

VOLKSWAGEN

AKTIENGESELLSCHAFT

KONZERNFORSCHUNG



WOOD MATERIALS - SUITABLE FOR STRUCTURAL AUTOMOTIVE APPLICATIONS

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HAMBURG | 27.03.2019

AGENDA

- I** Introduction of the Volkswagen Group Research
- II** Motivation for considering wood for structural automotive applications
- III** Current research activities
- IV** Necessity for further research
- V** Summary and Outlook



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VOLKSWAGEN GROUP

STATISTICS 2017

- 
- An aerial photograph showing a large industrial complex with several tall smokestacks and a large building with a corrugated metal roof. In the foreground, there is a modern research facility with several large, circular, and cylindrical buildings, green spaces, and a parking lot. A river flows through the middle of the site.
- ▶ **120 Production sites**
 - ▶ **Ø 43.500 Products p.d.**
 - ▶ **12 Brands**
 - ▶ **approx. 330 Models**
 - ▶ **626.700 Employees**



VOLKSWAGEN GROUP

12 BRANDS



ŠKODA



Nutzfahrzeuge



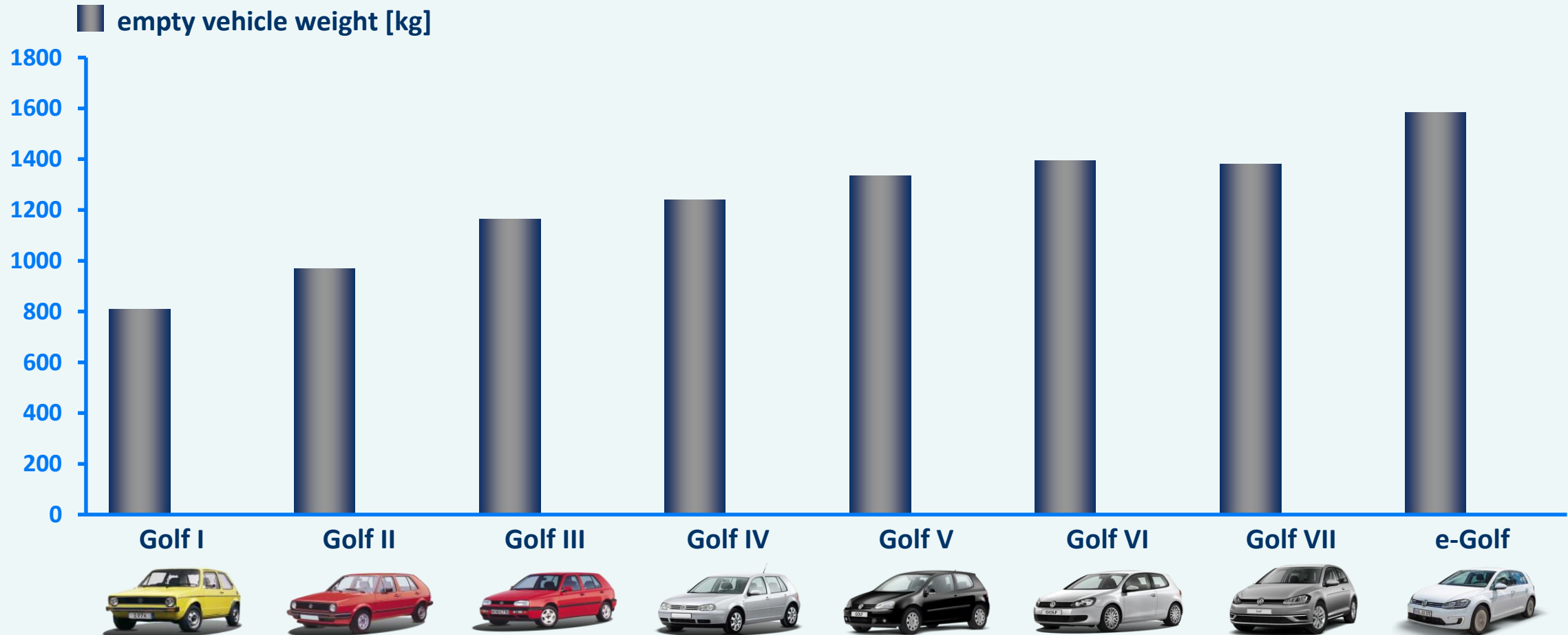
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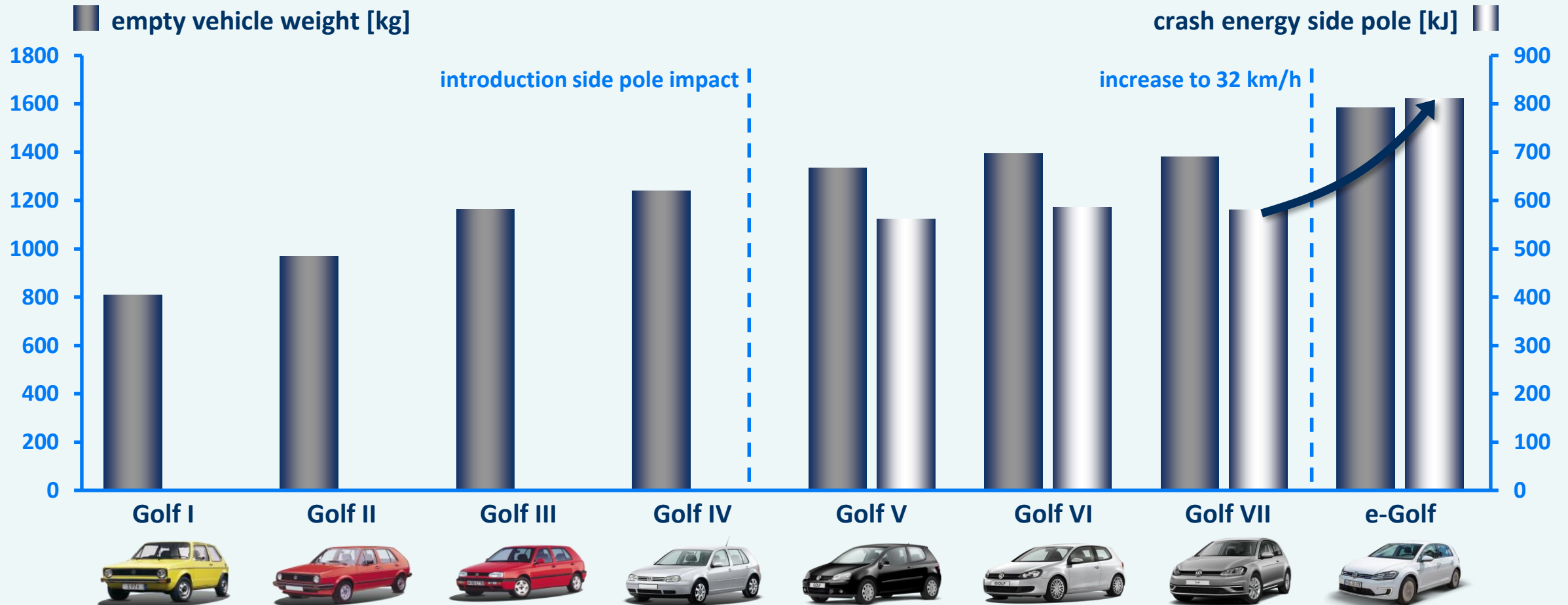
INCREASED CRASH REQUIREMENTS FOR ELECTRIC VEHICLES

