Transformation of lignocellulose into aromatic building blocks

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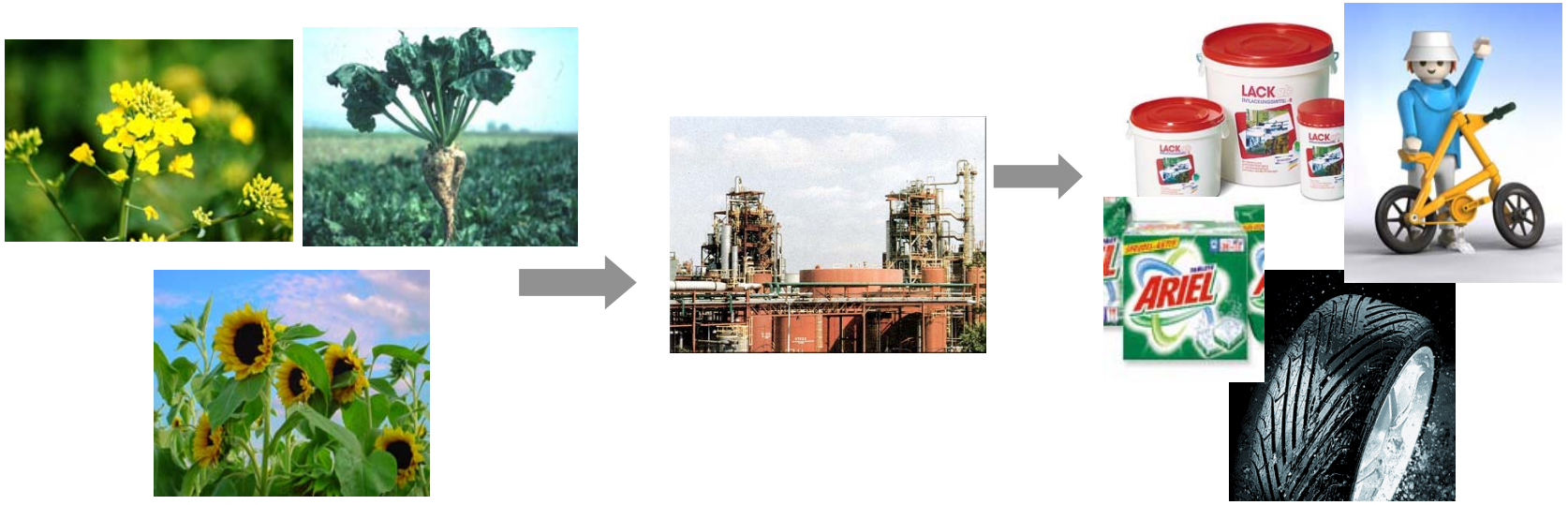
Introduction

