How we're scaling up lightweight materials

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March 26, 2015, Wesseling

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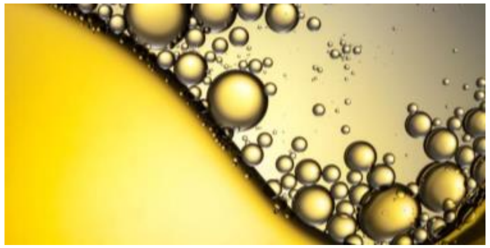
New concept for new materials: hybrid polymer systems

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

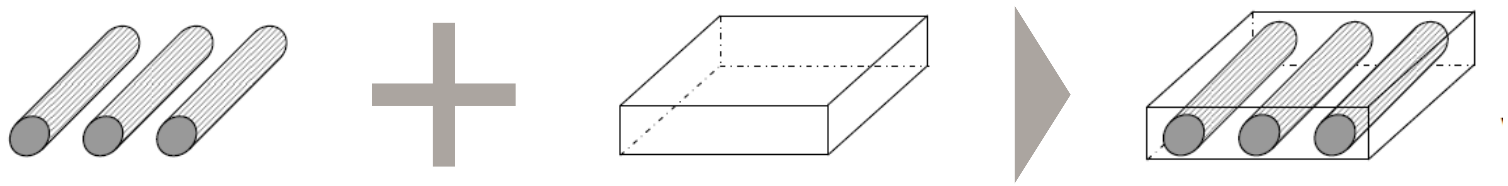
- Are lightweight
- Exhibit exceptional mechanical stability
- Combine different material properties
- Allow tailored properties

Structure of composite materials

Fibers
(glass or carbon)

