How we’re scaling up lightweight materials

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Evonik intends to make composites more suitable for mass production.
Major levers for efficient mobility

Lightweight construction

Lubricants

Tires
Composites for sustainable mobility

Trends in automotive and aerospace engineering
• Energy efficiency and reduction of CO$_2$ emissions
• Passive safety
• Multifunctional components
• Design freedom

Composite materials
• Are lightweight
• Exhibit exceptional mechanical stability
• Combine different material properties
• Allow tailored properties
Structure of composite materials

Fibers (glass or carbon) + Polymer matrix → Composite

Many material combinations and manufacturing technologies

⇒ Huge diversity in properties and potential applications
Extensive composite material expertise

Composite (sandwich) system

Thermoplastics

Interface

Fiber

Thermosets

Crosslinker

Thermoset modifier

Foam core

Additives/rheological modifier

Matrix

Adhesive/sealant

magnified 10,000 times
Composite materials are already used in certain vehicle classes

Application examples

- Roof
- Body components
- Engine hood
- Trim components
- Trunk lid
Composite materials are an attractive growth market

- Healthy, steady growth (CAGR: 6 – 11%)
- Stable thanks to applications in aviation, wind power, sports, and leisure
- Significant potential for growth in the automotive sector
- Success depends on technology development

The market for carbon-fiber reinforced plastics (CFRP)

Source: CCeV Market Report 2014
The challenge for mass production

Total costs of a painted composite part

- **Painting** (done by hand)
- **Processes** (unsuitable for mass production)
- **Carbon fiber**
- **Polymer matrix**

**High technology costs**
- Composite materials are not currently used in large amounts in all vehicles
Evonik’s aim: efficient production of composite materials

Ecological semifinished product manufacturing
- Minimized energy consumption
- No or low solvents

Simplify part manufacturing
- High processing speeds
- High process stability/minimal waste

- Most effective use of expensive fibers
- Little production waste as possible for parts and semifinished products

Target
Hybrid polymer systems

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Seeking: The best of both worlds

<table>
<thead>
<tr>
<th>Thermoplastic matrix</th>
<th>Thermoset matrix</th>
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<tbody>
<tr>
<td>(no crosslinking between polymer chains)</td>
<td>(irreversible crosslinking between chains)</td>
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<tr>
<td>Easy to process and readily recyclable</td>
<td>Excellent mechanical properties, but longer processing times</td>
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The challenge

Composite material with excellent mechanical properties that is easy to process
A solution: Reversible hybrid polymer systems

Hybrid polymer systems combine thermoplastic processing with thermoset properties

**Thermoplastics**
Can be processed quickly, molded, welded, and recycled easily

**Thermosets**
Excellent mechanical properties
Pilot production of semifinished products and sample components

- Development of suitable processing chains
- Collaboration with semifinished product makers, equipment manufacturers, and companies that process fiber-reinforced plastics

Semifinished product

Heating

Cooling (~ 30 sec.)

Molded component
How we’re scaling up lightweight materials

• Hybrid polymer systems: easy to process, mechanically robust

• Reversible crosslinking principle is one example of hybrid polymer systems

• Material properties remain stable, even after material has been heated multiple times

• Pilot production of semifinished products is underway

• Samples have already been sent to initial customers

• Expected to be ready for the market from 2018