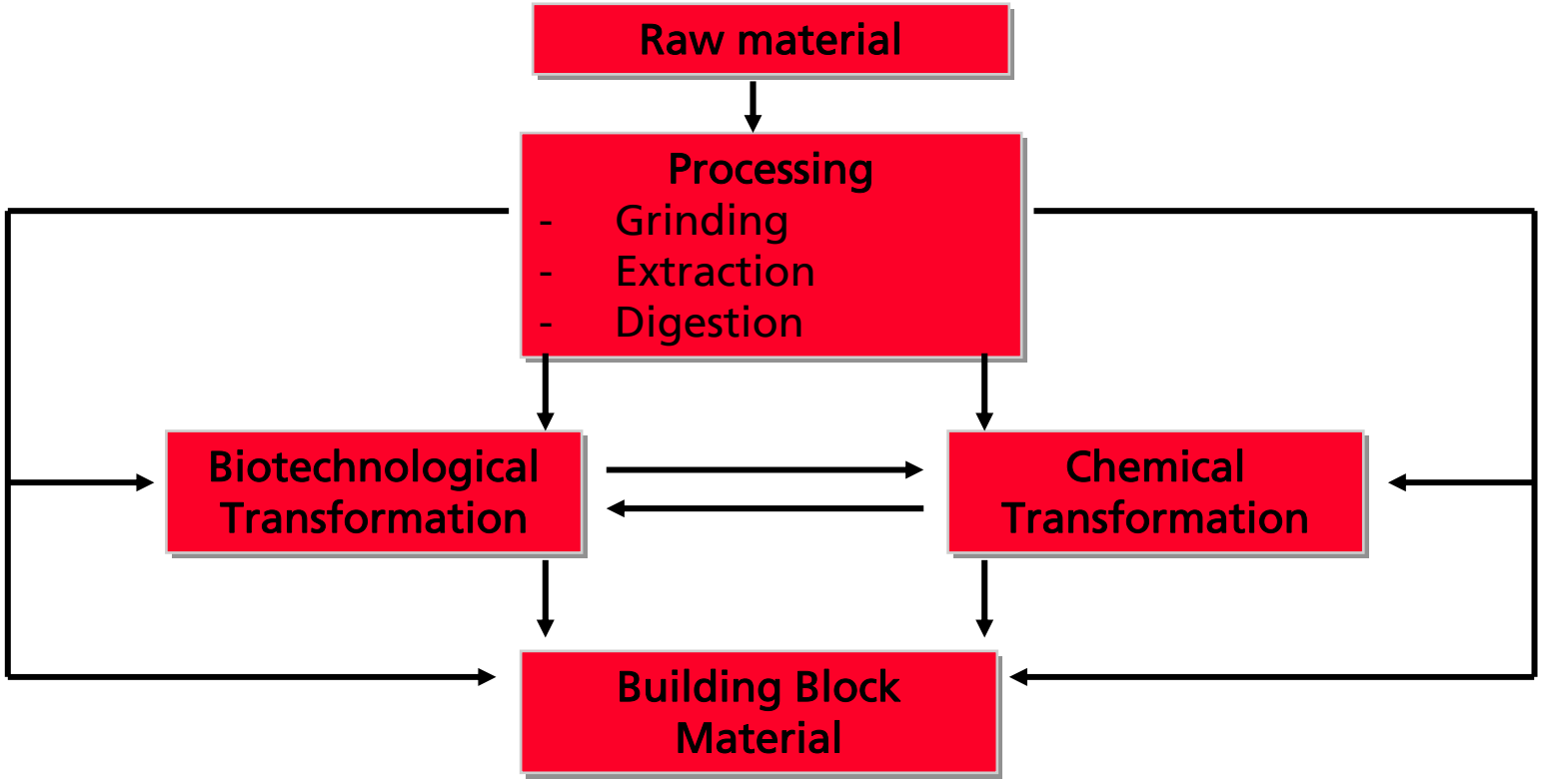
- Potential of

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

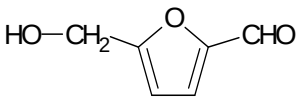
Cellulose

↓

Glucose

↓

Hydroxymethyl-Furfural (5-HMF)



