SGL Automotive Carbon Fibers
The utilization of carbon fiber materials is essential to meet the lightweight requirements of the BMW Megacity Vehicle

<table>
<thead>
<tr>
<th>Main arguments for the utilization of carbon fiber materials:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• <strong>Low weight:</strong></td>
</tr>
<tr>
<td>CFRP parts are approx. 50% lighter than comparable steel parts and approx. 30% lighter than comparable aluminum parts</td>
</tr>
<tr>
<td>• <strong>High tensile strength/stiffness:</strong></td>
</tr>
<tr>
<td>CFRP has excellent damping characteristics and high energy absorption in a crash</td>
</tr>
<tr>
<td>• <strong>Corrosion resistance:</strong></td>
</tr>
<tr>
<td>Avoidance of expensive protective coatings as CFRP is resistant to corrosion, acid and solvent</td>
</tr>
</tbody>
</table>
SGL Automotive Carbon Fibers

The joint venture was initiated to meet BMW Group’s demand for lightweight materials made of carbon fibers

Motivation for setting up the joint venture:

- **Supply guarantee:** Securing sufficient long-term production capacity for carbon fibers and fabrics
- **Technological competitiveness:** Securing technological competence for manufacturing carbon fibers and fabrics
- **Financial competitiveness:** Securing full cost transparency and influence on reducing production costs
Overview Global Value Chain

SGL ACF is responsible for the purchasing of PAN precursor, the production of carbon fibers and fabrics and the recycling process.

**SGL Automotive Carbon Fibers**

- **Crude Oil** → **Propylene** → **Acrylonitrile** → **PAN-Precursor** → **Oxidation** → **Carbonisation** → **Knitting** → **CF-fabrics**

- **Mitsubishi Rayon Co. Ltd. (MRC), Otake/Japan** → **JV MSP*, Otake/Japan** → **SGL ACF, Moses Lake/USA** → **SGL ACF, Wackersdorf/D**

**BMW Group**

- **Preform** → **CFRP-component** → **Megacity Vehicle**

- **BMW Group, Landshut/D and Leipzig/D**

---

1. Joint Venture Mitsubishi Rayon – SGL Precursor Co. Ltd. (MSP)
Moses Lake Plant – Carbon Fibers
The carbon fiber plant will be the most efficient and sustainable of its kind

Main facts:

• Groundbreaking July 7, 2010

• Initial production capacity with 2 lines: 3,000 metric tons

• Production Building 1 finished in Q1/2011

• Delivery of production material to Wackersdorf in Q3/2011

The decisive criteria for site selection:

• Availability of a sufficient supply of electrical energy from renewable sources (hydropower)

• Low cost of power supply
Wackersdorf Plant – Non-crimp Fabrics and Recycling Material
The Wackersdorf plant utilizes advanced textile manufacturing technology

Main facts:

- Opening ceremony July 19, 2010
- Initial production capacity of fabrics: 3,000 metric tons
- Commissioning of recycling machinery in Q1/2011

The decisive criteria for site selection:

- Utilization of existing BMW facilities and infrastructure (only 3 months implementation time)
- Immediate vicinity to technology (BMW R&D departments)
- Qualified workforce
Wackersdorf Plant – Non-crimp Fabrics and Recycling Material
The manufactured fabrics are delivered to the CFRP production at BMW Landshut
Wackersdorf Plant – Non-crimp Fabrics and Recycling Material

The purpose of the recycling process is to reintroduce semi-finished recycling products into CFRP production.

<table>
<thead>
<tr>
<th>Dry offcuts</th>
<th>Fiber preparation</th>
<th>Production of non-wovens</th>
<th>Production of non-wovens / non-woven sheet complexes</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Rovings/non-wovens</td>
<td>- Stamping/cutting the material</td>
<td>- Forming non-wovens: creation of fiber orientation</td>
<td>- Processing non-wovens into multi-layer complexes</td>
</tr>
<tr>
<td>- Preform offcuts</td>
<td>- Opening the material</td>
<td>- Fixing/stabilising</td>
<td></td>
</tr>
</tbody>
</table>

Reintroducing semi-finished recycling products into the CFRP production process
A BMW Group and SGL Group Joint Venture

Outlook and Challenges

• Decrease in sales price to BMW driven by significant improvement in production efficiency and economies of scale

• Identification of further sales price decrease potentials by employing alternative production technologies for specific automotive applications

• Expansion of the non-woven product portfolio including recycling material for use in other BMW automobiles