Development of Carbon Composite Materials using internal & external networks

Dr. A. Erber, Dr. T. Hauke | LCC Symposium | Garching; 2014-09-11
Company profile. SGL Group

- One of the world’s largest manufacturers of carbon-based products
- Comprehensive portfolio ranging from carbon and graphite products to carbon fibers and composites
- 43 production sites worldwide
- Service network covering more than 100 countries
- Sales of ~€ 1.5 bn in 2013
- Head office in Wiesbaden/Germany
- ~ 6,300 employees worldwide
- Listed on MDAX
Internal & External Networks for Material Innovations

Internal Networks  Material Innovations  External Networks
Development of Carbon Composite Materials using internal & external networks

Agenda

- Internal Networks: Corporate R&D, Business Units, Joint Ventures
- External Networks: Institutes, Associations, Public funded projects
- Examples for Material Developments in Networks
- Challenges, Summary and Perspectives
SGL Material Core Competence versus Process Chain Know-how

SGL GROUP
The Carbon Company: Materials as
- Core competence
- Core business

Process Know-how is critical to
- Material performance
- Material development
## SGL Group Organization

A strong network dedicated to Carbon

<table>
<thead>
<tr>
<th>SGL Group Organization</th>
<th>JVs</th>
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<tbody>
<tr>
<td>Graphite &amp; Carbon Electrodes (GCE)</td>
<td>SGL ACF</td>
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<tr>
<td>Cathodes &amp; Furnace Linings (CFL)</td>
<td>- Brembo SGL</td>
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<td>Graphite Specialties (GS)</td>
<td>- Benteler SGL</td>
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<td>Process Technology (PT)</td>
<td>- etc.</td>
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<tr>
<td>Carbon Fibers &amp; Composite Materials (CF/CM)</td>
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<td>Aero-structures (AS)</td>
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<td>Corporate Functions &amp; Service Centers</td>
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<td>Technology &amp; Innovation (T&amp;I)</td>
<td>Joint Venture Partners</td>
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<td>SGL Excellence (Six Sigma)</td>
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Joint Venture Partners

- SGL ACF
- Brembo SGL
- Benteler SGL
- etc.
## Technology & Innovation
Corporate Research Organization

<table>
<thead>
<tr>
<th>Carbon fibers &amp; composite materials</th>
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<tbody>
<tr>
<td>▪ Precursor</td>
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<tr>
<td>▪ Carbon fibers</td>
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<tr>
<td>▪ Thermoset &amp; thermoplastic Composites</td>
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<th>Synthetic graphite</th>
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<tr>
<td>▪ Graphite electrodes</td>
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<th>Energy systems</th>
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<tr>
<td>Materials for:</td>
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<tr>
<td>▪ Lithium Ion Batteries</td>
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<tr>
<td>▪ Redox Flow Batteries</td>
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<td>▪ Fuel cells</td>
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<td>▪ Thermal Management</td>
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<th>Ceramic fibers &amp; SiC composite materials</th>
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<tr>
<td>▪ C/SiC Ceramics</td>
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<tr>
<td>▪ SiC fibers</td>
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<tr>
<td>▪ Fiber reinforced ceramics</td>
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</table>
SGL Group masters the entire carbon value chain

Carbon Fibers & Composite Materials
- Raw Material
  - PAN Precursor
    - Fisipe (100%)
    - MSP: JV mit Mitsubishi Rayon (33%)
  - Carbon Fiber
    - Prod. Capacity
      - ~ 4kt in UK
      - ~ 2kt in USA
    - SGL-ACF: JV with BMW (51%)
      - ~ 3 kt* in USA
  - Composite Material
  - Prepreg Preform
    - SGL epo (100%)
    - SGL Kämpers (51%)
    - SGL-ACF: JV mit BMW (51%)

Composite Components
- Focus: Materials for Automotive and Industrial Applications
  - Automotive & Industrial
    - Benteler SGL (50%)
    - Brembo SGL Carbon Ceramic Brakes (50%)
  - Aerospace & Defense
    - HITCO (100%)