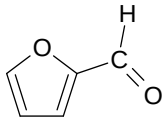
Hemicellulose

↓

Xylose

↓

Furfural



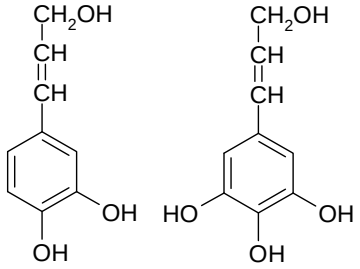
Lignin

↓

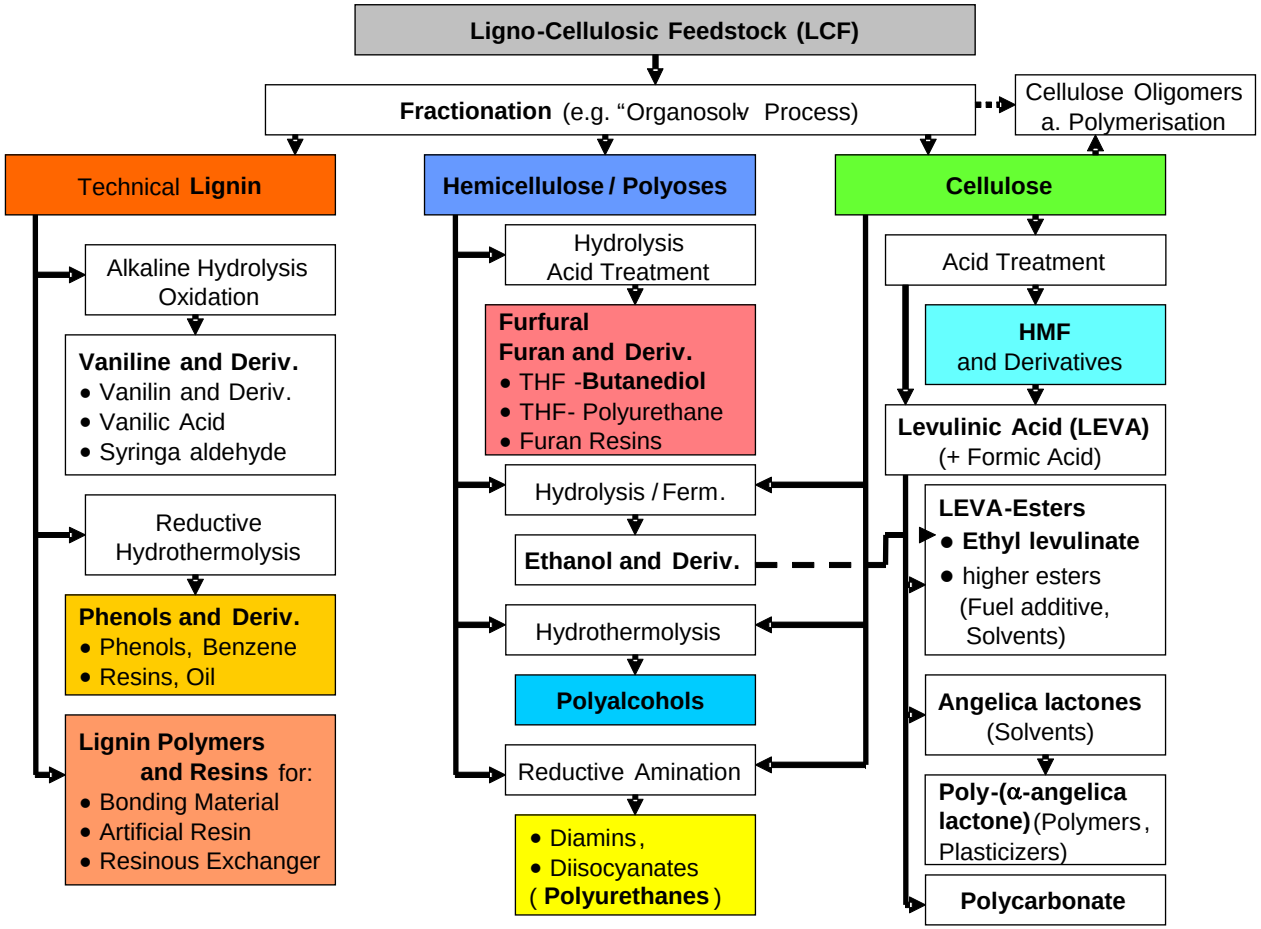
“Oligo-phenol“

↓

Monophenol

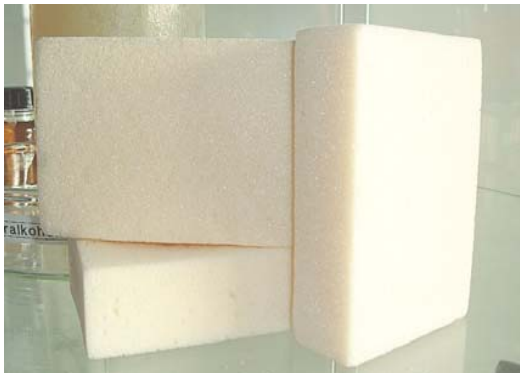


Transformation of Lignocellulose into aromatic building blocks



Source: DOW

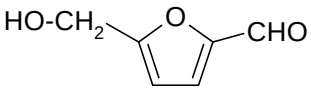
Sugar based aromatics



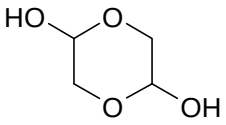
Glucose, Fructose

Hydrothermolysis

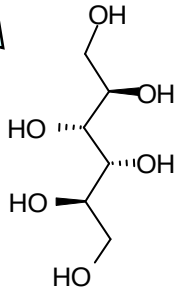
reductive Hydrothermolysis



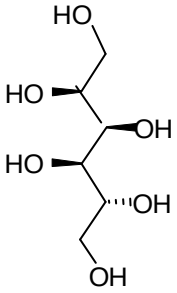
5-HMF
5-Hydroxymethylfurfural



DHD
2,5-Dihydroxydioxan

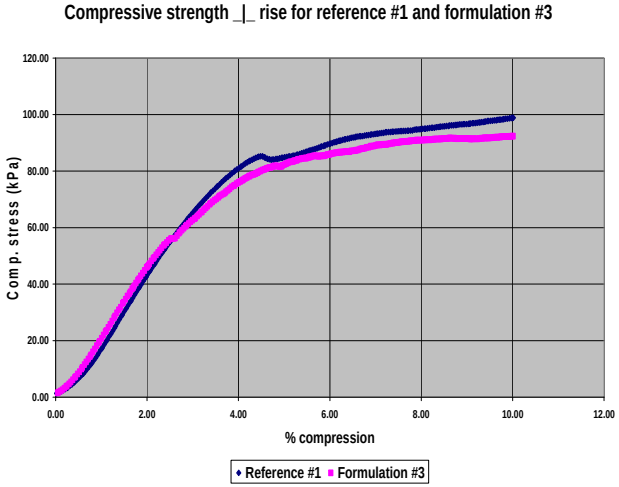


Mannit



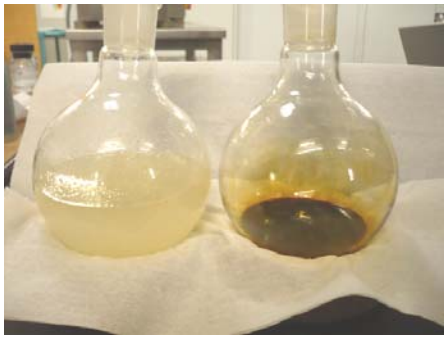
Sorbit

Polyalcohols

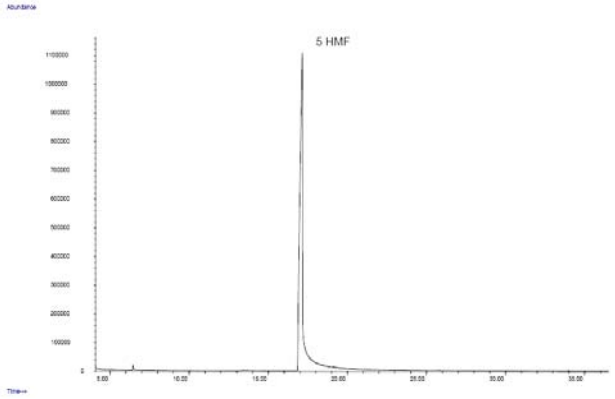


