Polyamides & *Circulen* Recover EP PA

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Business Development Manager

**Material Meets Engineering (MME) Conference**  
Frankfurt, 30th June, 2022
Agenda

- LyondellBasell Polyamide range
- Introducing the *Circulen* Brand
- Introduction of *Circulen*Recover EP PA
- Trends & next steps in *Circulen*Recover EP PA Range
- Example application – introducing TSL Outdoor’s 2023 Snow shoe
LyondellBasell Polyamides range
<table>
<thead>
<tr>
<th>Schulamid Product Range</th>
<th>General Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schulamid 6</td>
<td>compounds based on PA 6</td>
</tr>
<tr>
<td>Schulamid 66</td>
<td>compounds based on PA 66</td>
</tr>
<tr>
<td>Schulamid 612</td>
<td>compounds based on PA 612 (long chain polyamide)</td>
</tr>
<tr>
<td>Schulamid XT</td>
<td>compounds for extreme temperature applications requiring elevated long term heat aging properties</td>
</tr>
<tr>
<td>Schulamid XM</td>
<td>compounds blended with semi-aromatic polyamides showing an extreme modulus</td>
</tr>
<tr>
<td>Schulamid PPA</td>
<td>compounds based on semi-aromatic polyamides for high temperature applications</td>
</tr>
<tr>
<td>Schulamid RD</td>
<td>compounds with reduced density (followed by the number of base polymer – Schulamid RD6)</td>
</tr>
<tr>
<td>Circulen Recover EP</td>
<td>compounds based on post industrial recyclates (PIR)</td>
</tr>
</tbody>
</table>
### Schulamid grades – Range architecture

<table>
<thead>
<tr>
<th>Base Resin</th>
<th>Fillers</th>
<th>Features</th>
<th>Symbol</th>
<th>Color code</th>
<th>Packaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA6</td>
<td>Unreinforced</td>
<td>Heat Stabilized</td>
<td>H</td>
<td>Natural</td>
<td>Bulk</td>
</tr>
<tr>
<td>PA66</td>
<td>Glass Fiber</td>
<td>High Impact</td>
<td>HI</td>
<td>Blk</td>
<td>Octabins</td>
</tr>
<tr>
<td>PA666</td>
<td>Carbon Fiber</td>
<td>UV Stabilized</td>
<td>U</td>
<td>Other...</td>
<td>Other...</td>
</tr>
<tr>
<td>PA612</td>
<td>Glass Beads</td>
<td>Laser Weldable / IR transparent</td>
<td>LW</td>
<td></td>
<td>25kg bags</td>
</tr>
<tr>
<td>PPA</td>
<td>Mineral</td>
<td>Laser Markable</td>
<td>LM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blend (RD)= reduced density</td>
<td></td>
<td>Improved Surface</td>
<td>IS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fire retardant</td>
<td>FR</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glow Wire Tested</td>
<td>GW</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recycled Content</td>
<td>RC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>... And many more</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Example:** *SCHULAMID 6 GF50 H BLK968001, BG25HT*
MARKETS

- **Automotive**: Fans, shrouds, covers, Structural components, light weighting
- **Fire retardants**: Automotive grades, connectors, E&E applications, Appliances
- **New mobility**: Advanced compounds (shielding, signal compatibility, hydrolysis resistance), metal replacement
- **Consumer goods**: Structural components, covers, sporting equipment, permanent anti-static ATEX applications
- **Building & construction**: Technical functions, hand-held & power tools

- Range architecture built around features rather than applications
- Compounding ability: custom products design & development
Introducing the *Circulen* Brand
Links

- www.lyondellbasell.com/Circulen
- www.lyondellbasell.com/sustainability
CirculenRecover EP PA Range
1. Does my application allow for a material performance compromise?
   - Validation required?
   - Risk level?

2. I reach a defined performance level required
   - Validation required?
   - Risk level?

PA6 GF30 nominal product

CirculenRecover EP PA 6 GF30?

