Thermoplastic Composites

A trend to keep an eye on

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Polymer Innovation Day
November 11th 2014
Jos Lobée

- Education TU Delft 1985
- GE Plastics 1987 – 2000, TNO Industry, Pezy Development
- Modified Materials BV 2008
  - Engineering competences: product development polymer properties and polymer processing
  - Green projects
  - Co-operation
- Innovation coach DPI Value Centre
Thermoplastic composites

• Who are you?

• What is thermoplastic composite, and what can your company do with it?
  - Affordable strength and stiffness
  - Family of materials
  - Not suited for mirror-finish surfaces
Thermoplastic composites
Composites

- Mother Nature developed e.g. wood
- Fiber - binder combination, with good interaction: wetting and adhesion
Comparing with Thermosets

• **Thermosets**
  - Low viscosity resin, easily penetrating fibre material
  - Chemical bond to the fibre surface

• **Thermoplastics**
  - Viscous melt
  - Polymer modifications needed to get adhesion

=> Pre-impregnated materials
Impregnation with thermoplastics

- **Fabric**
  - Solvents method
  - Film stacking
  - Double belt press

- **UD-Tape and Long Fiber granules**
  - Impregnator head
Fibers

• Length of the fiber is a key determining factor:
  - Stiffness, Strength, Impact

• Fibers are supplied in several materials, forms and weights/m²
  - Glass, Carbon, Aramid, Basalt
  - Seizing
  - Fabric weave types: plain, twill, satin, random, Uni Directional
How to process Thermoplastic composites

- Heat, shape, cool
- Fibers can be curved, not stretched. 2D ++
- Welding vs. adhesive bonding
- Recycle by hacking and melting
- Combine with other processes
K 2013

• Three suppliers Arburg, Engel, Kraus Maffei with un-manned, automatic running production units.
What is happening in the market?

Important major trends:

• Reduce CO2, increase fuel efficiency
• Deep water oil-gas drilling
• Increased comfort, reduce physical efforts
• Fast moving machine parts
• High pressure containers for CNG and H2
Boeing 787 Dreamliner

Materials used in 787 body
- Fiberglass
- Carbon laminate composite
- Carbon sandwich composite
- Aluminum/steel/titanium

Total materials used by weight:
- Composites 50%
- Aluminum 20%
- Titanium 15%
- Steel 10%
- Other 5%

By comparison, the 777 uses 12 percent composites and 50 percent aluminum.
BMW i3 en i8
Automated high speed tape processing

AFPT : Tape placement 10 – 30 kg per uur
Where is it happening?

• Germany, in the Achen and Munich region
  - Mega clusters, mega budgets
  - We need to speed up to keep up

• The Netherlands
  - Tech University Enschede and Delft
  - TPRC and NLR
  - Saxion, Windesheim, InnHolland
  - Multinationals: Sabic, DSM, Fokker, Ten Cate, Voest Alpine, PPG
  - Less than 10 SME’s, few applications at OEM’s
For you: long fiber granules

- Standard injection moulding material
  - Increased stiffness: $E = 7000 \, \text{N/mm}^2$ and more
  - Increased strength: LG-PP is stronger than GF-PA
  - Increased impact: min. factor 2 vs short glass
  - Improved creep resistance
  - Lower orientation

- Needed: mild screw, gating
For you: tape

- Winding around mould or plastic product
- Hot air gun, and rotating axis

CMB, Hendrikx, Peters, MoMa
For you: tape properties

• **Fiber** is the determining factor
  - E-module 70 Gpa
  - Strength 2 GPa
  - Glass content 60% (wt) 35 % (vol)

• 0,35*25 mm tape contains ca. 3 mm2 glass. Theoretical tensile strength 6000 N **in length direction**

• **Thermoplastic material** determines e.g. use temperature, processing, adhesion. In bending the thermoplastic material transmits the loads
For you: Fabric

Voest Alpine Roosendaal
For you: Fabric properties

- Properties are depending on fiber direction, weave, polymer etc.

- Example:
  - Tepex dynalite 104-RG600 47% glass-PP

<table>
<thead>
<tr>
<th>Fiber direction</th>
<th>80%</th>
<th>20%</th>
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<tbody>
<tr>
<td>Tensile modulus</td>
<td>30 Gpa</td>
<td>14 Gpa</td>
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<tr>
<td>Tensile strength</td>
<td>470 Mpa</td>
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<tr>
<td>Flex modulus</td>
<td>24 Gpa</td>
<td>10 Gpa</td>
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<tr>
<td>Flex strength</td>
<td>545 Mpa</td>
<td>160 Mpa</td>
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</table>
Challenges

Supply and development
• Young industry, part manufacturing capacity is being built
• Part developments are more complex, co-operation is likely and smart
• Colours

Technology
• Surface quality
• Edge finish
• Thermal expansion differences
Possible applications

• **Pressurised systems**
  - Piping and couplings, storage tanks

• **Moving systems**
  - Automotive, scooters, bicycles
  - Buggy’s, wheel chairs
  - Machine parts

• **Portable systems**
  - Measuring devices, tools
  - Sporting goods, care market
  - Furniture

• Material replacement: metal assemblies, die-cast aluminum, thermosets, thick wall injection products.
DPI Value Centre

- Thermoplastic composites multi discipline
  - Thermoplastics
  - Fibers / textile
  - Composite engineering, QA

- DPI Value Centre’s role is to speed up and improve innovation at SME’s. Building networks and clusters is daily work.

- We are planning to set up cluster projects in Q1 2015. Please contact me if you are interested.
Thank you !