Purification of 5-Hydroxymethylfurfural via distillation

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



HMF (raw material) residue



DBU-Vorhaben

„Synthesebausteine aus nachwachsenden Rohstoffen„

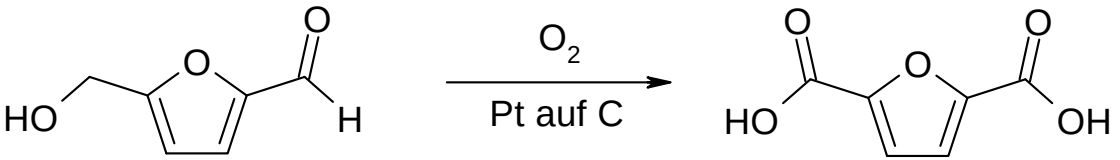
Aktenzeichen: 24621

DBU
Deutsche Bundesstiftung Umwelt

Fraunhofer ICT Institut Chemische Technologie

Fraunhofer IGB Institut Grenzflächen- und Bioverfahrenstechnik

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

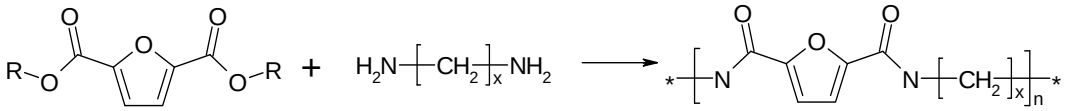
Polyesters,
Polyurethanes

2,5-Diaminomethylfurane

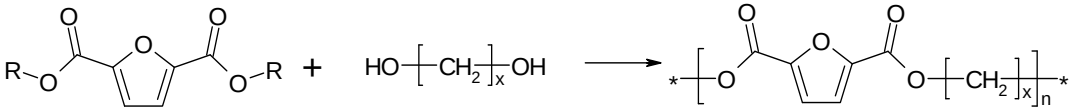
Polyamides,
Polyurethanes

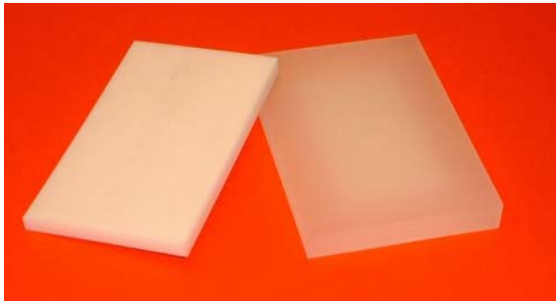
Biopolymers based on Furanedicarboxylic acid

Polyamides

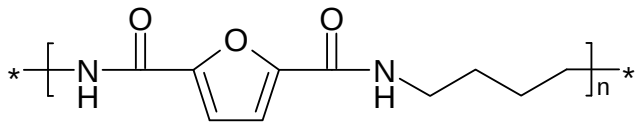
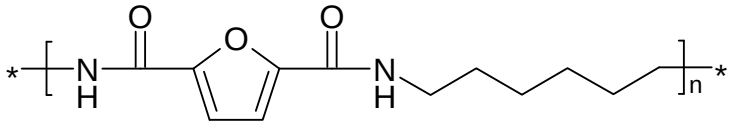
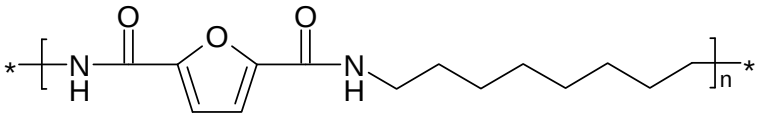