DEVELOPMENT OF EMPTY VEHICLE WEIGHT ON THE EXAMPLE OF VW GOLF



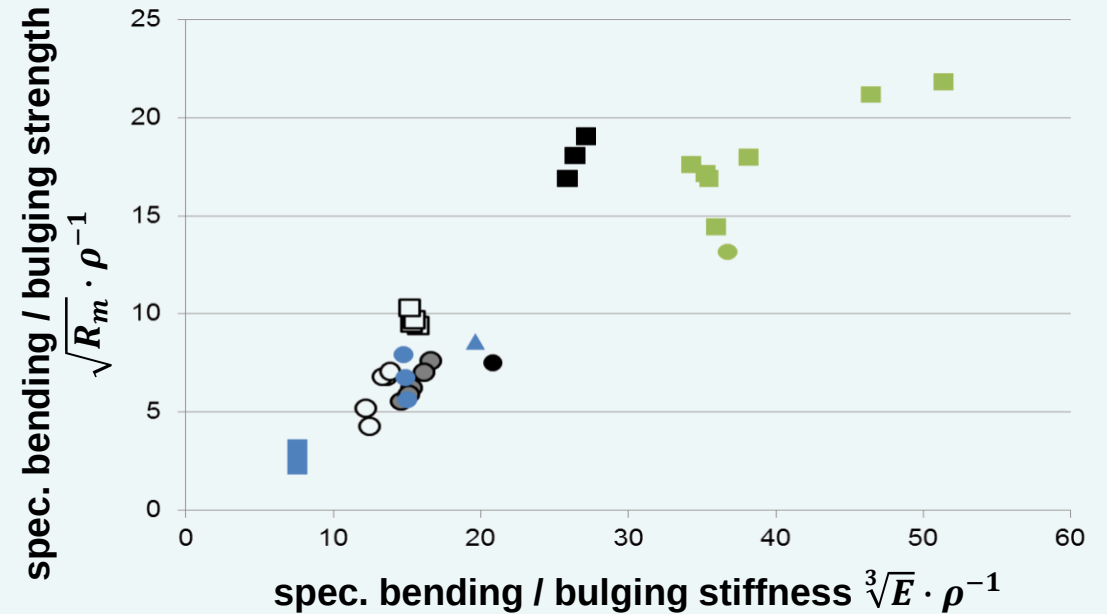
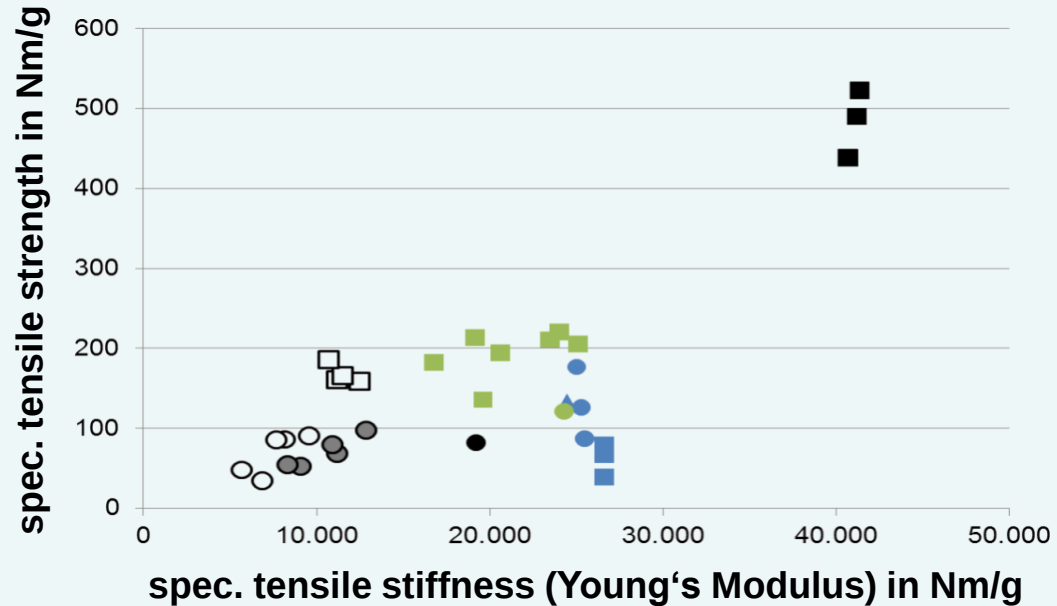
INCREASED CRASH REQUIREMENTS FOR ELECTRIC VEHICLES