CirculenRecover Other grade?
PA6 GF40, PA66 GF30?
Engineering plastic compounds based on recycled materials: *CirculenReCover*

- Recycled polymers
- (Virgin polymer)
- Reinforcement
- Additives

Plastic compound that is well balanced with desired properties using recycled polymers.
Circulen Recover – EP PA performance overview

SAM 6 GF30 H - dry (≤100%)

SAM 66 GF30 H - cond. (≤100%)
# CirculenRecover EP – Base Products in Development Phase

## Schulamid RC new nomenclature
(PA6 and PA66 Circular Economy Polyamide Compounds)

## Brand name: CirculenRecover EP

<table>
<thead>
<tr>
<th>CirculenRecover EP: PA6 resin</th>
<th>Functionalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>CirculenRecover EP PA6 GF20 H BLK</td>
<td>H, FR</td>
</tr>
<tr>
<td>CirculenRecover EP PA6 GF30 H BLK</td>
<td>H, FR</td>
</tr>
<tr>
<td>CirculenRecover EP PA6 GF30 HI H BLK</td>
<td>H, HI</td>
</tr>
<tr>
<td>CirculenRecover EP PA6 GF35 H BLK</td>
<td>H, FR</td>
</tr>
<tr>
<td>CirculenRecover EP PA6 GF50 H BLK</td>
<td>H</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>CirculenRecover: PA66 resin</th>
<th>Functionalities</th>
</tr>
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<tbody>
<tr>
<td>CirculenRecover EP PA66 GF15 HI H BLK</td>
<td>H, HI</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 GF20 H BLK</td>
<td>H, FR</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 GF30 H BLK</td>
<td>H, FR</td>
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<td>H, HI</td>
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<tr>
<td>CirculenRecover EP PA66 GF35 H BLK</td>
<td>H, FR</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 GF50 H BLK</td>
<td>H</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 GB30 H BLK</td>
<td>H</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 MKF4015 H BLK</td>
<td>H</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 MV HI H BLK</td>
<td>HI, H</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 MV SHI H BLK</td>
<td>SHI, H</td>
</tr>
</tbody>
</table>

Product datasheets available online

**New** – Datasheets now feature DIN91446 data

*H: heat stabilized; HI: high impact; SHI: super high impact, FR: Flame retardant*
## CirculenRecover EP – Base Products in Development Phase

### CirculenRecover EP PA
(PA6 and PA66 Polyamide Compounds)

<table>
<thead>
<tr>
<th>CirculenRecover EP PA6</th>
<th>Pre-consumer Recycled Content [%]*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CirculenRecover EP PA6 GF20 H BLK</td>
<td>55</td>
</tr>
<tr>
<td>CirculenRecover EP PA6 GF30 H BLK</td>
<td>45</td>
</tr>
<tr>
<td>CirculenRecover EP PA6 GF30 HI H BLK</td>
<td>30</td>
</tr>
<tr>
<td>CirculenRecover EP PA6 GF35 H BLK</td>
<td>40</td>
</tr>
<tr>
<td>CirculenRecover EP PA6</td>
<td>25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CirculenRecover EP PA66</th>
<th>Pre-Consumer Recycled Content [%]*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CirculenRecover EP PA66 GF15 HI H BLK</td>
<td>75</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 GF20 H BLK</td>
<td>75</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 GF30 H BLK</td>
<td>65</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 GF30 HI H BLK</td>
<td>55</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 GF35 H BLK</td>
<td>60</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 GF50 H BLK</td>
<td>45</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 GB30 H BLK</td>
<td>65</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 MKF4015 H BLK</td>
<td>55</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 MV HI H BLK</td>
<td>90</td>
</tr>
<tr>
<td>CirculenRecover EP PA66 MV SHI H BLK</td>
<td>80</td>
</tr>
</tbody>
</table>

*Pre-consumer recycled Content: Based on 100% of total formulation (including filler, additives, additives and pigments) – rounded in 5% steps