Polymer matrix

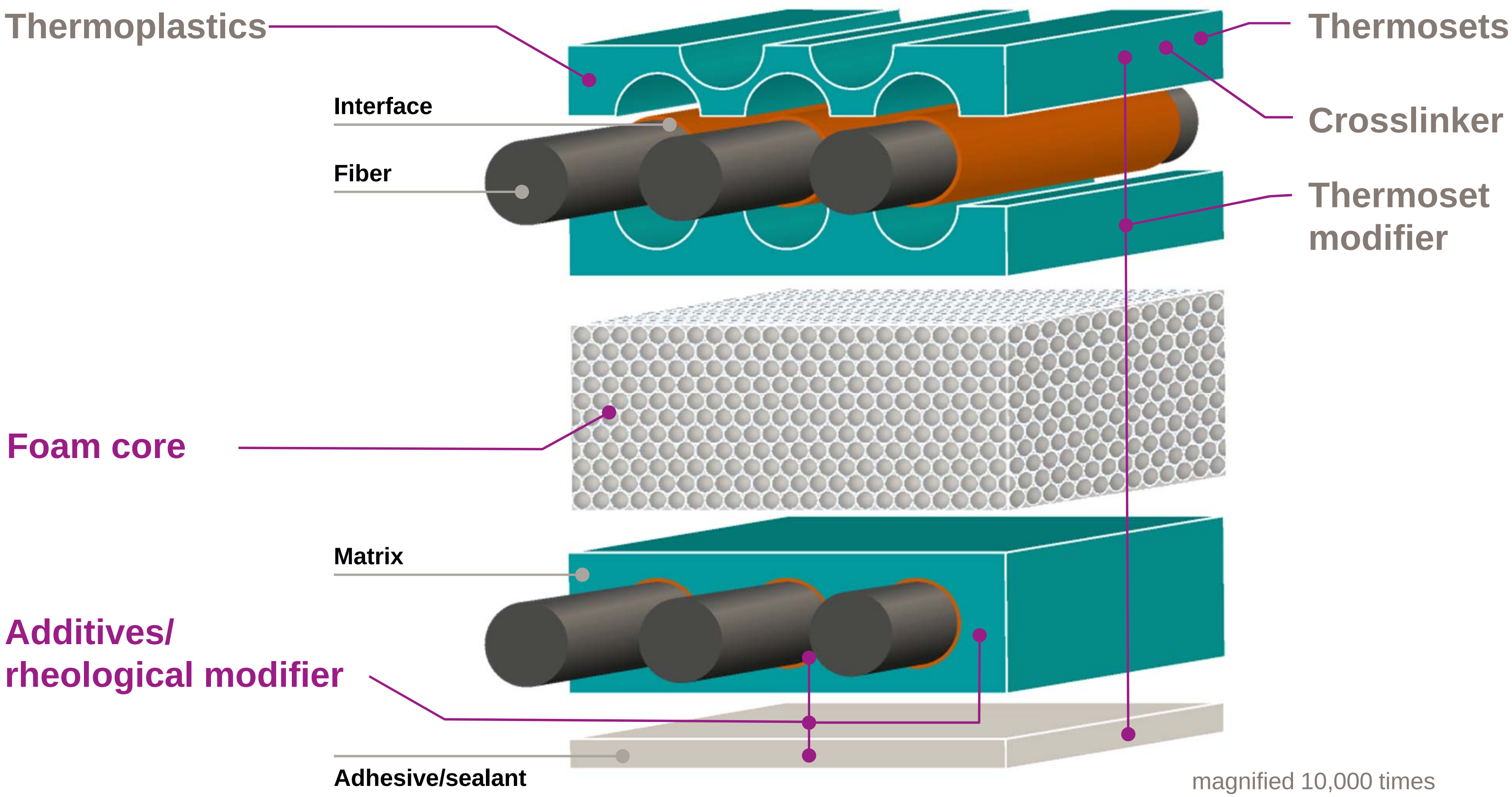
Composite



Many material combinations and manufacturing technologies
➔ **Huge diversity in properties and potential applications**

Extensive composite material expertise

Composite (sandwich) system



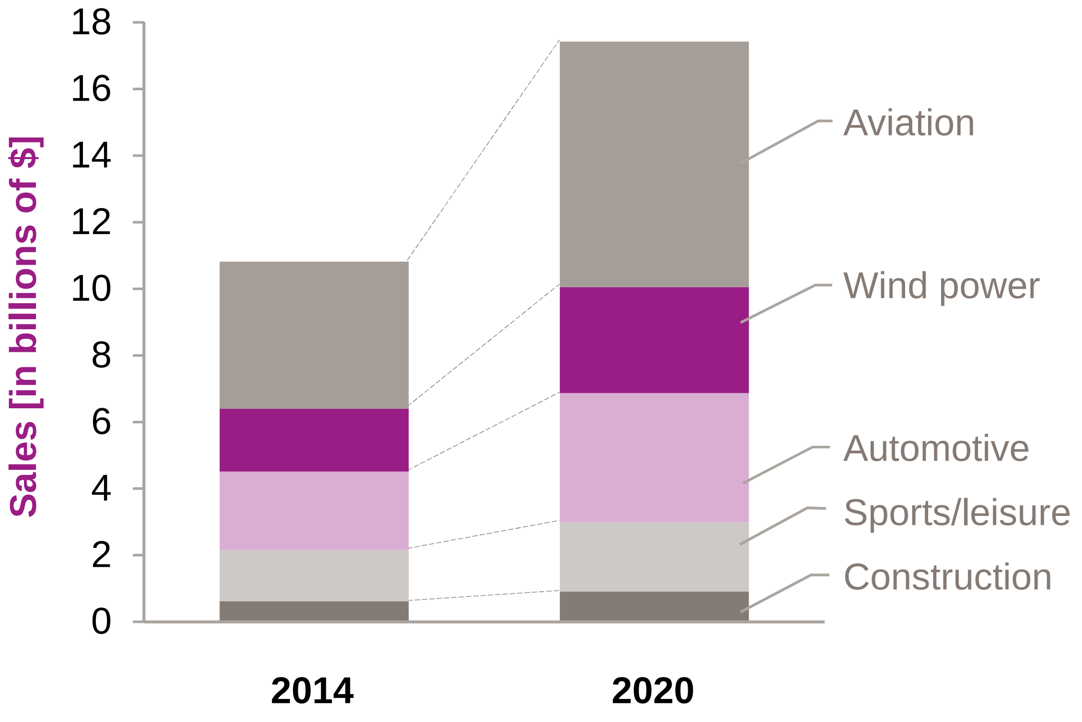
Composite materials are already used in certain vehicle classes

Application examples

- Roof
- Body components
- Engine hood
- Trim components
- Trunk lid

Composite materials are an attractive growth market

The market for carbon-fiber reinforced plastics (CFRP)

