

# Lignin-based Biocomposites

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# Applications and new developments

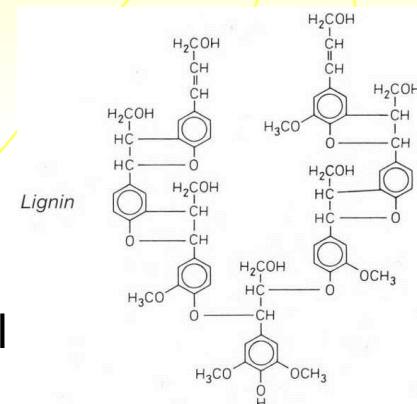
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## Lignin

- major component of wood
- Second most common material on earth besides cellulose
- About 20 billion tons of lignin are formed each year by photosynthesis → infinite supply of lignin as raw material without competing with food products
- Lignin can be extracted from tree bark, sawdust or straw



### *Industrial use of lignin:*

Development of ARBOFORM® at the Fraunhofer Institute  
Establishment of Tecnaro by Helmut Nägele and Jürgen Pfitzer in 1998

# Lignin-based biocomposites - Applications and new development



## ARBOFORM®

**ARBOFORM®** is based on lignin, natural additives and natural fibers.

It is made out of 100% renewable resources.







## Company Profile Tecnaro GmbH

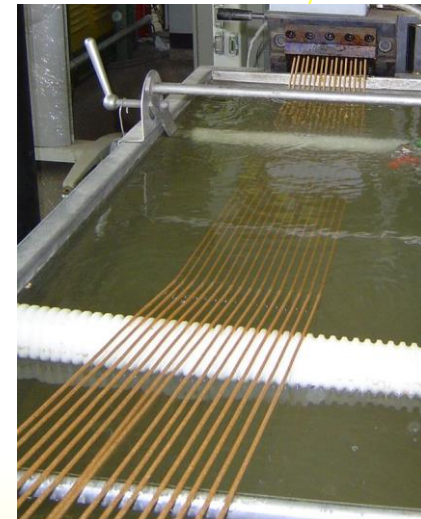
TECNARO GmbH was founded in 1998 as a spin-off company of the Fraunhofer-Gesellschaft.

TECNARO GmbH

- develops,
- produces and
- sells

high-quality **thermoplastic materials**, e.g. **ARBOFORM®** based on **renewable materials**, e.g. **lignin** for the plastic processing industry.

Furthermore TECNARO develops customized compounds and provides competitive compounding services.





## Company datas Tecnaro GmbH:

- First serial materials: 2003
- First automotive application: 01/2006
- Patents: 16
- Capacity of production: approx. 5.000 to/y
- Production lines: 3
- Employees: 30



TECNAROs' turnover has multiplied by a factor of three from 2010 to 2014. The demand for ARBOFORM and TECNAROs' other products ARBOBLEND and ARBOFILL is exploding. This success is also reflected by the increasing number of technical staff and the enlargement of the production area by 50% within the last four years.

## Material Overview

**ARBOFORM®**, **ARBOBLEND®** and **ARBOFILL®** can be processed by injection moulding, extrusion, melt spinning, calendering, blow moulding, thermoforming or compression moulding into moulded parts, semi-finished product, sheets, films or profiles.

### ARBOFORM®



### ARBOFILL®



### ARBOBLEND®







## Awards

- Green Band Germany 2013
- Diesel Award 2011
- EUROPEAN INVENTOR AWARD 2010
- German Industry Award 2009
- Werkbund Label 2008
- VR Innovation Award 2007
- Material ConneXion, NY 2002
- MDR 1st Place „Einfach genial“
- ZDF Show „WiSO“, 1st Place
- EuroMold Award in Gold, 2000

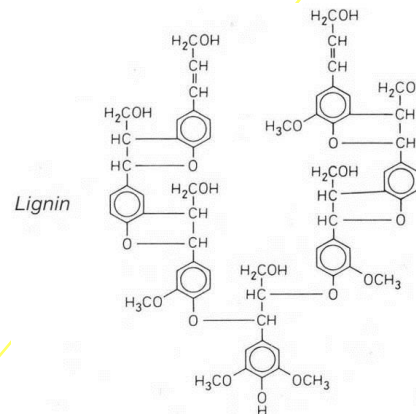


VR-InnovationsPreis Mittelstand 2007




## Composition of **ARBQ FORM**

- Lignin as Matrix (over 10 different lignin types)
- Natural Fibers (variation in kind and composition)
- Natural Additive (as processing aid)





## Processing of ARBOFORM® on injection moulding machines

- standard injection moulding machines
  - Tool construction important
  - processing temperature very low (up to 190 °C)
- 
- standard screw design for polyolefines, without mixing elements
  - standard non-return valve
  - hydraulic dosage

## Complete Equipment

### Technical Center

Test sample manufacturing (tension rods) and valuation of the processing parameters are carried out at the own 50 to IM-machine.

