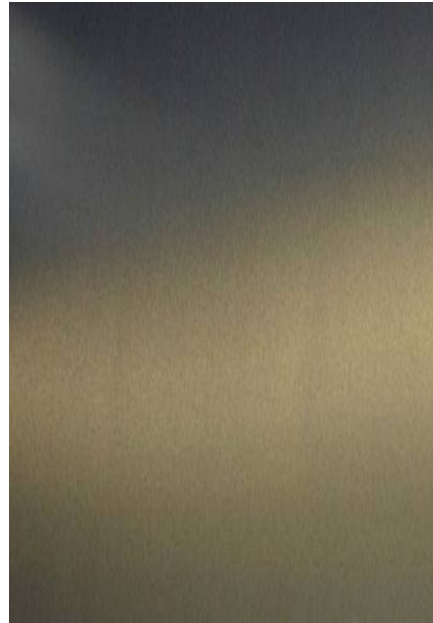
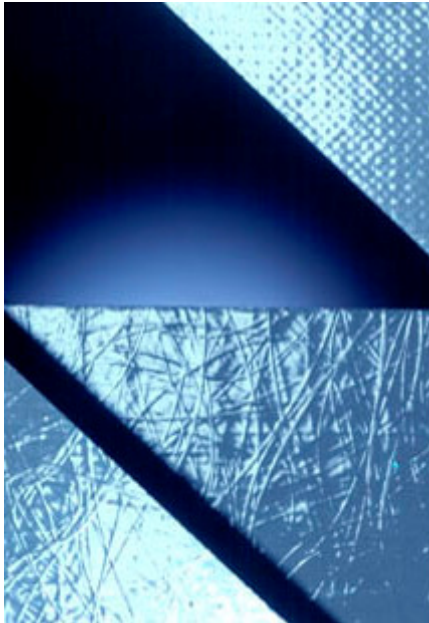




Advantages of GRP compared to Steel Sheets

# Advantages of GRP compared to Steel



- Overview product advantages
  - Low weight at high mechanical strength
  - Weathering resistance especially against hail
  - Lower deformation-incline than steel
  - Corrosion resistance (no rust)
  - On demand the GRP is protected by a special gel coat layer instead of a common finishing on steel
  - The gel coat is chemically bonded on the GRP (Spalling like on common finishing is not possible)
  - Gel coat provide high UV and colour stability over a long period
  - High gloss
  - Non-porous surface
  - Easy to clean
  - Unlimited colouring possibilities
  - Resistance to corrosion
  - Resistant to atmosphere conditions
  - The gel coat has a high flexibility and tensile elongation (it is crack insensitive)

# Advantages of GRP compared to Steel



- Overview product advantages

- Resistant to chemicals
- GRP and the gel coat layer are solid coloured compared to painting
- printing and painting of the GRP is possible
- Easy to handle in the process (sawing, drilling, jet cutting, ...)
- Compared to the sharpness of the edges of steel the risk of injury (cutting) with GRP is lower
- High chunking resistance (screws, rivets)
- No breaks or buckling while processing
- Much better thermal insulation than steel
- GRP has a better sound reduction index than steel sheets
- Better environmental balance than with many other materials
- GRP is (without any special additives) an insulator
- GRP transfers forces only remote
- Repairing possibilities of damages and scratches
- Consistent quality through continuous production process
- Production width of GRP up to 3,20m!
- Qualified for a usage in the food industry
- Moisture resistant

# Advantages of GRP compared to Steel



- Weathering resistance especially against hail
- Lower deformation-incline than steel



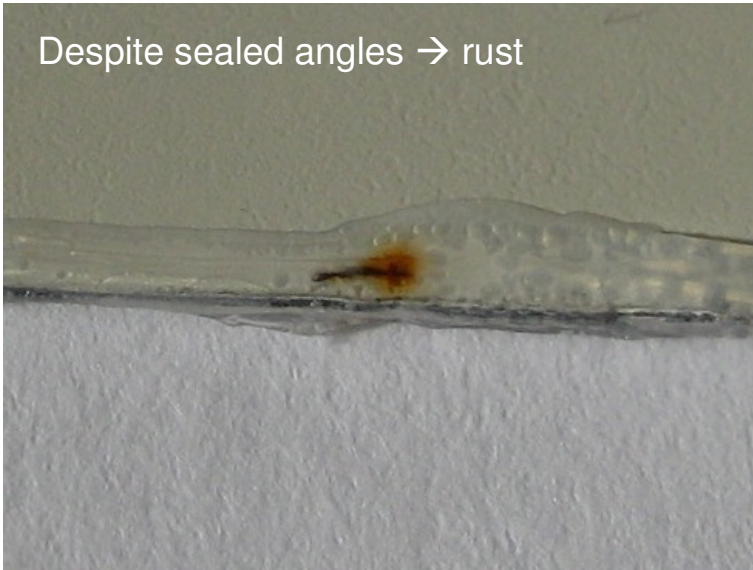
# Advantages of GRP compared to Steel



- Corrosion resistance (no rust)

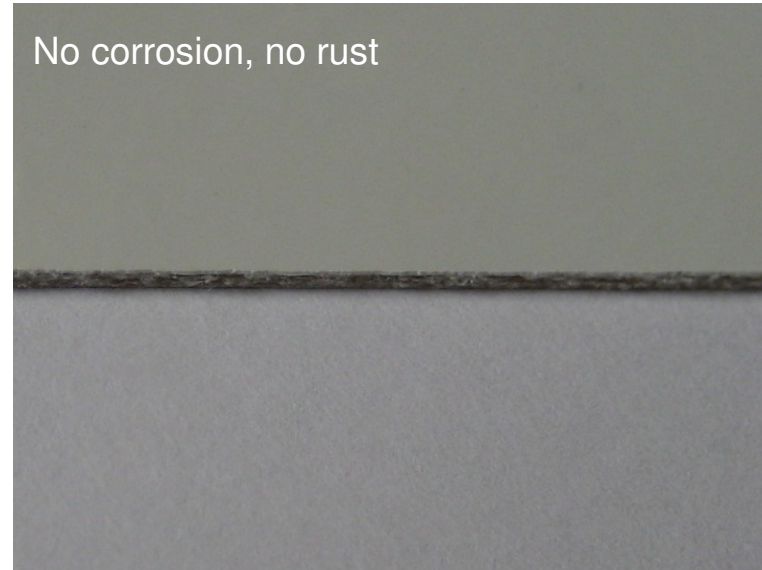
Towards DIN EN ISO 9227 NSS „salt spray test“ 480 h

Despite sealed angles → rust



Substrate: GI 120 gsm 0,5 mm with METASHELD™

No corrosion, no rust



LAMILUX Super Plus Gelcoat 1,2 mm



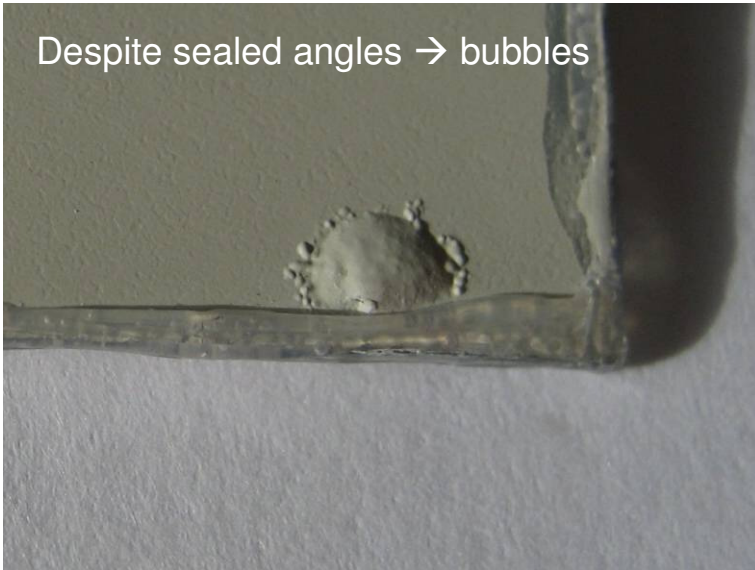
# Advantages of GRP compared to Steel



- Corrosion resistance (no rust)

