

**SGL GROUP**  
THE CARBON COMPANY

## Carbon fibres – Production, Products, Applications

„4a- Technologietag“  
3. März 2011

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**BROAD BASE. BEST SOLUTIONS.**

# Content

- **Introduction to SGL**
- **Market overview**
- **Processes and products**
- **Application examples**

# 1. Introduction to SGL Group

## Company profile



- SGL Group is one of the world's largest manufacturers of carbon-based products
- Comprehensive portfolio ranging from carbon and graphite products to carbon fibers and composites
- More than 40 production sites worldwide
- Service network covering more than 100 countries
- Sales of ~€ 1,2 bn in 2009
- Head office in Wiesbaden/Germany
- Approx. 6.000 employees worldwide
- Listed on MDAX

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# History

|      |   |  |
|------|---|--|
| 1878 | <b>Gebr. Siemens &amp; Co (Gesco)</b>   | Start of carbon production   |
| 1928 | <b>Siemens Plania Werke</b>   | Merger Gesco and Plania Sites in Poland  |
| 1985 | <b>SIGRI GmbH</b><br>50% Siemens, 50% Hoechst   | Merger Siemens Plania and Hoechst AG, Griesheim  |
| 1989 | <b>SIGRI GmbH</b><br>100% Hoechst   | Merger with Ringsdorff, Bonn   |
| 1992 | <b>SIGRI Great Lakes Carbon GmbH</b><br>67% Hoechst, 33% Horsehead Industries               | Merger with Great Lakes Carbon, USA  |
| 1993 | <b>SIGRI Great Lakes Carbon GmbH</b><br>59% Hoechst, 30% Horsehead Industries, 11% Pechiney | Merger with Pechiney Grafite, France   |
| 1995 | <b>SGL CARBON AG</b><br>51% Hoechst   | IPO Frankfurt/Main, Hoechst remains shareholder  |
| 1996 | <b>SGL CARBON AG</b><br>100% free float   | Listing on NYSE, USA, full independence  |
| 2007 | <b>SGL GROUP – THE CARBON COMPANY</b>   | Independent and listed company with operations in EU, NA, Asia and 3 global Business Units, delisting from NYSE, USA |
| 2008 | <b>SGL CARBON SE</b>  | Transformation of AG into a Societas Europaea  |

## Business structure



| Base Materials  | Advanced Materials  |  |
|---|---|--|
| Performance Products (PP)   | Graphite Materials & Systems (GMS)  | Carbon Fibers & Composites (CFC)   |
| <ul style="list-style-type: none"><li>– Graphite &amp; Carbon Electrodes</li><li>– Cathodes &amp; Furnace Linings</li></ul> | <ul style="list-style-type: none"><li>– Graphite Specialties</li><li>– Process Technology</li><li>– New Markets</li></ul> | <ul style="list-style-type: none"><li>– Carbon Fibers &amp; Composite Materials</li><li>– Composite Components</li></ul> |

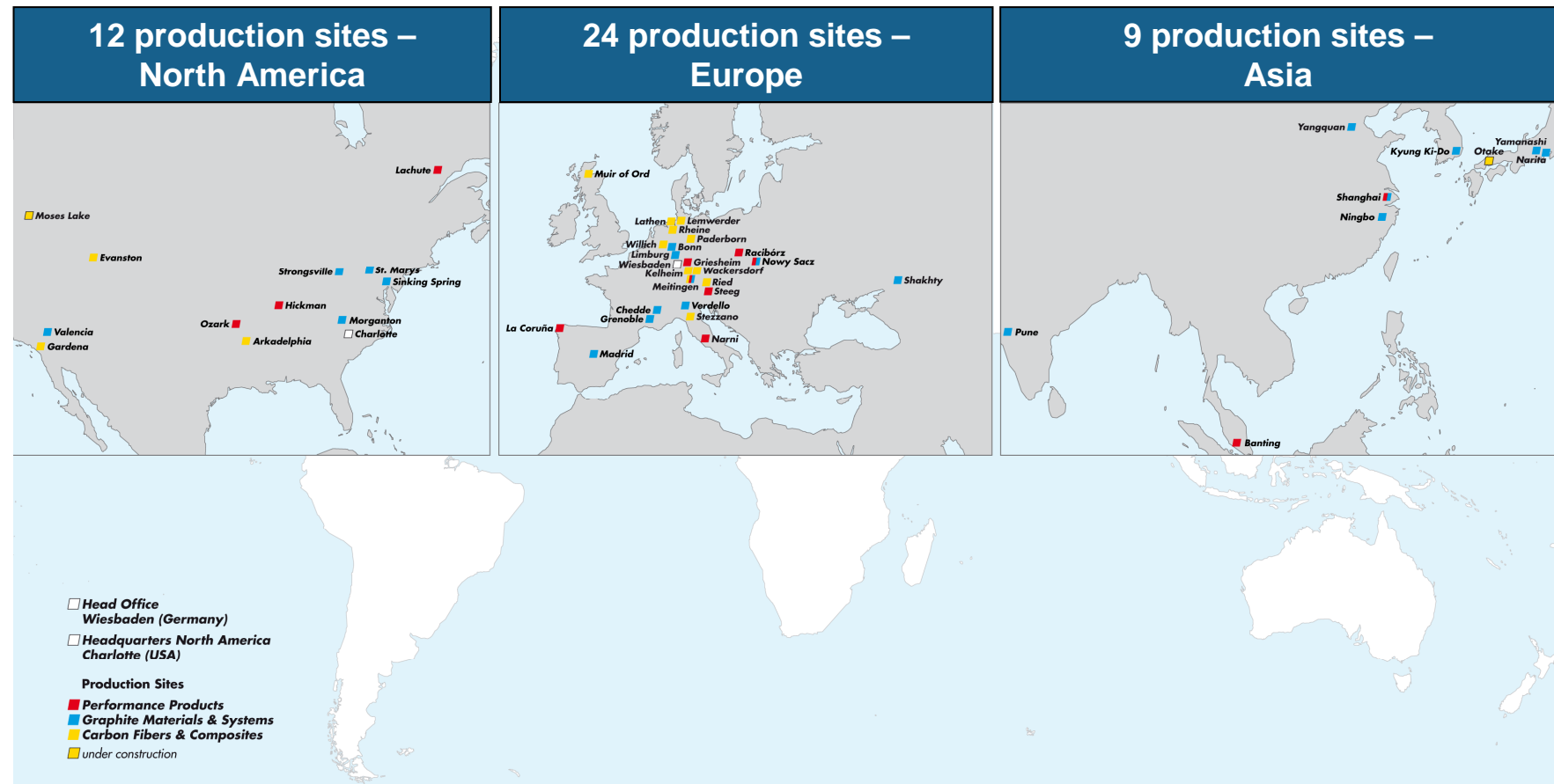
Technology and Innovation (T&I)