*Capacity increase to 9kt ongoing
SGL ACF
Global supply chain

1. Precursor
2. Carbon fiber production
3. Textiles and Recycling
4. Composite components
5. BMW i3/ i8 Production

Leipzig
Moses Lake
Wackersdorf

Landshut & Leipzig

Mitsubishi Rayon-SGL Precursor
SGL Automotive Carbon Fibers
BMW Group
SGL Kümpers
Textiles and Preforms

• Non Crimp Fabrics (Carbon, Glass, Hybrid)
• Braiding (Carbon, Hybrid)

- Textile Know-how
- Material competence
- Machine optimization
Beneteler-SGL
Automotive Composites

Automotive Know-how
Material systems
Process technologies
- Preforming & RTM
- Wet molding

CFRP – Insert for increased impact stability
Internal & External Networks for Material Innovations

Business Unit
CFCM

T&I

SGL KÜMPERS

External Networks

Material Innovations
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Institute for Carbon Composites (LCC)  
Endowed chair at TU Munich

- R&D support and services  
- Joint projects (public funded)  
- PhD Programs

PhD thesis  
V. Radlmaier

Influence of different PA grades on the material & component behavior
Carbon Composites e.V.
The Carbon Composite Association

- R&D Workshops
- Joint projects
- Networking platform
- Standards (e.g. testing)
- Marketing

Composites Germany
Leading Edge Cluster MAI Carbon

Goals
- 90% Process cost reduction
- 50% Material cost reduction
- 60% - 80% added value in Germany

Munich – Augsburg - Ingolstadt
Composite Cluster Singapore (CCS)
Composite Network for Asia

- Addressing Mega-trends
- Designed for Tropical Mega Cities
- Embedded in a comprehensive research approach

CFRP materials by SGL Group

Presented at Tokyo Motorshow in 2013
Internal & External Networks for Material Innovations

[Diagram showing various companies and networks related to material innovations]
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Functionalized Secondary Carbon Fiber Materials

- Nonwoven material based on secondary carbon fibers
- Load path oriented reinforcements via continuous heavy tow carbon fibers
- Controlled drapeability due to continuous carbon fibers
- Fast cycle times realized by wet molding

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<tr>
<td>Nonwoven materials based on secondary carbon fibers</td>
<td>Project coordination and material characterization • Textile characterization • Application of continuous tows together with external partners</td>
<td>Wet molding process • Textile handling • Molding of demonstrator parts</td>
</tr>
<tr>
<td>• Oriented – 96 g/m²</td>
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<tr>
<td>• Isotropic – 450 g/m²</td>
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Drapeability characterized by a Pole Peak test

- Recording of drape force for different textiles and orientations
- Characterization of textile behavior and failures during draping
- Development of draping concepts, rules and methodologies
Deposition of Continuous Carbon Fibers

Tailored Fiber Placement

Institute for Aircraft Design

Fiber Patch Preforming

IFB
Textile Preform Architectures

Drapeability influence

Load path oriented pattern
Lessons Learned

- Draping can be influenced by continuous fibers
- Mechanical performance can be increased by a small number of continuous fibers
- Positioning of pattern and matrix application process heavily depends on the part geometry
MAI plast
Development & Evaluation of UD-Tapes

SGL Material development
• Different process chains
• Several material grades

Testing of material process ability by state-of-the-art manufacturing technologies.
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Challenge
How to cope with the “Death Valley” of Innovations?

- Pilot plants are required to bridge the gap for innovations into products.

- Networks along the entire value chain enable a sustainable product development.

- A balanced portfolio between public funded and company funded projects keeps the innovation pipeline “under pressure”.
Summary & Perspective

- Material development has to take process & manufacturing requirements into account
- Internal and external networks are an enabler due to complementary know-how
- Global R&D approaches address different market boundary conditions
- Associations and public funded projects are necessary to drive innovation
- Pilot plants bridge the gap between innovation and new products
Thank you for your attention!

Some results were achieved within: