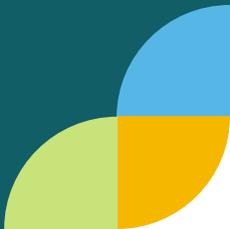




Fibers for Life.



# Natural cellulose and wood based fibers for plastics



# The JRS Group

- › **145 years** of experience
- › **Family-owned** group which is dynamically growing worldwide while keeping a sustainable approach
- › Global network of **90 production sites and offices** with over **4000 employees**

**Manufacturer, Solution  
Provider, System-  
and Technology-  
Partner**

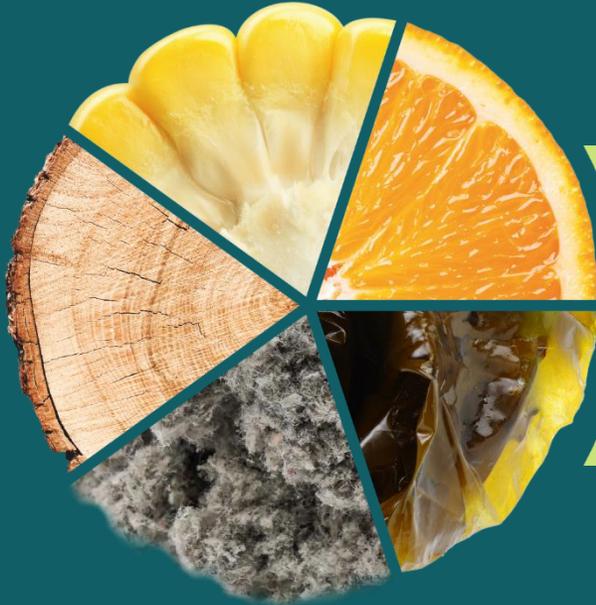


# Ecologic – natural – sustainable

- › Renewable plant-based raw materials
- › Biodegradable products
- › Mainly side-streams from the wood, paper, agricultural and food industry (no food competition)
- › Upcycling before thermic usage



# Raw Material



Wood | One year plants  
Citrus peels | Seaweed  
Cellulose Pulp | Secondary resources

# Product Groups



Processing

Mechanical Processing  
Extraction  
Chemical Processing

# Applications



Fibers | Powders  
Blends | Pellets & Granules  
Hydrocolloids



Life science  
Technical applications  
Consumer products

# Advantages for the thermoplastic industry

## Functional Filler

### Classic Thermoplastic (PE/PP/PVC/PS/...)

- › Sensory: Haptic ↑, **Optics** ↑
- › Physical: Heat deflection temperature ↑, Glass transition temperature ↑, Density ↓
- › Mechanical: E-Modulus ↑, Tensile strength ↓
- › Ecologic: **Biogenic content** ↑, CO<sub>2</sub> footprint ↓

### Thermoplastic Biopolymer (PLA/PBAT/PHB/...)

- › Sensory: Haptic ↑, **Optics** ↑
- › Physical: Heat deflection temperature ↑
- › Mechanic: E-Modulus ↑, Tensile Strength ↓
- › Ecologic: **Biodegradability** ↑, CO<sub>2</sub> footprint ↓
- › Economic: Costs ↓

## Information CO<sub>2</sub> Footprint Powder Cellulose

### Cellulose emissions

Data in kg CO<sub>2</sub> per ton of product

Process step	Impact on CO <sub>2</sub>
Emissions from processing wood into pulp	217 <sup>1</sup>
Emissions from transporting the pulp	35 <sup>2</sup>
Emissions from the manufacturing process of the JRS product	318 <sup>2</sup>
Emissions from packaging	22 <sup>2</sup>
Emissions from other energy and materials	25 <sup>3</sup>
<b>Total</b>	<b>617</b>
CO <sub>2</sub> storage of the product	1650 <sup>1</sup>
<b>Total after deduction of CO<sub>2</sub> storage</b>	<b>-1033</b>

This calculation is based on the following data:

<sup>1</sup> Manufacturer's data

<sup>2</sup> Conversion according to Federal Office of Economics and Export Control

<sup>3</sup> Estimate

Based on the external information relating to wood processing and transport, as well as the internal production processes, and taking into account the CO<sub>2</sub> storage of the product, the total value is **-1033 kg CO<sub>2</sub> / t product**.

#### Disclaimer:

To the best of our knowledge, the information contained herein is accurate and reliable as of the date of publication. However, we do not assume any liability whatsoever for the accuracy and completeness of the above information.