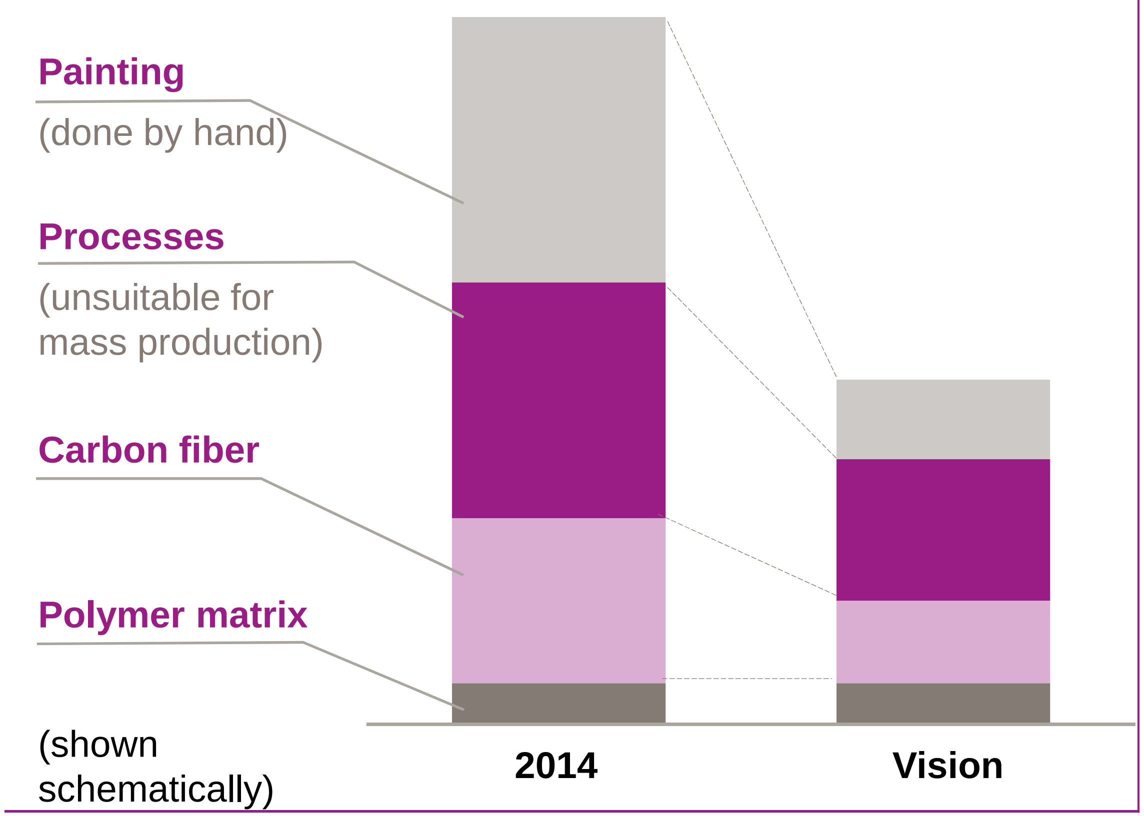


- Healthy, steady growth (CAGR: 6 – 11%)
- Stable thanks to applications in aviation, wind power, sports, and leisure
- Significant potential for growth in the automotive sector
- Success depends on technology development

Source: CCeV Market Report 2014

The challenge for mass production

Total costs of a painted composite part



High technology costs

- Composite materials are not currently used in large amounts in all vehicles

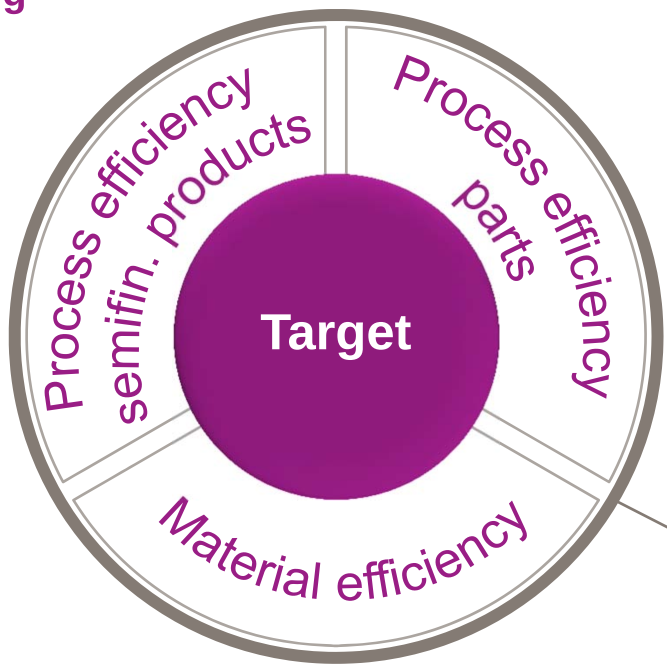
Evonik's aim: efficient production of composite materials

Ecological semifinished product manufacturing

- Minimized energy consumption
- No or low solvents

Simplify part manufacturing

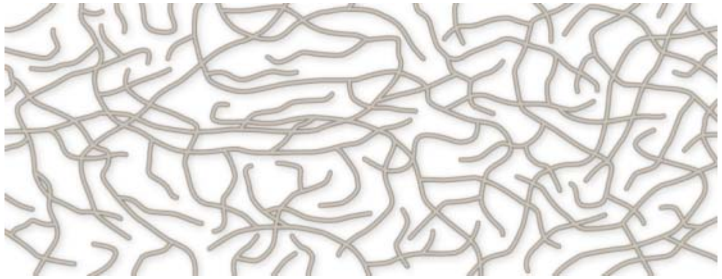
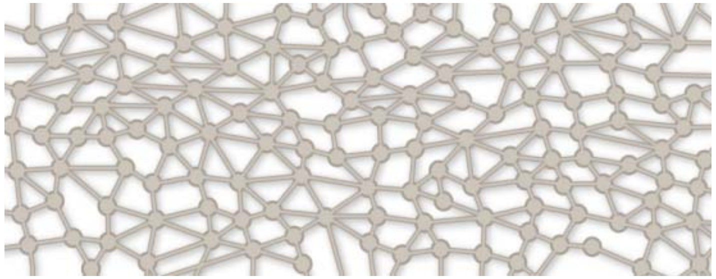
- High processing speeds
- High process stability/ minimal waste