SGL Excellence (Six Sigma based)

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# Global presence



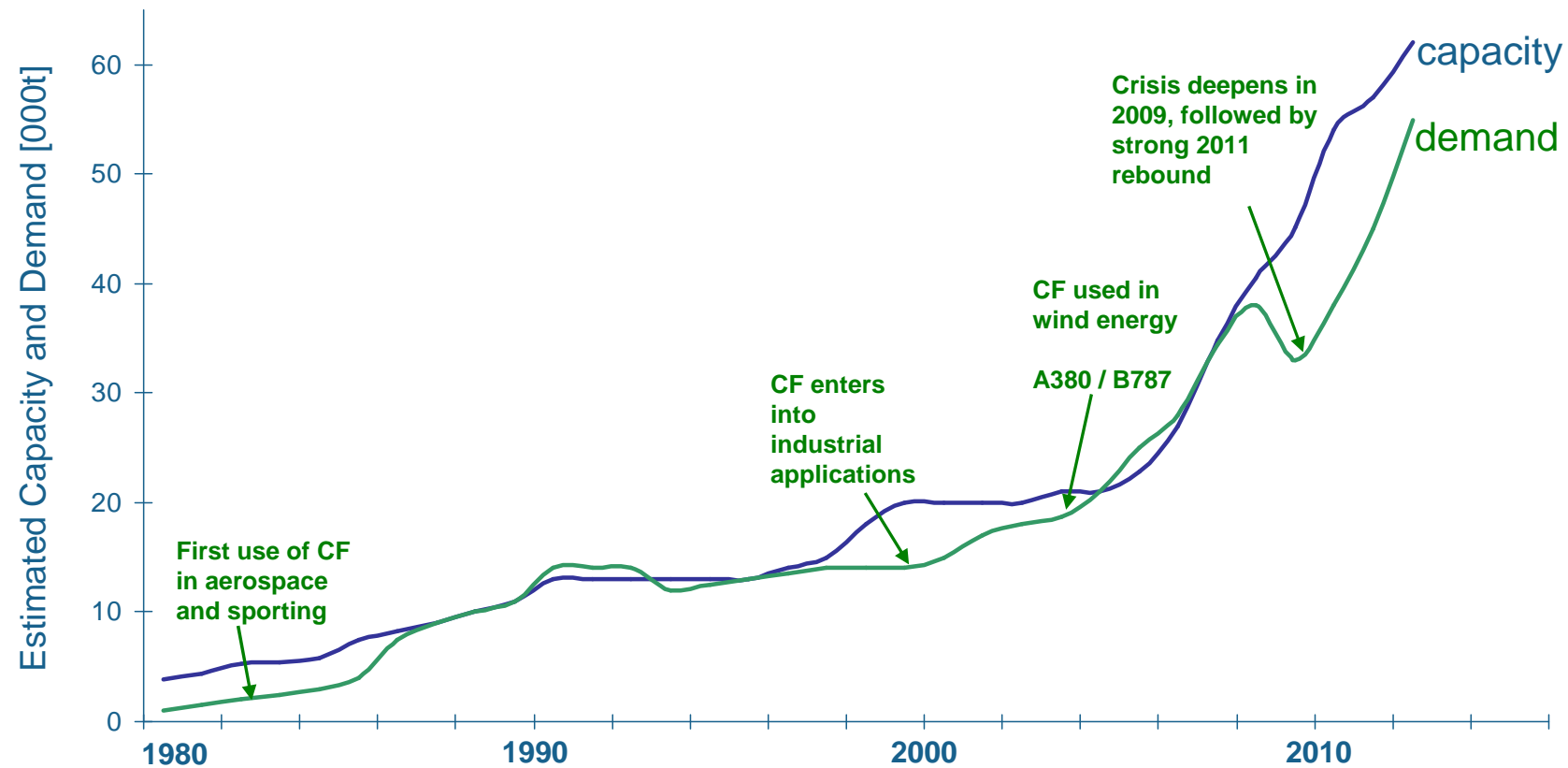
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## 2. Market Overview



# Global market for carbon fibres

**CAGR:** 1980-1989: 22%, 1990-1999: 5%, 2000-2005: 15%, 2006-2010: 8%

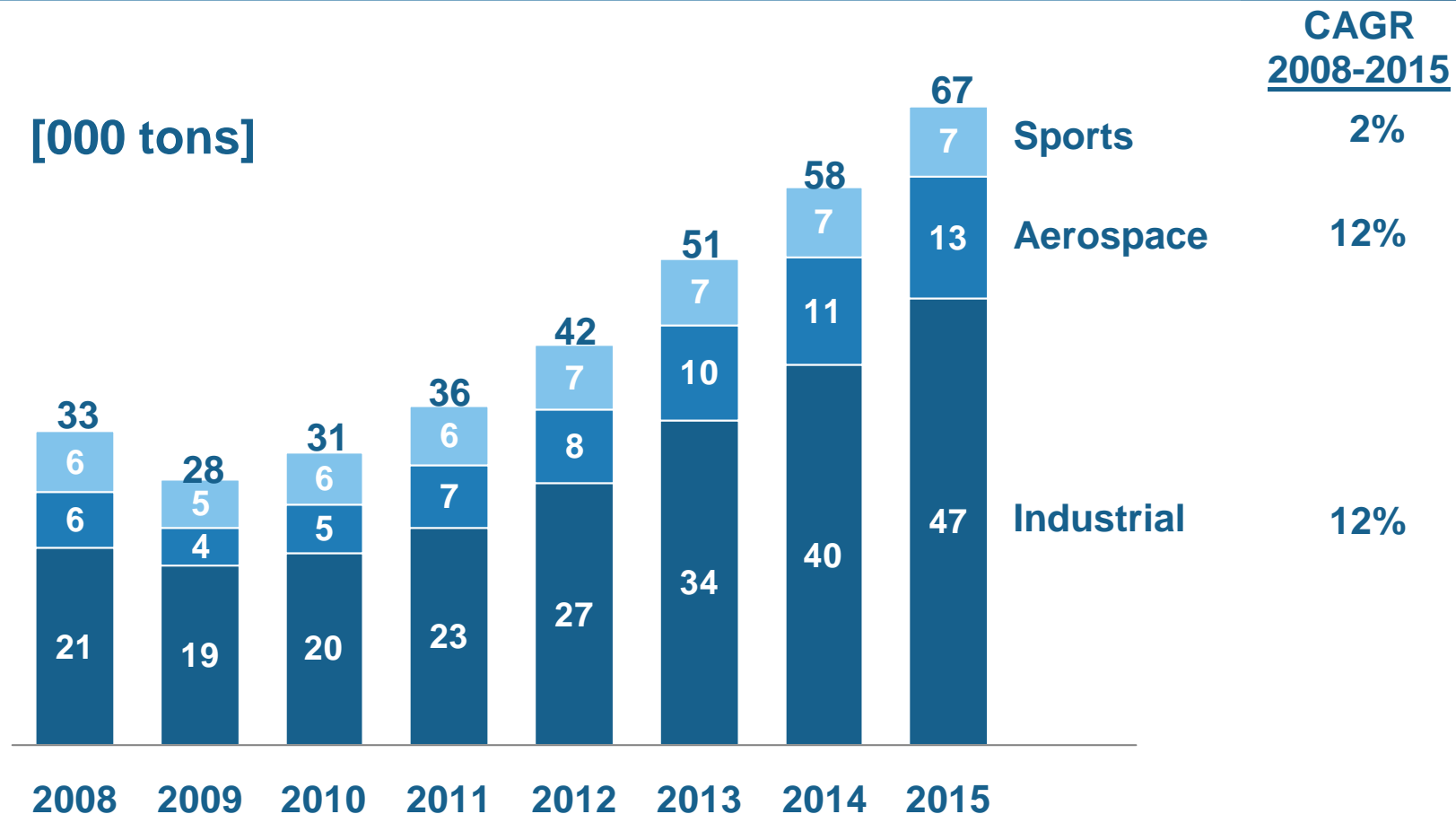


Source: SGL Group

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## Annual carbon fiber consumption is dominated by industrial applications

• [000 tons]



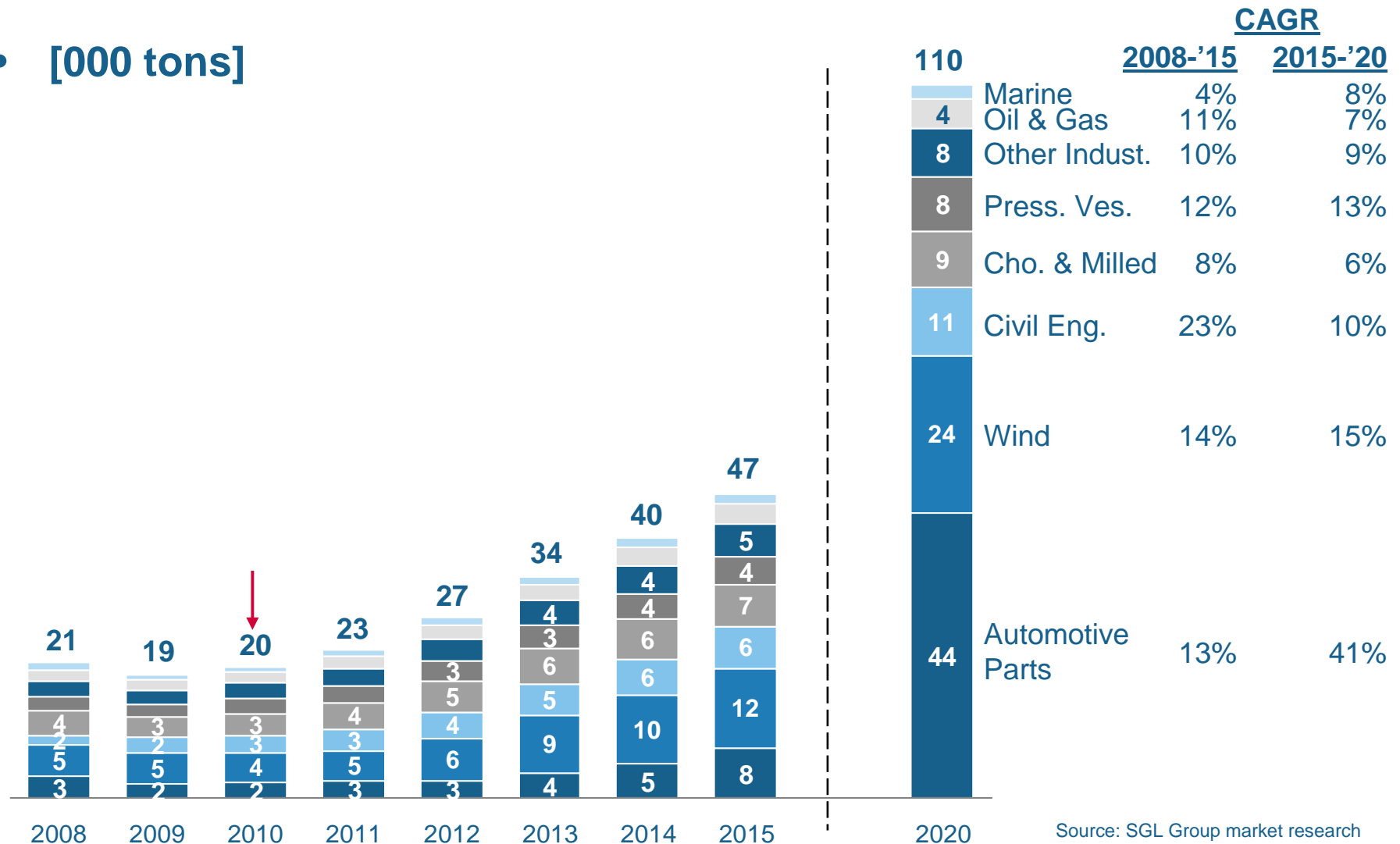
➤ Growth is delayed due to the impacts from the financial crisis, but all growth drivers are still intact