This information is to be treated confidentially and may not be passed on to third parties without the prior written consent of JRS.

## Information CO<sub>2</sub> Footprint Wood Fiber

### Cellulose emissions

Data in kg CO<sub>2</sub> per ton of product

Process step	Impact on CO <sub>2</sub>
Emissions from processing wood into wood raw material	0 <sup>1</sup>
Emissions from transporting the wood raw material	2 <sup>2</sup>
Emissions from the manufacturing process of the JRS product	157 <sup>2</sup>
Emissions from packaging material	22 <sup>2</sup>
Emissions from other energy and materials	25 <sup>3</sup>
<b>Total</b>	<b>206</b>
CO <sub>2</sub> storage of the product	1830 <sup>4</sup>
<b>Total after deduction of CO<sub>2</sub> storage</b>	<b>-1624</b>

This calculation is based on the following data:

<sup>1</sup> untreated by-product in the manufacture of wood products

<sup>2</sup> Conversion according to Federal Office of Economics and Export Control

<sup>3</sup> Estimate

<sup>4</sup> CO<sub>2</sub> content depends on the tree species, the water content as well as the growing conditions.

Based on the external information relating to wood processing and transport, as well as the internal production processes, and taking into account the CO<sub>2</sub> storage of the product, the total value is **-1624 kg CO<sub>2</sub> / t product**.

#### Disclaimer:

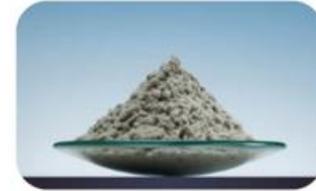
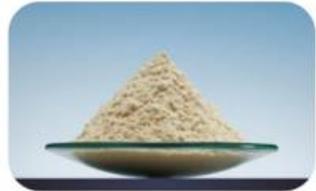
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# Guideline for product selection

Criteria	Wood	One-year-plants	Cellulose		
			White	Recycled off-white	Recycled grey
New material	✓	✗	✓	✗	✗
Side-stream	✓	✓	✗	✓	✓
PEFC	✓	✗	✗	✗	✗
FSC	✗	✗	(✓)	✗	✗
Regional supply-chain	✓	✗	✗	✗	✓
Food contact [EU 10/2011]	(✗)	✗	✓	✗	✗

› The right quality and product group for every application

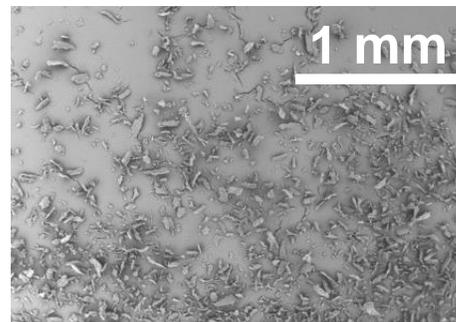


# Wood: Fibers und Particles

	5 – 13 µm	15 µm	30 µm	60 µm	120 µm	200 µm	300 µm	400 µm	700 µm	Food Contact [EU]	Food Contact [FCA]	Resource
CW 630 PU			■							✗	✓	untreated softwood
C 750 FP				■						✗	✓	
C 100					■					✗	✓	
C 320							■			✗	✓	
C 400								■		✗	✓	