DEVELOPMENT OF EMPTY VEHICLE WEIGHT AND CRASH ENERGY (EURO NCAP)



WOOD AS A LIGHTWEIGHT MATERIAL

FOR STRUCTURAL APPLICATIONS



Metals:

- steel
- aluminum
- ▲ magnesium

FRP:

- carbon fiber, endless
- glass fiber, endless
- carbon fiber, long
- glass/carbon fiber mix, long
- glass fiber, long

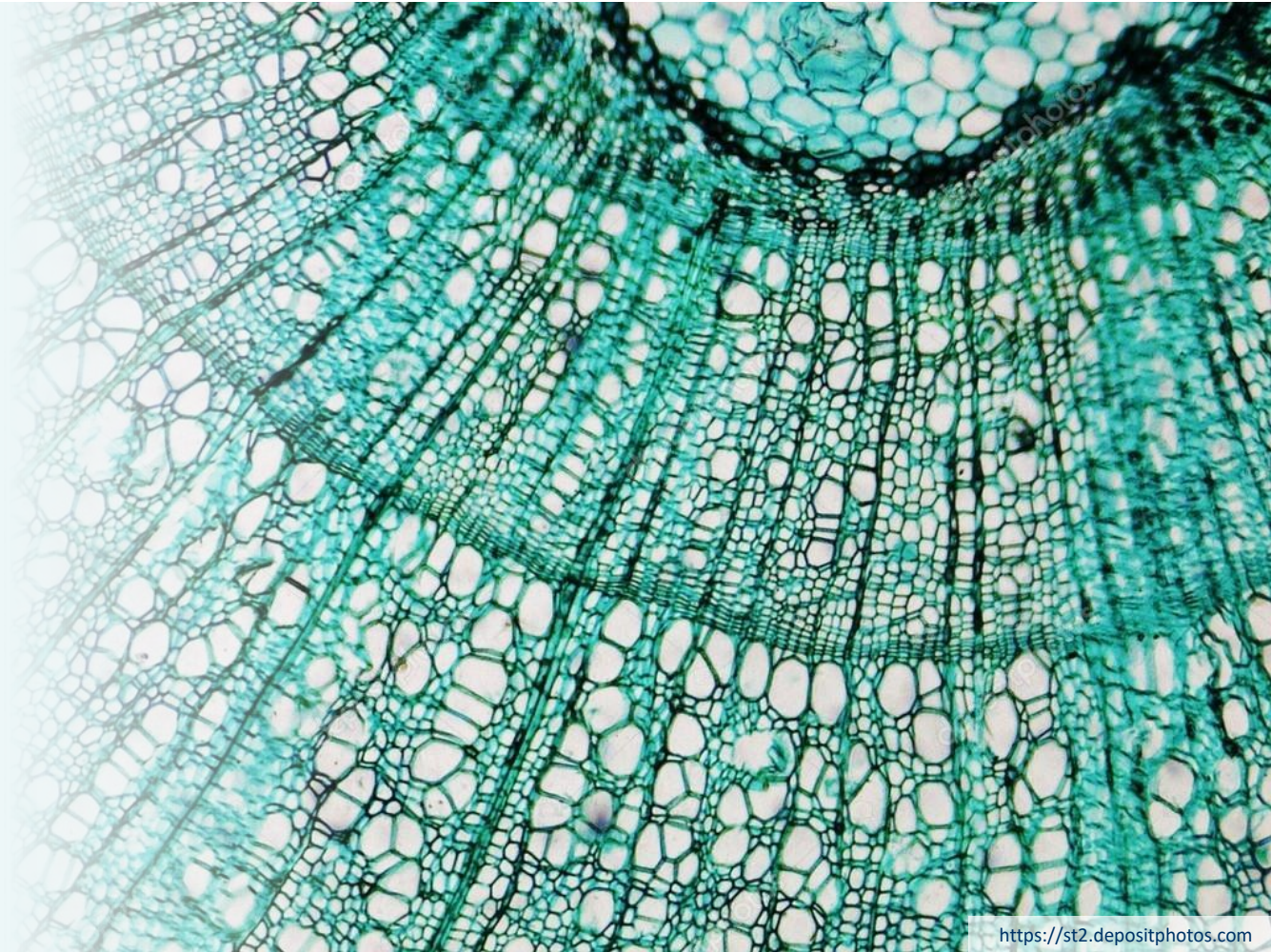
Wood:

- solid
- laminated



WOOD AS A SUITABLE MATERIAL FOR THE AUTOMOTIVE INDUSTRY

- ▶ Very good **specific mechanical material properties**
 - ▶ ~40 % higher specific tensile strength compared to steel (DP600)
 - ▶ specific bending / bulging stiffness and strength larger by a factor of ~4 than that of steel (DP600)
- ▶ **Sustainable Material**
 - ▶ Low primary energy requirement
 - ▶ Negative CO₂ value for life cycle assessment
- ▶ Very low **material costs**
- ▶ **Locally** available in **great quantities**