Polyesters

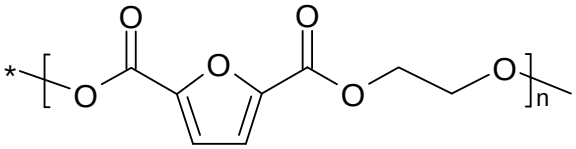
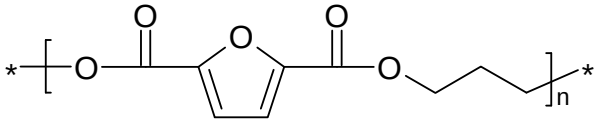
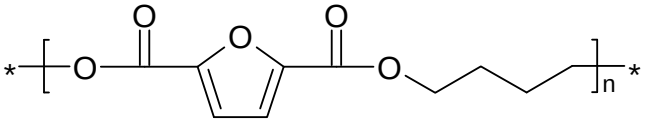
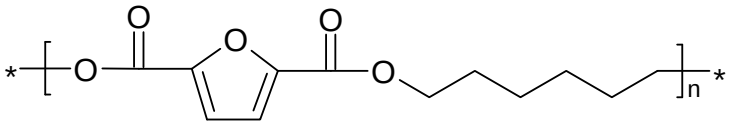




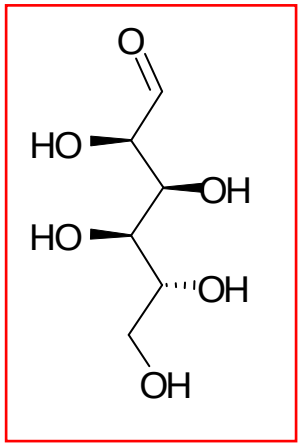
Thermal properties polyamides of glucose based polyamides

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

Thermal properties of glucose based polyesters

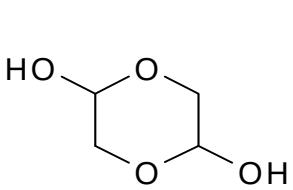
	Tm = 205-210 °C Fibres from melt
	Tm = 120 °C
	Tm = 163 – 165 °C
	Tm = 143 – 146 °C

Glucose



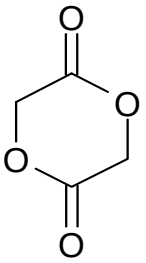
DHD

sc. H_2O

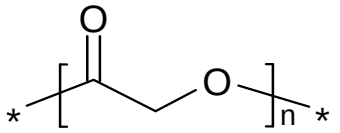


Glykolide

Oxid.