Source: SGL Group market research

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## Until 2015 wind will remain the largest industrial application but automotive parts have the potential to change the CFRP industry

- [000 tons]



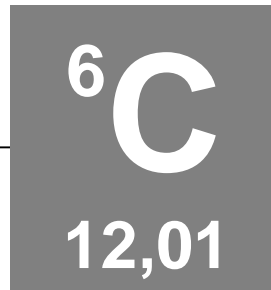
Source: SGL Group market research

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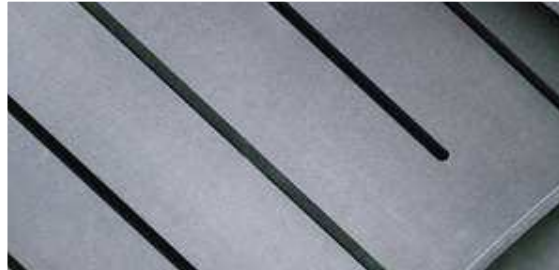


### 3. Processes and Products

## Unique properties of carbon



### Synthetic carbon & graphite



- Heat resistant
- Electrically conductive
- Corrosion resistant
- Environmentally safe

### Natural graphite



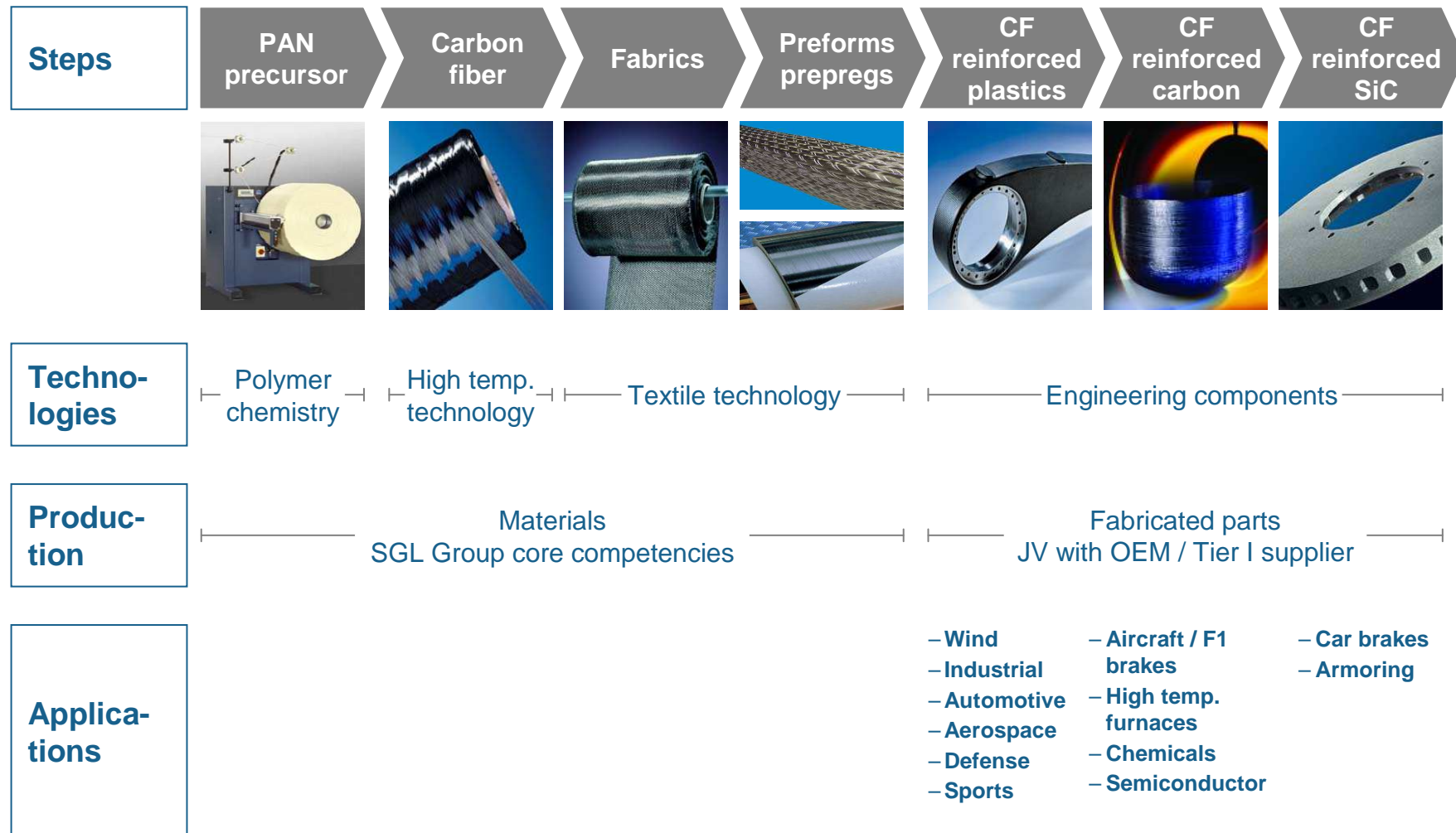
- Thermally conductive
- Dense
- Energy storing