The tradename "Schulamid" may be abbreviated "SAM" in documents or on labels, "Recover" may be abbreviated "RC".
**CirculenRecover EP PA – Commercial range**

- **Documentation level**
  - All Technical datasheets are available in LyondellBasell portal
  - TDS are documented according to **DIN spec 91446:2021**
    - Aiming at controlling the way recycled content is reported
    - As well as grading a documentation level related to the recycled content source
  - Safety Datasheets are available as well
  - LCA data is being documented (Work in progress)
    - An LCA request form has to be filled in
    - Please reach out
Circulen Recover EP PA Range trends
**CirculenRecover EP PA – FIRE RETARDANT**

- **CirculenRecover EP PA – FR versions first tests**
  - CirculenRecover EP PA shows good fire resistance compatibility
  - Heat deflection, impact slightly lower as recycled content increases
  - Flammability properties like UL94, GWIT and GWFI show identical values
  - UL listing would not be an issue
  - Electrical properties are unchanged
Color matched compound
- New source allows even up to WHITE coloration (PA 6)
  - Volume secured and guaranteed
  - 40+ T available today (white)
- Other colors possible:
  - Blue, green, red going through customer validation stages today
  - Vivid colors preferrable (light yellow, brown difficult)
  - PA6 or 66 base
  - NAT version in progress =>

Trend: Visualize recycled source
- Customer ask for “dots” or “points” to differentiate product
- Achievable through compounding or masterbatch

Example: Background color + black dots
Current developments

- Post-Consumer sources
  - Origin & content challenges
- Recycled origin fillers
  - Carbon Fibers
- Conductivity & resistivity
  - Thermal
  - Electric
  - Signal conductivity or shielding
  - Anti-static
  - EMI
- Food contact grades range extension

Technology trends

- UWB, radar signals
- Automation & sensors (camera, sensor activation of functions, remote accessibility, autonomous driving)
- New drivetrains = new requirements (temperature, batteries, dielectric fluids, function controls)
- Screen controls vs buttons, device connectivity (phone, keys)
- Passenger experience (touch, feel, lighting, comfort, assistance & connectivity)
Success story: introducing TSL Outdoor 2023 Snow shoes
TSL Outdoor: company & values

- TSL is world leader in Snowshoes development & manufacture

- Brand values are strongly connected to the respect of nature, well-being & innovation

- Thus leading TSL to investigate recycling, sustainable material in products design

- www.tsloutdoor.com
Snowshoes: product profile

- Typically, snowshoes are principally composed of
  - PP based materials
  - PA blends

- Critical characteristics
  - Resistance to impact
  - Cold temperature behavior
  - Fatigue in challenging conditions (cold, steps repeating)

- Usually incompatible with recycled content products

- Timeline
  - LyondellBasell sampled CirculenRecover EP PA6 MV SHI H Black in December 2021
  - Trials ran end of January 2022 due to production constraints @ TSL & suppliers
  - Winter testing successfully completed March 2022 – 100 days in the snow
Snowshoes: product profile

- **CirculenRecover EP PA value proposition**
  - Recycled content
  - Quality of pre-consumer recycled content
  - Compounding experience of LyondellBasell
  - Processability, perceived quality after injection
  - Successfully passed physical testing in snow environments

- **Future developments**
  - **CirculenRecover EP PA** is differentiated by its color in the TSL range: Black vs a corporate grey on “virgin material” parts
  - This allows communication based on the recycled content of the shoe
    - Thus targeting specific markets
    - And extend the product offer
  - Production differentiation: recycled content parts are easily recognizable in production

- **CirculenRecover EP PA color-ability** also allows the potential for future differentiation specific to customers, countries…
ACKNOWLEDGEMENT

I would like to express my special thanks and gratitude to TSL team members, for their contribution along the entire project, as well as their contribution to the presentation today.

Yoan BIBOLLET – TSL Outdoor – Head of product development

Bertrand Schutz – Injection 74 (TSL group) – Commercial director

TSL products based on CirculenRecover are presented in the exhibition floor, at LyondellBasell Stand.
Thank you