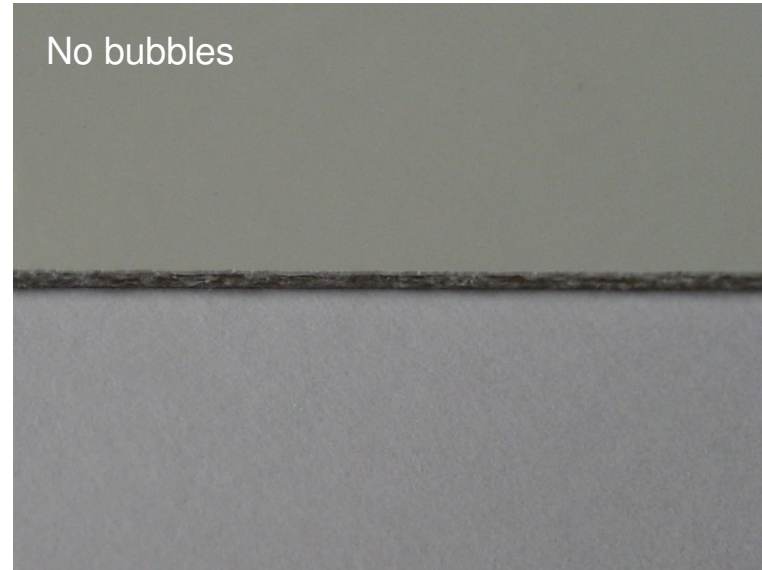
Towards DIN EN ISO 9227 NSS „salt spray test“ 480 h

Despite sealed angles → bubbles



Substrate: GI 120 gsm 0,5 mm with METASHELD™

No bubbles



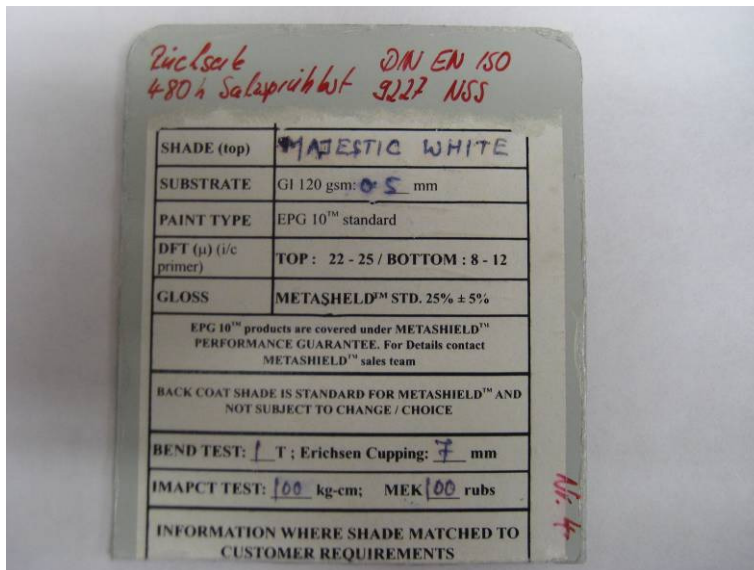
LAMILUX Super Plus Gelcoat 1,2 mm

# Advantages of GRP compared to Steel

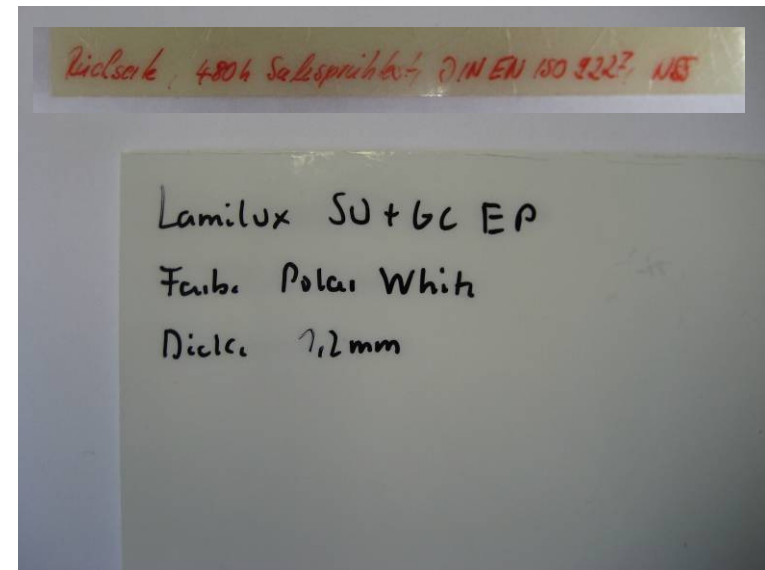


- Corrosion resistance (no rust)