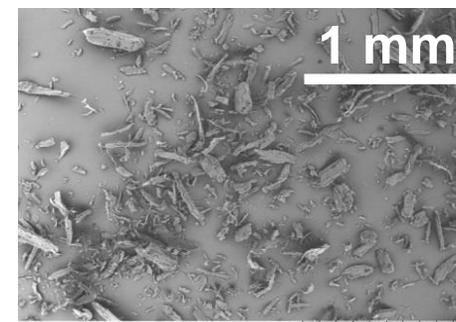


**CW 600 30 PU**



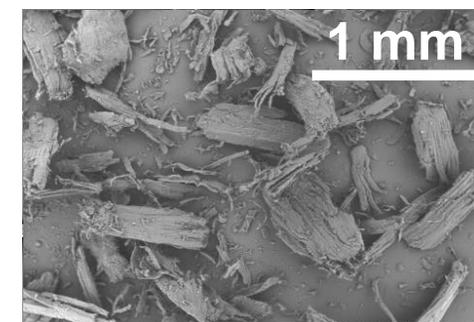
**30 µm**

**C 100**



**70 - 150 µm**

**C 320**



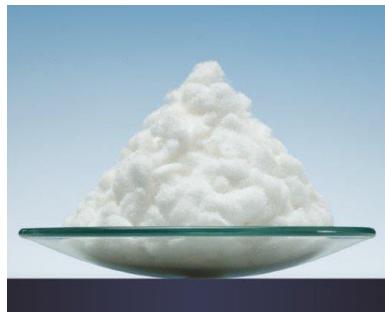
**200 - 500 µm**

## Example: Influence of particles size on optics

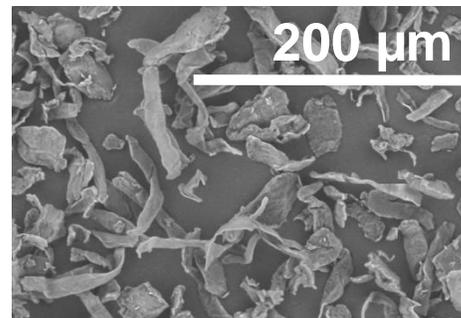


# Cellulose: Fibers and particles

	5–13 µm	15 µm	30 µm	60 µm	120 µm	200 µm	300 µm	400 µm	700 µm	Food Contact [EU]	Food Contact [FCA]	Resource
BE 600 10 TG		■								✓	✓	hardwood cellulose
BE 600 30			■							✓	✓	
B 600				■						✓	✓	
BWW 40						■				✓	✓	
BC 1000									■	✓	✓	
FD 600 30			■	■						✗	✗	recycling cellulose

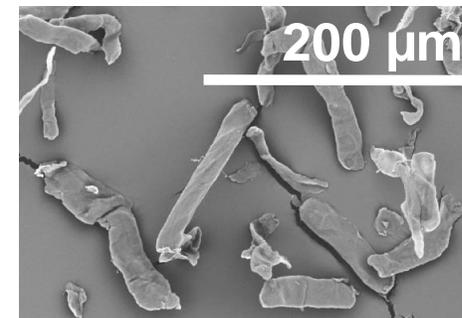


**BE 600 30**



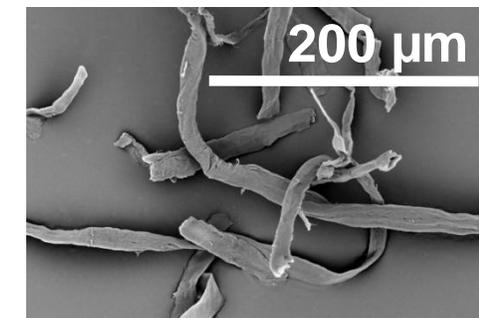
**30 µm**

**BWW 40**



**200 µm**

**BC 1000**



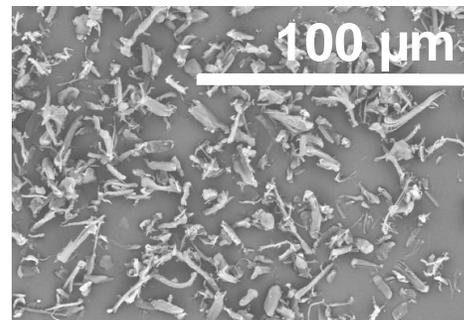
**700 µm**

# Cellulose: Granulates and Microcrystalline Cellulose

	5–13 µm	15 µm	30 µm	60 µm	120 µm	200 µm	300 µm	400 µm	700 µm	Food Contact [EU]	Food Contact [FCA]	Resource
UFC 100	█									✓	✓	microcrystalline cellulose
HW 101				█						✓	✓	
HW 200						█				✓	✓	
EPG 70							█			✓	✓	hardwood cellulose