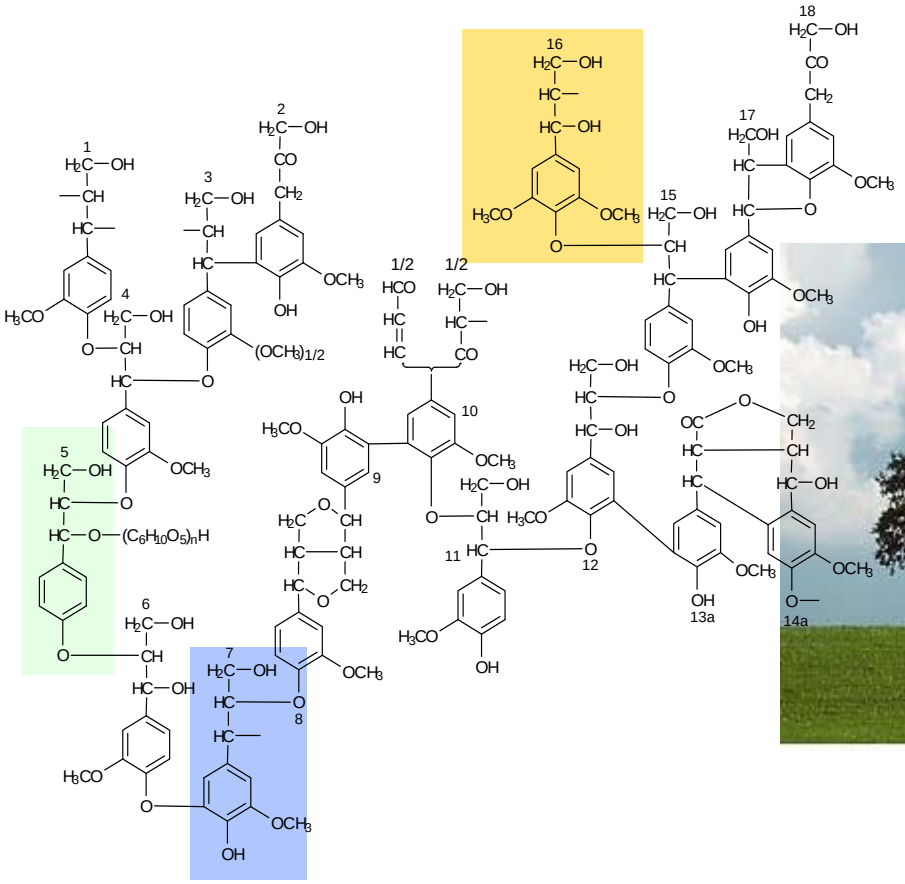
Polyglykolide



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

Lignin separation and transformation

Lignin



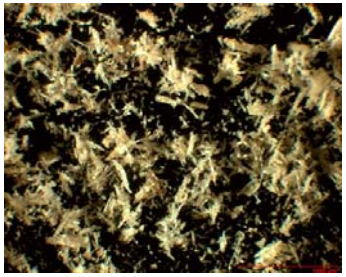
Lignin release from wood

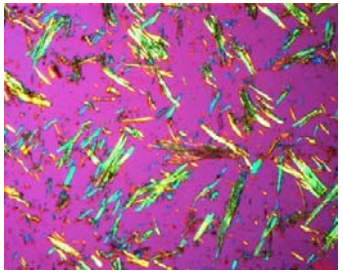
- Sulfate or sulfite process
- Acid wood digestion
- Ionic liquids
- Hydrothermal Treatment (Aquasolv-Process)
- **Organosolv-process (Ethanol, …)**
- Enzymatic cleavage (+ Fraunhofer IGB)

Lignin production:

