# Advanced Materials for a Smart Lightweight Design

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Content:

- What is “Smart Lightweight Design”?
- Manufacturing of materials
- Material grades
- Processing
- Applications
- Recycling solutions
- Summary and future aspects

Target definition: weight saving without increasing part or system costs

- Conventional approaches:
  - Reduction of wall thickness
  - Reduction of material costs by downgrading
- Disadvantage: loss of properties / performance
- Smart and cost effective lightweight design:
  - Integration of functions and simplification of processes by high performance materials
  - Reduction of material density by tailored consolidation of selfexpanding composites

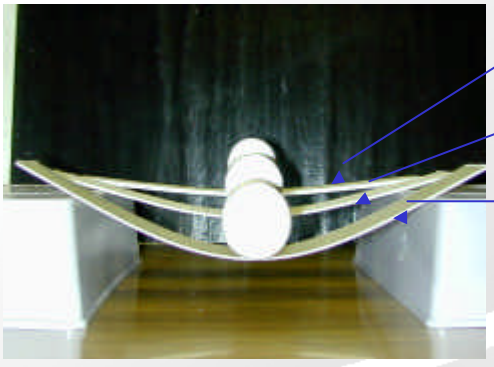






## TAILORED CONSOLIDATION

All specimen have same weight but different thickness and density --> significant reduction of deflection under the same load



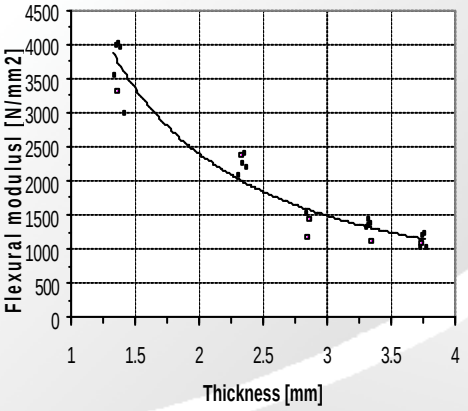
h = 3.6 mm, ρ = 0.37 g/cm$^3$

h = 2.4 mm, ρ = 0.55 g/cm$^3$

h = 1.2 mm, ρ = 1.1 g/cm$^3$
(Conventional design)

# TAILORED CONSOLIDATION

## Flexural modulus as function of thickness:




Areal weight:
1400 g/m$^2$

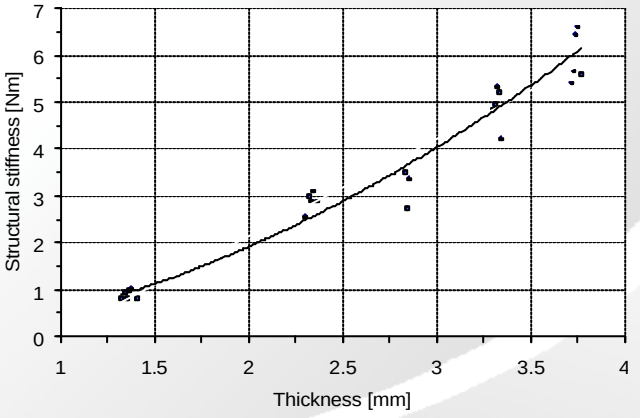






# TAILORED CONSOLIDATION

## Structural stiffness as function of thickness




E x I = f (h$^2$)

## Manufacturing process of fleeces (carding):

- Manufacturing of mixed fiber fleeces out of natural and thermoplastic fibers (“Nafcoform”)
- Manufacturing of sandwich-fleeces by thermobonding (“Loprefin”)
- Manufacturing of customer tailored blanks or delivery as rolls

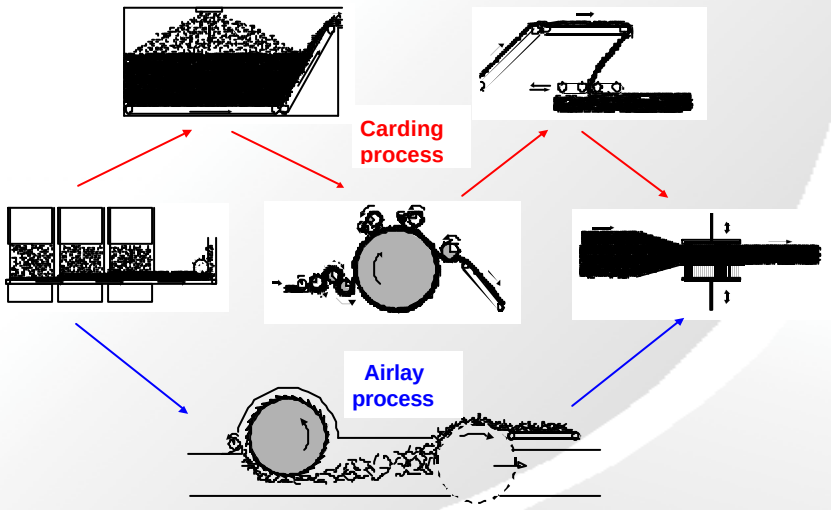




Manufacturing of Materials

## Manufacturing process of consolidated fleeces (airlay):

- Manufacturing of mixed fiber fleeces out of reinforcement and thermoplastic fibers
- Online consolidation and impregnation of reinforcement fibers (“SymaLite”)
- Lamination of functional layers on the surfaces (films, adhesion films, fleeces, ...)
- Online cutting of customer tailored blanks