Towards DIN EN ISO 9227 NSS „salt spray test“ 480 h



Substrate: GI 120 gsm 0,5 mm with METASHIELD™

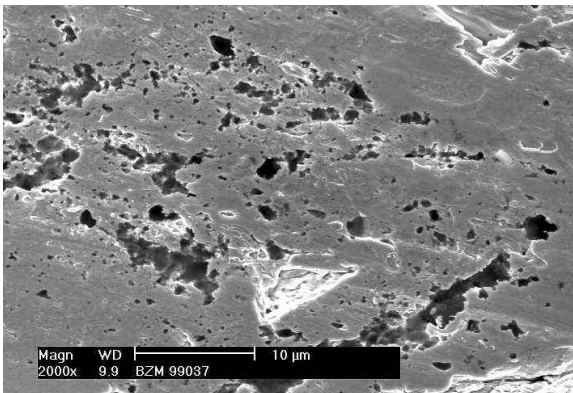


LAMILUX Super Plus Gelcoat 1,2 mm

# Advantages of GRP compared to Steel



- Comparison towards DIN EN ISO 9227 NSS „salt spray test“ 480 h:
  - Despite the sealed angles of the coated steel the sample began to rust and to build up bubbles under the coating
  - The LAMILUX Super Plus Gelcoat 1,2 mm however showed no changes in the “salt spray test”





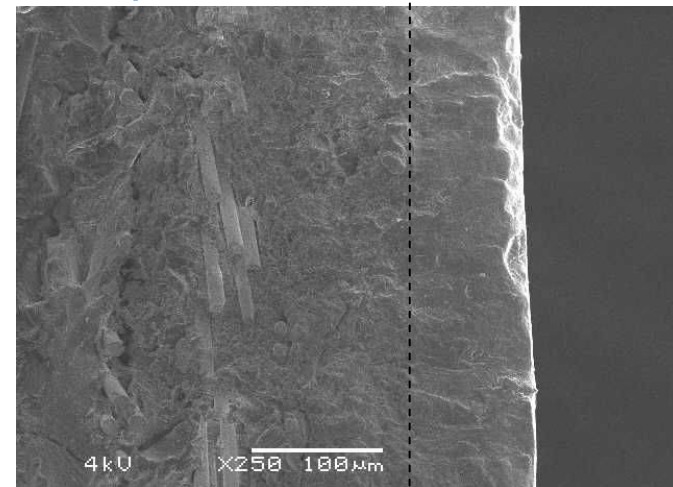
# Advantages of GRP compared to Steel



- On demand the GRP is protected by a special gel coat layer instead of a common finishing on steel
- This provides a lot of advantages
- The gel coat is chemically bonded on the GRP

Spalling like on common finishing is not possible

- The gel coat is fibre free and based on isophthalic acid



# Advantages of Gel Coat



- Gel coat provide high UV and colour stability over a long period
- High gloss
- Non-porous surface
- Easy to clean



# Advantages of Gel Coat



- Unlimited colouring possibilities
  - RAL
  - NCS
  - Customer specific
  - Metallic
  - Translucent
- Resistance to corrosion
- Resistant to atmosphere conditions
  - Rainwater, seawater, de-icing salt, environmental pollution durability
  - Tough surface against dust and sand erosion



# Advantages of Gel Coat



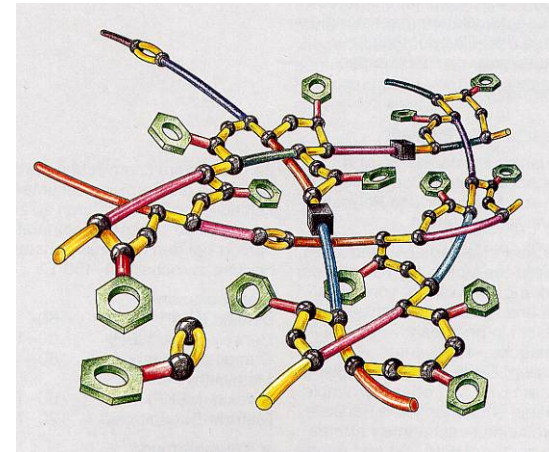
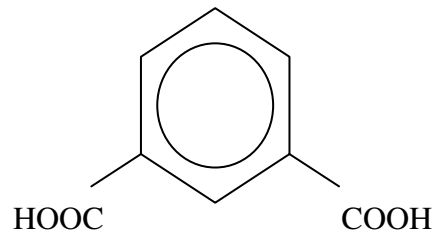
- The gel coat has a high flexibility and tensile elongation
- It is crack insensitive