The ORGANOSOLV-Process

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





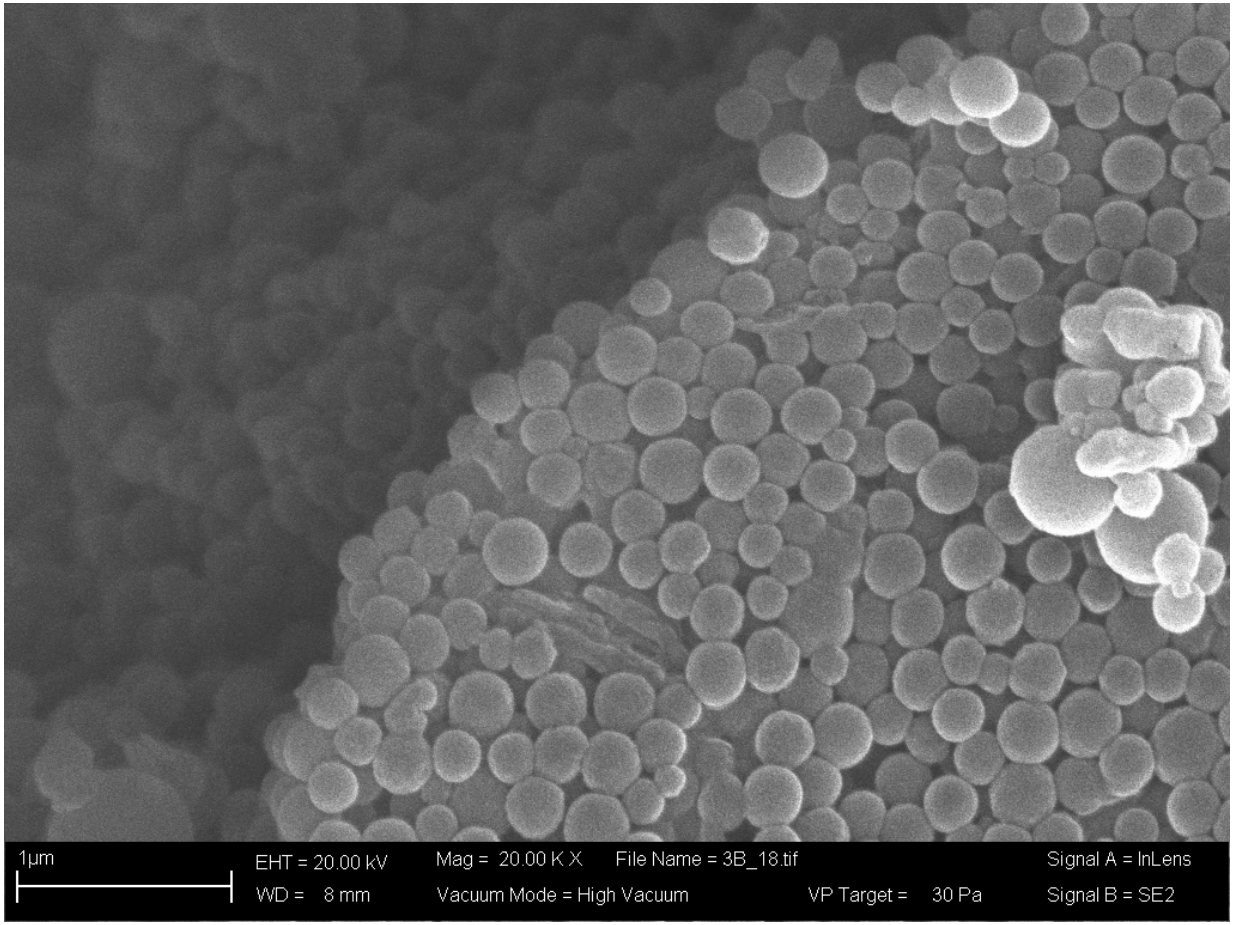
Beech wood

Autoclave (13 L)