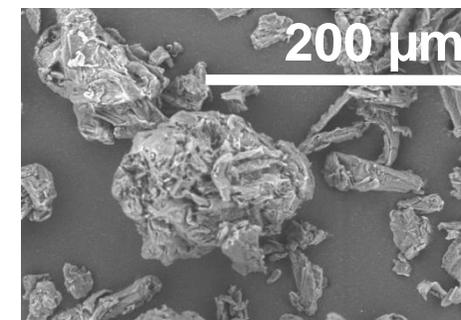


**UFC 100**



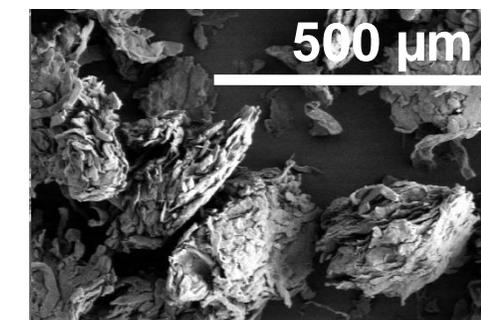
**5-13 µm**

**HW 101**



**60 µm**

**EPG 70**



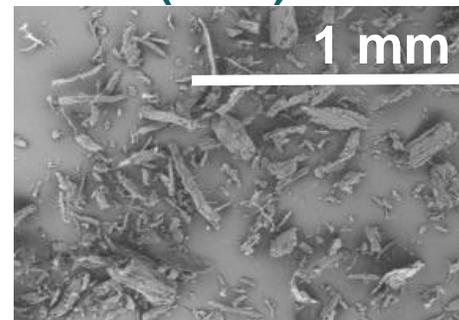
**300 µm**

# Specialties: Olive Pits and Corn Cobs

	5-13 µm	15 µm	30 µm	60 µm	120 µm	200 µm	300 µm	400 µm	700 µm	Food Contact [EU]	Food Contact [FCA]	Resource
UNG 150										✘	✘	olive pits
UNG 300										✘	✘	
MK 100										✘	✘	corn cobs
MK 150-300										✘	✘	

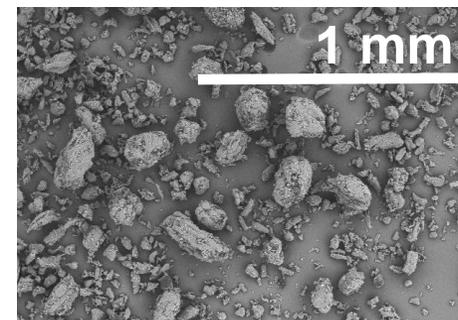


**C 100 (Holz)**



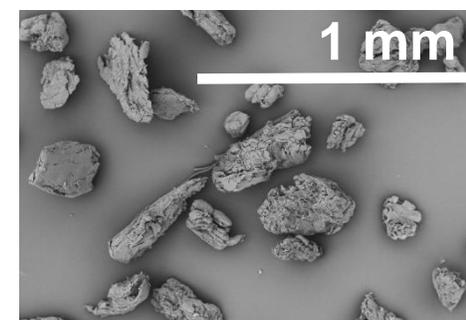
**70 - 150 µm**

**UNG 150**



**30 - 150 µm**

**MK 100**



**100 - 250 µm**



# Scientific study



# Influence of cellulosic fibers on biopolymer compounds

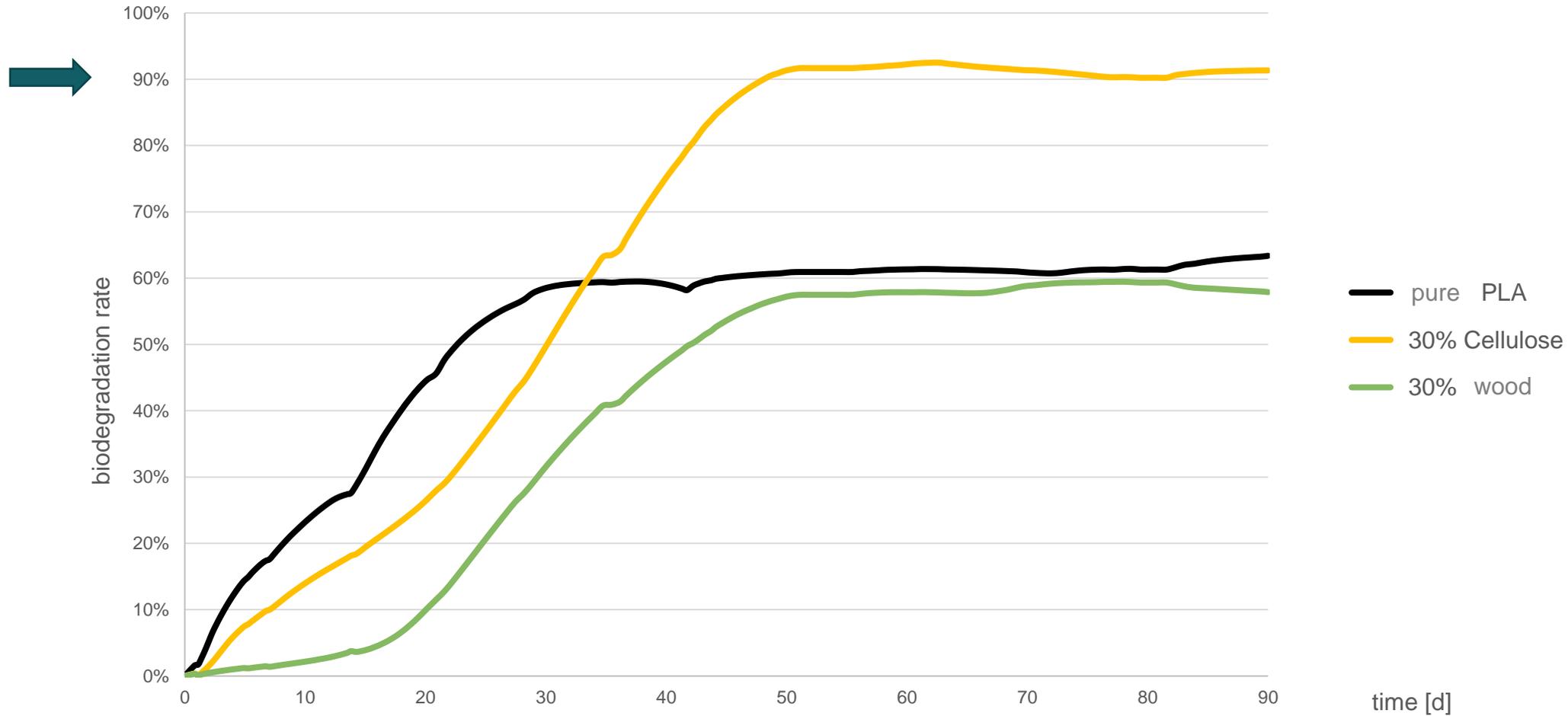
## Study with the Fraunhofer IVV and UMSICHT

