Moving towards becoming fully circular

Sustainable Polycarbonate solutions from Covestro
Who is presenting today?

Dr. Ute Wollborn  
Head of Product Technology

Frederik Kerstholt  
Technical Product Manager
Forward-looking statements

This presentation may contain forward-looking statements based on current assumptions and forecasts made by Covestro AG.

Various known and unknown risks, uncertainties and other factors could lead to material differences between the actual future results, financial situation, development or performance of the company and the estimates given here. These factors include those discussed in Covestro’s public reports which are available on the Covestro website at www.covestro.com
Covestro
Leading in the world of plastics

Strong
- €10.7 bn in sales
- ~18,000 employees\(^1\)

Useful
- Plastics, pre-products and solutions
- For many industries

Global
- ~50 production sites globally
- Close to customers and partners

Innovative
- ~1,500 employees in research and development
- 80 years of ideas and inventions

Information is based on financial results for 2020, except amount of employees and amount of global production sites. Those are as of June 30, 2021. 1calculated as full-time equivalent (FTE)
Circular Economy
Covestro offers material solutions and design support

**Mechanical Recycling**
Makrolon® and Bayblend® with **post-consumer** or **pre-consumer recycled content** for different applications

**Renewable attributed Polycarbonates**
High quality, certified*, mass balanced polycarbonates - **bio-circular resources** replace fossil resources

**Design for Sustainability**
**Circular Design Guidebook** for EEA industry for customer product design co-creation to drive “Circular Design”

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*ISCC Plus certified (International Sustainability and Carbon Certification)
Mechanical recycling
Stepping towards a circular economy

Waste collection

Sorting / shredding

Giving waste a new life

Picture: © Pixel-Shot - stock.adobe.com
Picture: © Pavel - stock.adobe.com
Picture: © 831days - stock.adobe.com
Polycarbonate recycling process

Whole recycling process requires many quality control steps and specification
Strong mechanical recycling (PxR*) polycarbonate portfolio

With outstanding features

- Thinwall FR
  - UL 94 V0 @ 0,75 mm

- Processing
  - Prime-like processing

- Lighter & Stronger
  - Carbon / Glass Fiber PCR

- Mechanical performance
  - Tough and strong materials

- High Heat Resistance
  - Vicat Softening temperature 145°C

- High PxR content
  - Up to 75 % PCR

- Good surface quality
  - For aesthetically demanding applications

- Good paintability
  - Protection and design

*PxR refers to post-consumer or pre-consumer recycled
Feedstock of renewable attributed polycarbonates

Waste and residual materials from biological source have been introduced into the value chain from our mass balanced bio-circular products*

*ISCC Plus certified (International Sustainability and Carbon Certification)
Principle of Mass and Energy Balance Approach

**Feedstock**
- Substitution of fossil feedstock by renewable feedstock in petrochemical production

**Value chain**
- Co-feeding fossil based and renewable raw materials and energy into existing plants all along the value chain

**Products**
- Attribution of the renewable feedstock and energy to dedicated products according chemical feasibility and consumption

*Energy is allocated directly to the process and according ISCC PLUS to renewable raw materials.*

Illustration based on Nova institute

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A major step toward climate neutral solutions
Mass balanced alternative raw materials replace fossil resources

Making a contribution
Increasing the use of alternative raw materials to replace fossil resources

Endless possibilities
No limitation on colors & grades and same quality as fossil-based products

Proven claimable benefits
Sustainability declaration (ISCC PLUS) - preliminary LCA under NDA

Drop-in solutions
Complies with relevant regulations and fulfilling relevant technical certifications

Flexible product portfolio
We release mass balanced products on demand and in large quantities

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Our RE-Grades make it possible

Starting portfolio

We offer known products: That are certified to be attributed with **bio-circular** feedstocks and can be used as a drop-in solution

**Electrical / Electronics & Appliances**
- Makron® 2407 RE
- Makron® 2807 RE
- Makron® 6487 RE
- Makron® 6557 RE
- Bayblend® FR3010 RE

**Mobility / Electrical Vehicles / Powertrain**
- Bayblend® T85 X RE
- Makron® AR205 RE
- Makroblend® UT235 M RE
- Makron® 2205 RE
- Makron® AL2447 RE

**Healthcare**
- Makron® LQ3187 RE
- Makron® LQ2647 RE
- Makron® LED2245 RE
- Makron® Rx2530 RE
- Makron® Rx1805 RE

**Construction**
- Makron® ET3113 RE
- Makron® ET3117 RE
- Makron® ET3227 RE

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The Suffix RE indicate our new grades, attributed with **bio circular content via mass balance**.

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Our mechanically recycled grades come with a detailed specification and test-certificates and meet the high expectations of the automotive and electrical industry.

<table>
<thead>
<tr>
<th><strong>Electrical / Electronics &amp; Appliances</strong></th>
<th><strong>Mobility / Electrical Vehicle / Powertrain</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayblend® FR3005 L30</td>
<td>Bayblend® T85 X RXX</td>
</tr>
<tr>
<td>Bayblend® FR3017 R30</td>
<td>Makroblend® UT235 M RXX</td>
</tr>
<tr>
<td>Makrolon® 6487 RXX</td>
<td></td>
</tr>
<tr>
<td>Makrolon® GF8006 R30</td>
<td></td>
</tr>
<tr>
<td>Bayblend® FR3210 L30</td>
<td></td>
</tr>
<tr>
<td>Bayblend® FR3010 RXX</td>
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</tbody>
</table>

The Suffix R or L indicate our new grades, based on post-consumer- and pre-consumer recyclate.