# Advantages of Gel Coat



- Resistant to chemicals
- UP resin gel coat based on isophthalic acid





# Advantages of Gel Coat



- GRP and the gel coat layer are solid coloured compared to painting
  - Insensitive to scratches
  - Non-sensitive to stone-chipping
  - Additional painting is not necessary



# Advantages of Gel Coat



- Nevertheless printing and painting of the GRP is possible
- Easy to roughen
- Uncomplicated to paint



# Advantages of GRP compared to Steel



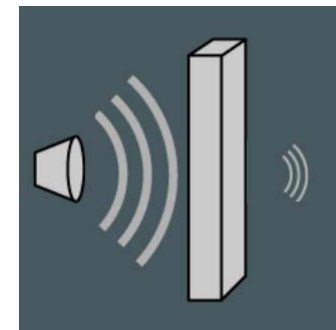
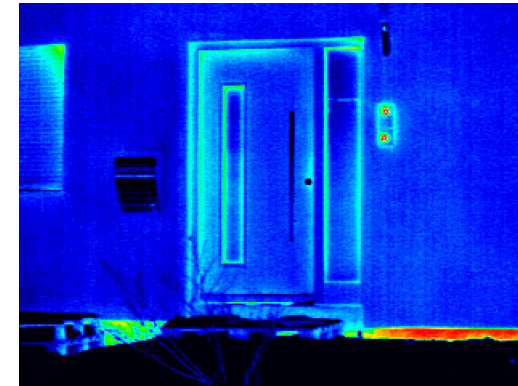
- Easy to handle in the process (sawing, drilling, jet cutting, ...)
- Compared to the sharpness of the edges of steel the risk of injury (cutting) is with GRP lower
- High chunking resistance (screws, rivets)
- No breaks or buckling while processing



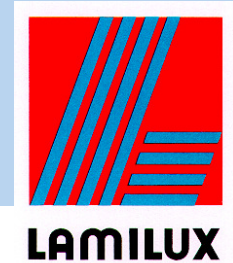
# Advantages of GRP compared to Steel



- High strength
- Much better thermal insulation than steel
  - GRP has a heat conductivity about 0,21 W/mK
  - Steel has a over 200 times higher heat conductivity with approx. 45 W/mK
- GRP has a better sound reduction index than steel sheets
  - this is especially an advantage for applications with higher demands on sound reduction (e.g. roof)



# Advantages of GRP compared to Steel



- Better environmental balance than with many other materials

| Environmental balance             | Unit           | Construction Steel<br>S235J2 | Stainless Steel<br>AISI316L | GRP<br>E23             | Aluminium<br>AlMgSi1   |
|-----------------------------------|----------------|------------------------------|-----------------------------|------------------------|------------------------|
| Energy consumption                | GJ             | 270                          | 300                         | 120                    | 269                    |
| Critical volume of polluted air   | m <sup>3</sup> | 697                          | k.A.                        | 74                     | 565                    |
| Critical volume of polluted water | m <sup>3</sup> | 7,3 * 10 <sup>6</sup>        | k.A.                        | 17,7 * 10 <sup>6</sup> | 53,6 * 10 <sup>6</sup> |

Source: Greenbuilding, Issue 05/09, Bauen, Page 27

- the production of Construction steel or Aluminium has a approx. 125 % higher energy consumption in comparison to the production of GRP
- in comparison to the production of GRP, the production of Construction steel has a 9,4 times higher volume of critical polluted air



# Advantages of GRP compared to Steel



- GRP is (without any special additives) an insulator
- GRP does not conduct electricity
  - Insulator  $\rho > 10^{12} \Omega \cdot \text{cm}$
  - Semiconductor  $\rho = 10^{-4} \text{ to } 10^{12} \Omega \cdot \text{cm}$
  - Conductor  $\rho < 10^{-4} \Omega \cdot \text{cm}$

