DELIVERING PERFORMANCE THERMOPLASTICS THROUGH LEADING GLASS FIBER SOLUTIONS

Under the Hood conference, Stuttgart May 2015

Geoffrey Gendebien
Global Thermoplastics Product Manager
WHY CHOOSE OWENS CORNING?

Globally available products produced in multiple facilities providing unrivaled supply redundancy

Local technical support combined with global account coordination provides you with superior response times and vital market knowledge

Broadest range of reinforcement products allowing for more specialized matrix/reinforcement combinations

Inventor of Fiberglas™ reinforcements with a long history of introducing innovative, robust products that meet the most stringent performance and quality
A Leading producer of fiberglass in the world

Innovator in glass fiber since 1938

200+ researchers in 6 R&D centers

Hundreds of patents

30 plants in 15 countries

Worldwide manufacturing chopped strands & Type30® roving
FILLED PERFORMANCE POLYMERS ARE KEY FOR THE COMPOSITES INDUSTRY

Group contains PA, PBT, PP (short fiber), LFTP (long fiber), and other

Est. 1,300Kt - relatively good growth predicted driven by continued material substitution in automotive

Reinforced with glass fiber to enhance performance / durability in their applications

Producers seek to enhance performance and lower the average cost of the engineered plastic

Data source: PCI Nylon analysis, OC internal data
Automotive based applications are the key drivers of thermoplastic demand.

Global car production forecasts thru 2021 show 2015 at 90MM units, increasing to 106MM units by 2021.

Most growth will come from the world’s emerging BRIC market economies.

Expect limited growth in developed countries. Instead changes in regulations, functional integration, and safety will transform developed light-vehicle markets.
CARBON EMISSION REGULATIONS KEY DRIVER FOR WEIGHT REDUCTION IN AUTOMOTIVE

**Mega Trends**
- Lower CO₂ emissions
- Urbanization
- Globalization

**Transportation Trends**
- Need for lighter, less pollutant vehicles
- 50% of automotive sales from BRIC
- Increased comfort demands

**Automotive Industry Trends**
- Improve fuel efficiencies
- New OEM & market concentration
- Increased vehicle functionality

**Impact for Materials and Chemicals**
- Advanced composites solutions
- Advanced polymers
- High strength metals
- New battery materials & chemicals
REGULATIONS, THE KEY DRIVER FOR LIGHT WEIGHTING

- Solid lines: historical performance
- Dashed lines: enacted targets
- Dotted lines: proposed targets

Source: International Council of Clean Transportation
• In Europe, CO2 emissions from new cars sold in 2014, fell 2.6% to an average 123.4 grams/km, exceeding the legal target of 130g/km set for 2015.  
(Source: European Environment Agency; provisional data April 2015)

• The EU commission has decided that the 95 gr/km cap on CO2 emission will be fully implemented as of 2021, and no longer 2020 as initially foreseen.  
(Source: European Commission report February 2014)

• By 2016, 30 percent of the cars bought by the Chinese government, have to be electrical vehicles.  
(Source: China’s Ministry of Industry and Information Technology July14)

<table>
<thead>
<tr>
<th>Region</th>
<th>Fiscal: Penalty for excess emissions</th>
<th>Non-fiscal: Revoke type-approval certificate</th>
<th>Non-fiscal: publish name of manufacturer</th>
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<tbody>
<tr>
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<td>S-Korea</td>
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</table>

Source: International Council of Clean Transportation (ICCT), May 2014
WAYS TO REACH EMISSIONS & FUEL EFFICIENCY TARGETS

- Efficient Diesel Engines
- Smart Gasoline Engines
- Alternative Power Train Designs
- Alternative Transmission Systems
- Use of Bio Fuels and Bio Diesel
- Light Weighting with the use of composite

-100 Kg
-0.35 l/100 km
-9.0 g/km

Fuel consumption breakdown

Independent of weight 64%
Dependent on weight 36%

Pie data source: Owens Corning estimate, September 2014
## STRUCTURAL COMPOSITES, COMPETITIVE SOLUTIONS

### Short term
- Aluminum will displace steel for one on one replacement,
- With pure focus on weight out.

### Medium-long term
- Composites allow for enhanced function integration,
- But requires re-engineering of the car modules.

### Comparison Table

<table>
<thead>
<tr>
<th>Steel vs.</th>
<th>Steel vs. Aluminum</th>
<th>Steel vs. Composites</th>
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<tbody>
<tr>
<td>Process Complexity</td>
<td>=</td>
<td>↓</td>
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<tr>
<td>Weight Reduction</td>
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<tr>
<td>Raw Mat. Cost</td>
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<tr>
<td>Design Freedom</td>
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<tr>
<td>Function Integration</td>
<td>=</td>
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</table>

Source: Owens Corning estimate, September 2014

Approximately 200kg of weight reduction per vehicle will be required to address OEMs CO₂ gap.
PERFORMAX® SE4850 ROVING
REDEFINING DLFT PP PERFORMANCE

For value-added DLFT manufacturing processing and overall system cost reduction

For a variety of DLFT applications requiring intricate function integration, particularly in automotive

For most DLFT design concepts to enhance part consolidation and to reduce weight

For durable and corrosion resistant structural and semi-structural challenging complex parts

- Modular Front Ends
- Underbody Shields
- Seat Components
- Door Modules
- Load Floor
- Clutch Pedal, Cooling Fans,
- Brackets

Plus a variety of non-automotive applications

Car picture copyright Leonello Calvetti/shutterstock.com
PERFORMAX® SE4850 ROVING
REDEFINED PRODUCT BENEFITS

- Improved resistance to fuzz generation for easier processing and improved housekeeping
- Reduced strand stiffness for easier splaying
- Increased lubricity for lower strand tension
- Improved splice tensile strength for enhanced package-to-package transfer and improved line efficiencies
- Outstanding compatibility with PP for better wet-out and dispersion
- Optimized adhesion to PP to meet or exceed all mechanical performance needs

Delivering...