## Fleeces (Nafcoform, PP/glass):

- Weight per area: 300 - 1700 (5000) g/m$^2$
- Natural fibers (Kenaf, Hemp, Flax, Sisal, Jute) / PP: content of natural fibers: 20 - 80 %
- Glass fibers / PP: content of glass fibers: 20 - 40 %
- Natural fibers / acetates: content of natural fibers: 20 - 80 %

## Fleeces (Loprefin, PP/glass):

- Weight per area: 300 - 1700 (5000) g/m$^2$
- Sandwich-fleeces with surface layers (Loprefin):
  core: PP / natural fibers
  surface layers: PP / PET - 70 / 30
- Synthetical sandwich-fleeces:
  core: PP / PET - 30 / 70
  surface layers: PP / PET - 70 / 30







## Fleeces (Nafcoform, Loprefin):

## Fully consolidated fleeces (SymaLite):

- Basis grades: glass fibers / PP
  - Weight per area: 600 - 3000 g/m$^2$
  - Fiber content: 20 - 60 %
  - Different functional surface layers available
- Advanced grades: glass fibers / PET / PBT / PA
  - Same product range, higher HDT







## Fully consolidated fleeces (SymaLite):

- SymaLite as delivered (1400 g/m2 = 1,5 mm):

- SymaLite after heating (1400 g/m2 > 8 mm):

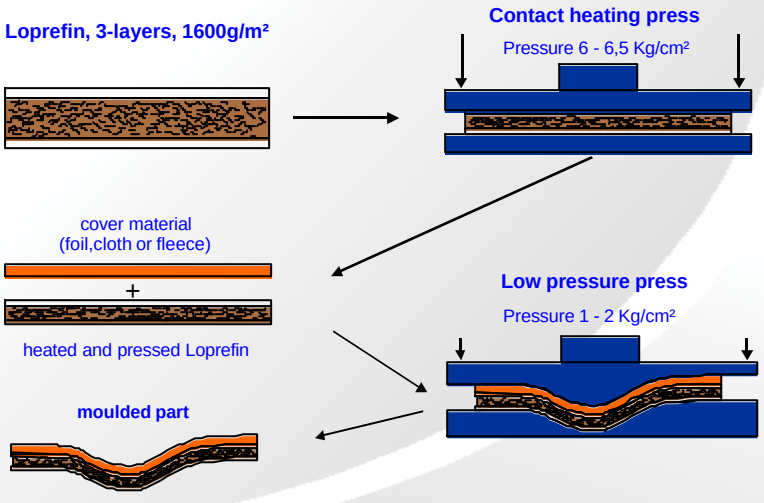
- Heating with contact press (pressure needed for impregnation): Nafcoform and Loprefin
- Heating with infrared or hot air: SymaLite
- Stacking with decorative layers > one step decoration process
- Automized transfer into the mold
- Part stamping with low-pressure-molding (< 5 bar) -> sensitive materials like foam possible
- Molds from aluminum (serial tools), wood or plastic (prototypes) -> low cost production process



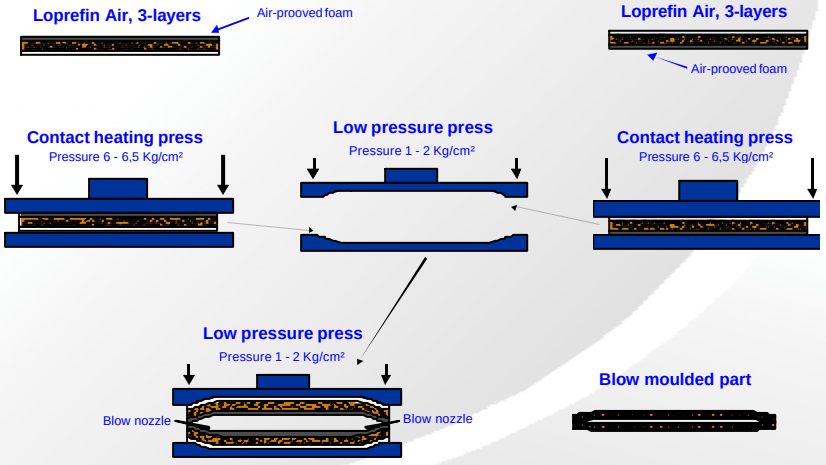




## Processing of Loprefin:



# Processing of Loprefin Air:

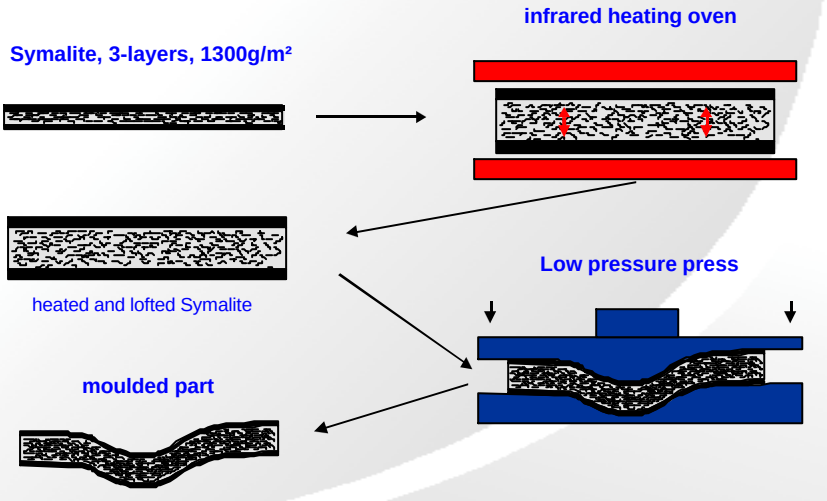









# Processing of SymaLite:



# INTERIOR APPLICATONS

Natural or glass fibers / PP, PET / PP:

- Hat rests
- Door panels
- Roof liners
- Instrument panels
- Center consoles
- Pillar cladding
- Luggage compartment cladding
- Surface layers for sandwich parts like load floors







PP/glass fleece: hat rest of BMW 3-series:

## Loprefin: Door insert of Ford Mondeo:







## PP/NF fleece : Load floor of Mercedes C-class:

## SymaLite: Door panel

In mold graining: molding of PP-film with foam-back in sequence with low pressure forming of structural back with blank of SymaLite (alternative: Nafcoform)

Mold- and process technology:
Röder & Spengler, Offenbach







## SymaLite: Door panel

Cross sections show excellent 3-d-drapability and homogeneity of wall thickness - no collapsing of foam layer

# EXTERIOR APPLICATIONS

Glass fibers / PP

- Big underfloor parts with high toughness PP-films for protection against stone chipping
- Structural part for exterior body panels with a surface skin out of
  - coil coated aluminum
  - incolored plastic film, thermoformed or injection molded

Natural fibers / PP

- Wheel housings

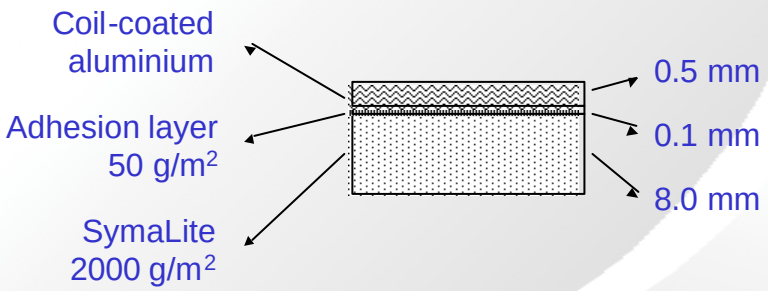






SymaLite: Underbody parts

## Structural roof module out of SymaLite:




Generic cross section







## Glass / PP with PP-film:

- Coarse granulation (particle size: 20 mm)
- Use as raw materials for GMT-production or inhouse LFT compression or injection molding process

## Natural fibers with different decoration materials:

- Fine granulation (particle size: 3 mm)
- Use as center layer of sandwich fleeces
- Use as raw materials for injection molding process

Advantages of materials for lightweight design by tailored consolidation:

- High specific structural stiffness
- Good acoustic properties (noise absorption)
- High specific energy consumption (toughness)
- One-step-decoration with sensitive materials like films and textiles with a foam backside
- Simple process technology and low investment cost due to low pressure molding
- Fast and low cost production of prototypes with final material (wooden or plastic tools)







# HIGH END APPLICATIONS (DEVELOPMENT)

Glass, aramide und carbon fibers / engineering and high performance thermoplastics:

- Underbody shields with higher operating temperature (GF/PET/PBT)
- Online paintable structural parts (CF/PET/PBT)
- Big interior parts for buses, trucks and railways (GF / flame retardant thermoplastics)
- Aircraft interior parts: sidewall panels, hat racks, floor panels and roofliners (CF/PEI)