Hybrid polymer systems

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

Seeking:
The best of both worlds

Thermoplastic matrix (no crosslinking between polymer chains)	**Thermoset matrix** (irreversible crosslinking between chains)
	
Easy to process and readily recyclable	**Excellent mechanical properties**, but longer processing times

The challenge

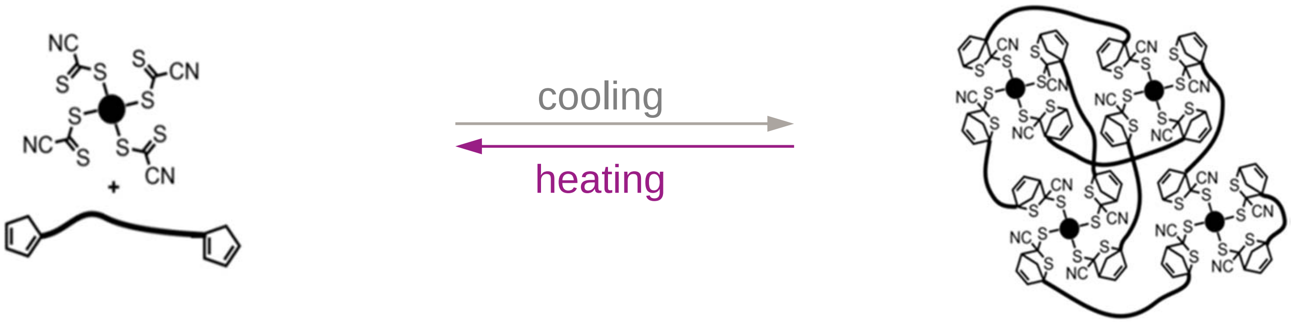
Composite material with **excellent mechanical properties** that is **easy to process**

A solution:
Reversible hybrid polymer systems

Hybrid polymer systems combine thermoplastic processing with thermoset properties

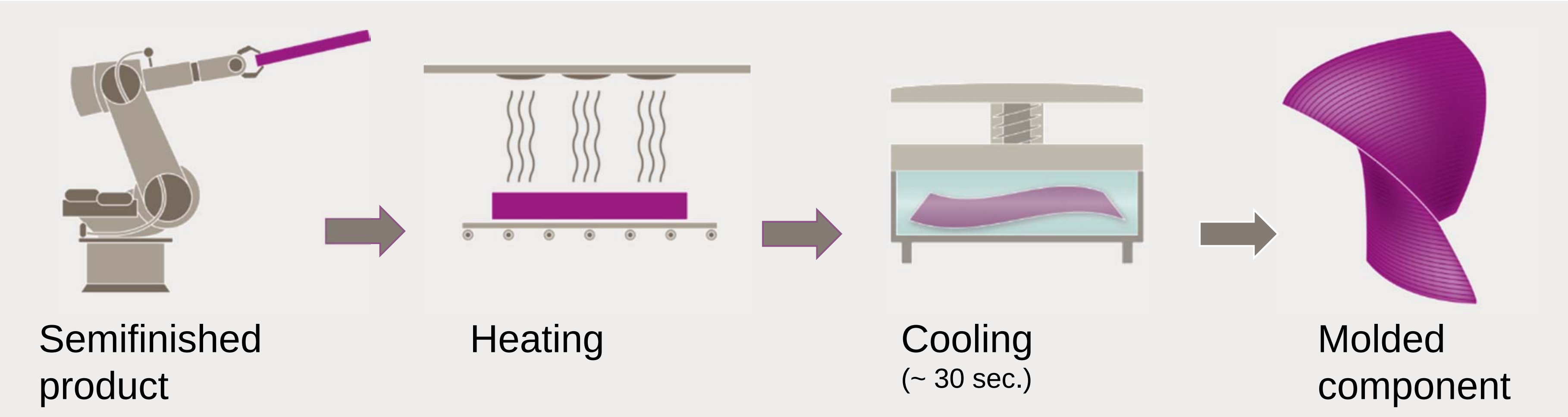
Thermoplastics
Can be processed quickly, molded, welded, and recycled easily

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



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

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