sgl carbon

Gas Diffusion Layers

Challenges and key steps towards industrialisation

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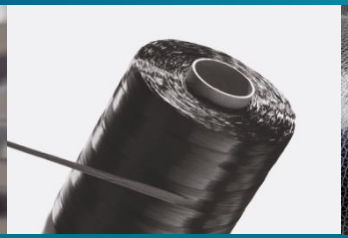
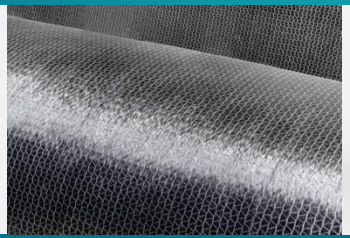
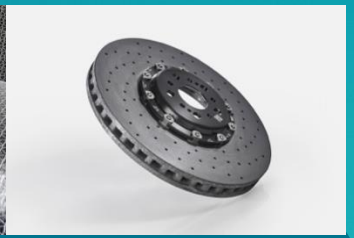
FCH WORKSHOP **PEMFC stack and MEA manufacturing: Is the EU industry ready for the challenge?"**
Brussels | October 11, 2018

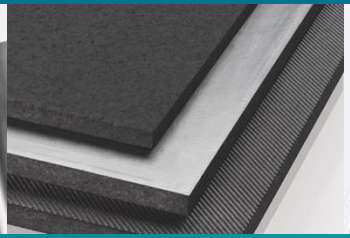
SGL Carbon at a glance

Carbon Fibres and Composites

Raw materials | Intermediate stages | Semi finished products | Solutions & components



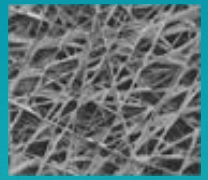



Graphite Materials and Systems

- 4200 employees
- 34 sites (EU, US, Asia)
- 870 m€ Sales in 2017

We are a technology-based company and world leader in the development and production of carbon based solutions. Our high-quality materials and products made from specialty graphite and composites are used in industrial sectors that shape the future: **automotive, aerospace, solar and wind energy, semiconductors and LEDs** as well as in the production of lithium-ion **batteries** and other energy storage systems. In addition, we develop solutions for many **chemical and industrial applications**.

PEMFC History @ SGL



1996
Start of R&D
Bipolar Plates
GDL

Compression-moulded
Graphite-based BPP

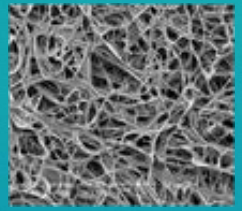
Injection-moulded
Graphite-based BPP

2002
First generation of carbon paper GDL

2012
Own carbon fibre precursor

Since 2016
Expansion of GDL manufacturing capacity

1999
World's first fully treated R2R nonwoven GDL (GDL 10)



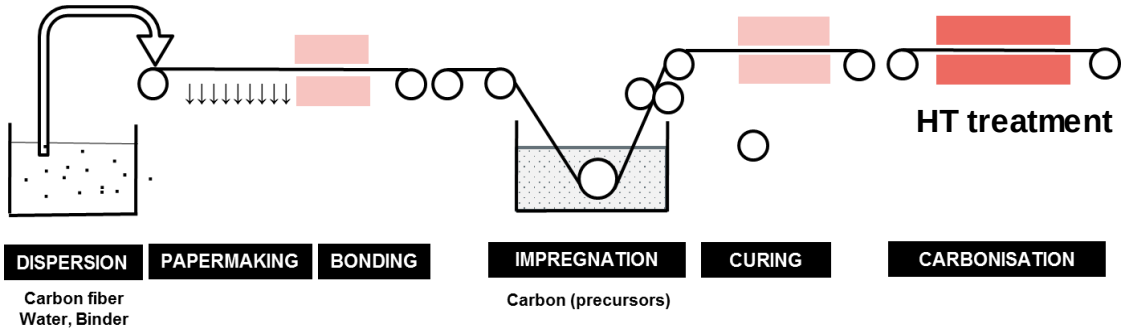
2005
Termination of BPP activities

Focus on GDL

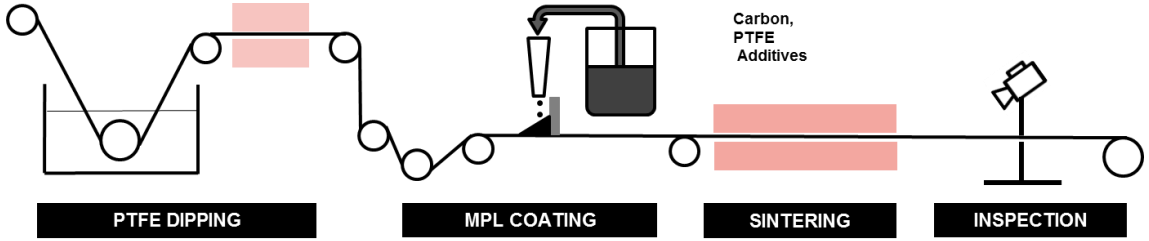
2017
Recent generation GDL with optimised properties (6 different grades)