<https://st2.depositphotos.com>



WOOD-BASED VEHICLE CONCEPTS



1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 Today



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WOOD-FRP-HYBRID PULTRUSION

PULTRUSION TECHNOLOGY

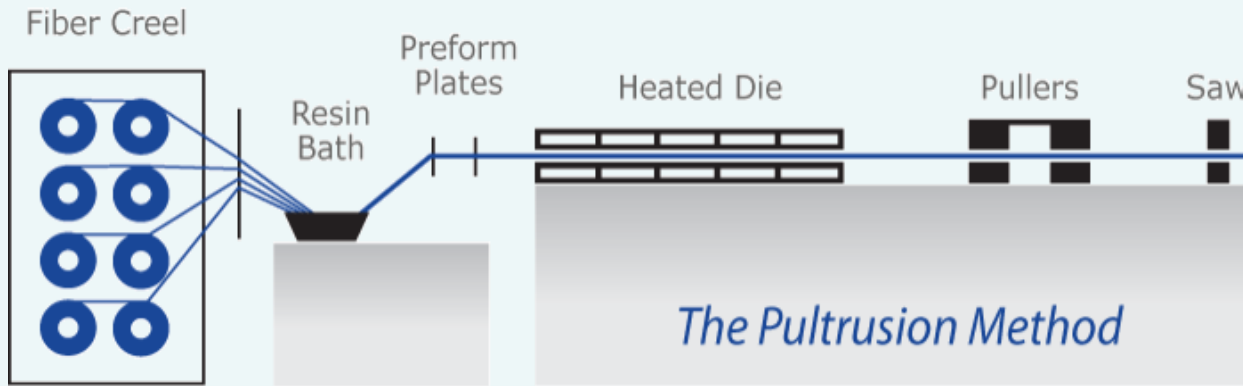


Image source: www.unipullc.com

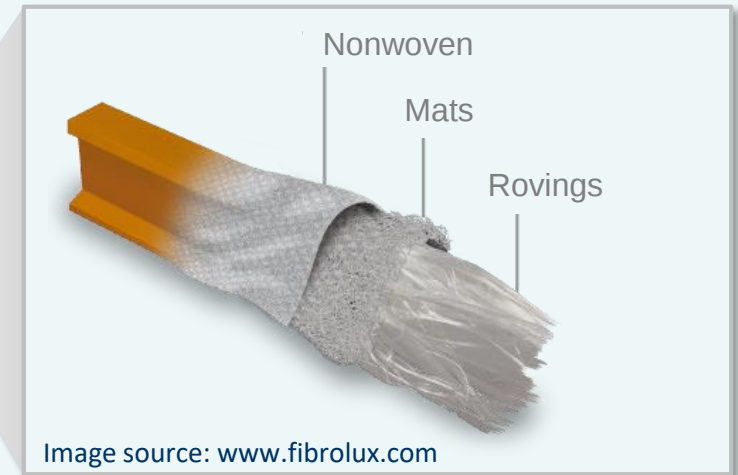


Image source: www.fibrolux.com

PROFILE SAMPLES

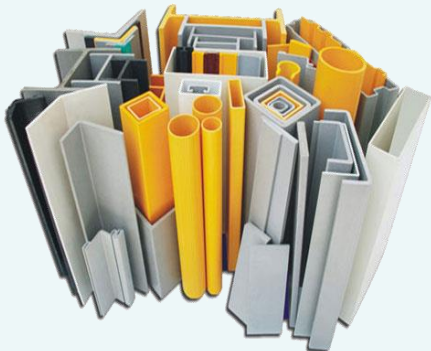


Image source: www.grpsafety.co.uk

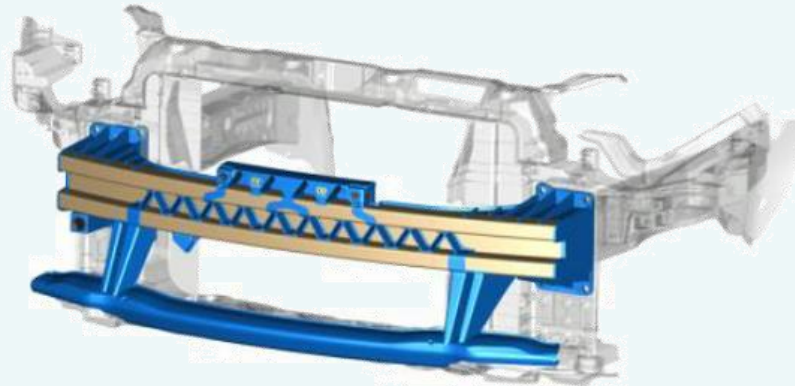


Image source: www.kunststoff-magazin.de

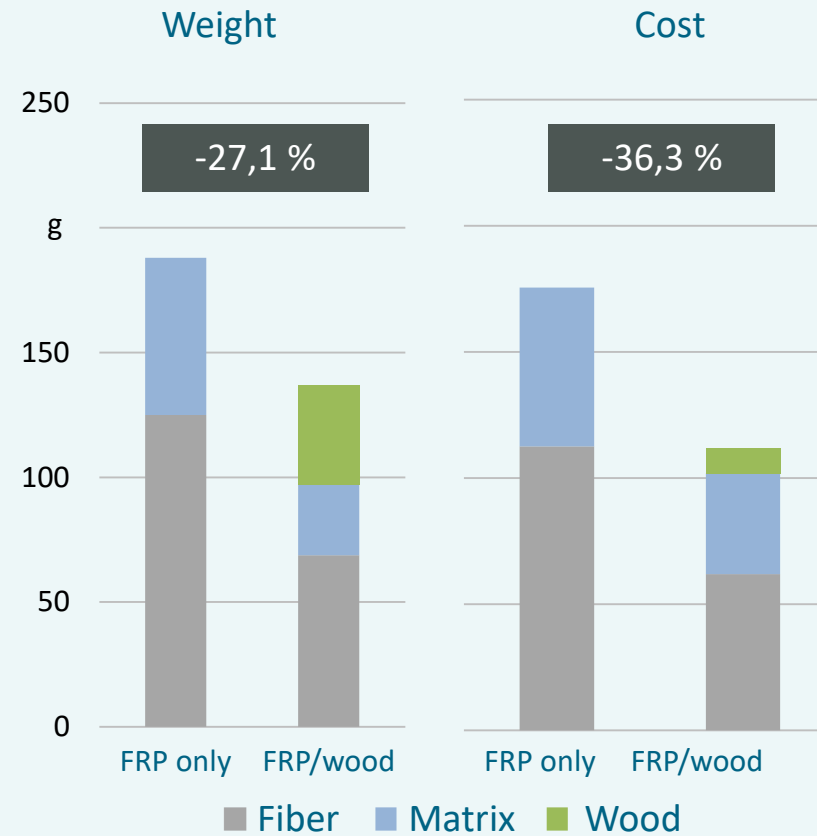
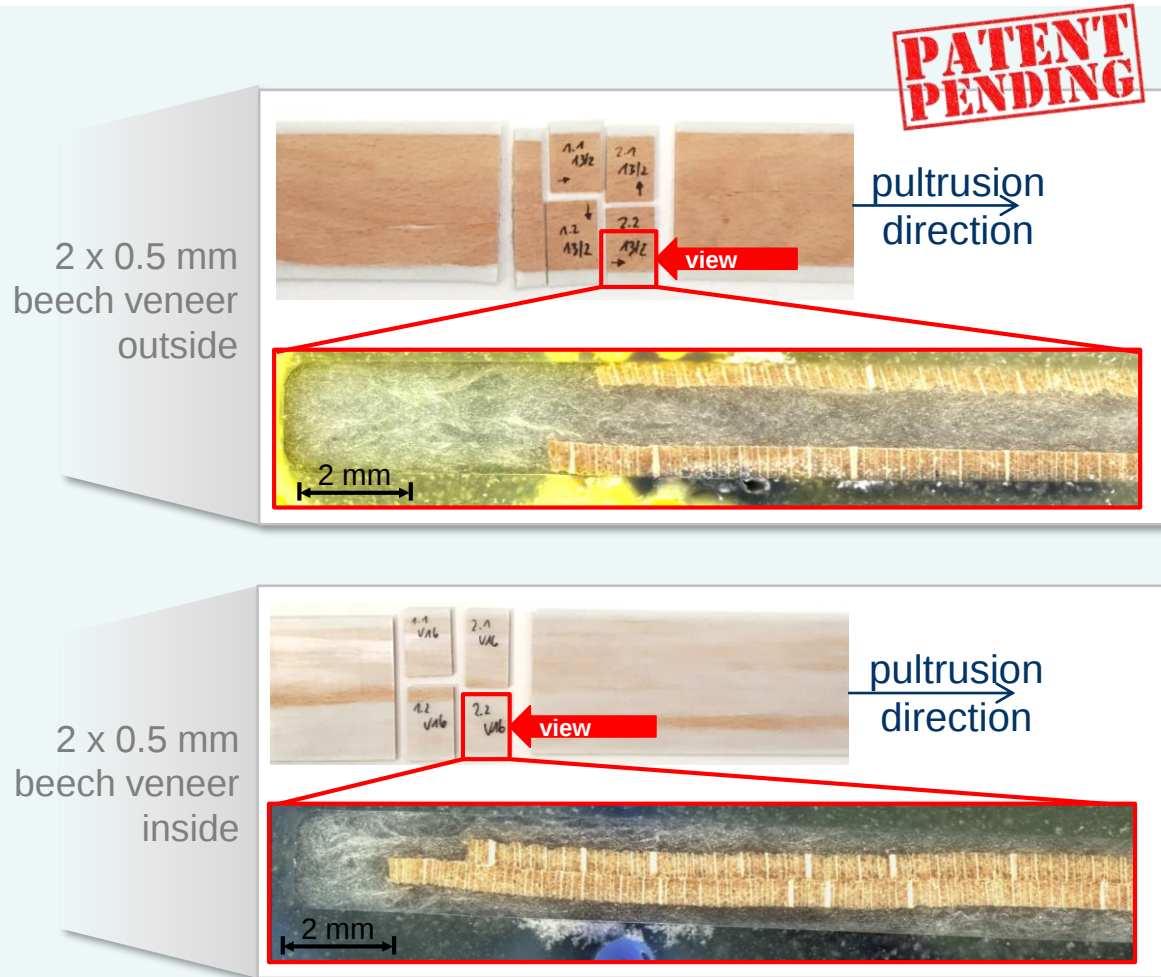


Image source: www.k-zeitung.de



WOOD-FRP-HYBRID PULTRUSION

RESULTS



Boundary conditions:

rectangular profile

Width 20 mm

Height 5 mm

Length 1000 mm

Calculated to equal bending stiffness

FRP only

Fiber content: 50 v%

FRP/wood

Wood content: 50 v%

Fiber content FRP: 55 v%



RESEARCH PROJECT “FOR(S)TSCHRITT”

PROJECT OVERVIEW

Key data

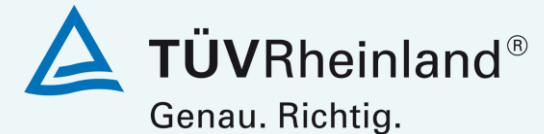
- ▶ Project duration from march 2017 to february 2020
- ▶ Funded by the German Federal Ministry for Economic Affairs and Energy, promoted by the TÜV Rheinland
- ▶ Partners:
 - ▶ Leadership: Volkswagen Group Research
 - ▶ Further industrial partners: Alstom, Salzgitter Mannesmann Research, Siebenwurst, RohTech, Schaltbau Bode
 - ▶ Research partners: Fraunhofer WKI, Kassel University (tff), DLR (Institute for vehicle concepts)

