Current challenges for fuel system solutions

► New aggressive (bio)fuels
► Increasing fuel temperatures
► Longer lifetimes
► Elevated pressure levels
► Reduced fuel emissions
► More efficient fuel systems
Fuel systems
Applications with Hostaform® POM and Fortron® PPS
Fuel systems
Applications with Hostaform® POM and Fortron® PPS
Fuel systems
Applications with Hostaform® POM and Fortron® PPS

Fuel Supply Module

Hostaform® POM C13031XF 50/5339 and Hostaform® POM EC140XF
Fuel systems
Applications with Hostaform® POM and Fortron® PPS

Fuel Pumps

Hostaform® POM and Fortron® PPS
# Hostaform® POM Portfolio for Fuel Applications

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 9021</td>
<td>Standard injection molding grade. Excellent flex fuel resistance.</td>
<td>Valves, Flanges, Modules, Filter Housing, Tank Caps</td>
</tr>
<tr>
<td>C 13021</td>
<td>Medium viscosity, easy flowing injection molding grade for precision parts and thin-walled moldings. Excellent flex fuel resistance.</td>
<td>Valves, Flanges, Modules, Filter Housing, Tank Caps</td>
</tr>
<tr>
<td>C 13031</td>
<td>Medium viscosity, injection molding grade for precision parts and thin-walled moldings. As for C 13021 but with 10 % higher strength, rigidity and hardness over the entire permissible temperature range for Hostaform®. Excellent flex fuel resistance.</td>
<td>Valves, Flanges, Modules, Filter Housing, Tank Caps</td>
</tr>
<tr>
<td>C 13031 XF</td>
<td>Injection molding grade, based on C 13031 with improved hot diesel resistsants for long-term diesel temperatures up to 100 °C.</td>
<td>Hot Diesel Applications Valves, Flanges, Modules</td>
</tr>
<tr>
<td>EC140XF</td>
<td>Injection molding grade, electro conductive with improved hot diesel resistsants – for fuel system applications requiring electro conductive properties.</td>
<td>Filler Neck, Brackets, Filter Housings, Valves, Pumpcarrier with ESD requirements</td>
</tr>
<tr>
<td>C 9021 GV1/30</td>
<td>Injection molding grade, reinforced with 26 % (w/w) glass fibers, for parts requiring very high strength and rigidity and increased hardness. Reduced thermal expansion, shrinkage and dimensional change.</td>
<td>Fuel Pumps, Connecting Piece, Overmoulding</td>
</tr>
</tbody>
</table>
## Fortron® PPS Portfolio for Fuel Applications

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1140L4/ L6</td>
<td>Injection molding grade, reinforced with 40% (w/w) glass fibers. Parts with high tolerance requirements in fuel contact at elevated temperatures. Very high stiffness and strength.</td>
<td>Pumps, connecting piece, brush holder, over molding of stator or rotor, fuel rail</td>
</tr>
<tr>
<td>6165A4/ A6</td>
<td>Injection molding grade, reinforced with 65% (w/w) glass fibers and mineral. Parts with very high tolerance requirements in fuel contact at elevated temperatures. Reduced thermal expansion and shrinkage.</td>
<td>Pumps, inlet cover, upper cap, impeller</td>
</tr>
<tr>
<td>6162XF</td>
<td>Injection molding grade, reinforced with 65% (w/w) glass fibers and mineral. Similar to 6165A6 but with reduced fuel uptake and increased crystallization speed.</td>
<td>Pumps, inlet cover, upper cap, impeller</td>
</tr>
</tbody>
</table>
Improvement of Diesel Engines Common Rail Systems

Diesel vehicles produce 30% lower CO₂ emissions than petrol cars.

Source: en.wikipedia.org
Degradation of Diesel Fuel

Oxidation of Diesel-Fuel

- Temperature
- Diesel quality
- Oxygen
- Light
- Cu-Ion

Aggressive degradation products (organic acids, peroxides)

Chemical attack of polymers results in weight loss / brittleness
Storage of Hostaform® POM Grades in Diesel RF-73-A-93 CFPP at 100 °C
Testing Hostaform® POM in Diesel
Elongation at break

Storage of Hostaform® POM Grades in Diesel RF-73-A-93 CFPP at 100 °C

Elongation at Break (%)
0 5 10 15 20 25 30 35

Ref. Sample
500 h
1000 h

C 13031
C 13031 XF 50/5339

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Test Fuel Overview

Composition various test fuels

- **Fuel C**: 85% Toluol, 50% Isooctan
- **CM 15**: 85% Fuel C, 50% Isooctan
- **CE 22**: 78% Fuel C, 22% Ethanol
- **CE 85**: 85% Ethanol
- **FAM A**: 15% Methanol, 78% Ethanol, 5% Diisobutyl, 15% Isooctan, 0.5% Wasser
- **FAM B**: 84.5% Methanol, 50% Toluol

Prüfflüssigkeit 1 nach ISO 1817
Prüfflüssigkeit 2 nach ISO 1817
EU Biofuels Directive 2009 sets “reference values” of a