### Carbon fiber



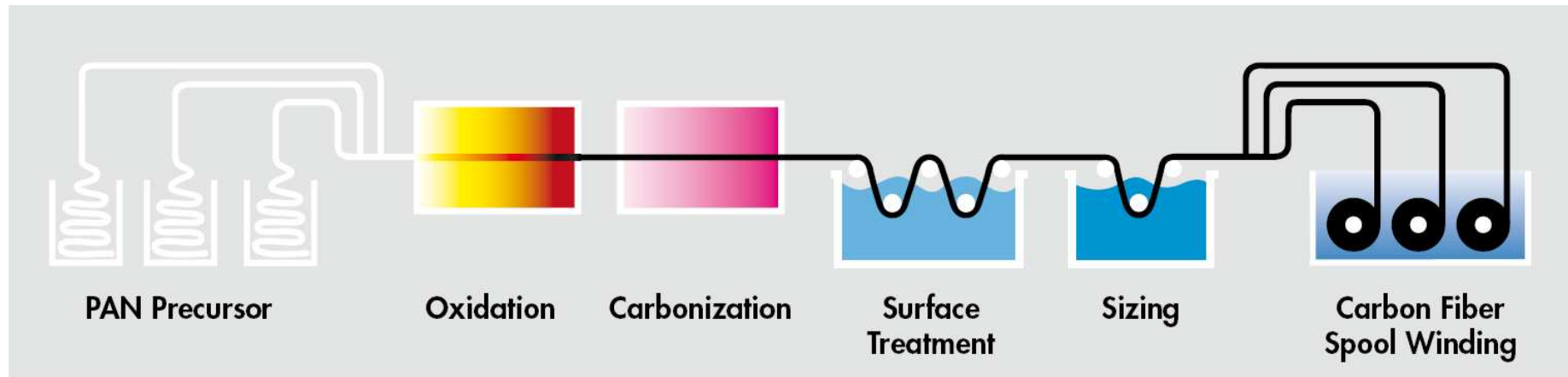
- Light
- Strong
- Stiff

# We master the entire carbon fibers value chain

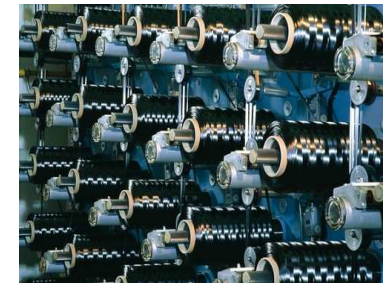


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# Carbon fibre production process



Production process of SIGRAFIL C

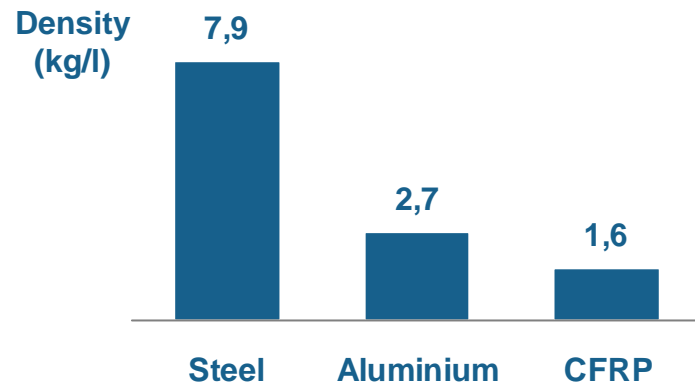


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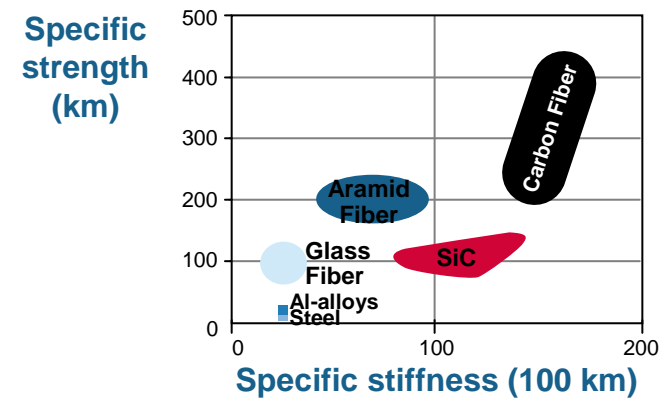