- › **goal**  
check the influence of wood / cellulose on the mechanical properties of PLA and the biodegradation
- › **parameter**  
PLA matrix (Natureworks 2003D & Natureworks L130, 30% filling rate, no coupling agent)
- › **mechanical properties**  
tensile test according to DIN ISO 527, HDT B (Vicat HDT test)
- › **biodegradation**  
biodegradation according to DIN ISO 14855-1 (controlled composting)  
disintegration test (climate cabinet at 58 °C and 90% humidity)

# mechanical properties (in comparison to pure PLA)

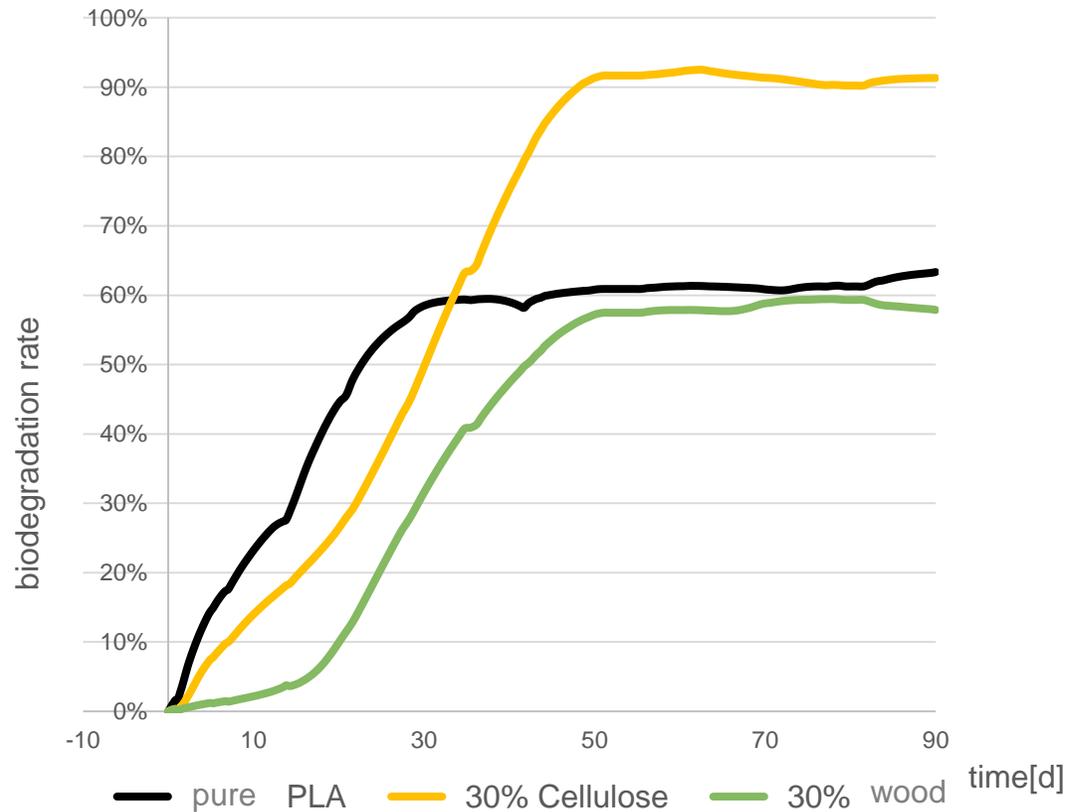
Compound	e-modulus	tensile strength	tear resistance	elongation at break	HDT B
PLA (Natureworks 2003D)	3.580 MPa	74,2 MPa	61,3 MPa	5,8%	55,8 °C
30% cellulose (60 µm)	+ 45%	- 8%	+ 11%	- 69%	+ 1%
30% wood (120 µm)	+ 74%	- 3%	+ 16%	- 53%	+ 5%
PLA (Natureworks L130)	3.552 MPa	69,7 MPa	61,4 MPa	7,0%	53,6 °C
30% cellulose (60 µm)	+ 55%	- 8%	+ 3%	- 63%	+7%
30% wood (120 µm)	+ 76%	- 2%	+ 8%	- 63%	+ 11%