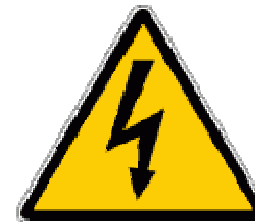
## GRP

specific resistance:  
approx.  $10^{15} - 10^{16} \Omega \cdot \text{cm}$



## Steel

specific resistance:  
approx.  $10^{-8} \text{ to } 20^{-8} \Omega \cdot \text{cm}$



# Advantages of GRP compared to Steel



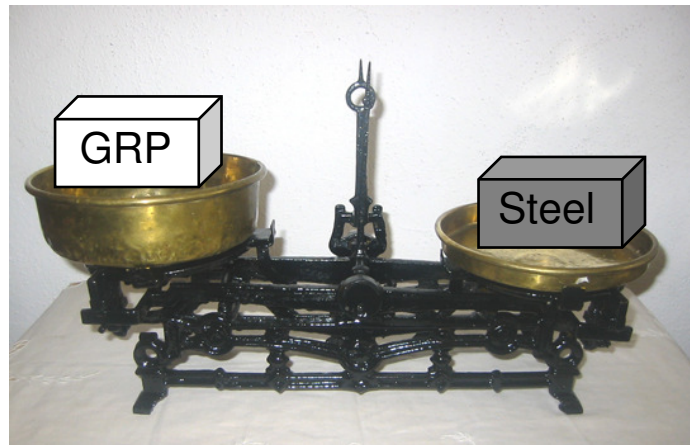
- GRP transfers forces only remote
  - In case of a small accident merely a slight part around the force transmission point has been damaged
- Repairing possibilities of damages and scratches
  - For more information, see our [repair manual and recommendations](#) on the LAMILUX homepage and do not hesitate to contact us if you need any support



# Advantages of GRP compared to Steel



- Using GRP can save weight (and energy) in a lot of cases
  - Density of GRP (in our case) is about  $1,35 \text{ g/cm}^3$
  - Density of steel is about  $7,85 \text{ g/cm}^3$



# Advantages of GRP compared to Steel

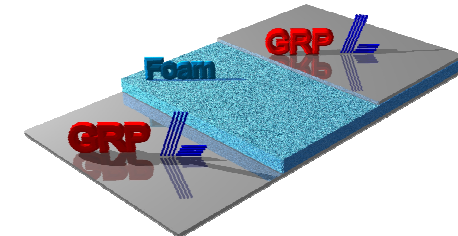


- Using GRP can save weight (and energy) in a lot of cases
  - For instance this means for a sandwich-panel:

If you use 2.0 mm GRP instead of 0.6 mm steel

GRP:  $2 * 1 \text{ m}^2 * 2.0 \text{ mm} * 1,35 \text{ kg/m}^2\text{mm} = 5,4 \text{ kg}$

Steel:  $2 * 1 \text{ m}^2 * 0.6 \text{ mm} * 7,85 \text{ kg/m}^2\text{mm} = 9,42 \text{ kg}$



→ in this case you can save approx. 4 kg per m<sup>2</sup> sandwich panel

or in other words:

→ you reduce the weight of the sandwich panel about 40 %

# Advantages of GRP compared to Steel



- Physical Properties of GRP in comparison to Steel

|                                       | GRP                                                                                              | Steel                          |
|---------------------------------------|--------------------------------------------------------------------------------------------------|--------------------------------|
| Density [kg/m <sup>3</sup> ]          | approx. 1.350<br>(depending on glass content)                                                    | 7.850                          |
| Linear expansion                      | approx. $30 - 40 \cdot 10^{-6} \text{ 1/K}$<br>(depending on glass content,<br>thickness, resin) | $12 \cdot 10^{-6} \text{ 1/K}$ |
| Heat conductivity [W/mK]              | 0,21                                                                                             | 45                             |
| Tensile strength [N/mm <sup>2</sup> ] | 35 – 150<br>(depending on glass content / glass<br>construction, product-type)                   | 270 - 440                      |
| Tensile elongation [%]                | 1,3 – 4,0<br>(depending on glass content, resin)                                                 | approx. 28                     |