- 10% biofuel component in vehicle fuel by 2020
- 20% share of renewables in overall EU energy consumption by 2020
Ageing of Hostaform® POM C 13031 in RME temperature 100° C, ISO 1/4 Bars

Change of weight over soak time (hours):
- 500 h
- 1000 h
- 2000 h
- 4000 h

Change of weight (%)
Ageing of Hostaform® POM C 13031 in RME temperature
100° C, ISO 1/4 Bars

Tensile strength

<table>
<thead>
<tr>
<th>Soak time (hours)</th>
<th>500 h</th>
<th>1000 h</th>
<th>2000 h</th>
<th>4000 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>
### General parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent test lab used</td>
<td>EG&amp;G Automotive Research</td>
</tr>
<tr>
<td>Test protocol</td>
<td>SAE J1748</td>
</tr>
<tr>
<td>Temperatures</td>
<td>65°C &amp; 121°C</td>
</tr>
<tr>
<td>Total time</td>
<td>5000 hours</td>
</tr>
<tr>
<td>Factors measured</td>
<td>Dimensional stability, weight change, tensile strength, tensile elongation, tensile modulus, ISO notched charpy impact strength</td>
</tr>
</tbody>
</table>

### Thermoplastics tested

#### 65 °C

<table>
<thead>
<tr>
<th>Thermoplastic</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetal copolymer</td>
<td>Polyphenylene sulfide</td>
</tr>
<tr>
<td>Acetal homopolymer</td>
<td>Nylon 6.6</td>
</tr>
<tr>
<td>Polybutylene Terephthalate</td>
<td>High temperature nylon</td>
</tr>
<tr>
<td>Aliphatic polyketone</td>
<td>Polychthalamide</td>
</tr>
</tbody>
</table>

#### 121 °C

<table>
<thead>
<tr>
<th>Thermoplastic</th>
<th>Details</th>
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<tr>
<td>Acetal copolymer</td>
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</table>

### Test Fuel (65 °C)

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMO</td>
<td>Fuel C (50% Isooctane and toluene)</td>
</tr>
<tr>
<td>CAP</td>
<td>Fuel C + agressive water + peroxide</td>
</tr>
<tr>
<td>CM15A</td>
<td>85% Fuel C + 15% methanol + agressives water</td>
</tr>
<tr>
<td>CM25A</td>
<td>75% Fuel C + 25% methanol + agressives water</td>
</tr>
<tr>
<td>CM85A</td>
<td>15% Fuel C + 85% methanol + agressives water</td>
</tr>
<tr>
<td>CE22A</td>
<td>78% Fuel C + 22% ethanol + agressives water</td>
</tr>
<tr>
<td>CE85A</td>
<td>15% Fuel C + 85% ethanol + agressives water</td>
</tr>
<tr>
<td>TF1</td>
<td>GM TF1 (equivalent to IE10)</td>
</tr>
<tr>
<td>TF2</td>
<td>GM TF2 (equivalent to IM5E2)</td>
</tr>
</tbody>
</table>

### Test Fuel (121 °C)

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<td>GM TF1 (equivalent to IE10)</td>
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Testing Hostaform® POM in Flex Fuels

Change of weight

Hostaform® POM C13031 after Fuel Soak 5000 Hours at 65 °C in Flex Fuels

© Celanese

CM15A
CE22A
CE85A
C

© Celanese

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Testing Hostaform® POM in Flex Fuel

Tensile strength

Hostaform® POM C13031 after Fuel Soak 5000 Hours at 65 °C in Flex Fuels

[Graph showing percent retained (%) vs. soak time (hours)]

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Fuel Systems Solutions
Testing various thermoplastics in Flex Fuels

Change of weight in Fuel CE22A

Various Grades at 121 °C over 5000 Hours in Fuel CE22A

Testing various thermoplastics in Flex Fuels

- Nylon 6/6 25% GR
- HTN 35% GR
- PPA 45% GR
- Fortron 40% GR
Testing various thermoplastics in Flex Fuels

Change of weight in Fuel CAP

Various Grades at 121 °C over 5000 Hours in Flex Fuels in Fuel CAP

- Nylon 6/6 25% GR
- Fortron 40% GR
- PPA 45% GR
- HTN 35% GR
Testing various thermoplastics in Fuel CM15
Long-term behavior

Storage in 15% Methanol Containing Fuel (CM15, 1500h, 50 °C)

- **PA 6**
- **PA 6.6**
- **PBT**
- **POM Copolymer (Hostaform® C)**
- **PPS (Fortron®)**

* Stress cracking after drying  ** Polymer degradation

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AdBlue® SCR* technology: Reduced NOx emissions

► AdBlue® = aqueous urea solution used in Selective Catalytic Reduction (SCR) Systems
► Reduces nitrogen oxide concentration in the exhaust emissions from diesel engines.
► Use of SCR technology in vehicles eliminates the need to switch to the so called ‘rich-burn mode’ to regenerate the storage
► Diesel engine can be further improved for reduced fuel consumption.

*Selective Catalytic reduction
AdBlue is a registered trademark of VDA
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