## The competitive advantages of carbon

### No other material is lighter ...



### ... or stronger and stiffer



### Other ceramics would break ...



### ... or fail at temperatures > 1.500 °C





## Woven fabrics and preforms



Hand Loom 1568

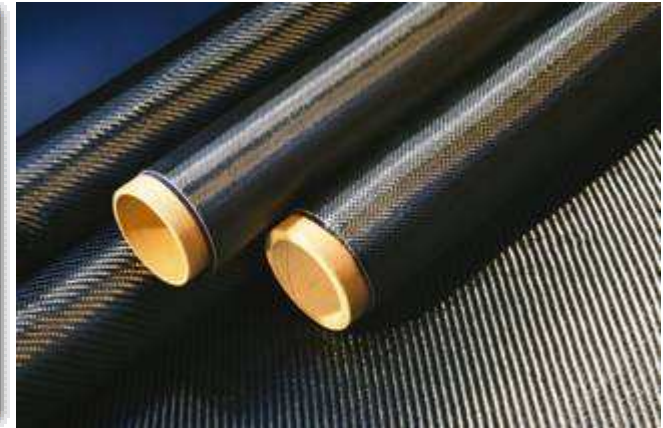
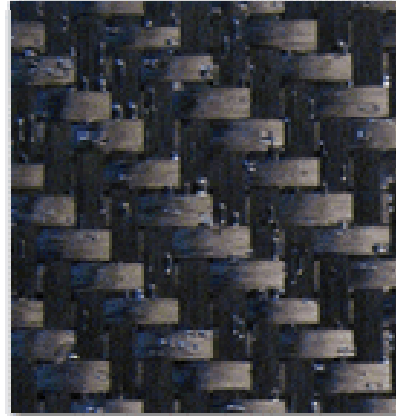
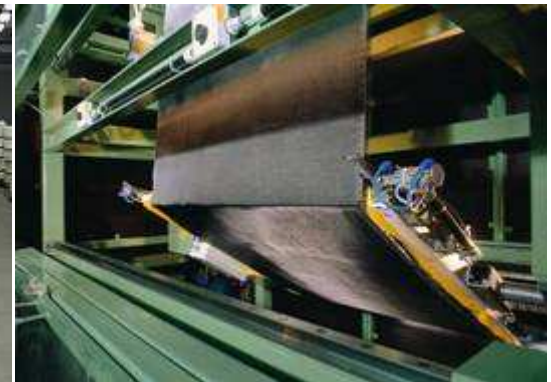


Foto: Dornier

Loom today

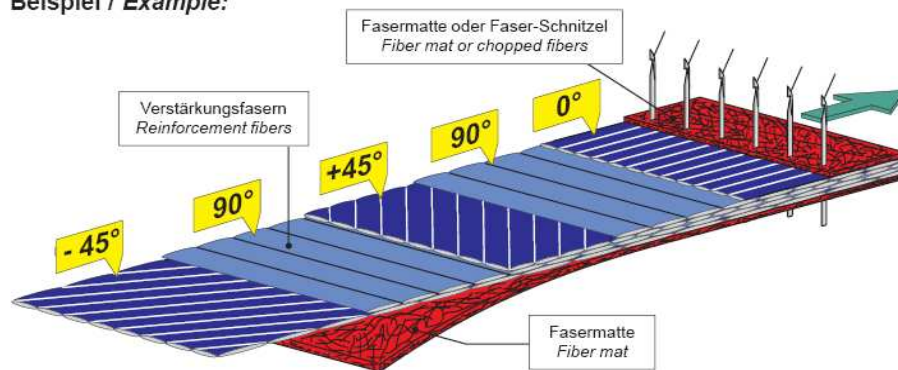


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## Multi axial fabrics for tailored properties



Beispiel / Example:

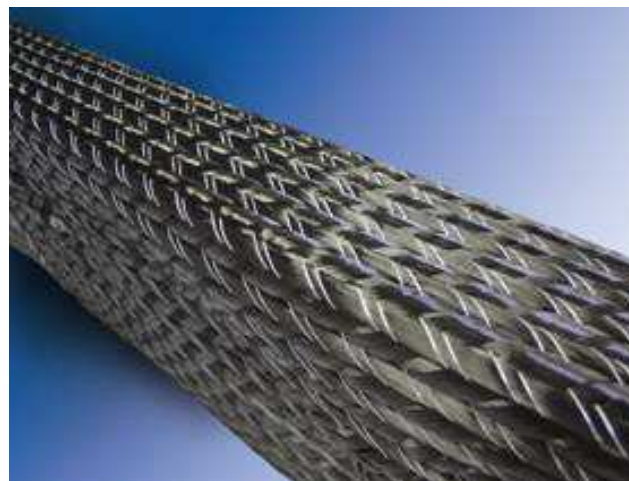
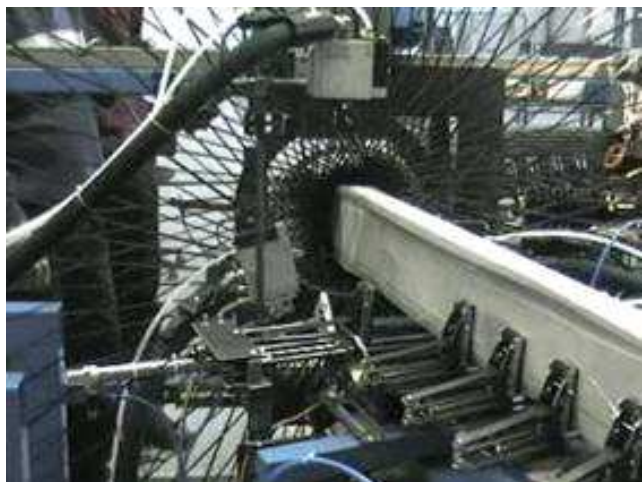