# biodegradation (according DIN ISO 14855-1)

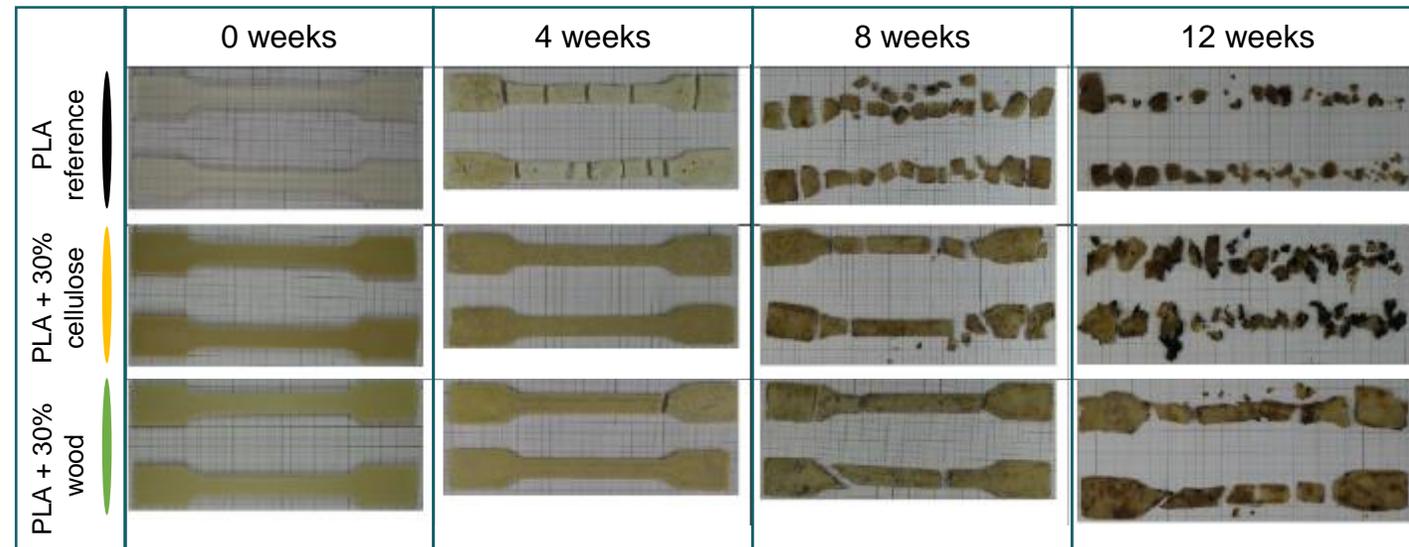


# Biodegradability analysis

biodegradability DIN ISO 14855-1



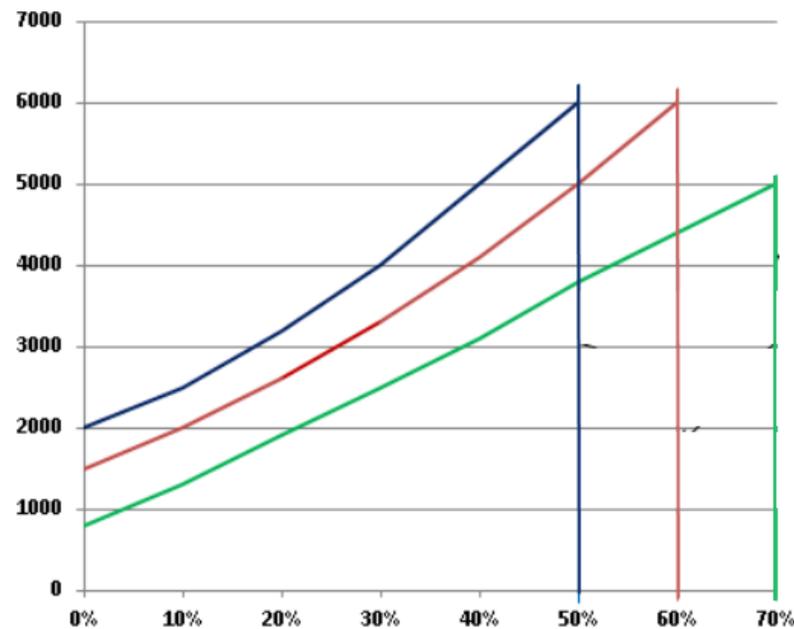
disintegration test



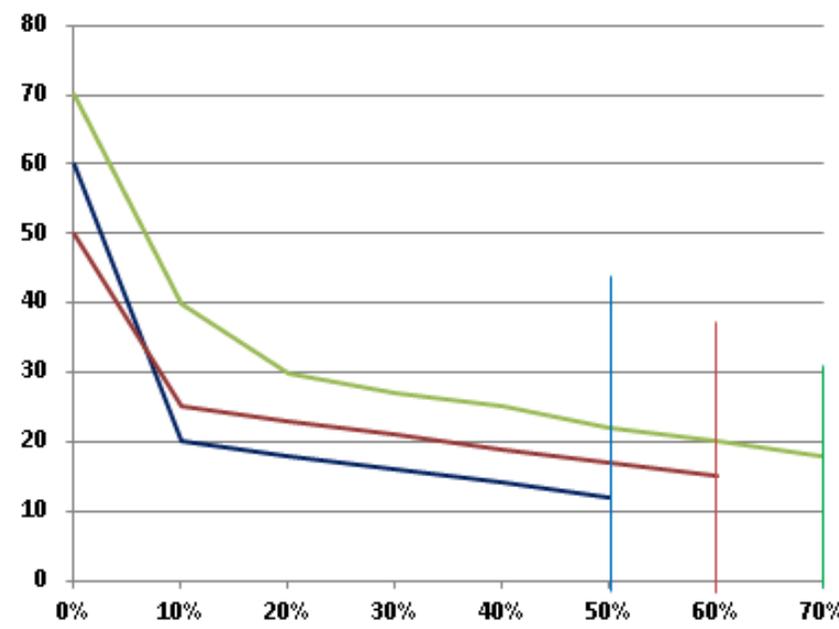