- UP TO 83% REDUCTION IN FUZZ GENERATION
- UP TO 40% IMPROVEMENT IN GLASS DISPERSION
- UP TO 80% INCREASE IN SPLICE STRENGTH
- UP TO 80% INCREASE IN IMPACT PERFORMANCE
PERFORMAX®4850 ROVING
EXCELLENT MECHANICAL PROPERTIES FOR HIGH PERFORMANCE

Outstanding Mechanical Properties delivers up to 80% increase in Impact Strength

Potential for reduced wall thickness and/or reduced use of coupling agent for comparable end-use performance

Mechanical Properties - SE4121 at 100%

<table>
<thead>
<tr>
<th></th>
<th>Tensile</th>
<th>Flex</th>
<th>N. Izod</th>
<th>UN. Izod</th>
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<th>Flex</th>
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<td>Cross Direction</td>
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<td>Comp Avg.</td>
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<td>90</td>
<td>80</td>
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30% Glass Content; Compression Molding

SE4850* BEST (overall)

* BEST

OC internal testing
REDEFINING PERFORMANCE WITH HYDROSTRAND® 258 CHOPPED STRANDS FOR PA RESINS

Excellent dry as molded properties in a wide range of polyamides formulations

Outstanding performances in glycol resistant PA66 formulations

Enables designers to reduce vehicle weight to improve fuel economy without sacrificing performance
HYDROSTRAND® 258 CHOPPED STRANDS FOR PA REDEFINED PRODUCT BENEFITS

- Reduces manufacturing changeovers
- Strong thermal stability – less discoloration at higher temperatures.
- Low yellowness – Easy to use in natural color applications
- Improves impact properties in glycol applications
- Improved fatigue resistance
- Strong processing – No hassle feeding
- Reduces inventory carrying costs

**UP TO 22% INCREASE IN IMPACT PERFORMANCE**

**UP TO 26% IMPROVEMENT IN COLOR CLARITY**

**UP TO 13% INCREASE IN IMPACT AFTER HEAT AGING**
HYDROSTRAND® 258
EXCELLENT MECHANICAL PROPERTIES IN PA APPLICATIONS

Outstanding Mechanical Properties delivers up to 22% increase in Impact Strength

Increases the potential to integrate automotive functions and be more flexible in designing efficient parts

Mechanical Properties - 995 at 100%
- HS258
- 995
- Comp Avg.

BEST

30% Glass Content; Impact Modified PA6
**HYDROSTRAND® 258**

EXCELLENT HYDROLYSIS RESISTANCE IN PA APPLICATIONS

**Outstanding Heat aged Property Retention delivers up to 13% increase in Impact Strength**

**Enables metal substitution in exposed to glycol and other liquid applications**

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**Heat Aged Property Retention - 983 at 100%**

- **HS258**
- **983**
- **Comp Avg.**

* BEST (overall)

30% Glass Content; PA66
Ethylene Glycol @135°C after 200h

OC internal tests
REDEFINING PERFORMANCE WITH HYDROSTRAND® 276 CHOPPED STRANDS FOR PBT RESINS

Excellent dry as molded properties in a wide range of PBT formulations

Outstanding performance in hydrolysis resistant PBT applications

Suitable for a variety of automotive exterior and interior parts and most particularly, in auto electrical system components.
HYDROSTRAND® 276 CHOPPED STRANDS FOR PBT REDEFINED PRODUCT BENEFITS

- Lower yellowness index offers improved color versus competing hydrolysis resistant PBT grades
- Improved dry as molded impact properties
- Outstanding hydrolytic performance in PBT applications
- Superior tensile properties after heat aging
- Strong processing – No hassle feeding

UP TO 17% INCREASE IN IMPACT PERFORMANCE

UP TO 27% IMPROVEMENT IN COLOR CLARITY

UP TO 36% INCREASE IN TENSILE AFTER HEAT AGING
HYDROSTRAND® 276
EXCELLENT MECHANICAL PROPERTIES IN PBT APPLICATIONS

Outstanding Mechanical Properties delivers up to 17% increase in Impact Strength

Excellent dispersion makes it the perfect choice for thin wall processing allowing for potentially shorter cycle times

Mechanical Properties - 272 at 100%

- HS276
- 272
- Comp Avg.

30% Glass Content; PBT

OC internal tests
HYDROSTRAND® 276
EXCELLENT HYDROLYSIS RESISTANCE IN PBT APPLICATIONS

Outstanding Heat aged Property Retention delivers up to 36% increase in tensile strength

Designed for optimal performance in automotive components which withstand operation under intensive conditions

% Tensile Strength Retention - FT592 at 100%

- HS276
- FT592
- Comp Avg.

* BEST (overall)

after 24h
after 48h
after 72h

30% Glass Content; PBT
Water @120°C

OC internal tests
PERFORMAX® SE4850 makes it possible to deliver higher glass loadings thereby improving modulus characteristics by up to 20%

HYDROSTRAND® 258 offers outstanding impact performance and increased glycol resistance in PA6/66 for automotive under hood applications

HYDROSTRAND® 276 offers exceptional hydrolysis resistance in PBT for harsh automotive environments
Thank you.

For more information or inquiries, please contact

RTP_CS@owenscorning.com