- Developed in early 70th with glass fibres
- Mono or multi layer fixed with fibre stitching
- UD / Biax / Triax /Quadrax
- Fibres 24k /50k / 80k
- Fibre direction 0/90° und +/-45°
- Area weight: 80 .. 1200g/m<sup>2</sup> per layer
- Non Crimp
- Semi isotropic through multi layer
- Better drapability
- Efficient because of heavy weight

Fig. LIBA Naila



## 3d-Braiding technology



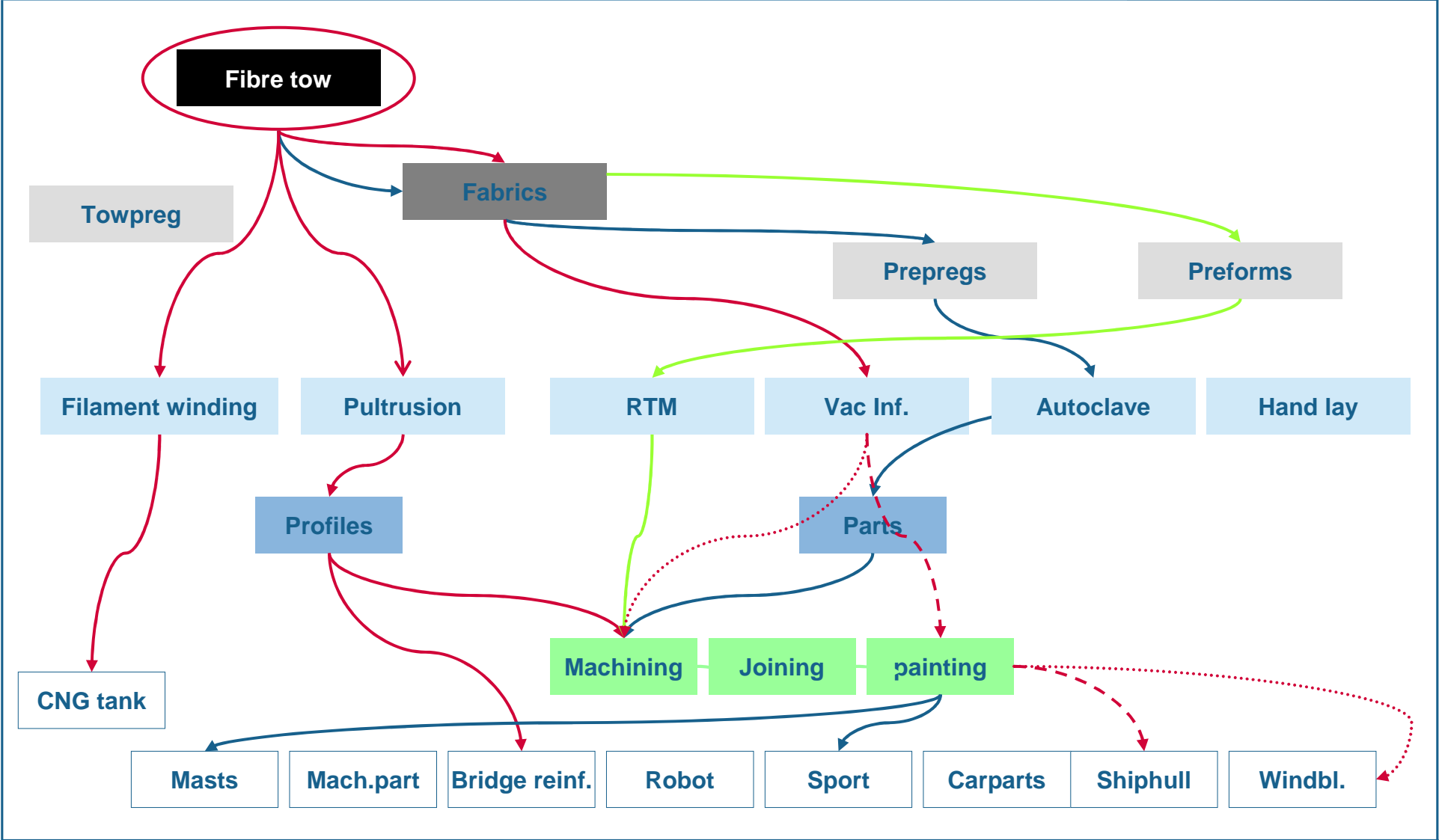
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## Prepreg technology



- **Proven technology for exact resin impregnation**
- **Resin is only dry but not cross-linked**
- **Used in all applications with high quality requirements**
- **SGL offers a wide range of different resin and fabric combinations for wind, marine and other applications**
- **4 prepreg lines plus one prototype line for development and quick sampling.**

**The ways of producing CFRP can be complex even for experts**



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## 4. Application Examples

## Application – wind energy



- **Carbon fibers**
  - Enable big offshore wind parks
  - Increase wind turbine performance

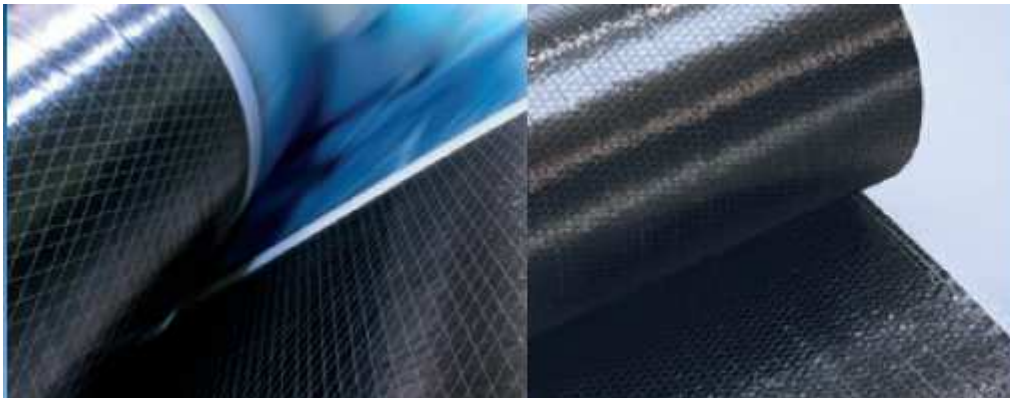


## Application - civil engineering repair

Carbon fibre grid



Carbon fibre sheet



Carbon fibre lamella





## Application - civil engineering

Fibre reinforced concrete

Replacement of steel fibres in UHPC



## Application - moving structures

Project “Zenit”