Demonstrators

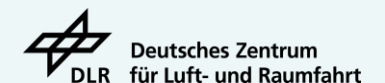
- ▶ Train Side Panel (Alstom)
- ▶ Train Door (Schaltbau Bode)
- ▶ VW Tiguan front door (Volkswagen)



Gefördert durch:



aufgrund eines Beschlusses
des Deutschen Bundestages



RESEARCH PROJECT “FOR(S)TSCHRITT”

DEMONSTRATOR PART

VW TIGUAN FRONT DOOR (SERIES)

Door impact beam (DIB) – 1.575 kg

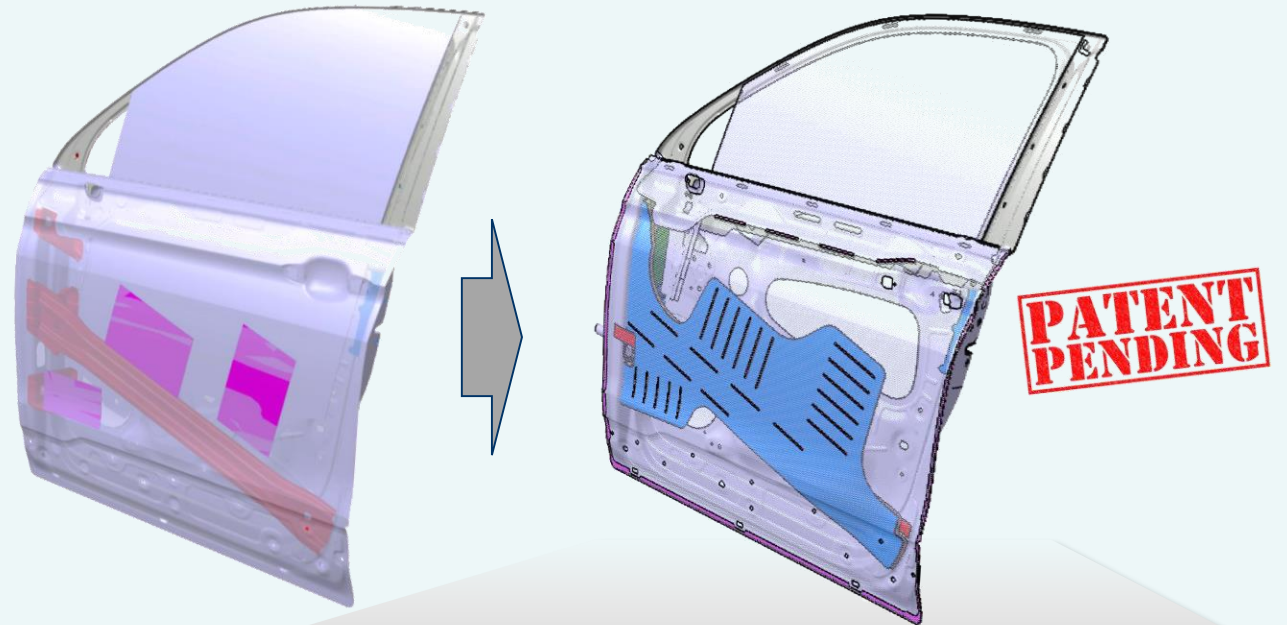
DIB reinforcing plate – 0.511 kg

Upper hinge reinforcement – 0.576 kg

Lower hinge reinforcement – 0.553 kg

Damping mats – ~0.400 kg

Overall weight: 3.615 kg



ACTUAL WEIGHT PROGNOSIS

- ▶ Function integrated wood veneer part incl. steel tension strip: 3.564 kg
- ▶ Weight optimization pending

FUNCTION-INTEGRATED WOOD-BASED DOOR INNER MODULE

- ▶ Shell-shaped laminated wood veneer for reinforcement functions
- ▶ Laminated wood / steel tension strip for side impact

RESEARCH PROJECT WOODC.A.R.

PROJECT OVERVIEW



Project focus

- ▶ Design, engineering and optimization of wood in applications across different industry sectors
- ▶ Ecologic and economic assessment of wood as loadbearing material in dynamically loaded structures
- ▶ Simulation models and material cards for wood and wood materials
- ▶ Life Cycle Assessment
- ▶ Partner-specific use-cases