Current GDL Manufacturing Process

Substrate Manufacturing (Carbon Paper)

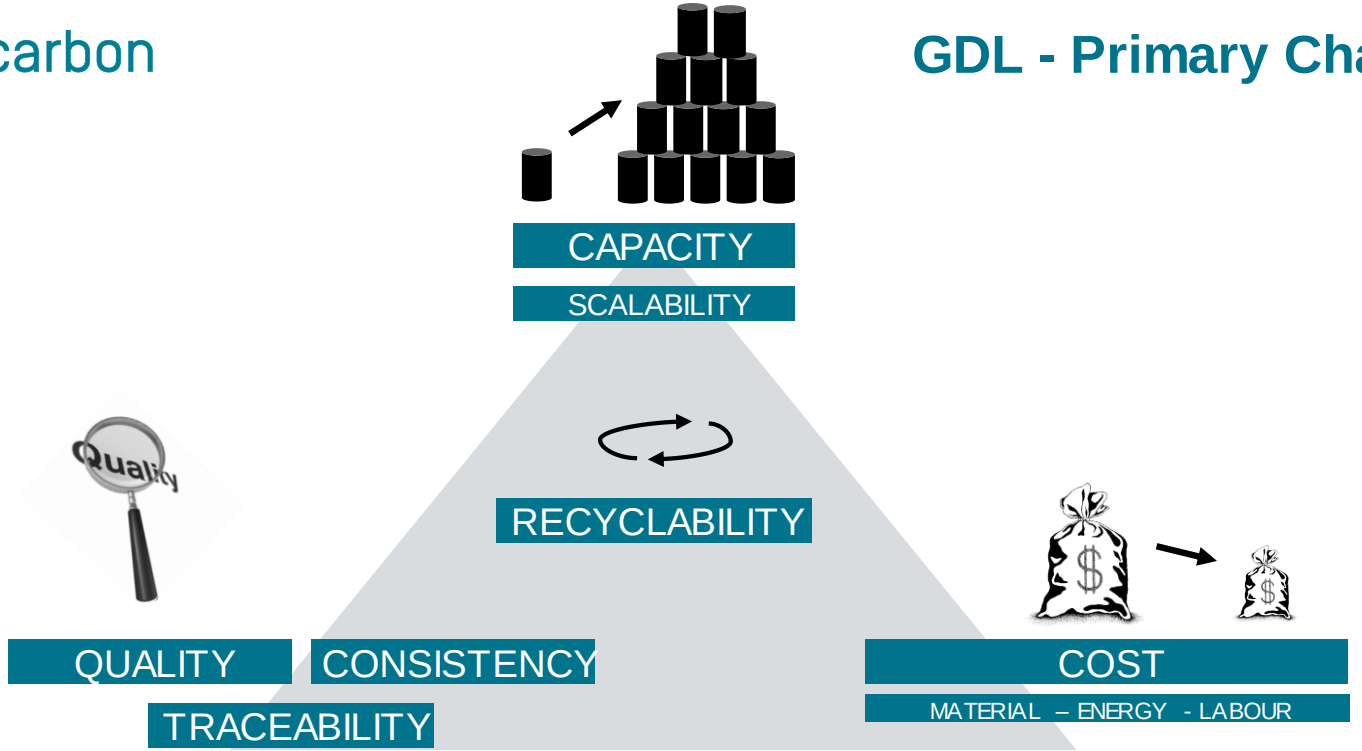


Hydrophobic Treatment + MPL



- Own carbon fibre
- Dedicated line
- Proprietary processes
- R2R processes only

GDL - Primary Challenges



„…Developing a textile-based product (which inherently features a variance in properties of at least ± 10%) into a functional material of highest consistency at high volumes“

GDL – Current Status and Future Needs

	Today	Future
Volume Manufacturing	• Line speeds of 1 – 10 m/min • Web widths for HT < 600 mm • Campaign-type manufacturing of webs • Inks prepared by batch mixing	• Web widths for HT > 600 mm • Continuous lines for HT/coating • In-line mixing of inks • Higher speed coating technology
Quality+ process control (physical properties)	• Large manual effort • Samples/destructive testing • In-line control (beta gauge, x-ray) → require calibration	• In-line process control/feedback loops • Key properties measured in-line (mapping) • Full traceability • Digital fingerprint of material batches
Quality control (defects)	• Substitution of manual (100%) inspection of sheet/rolls by camera systems in progress • Defects labelled with tags • ISO9001 standard	• Full roll mapping • Digital fingerprints • IATF 16949
Cost	• Governed by **labour costs** (Prod/QM) • Feeding losses/scrap • Energy/flue-gas treatment	• Economy of scale/utilisation • Automation/simplification • Reduction of scrap rate by continuous operation

Conclusions

- Industrial manufacturing of GDL is just about to materialise
- Manufacturers take best-practice approach as **specific quality standards** are lacking
- **In-line process control** and **full roll mapping** will be essential for large volume production
- A **joint effort** from the PEMFC industry is needed to define standards (CTQs, quality control methods, material data formats) along the supply chain

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