectable
- There exist several ways for the production of lignocellulosic products .
- Lignin based products could partially substitute fossil resources. Technical feasibility studies are still running.
- High grade of functionality needs special conversion technologies.




Acknowledgment:

Deutsche Bundesstiftung Umwelt (DBU)

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Thank you for your attention !