Scientific Partners

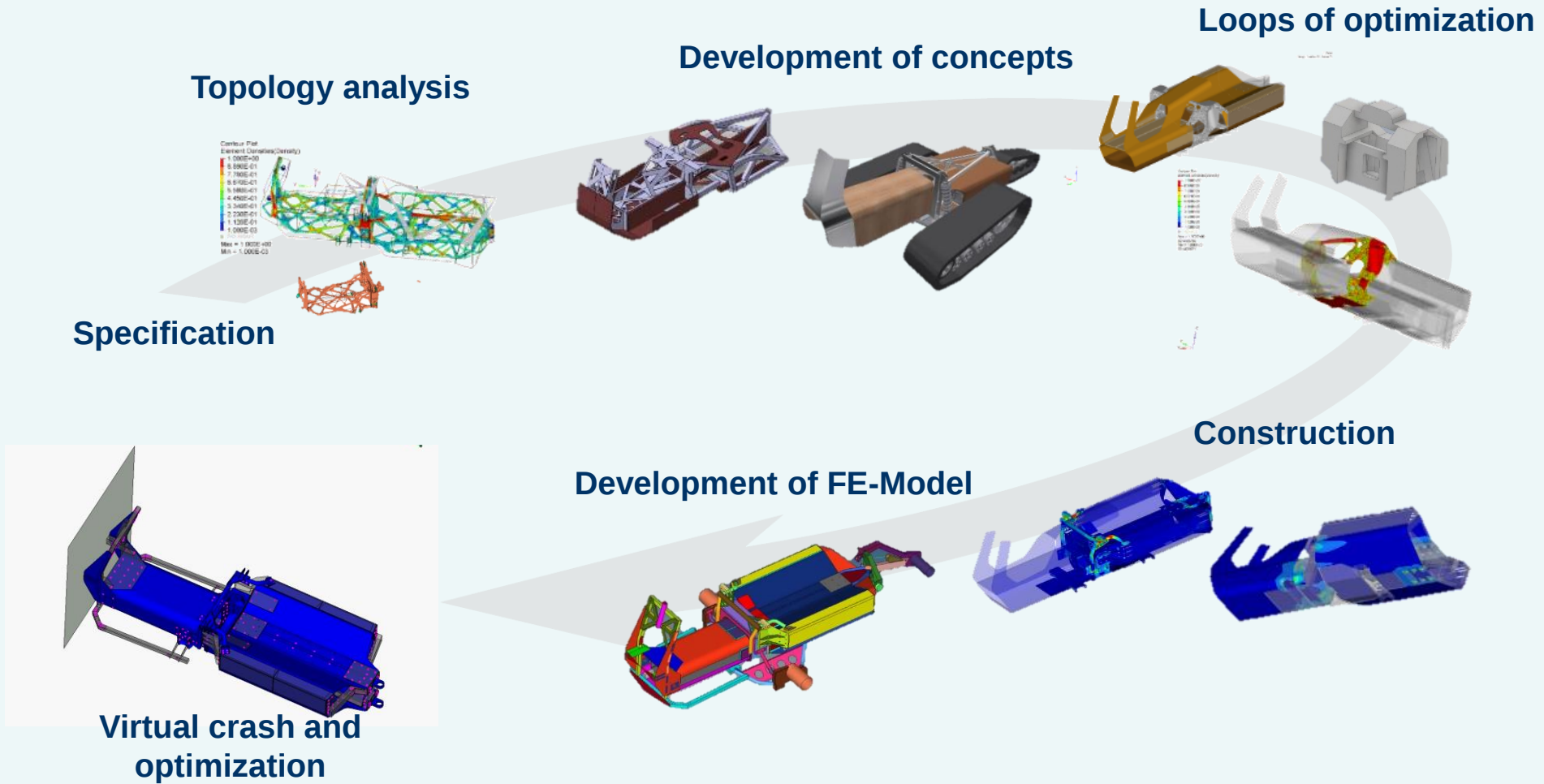


Industrial Partners



RESEARCH PROJECT WOODC.A.R.

APPROACH FOR STRUCTURAL APPLICATIONS



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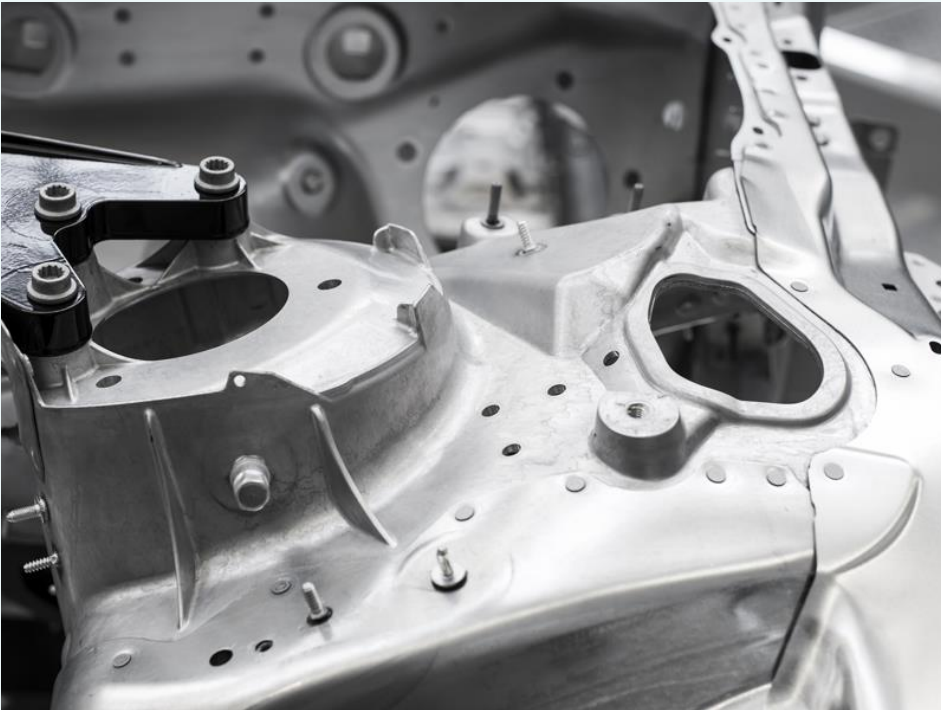
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OPEN QUESTIONS

