Manufacturing with Biocomposites

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Content

• Who is IVW?
• Standard Applications for Natural Fiber Composites
• Main Challenge – Mechanical Performance
• BioBuild Materials
• Manufacturing Methods
• Results
• Summary
Who is IVW?

Established: 1990
Budget: 35 % State, 65 % External

Internal Research Projects
New Ideas, Exploratory Work, Fundamentals (DFG, RLP)

Governmental Research Projects
Funded Research Work (BMBF, BMWI, EU,…)

Industrial Projects & Cooperation
New Developments in Technology and Application, Industry Funded Research, Service Contracts

Role in the BioBuild Project

Competence Field Materials Science:
Treatment of natural fibers yielding water- and fire-resistant “green” coatings on the fibers’ surface by using bio-derived super-hydrophobic phenalkamines and water glass

Competence Field Manufacturing Science:
Processing of biocomposite panels and profiles in a continuous compression molding process by using pre-impregnated textiles developed in a previous WP

Cooperation-contract with TU
Standard Applications for Natural Fiber Composites

• Since decades common use in the automotive industry for semi-structural components
  • Door panels
  • Backrests
  • Roof stiffenings

• New application fields
  • Sports
  • Furniture
  • Ship building

• Usage of „Green Composites“

Source: Global Hemp

Mercedes E-Class

Mercedes C-Class

Source: warwick.ac.uk
Standard Manufacturing Process

- Fibers are almost randomly distributed in the non-woven

- 95% of all natural fiber composites are manufactured by compression molding, 5% injection and others

- Fiber weight content in NFC not comparable to GFC
  - 40 - 50 wt.-% for thermoplastic matrices
  - 50 - 70 wt.-% for thermoset matrices
Main Challenge – Mechanical Performance

Influence of fiber orientation in reinforcing textiles

- Multi-directional natural fiber textile
- Bi-directional natural fiber textile
- Uni-directional natural fiber textile
Main Challenge – Mechanical Performance

Influence of density on E-Modulus

![Graph showing the relationship between density and E-Modulus.](image)

- **Standard NF/PP material for automotive applications**

Low compression → low density → high porosity

High compression → high density → low porosity

Same natural fiber material
BioBuild Materials

- Increasing the mechanical performance by using aligned fibers

- Use of furan resin as an agricultural waste product from the sugar industry

- Use of leftovers from the cork stoppers manufacturing → cork composites
Impregnation of Textiles

- Impregnation of textiles with furan resin
  → Production of prepregs
- Excess resin is squeezed out in the squeeze rollers
- Subsequent press process in order to produce finished parts
Compression Molding

- Natural fibers are
  - pressure sensitive (max. 60 bar)
  - temperature sensitive (degradation at 200 °C)
- Natural fiber composites always contain porosity
  → decreasing density and mechanical performance
- Furan resin cures by a polycondensation reaction
  → steam occurs
Compression Molding

Optimization of compression molding process in order to increase the density and reduce porosity content in the composite

- repeated opening of the mold to release the steam
- Isochoric pressing with distance plates for defining the end volume
Continuous Compression Molding

- Production of almost endless panels, sandwiches, and profiles using the CCMM
- Works on the basis of a semi-continuous process with alternating press and transport stages
Other Processing Methods

Vacuum infusion
- Resin mixing, cutting of textiles, infusion, sectioning and cutting
- Resin cures at RT (48 h)

Pultrusion
- Fiber reinforcement is saturated with a resin and pulled through a heated die
- Requirements for the resin are high pot life, low viscosity, high reactivity, and low amount of volatiles
Results - Natural Fiber Composites

- Tensile modulus of flax/jute-furan composites much higher than of standard NF materials
- Lower natural fiber weight content
- Mechanical performance of NF composites depends on density

Improving the mechanical performance of natural fiber composites by using aligned fibers and optimizing the manufacturing process (increasing the density)
Results - Cork Sandwiches

- Combination of high performance NF composites with cork core
  → Improving the effective bending stiffness
  → Increase of Charpy impact resistance
- Correlation of performance to cork thickness
Summary

- Standard applications of natural fibers in Europe in the automotive industry for semi-structural components
- For the application as structural parts mechanical performance must be increased
- Increase of mechanical properties due to aligned fibers (textiles) and optimization of the manufacturing process (high density)
- Increase of bending behavior and Charpy impact resistance due to the use of cork composite as sandwich core material
Thank you for your attention

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