* as of August 21, ** under development / black and dark grey colors, names can be preliminary
TV Applications
Requirements and material solutions

Requirements
- UL94 V0
- Good flowability
- Good surface aesthetic
- Good mechanical performance
- Halogen-free flame retardants

Selected material solutions
- Bayblend® FR3005 L30¹ (EMEA, 30 % PIR)
- Bayblend® FR3210 L30¹ (EMEA, 30 % PIR)
- Bayblend® FR3070 R35¹ (APAC, 35 % PCR)

¹ Partly made with pre-consumer recycled (PIR) content or post-consumer recycled (PCR) content
Coffee Machines

Requirements and material solutions

Requirements
- GWFI 850 °C
- GWIT 775 °C
- Heat stability
- Good flowability
- Hydrolysis resistance
- Chemical resistance

Selected material solutions
- Bayblend® FR3005 L30¹ (EMEA, 30 % PIR)
- Bayblend® FR3008 R65¹ (APAC, 65 % PCR)
- Bayblend FR3008 RE (mass balanced bio-circular share)

¹ Partly made with pre-consumer recycled (PIR) content or post-consumer recycled (PCR) content

Picture: © Delyk - stock.adobe.com
Mobility – Interior and exterior parts
Requirements and material solutions

Requirements
- Excellent surface aesthetic
- Good paintability
- High heat resistance
- High flowability
- Good dimensional stability

Selected material solutions
- Bayblend® T85 X R25¹ (EMEA, 25 % PIR)
- Bayblend® T85 X RE (mass balanced bio-circular share)

¹ Partly made with pre-consumer recycled (PIR) content or post-consumer recycled (PCR) content
EV Charging Stations
Requirements and material solutions

Requirements
- 5VA flammability according UL94
- f1 listing according to UL746C
- Good impact performance
- Good weatherability performance

Selected material solutions
- Makrolon® 6487 RE (mass balanced bio-circular share)
- Makrolon® 6487 R301,2 (EMEA, 30 % PIR)
- Makrolon® 6485 GR1 (APAC, 30 % PCR)

1 Partly made from post-industrial recycled (PIR) content or post-consumer recycled (PCR) content, 2 Trial products, preliminary material data

Picture: © Covestro AG & Mohammed Aldulaymi

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Safety goggles
Requirements and material solutions

Requirements
• High purity
• High transparency
• Dimensional stability
• UV resistance (UV cut 400 nm)
• Easy release
• Mechanical performance

Selected material solutions
• Makrolon® LQ3187 RE
  (mass balanced bio-circular share)
Membrane Oxygenators (also known as artificial lungs)

Requirements and material solutions

**Requirements**
- Biocompatibility (complies with ISO 10993-1)
- High transparency
- High flow
- Balance of toughness & stiffness
- Steam sterilizable

**Selected material solutions**
- Makrolon® 2458 RE (mass balanced bio-circular share)
Comparision of Makrolon® 6487
With sustainable alternatives

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Method</th>
<th>Unit</th>
<th>Makrolon® 6487 (virgin)</th>
<th>Makrolon® 6487 RE (mass balanced)</th>
<th>Makrolon® 6487 R30** (PIR)</th>
<th>Makrolon® 6485 GR (PCR)</th>
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</thead>
<tbody>
<tr>
<td>Circularity type (content)</td>
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<td>mass balanced</td>
<td>PIR (30%)</td>
<td>PCR (30%)</td>
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<td>availability</td>
<td>global</td>
<td>EMEA, APAC</td>
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<td>APAC</td>
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<td>MVR (300 °C; 1,2 kg)</td>
<td>ISO 1133</td>
<td>cm³/10 min</td>
<td>9</td>
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<td>11*</td>
<td>10.5</td>
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<tr>
<td>Charpy notched impact strength @ 23°C (3 mm)</td>
<td>ISO 21305 / ISO 179eA</td>
<td>kJ/m²</td>
<td>70P(C)</td>
<td>70P(C)</td>
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<td>Charpy notched impact strength @ -30°C (3 mm)</td>
<td>ISO 21305 / ISO 179eA</td>
<td>kJ/m²</td>
<td>12C</td>
<td>12C</td>
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<td>11C</td>
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<tr>
<td>Vicat Softening Temperature 50 N; 50 °C/h</td>
<td>ISO 306</td>
<td>°C</td>
<td>141</td>
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<td>142*</td>
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<td>Tensile modulus</td>
<td>ISO 527-1, -2</td>
<td>MPa</td>
<td>2450</td>
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<td>2400*</td>
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<tr>
<td>Tensile Stress at break</td>
<td>ISO 527-1, -2</td>
<td>MPa</td>
<td>65</td>
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<td>65*</td>
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<td>UL 94 V-0 @ 1,5 mm</td>
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<td>V-0</td>
<td>All Colors</td>
<td>V-0</td>
<td>All Colors</td>
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<tr>
<td>RTI Strength (1.5 mm)</td>
<td>UL746C</td>
<td>°C</td>
<td>125</td>
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<tr>
<td>RTI Impact (1.5 mm)</td>
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<td>°C</td>
<td>115</td>
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<td>UL f1</td>
<td>UL94</td>
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<td>All Colors</td>
<td>All Colors</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* preliminary data and Covestro test
**preliminary name
Your go-to partner for sustainability
A sustainable product portfolio with innovative services and solutions

Materials for a Circular Economy
- Mechanically recycled (PCR, PIR)
- Renewable attributed polycarbonate

Services
Design for sustainability
- Circular Design Strategies
- CMF design service

Joint Solutions
Enabling new circular business models
- Closed/open loop recycling
- Material tracing

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Thank you for your attention