Designer: Kisho Kurokawa,



- Sliding roof and sliding field for the “Zenit” football stadium in St. Petersburg
- Potential 300 – 400 metric tonnes CF

## Application - free form shaped structures

“HEYDAR ALIYEV CULTURAL CENTER”, BAKU (Azerbaijan)

ARCHITECT / BUILDER: Zaha Hadid / T.S.M.M. Composite works (Turkey)



- Composite structure
- >1.000.000 m<sup>2</sup> NCF
- UD, biax 300 - 600 g/m<sup>2</sup> NCF with biax glass
- Mainly epoxy infusion technology, some pultrusion profiles,

## Application - free form shaped structures

Maritim- Museum Lingang (Shanghai)

Architekt / Builder: gmp / Richard Sprenger



- Finished 2009?
- Glas / Carbon composite structure

## Application - multi functional facade

“Stedelijk” museum Amsterdam

ARCHITECT / BUILDER: Benthem Crouwel architects / Holland Composites



- Composite facade
- > 500.000 m<sup>2</sup> NCF
- Carbon / aramid prefabricated sandwich panels

## Application – marine solar boats

Architect + Designer / Builder: Judel & Vrolijk / Knierim

**SGL supplies 30 tonnes of UD und multi-axial carbon fibre fabrics**



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## Application – luxury sailing performance cruisers

Designer / builder: Gerard Dykstra & Partners / Baltic Yachts (FIN)



- **Model:** 60 m Panamax (Baltic Yachts)
- **Boat Type:** Ketch-Performance cruiser
- **Fibre Quantity:** 20 – 25 t C-fibre consumption + Mast (2 t)
- **Fibre Type:** UD, biaxial
- **Parts of Boat:** Hull, Super structure
- **Other Components:** ruder, interior (CFK laminated with wood), C-Fibre also for mould making
- **Building Year:** 2009
- *What would you wish for the future?*
- **Build even lighter!**

Source: Producer

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## Application – commercial craft

Designer/Shipyard: BRØDRENE AA , NO



- **Model:** YARD 248
- **Building Year:** 2007
- **Boat Type:** Fast Ferry
- **C-Fibre quantity used:** 5-10 tonnes
- **Parts of the boat:** everywhere
- **Technology used:** vacuum infusion, sandwich
- **Total Projects:** 3-5 Year
- **Fibre Consumption:** 20-30 mt

30% less petrol consumption due to downsizing of power unit!



## Application - wave energy power plants

SeaGen



SeaFlow



## Application - oil off-shore

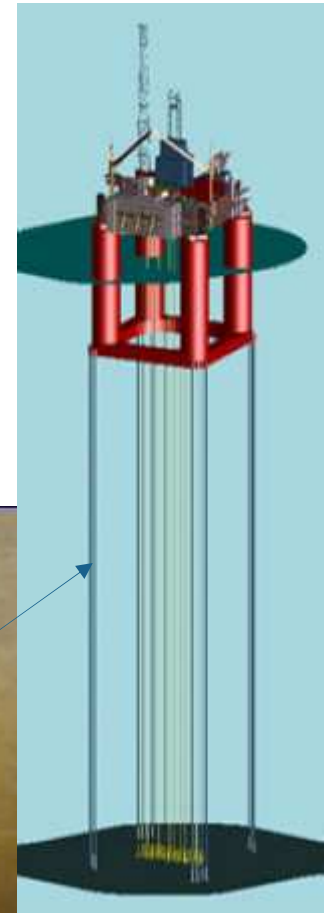


Umbilical



Risers

Moorings



## Application - CFRP design parts

Driven by image



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## Application – automotive structural parts

### Driven by function

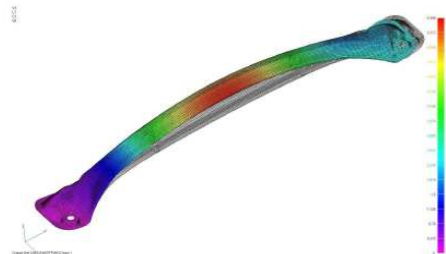
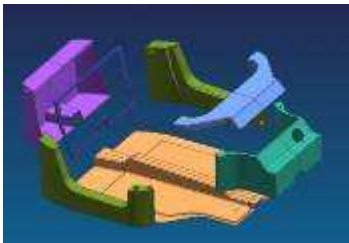


figure 4.6: total translation linear static simulation



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## Future view and open points

### Future View

- New Materials will further penetrate into innovative high tech applications
- Design oriented projects will use more and more composite elements
- Multi-functionality of composite structures will create new application areas
- Automotive mass-production will drive process automation
- Big growth areas are automotive, wind and aerospace, high potential also in civil engineering and architecture

### Open points:

- No existing material standards
- Limited knowledge about composite engineering
- Automatic processes have to be developed for cost reduction
- Long term experience is missing for most areas
- Fire engineering
- Failure/ life time prediction

**Thanks For Your Attention!**

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