› sample specimen is longer stable and reaches 90% mineralization after 50 days (cellulose)

# mechanical porperties of standard polymers

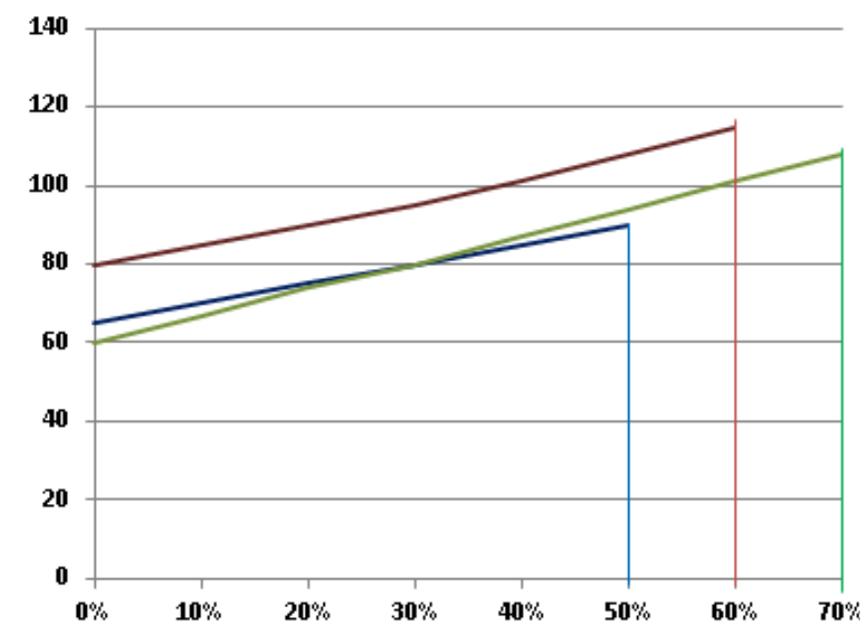
e-modulus [N/mm<sup>2</sup>]



impact strength [kJ/m<sup>2</sup>]



heat deflection temp. [°C]