# Advantages of GRP compared to Steel



- Physical Properties of GRP in comparison to Steel
  - Thin sheet steel often has to be “corrugated” to handle it easy in the process and to have a good stiffness in the product
  - This is not necessary with GRP
  - The high stiffness of GRP allows to use a flat and smooth surface





# Advantages of our Production Process



- Consistent quality through continuous production process
- We can supply you with GRP up to 3,20 m width, this is really unique in the continuous production of GRP and continuous sheet materials
- Due to our automated temperature control on the line we are able to produce tension free material



# Overview of LAMILUX GRP Product Range



- Thickness 0,8 – 5,0 mm
- Width max. 3.200 mm
- Delivery form sheets up to 12 m length - coils up to 300 m length
- Colour RAL, NCS, dual colour or customized colours
- Reinforcement glass mats, woven fabric, multi-axial fabrics
- Surface veil, gel coat
- Optical characteristics woven structure, veil, high gloss, mat finish, decor
- Reverse side smooth, corona treated, sanded



# Advantages of our Production Process



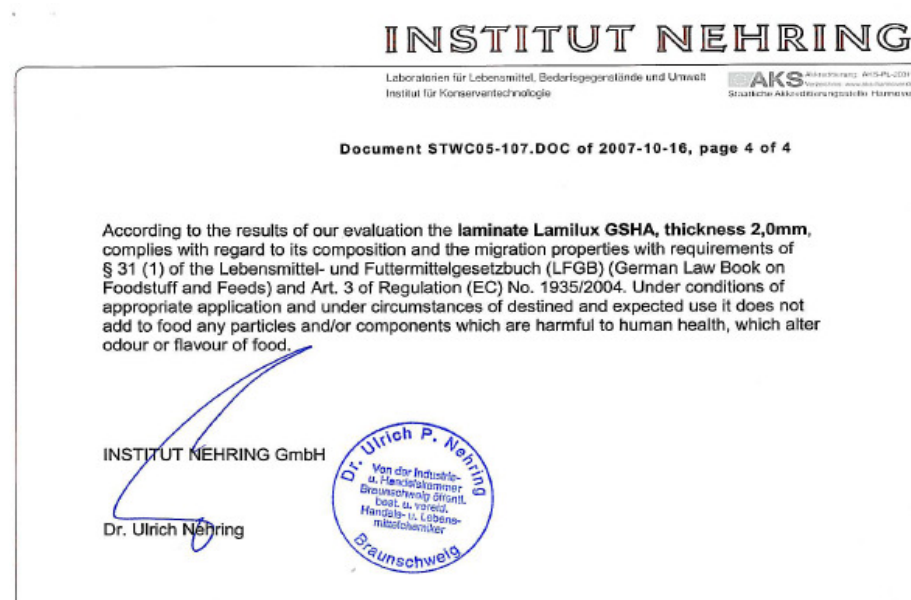
- Besides the unlimited colour range it is possible to produce translucent material, for instance for the roof of trailers



# Advantages of our Production Process



- Our material is qualified for a usage in the food industry
- This was analysed and approved by „Institut Nehring“  
(extract from the original test certificate)



# Advantages of our Production Process



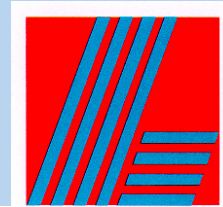
- Due to the moisture resistance of the GRP, the material has a good resistance to microorganisms and moulds
- For example: tests showed, that LAMILUX GRP material without any antibacterial additives is resistant to staphylococcus aureus ATCC 6538
  - After 24 hours nothing could be detected

[cfu/sample]

| Test strain -->                                    | Staphylococcus aureus ATCC 6538            |                |
|----------------------------------------------------|--------------------------------------------|----------------|
| Samples                                            | 0'                                         | after 24 hours |
| 01 CXS07.0239-1,<br>Blank                          | 1.0*10 <sup>5</sup><br>1.1*10 <sup>5</sup> | <100<br><100   |
| 02 CXS07.0239-2,<br>IRGAGUARD B6000                |                                            | <100<br><100   |
| 03 CXS07.0239-3,<br>IRGAGUARD B6000                |                                            | <100<br><100   |
| 01 CXS07.0239-1,<br>Blank<br>Without preincubation | 1.0*10 <sup>5</sup><br>1.1*10 <sup>5</sup> | <100<br><100   |