### Material Testing

Characterization of ARBOFORM® in the own test laboratory (Mechanical, thermal and rheological properties).

### Material Data Base

Internal MDB contains a vast variety of different compounds of ARBOFORM®.



## Technical Data

### ARBOFORM® - Examples

Properties	Norm	Unit	ARBOFORM® Example 1	ARBOFORM® Example 2	Max. Value ARBOFORM® Materials
Tensile Strength at Yield	DIN 53 455	N/mm <sup>2</sup>	18	70	100
Tensile Strain at Break	DIN 53 455	%	0,3	4,5	10
Tensile Modulus	DIN 53 457	N/mm <sup>2</sup>	6.000	4.000	7.000
Impact Strength (Charpy)	EN ISO 179	kJ/m <sup>2</sup>	2,0	32	no break
Vicat-Softening- Temperature (B/50)	DIN 53 460	°C	82,5	70	...> 160 (after Pyrolysis > 900°C)



## European Inventor Award made of ARBOFORM®

TECNARO as winner of the European  
Inventor Award 2010



Centre: EPO-President **Alison Brimelow** and the  
spanish heir apparent couple **Prince Felipe** and  
**Princess Letizia**

Picture: EPO, Tecnaro

European Inventor Award 2011  
trophy out of ARBOFORM®



## Romolo Stanco's Green Lamp made from ARBOFORM®



Through the minor shrinkage it's possible to produce component geometries with heavy varying wall thicknesses including thick-walled areas.



Picture: <http://interspacedesign.files.wordpress.com/2011/02/romolostancogreenlamp1.jpg>

## Technical Components

Through the minor shrinkage and the therefore minor warpage it's possible to manufacture within very tight tolerances.



Injection moulded 12 H7 fit (toleranz 0,018 mm)



## Natural Surface

By the use of the special granulation procedure of the ARBOFORM® F, it reveals a very natural appearance.



Steering wheel segment and loudspeaker model with varnished ARBOFORM® appearance.

## Acoustics

Injection moulding of ARBOFORM® enables root wood appearance and acoustical properties comparable to hard wood and combined with less moisture absorption and therefore less deviations.



Loudspeaker and instruments made out of ARBOFORM®



## „WOOD WATCH (Lacher)“

Housing of Wood Watch is made out of ARBOFORM®.





## Carbon Parts

Injection moulding of ARBOFORM® with subsequent pyrolization add up to carbon parts (99,9% C-Concentration) with electric conductivity and high dimensional stability under heat.



## Thin Wall Injection Moulding

Thin wall injection moulding of long flow paths is possible through flow optimized grades.

Eco-Keypad from Fujitsu.  
Leader in Green IT: Palm rest made from  
ARBOFORM®



Picture: Kerb



Picture: Fa. Fujitsu

## Toys

According to part geometry the material-specific usage of ARBOFORM® will be preferred.



Picture: Spielzeug-Heller



## Urns made of injection moulding

The Urn is made of ARBOFORM® (=Liquid wood), which can be harmlessly decomposed in the forest.



Picture: Homepage Friedwald GmbH



## Designer Shoe

Eco Pump from Sergio Rossi, Gucci Group: High heel made out of ARBOFORM® F, Sole and packaging made out of ARBOBLEND®.