■ PVC, ■ PP and ■ HDPE Compounds with ARBOCEL<sup>®</sup> fibers



# Application examples













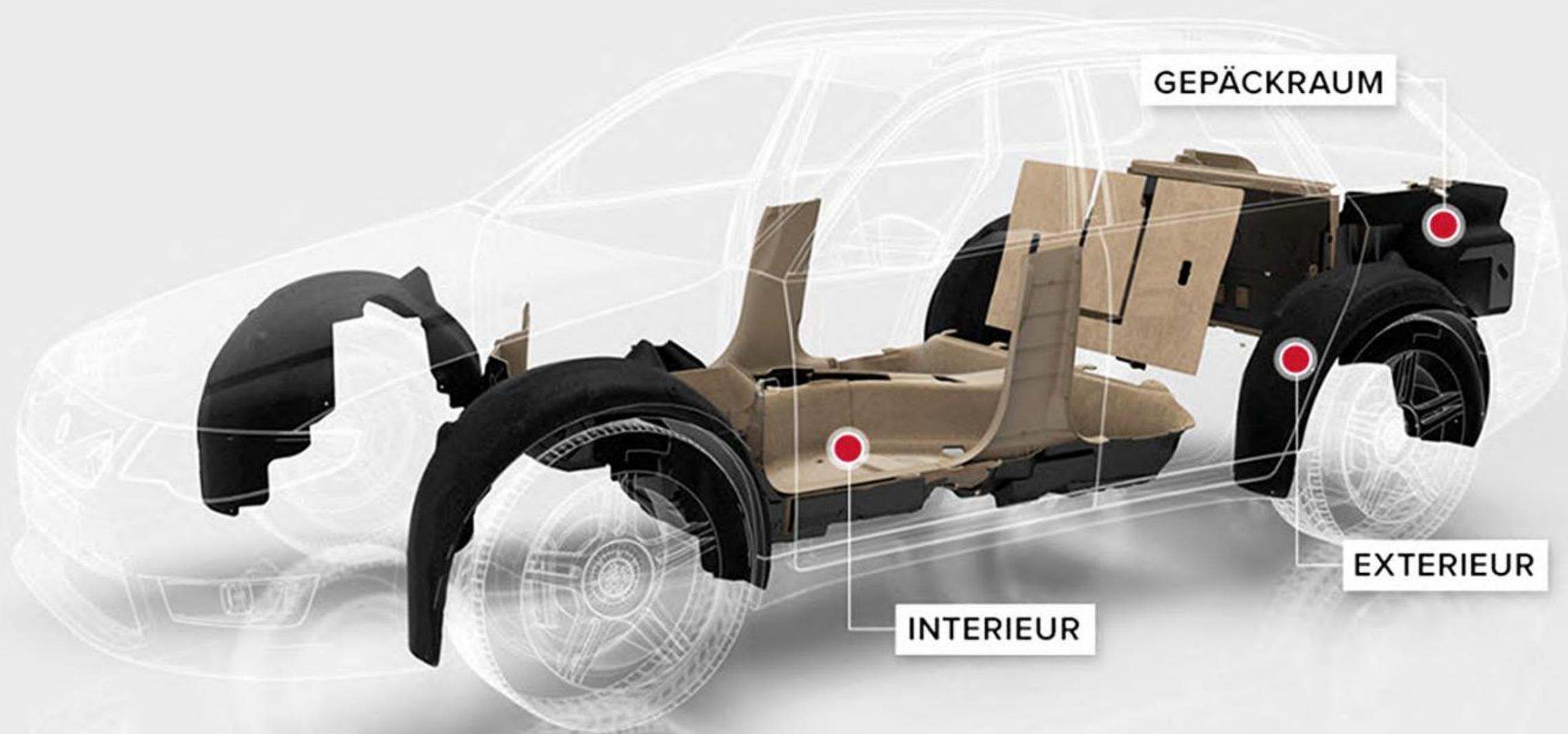












GEPÄCKKRAUM

INTERIEUR

EXTERIEUR

# Your JRS - BU-Chemistry