O/n culture *Staphylococcus aureus* ATCC 6538: 8.7\*10<sup>9</sup> KBE/ml (1:10000)

# Quality and Consistency



**LAMILUX**



## Raw Material Control

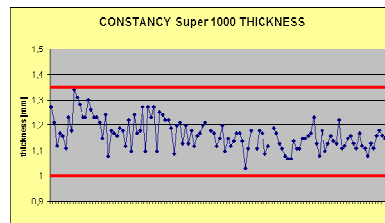
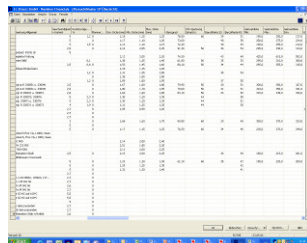
- 100% of all resins
- Partial control of glass mats

## Process control and final control

- 100% process control
- Final control:
  - Every second coil: barcol hardness, thickness, delamination, transparent
  - 2 times per shift: surface tension, gel coat thickness
  - 3 times per shift: pinholes



## Feedback and Statistic



## Laboratory

- Approx. 1% of the production
- Tensile and binding strength
- Residual styrene
- Gloss
- Yellowing
- Long term surface tension
- IR-test
- Barcol hardness
- Glass content
- Surface tension, dyne level
- Long term temperature tests
- Bending radius



27.05.2009

M. Gräf

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# Continuous Product Testing



- Impact and tensile strength
- Test reports



# Continuous Product Testing



- Heat-cold bending test
  - 8 hours at 80 °C
  - 16 hours at -30 °C



- Heat-cold test
  - 8 hours at 80 °C
  - 16 hours at -30 °C



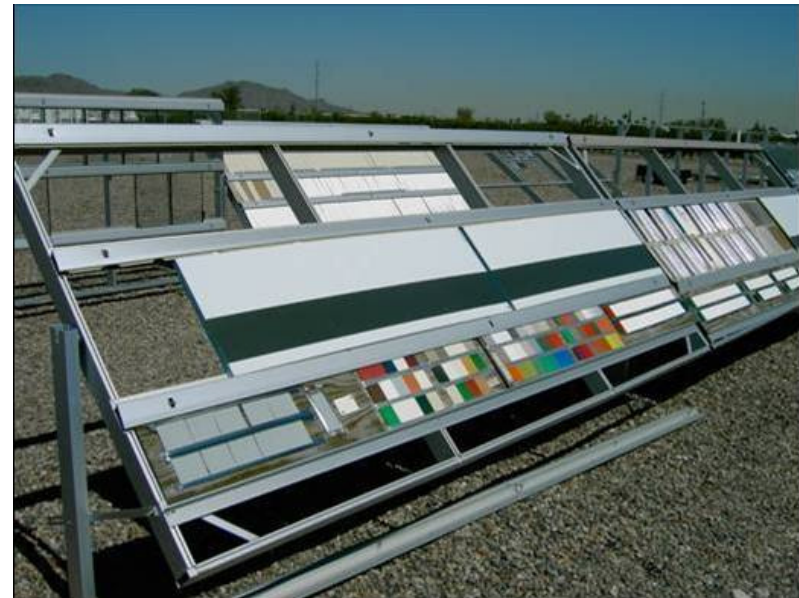
# Continuous Product Testing



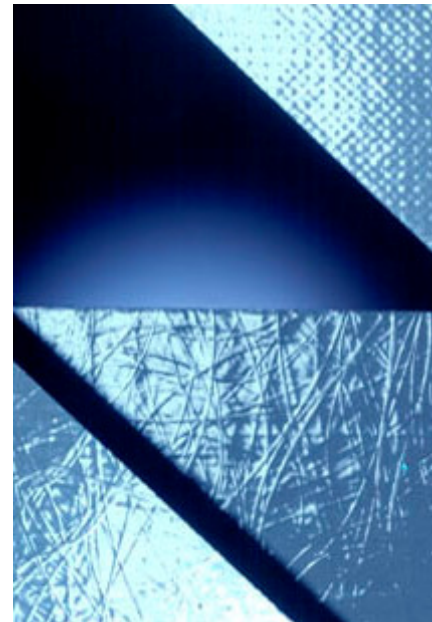
- Halogen radiation at 80 °C



# Continuous SUN-tests in Arizona







We are looking forward to welcoming you to LAMILUX