Picture: Sergio Rossi, Gucci Group, Italien



HOME, a film by Yann Arthus-Bertrand



## Extrusion of Profiles





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*Transforming urban and agricultural residues into high performance biomaterials for Green Construction*

## Advantages of **new wheat straw lignin (CIMV):**

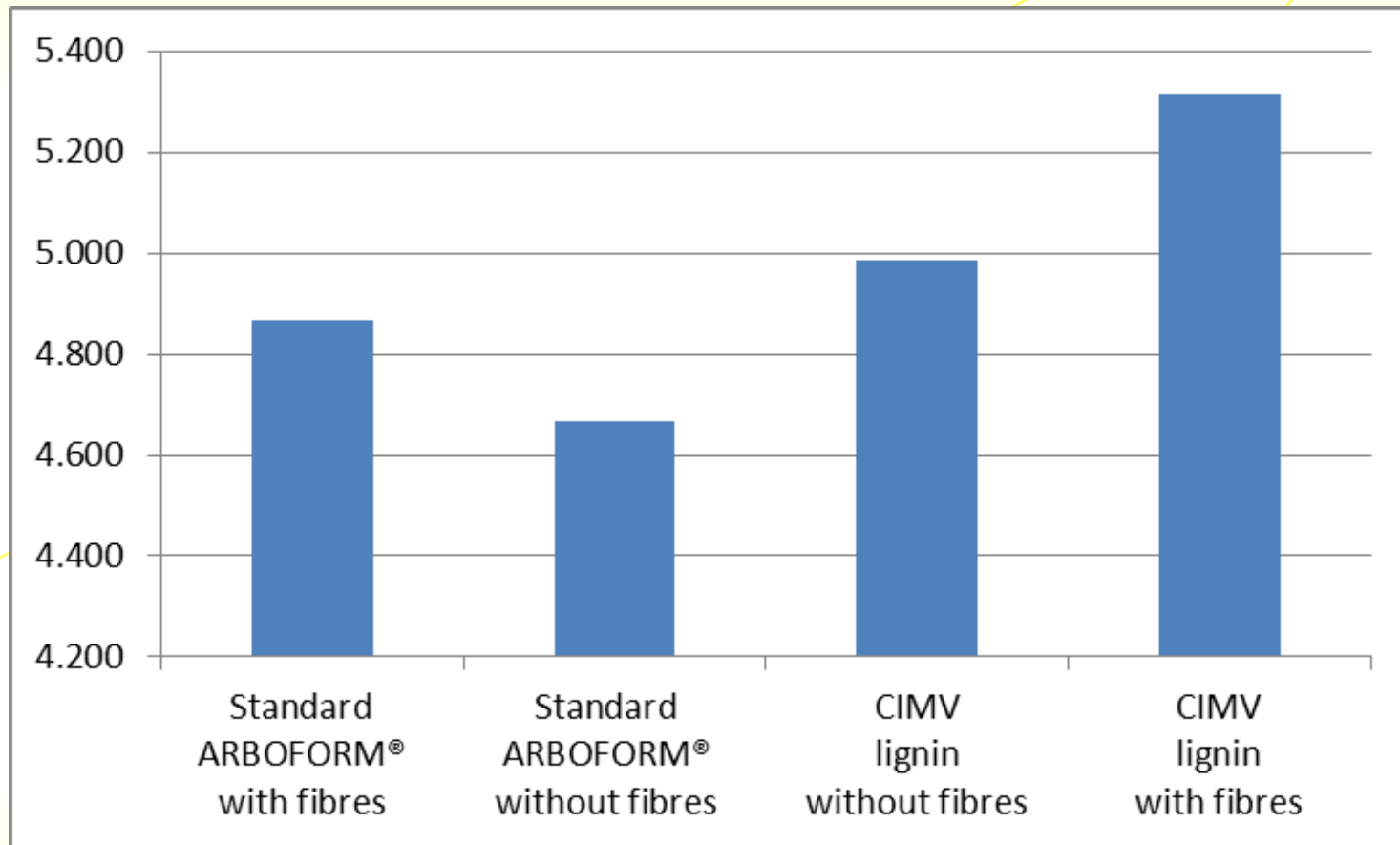
- Less sensitivity to shear and heat
- Less tendency to produce inclusions (suitable especially for compounds intended for extrusion)
- Impact on the mechanical properties
- Available at acceptable prices



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## Elastic Modulus [MPa] of different materials (specimens produced by injection moulding)





## Technical and economical advantages

- ARBOFORM® offers the same processing qualities and features as plastic
- ARBOFORM® can be used for various products manufactured by conventional plastic fabrication techniques
- ARBOFORM® looks like wood, feels like wood, but can be processed easily into a wide variety of three-dimensional shapes
- Special ARBOFORM® formulations with CIMV lignin are suitable for profile extrusion (INNOBITE)

## Ecological benefits

- With ARBOFORM® industry becomes independent from petroleum as a raw material
- ARBOFORM® can easily be recycled, and even composted or burnt without realising additional CO<sub>2</sub>



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## Thank You!



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