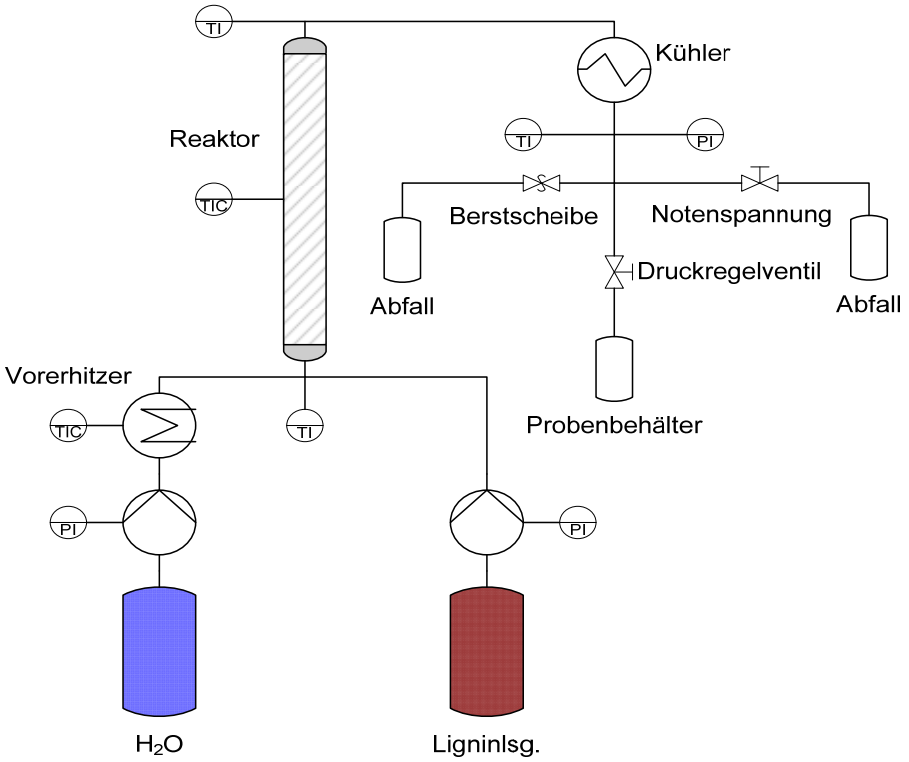
Separation
Solvent Regeneration

Nanosized

Organosolv-Lignin



Lignin Transformation:
Hydrothermolysis

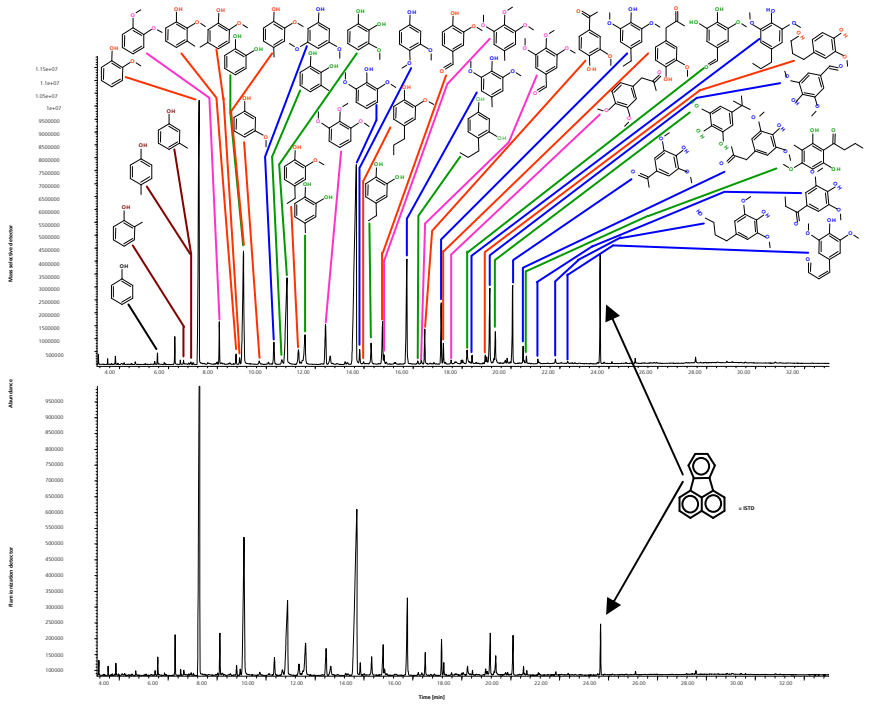


Process parameter

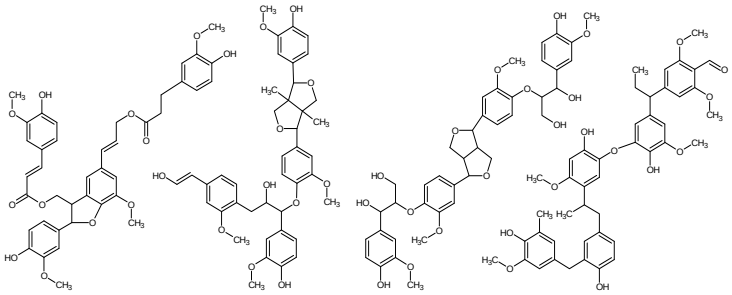
max. temperature:	400°C
max. pressure:	250 bar
max. flow rate:	7,3 L/h
Reactor length:	8- 12 m
Reactor diameter:	9 mm
Residence time:	15 min

Chemical composition of the products

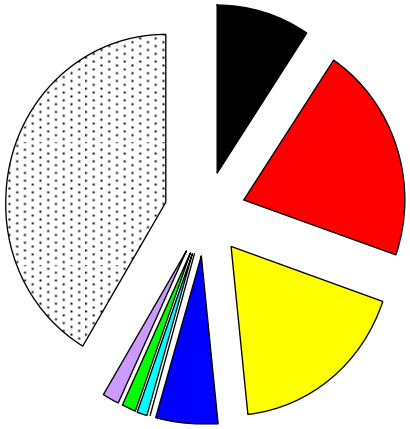
Fraction of monomers

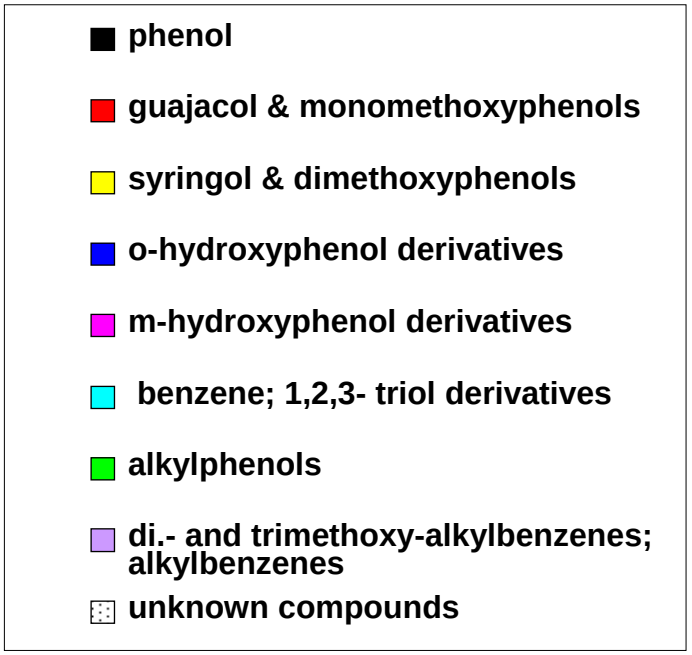


Fraction of oligomers

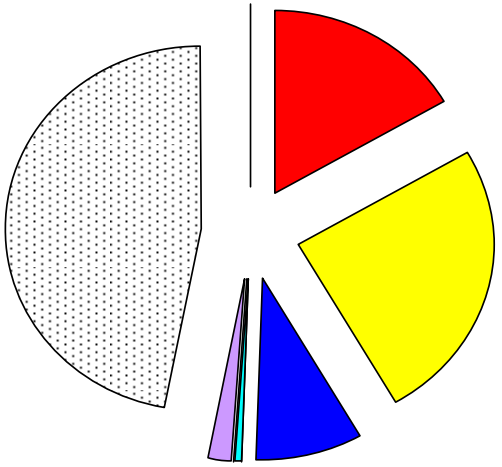


Poplar lignin





Beech wood lignin



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)

Fachagentur Nachwachsende Rohstoffe (FNR)

Thank you for your attention !

Fraunhofer Institut Chemische Technologie

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