GEOMETRICAL ACCURACY

EXAMPLE: AUDI CASTING NODES



www.produktion.de

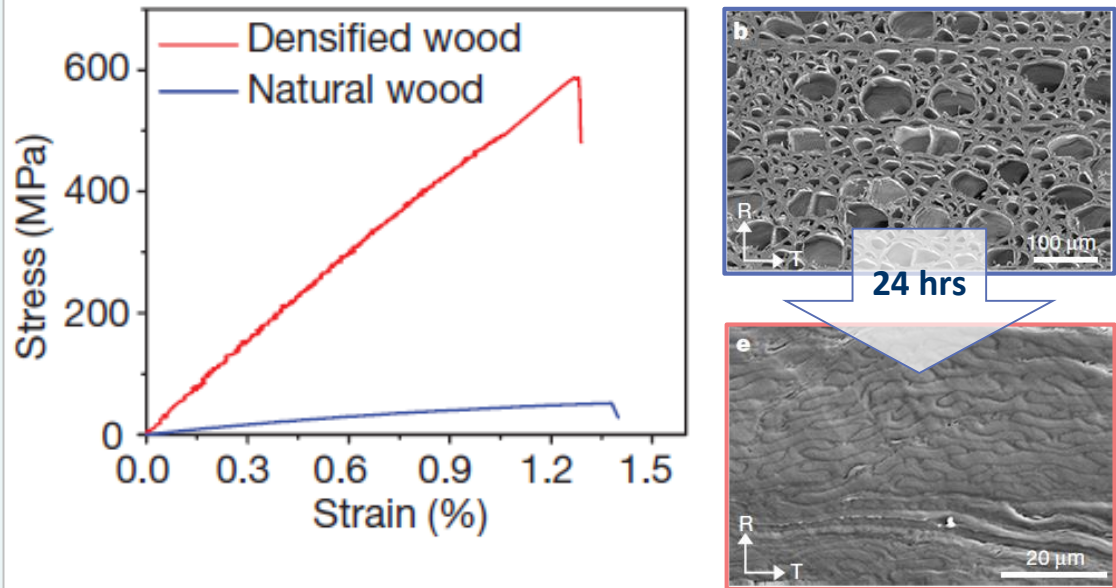
WOOD MATERIALS IN MULTI-MATERIAL STRUCTURES

- ▶ Complex 3D geometries vs. mechanical properties
- ▶ Shape accuracy
 - ▶ in production
 - ▶ over lifetime
- ▶ Hygroscopic length variation
- ▶ Thermal length variation
- ▶ Suitable joining technology

OPEN QUESTIONS

COMPATIBILITY TO SERIES PRODUCTION PROCESSES

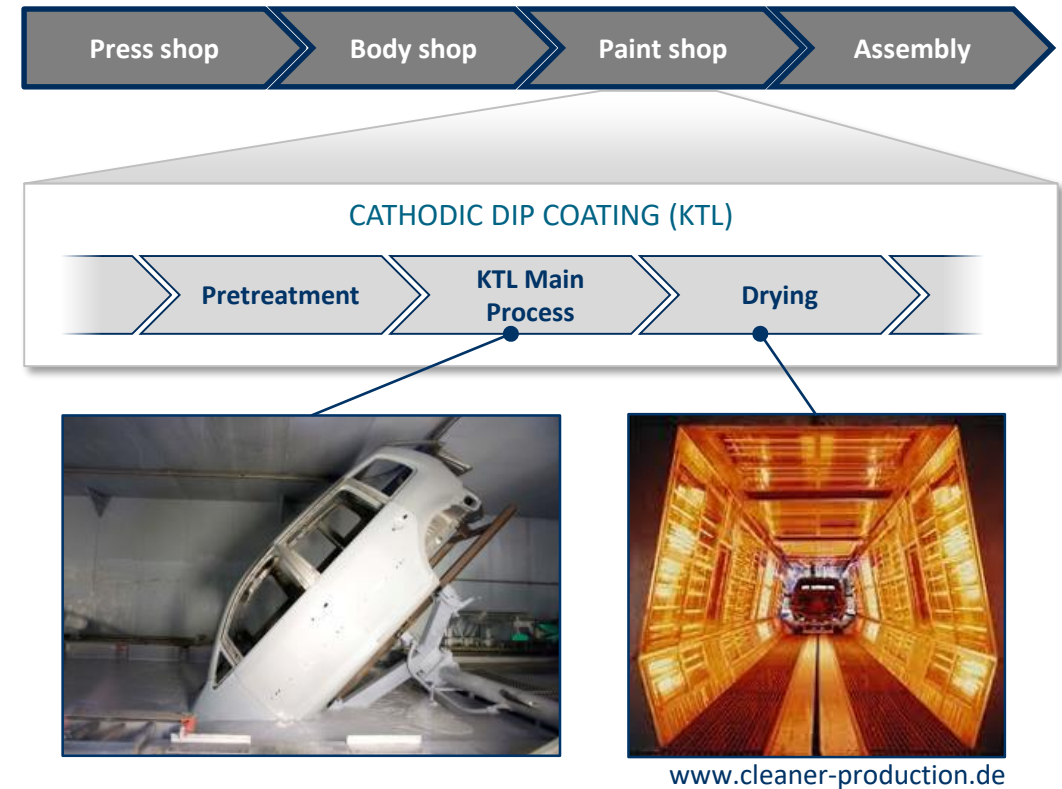
QUANTITY AND CYCLE TIME



doi:10.1038/nature25476

- ▶ Annual quantities: 50.000 to 250.000 cars/a
- ▶ Typical Automotive cycle times: 30 to 60 s

CAR MANUFACTURING PROCESS



OPEN QUESTIONS

WOOD PRESERVATION VS. EMISSION



Source: Morgan, Screenshot from: <https://www.youtube.com/watch?v=25-Ee6pq4yQ>

REQUIREMENTS

- ▶ Preservation against air, moisture and fungal attack for decades
- ▶ Wide temperature and humidity range
- ▶ Hardly inflammable
- ▶ No occurrence of
 - ▶ Unpleasant odors
 - ▶ Noxious volatile organic compounds (VOC), e.g. phenol
 - ▶ Fogging
- ▶ Recyclability with low environmental impact



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SUMMARY AND OUTLOOK

- ▶ Wood and wood materials offer great potential for automotive applications beyond actual “design-only” elements.
- ▶ To exploit the potential, research in the fields of
 - manufacturing technology
 - material development
 - automotive-specific question of (long-time) material behavior of wood materials is necessary.



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THANK YOU.

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Quelle: www.motortalk.de