Polycarbonate-Blends in Automotive
Agenda

- Product Portfolio
- Color Competence
- Interior Application
- Exterior Application
- Lighting Application
Polycarbonate and its Blends
Outstanding Combination of Properties

Transparency
Glass like:
88-90% in 2 mm thickness

High flame retardance
UL94 V-0, V2, HB ...
Glow wire ≥ 850 °C

Heat resistant
Tg ~ 150 °C (DSC)
Vicat (ISO 306) ~ 145 °C

Toughness
notched impact resistance:
(IZOD ISO180A, 23 °C, 3.2 mm)
60-90 kJ/m²

Glow wire ≥ 850 °C
## Products

<table>
<thead>
<tr>
<th>Brand</th>
<th>Product Type</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAKROLOM®</strong></td>
<td>PC Polycarbonate</td>
<td>High transparency, high toughness, high heat resistance, high flame retardance, good electrical properties</td>
</tr>
<tr>
<td><strong>APEC®</strong></td>
<td>PC High Heat Polycarbonate</td>
<td>High transparency, high toughness, tailor-made Vicat up to 205 °C, good electrical properties</td>
</tr>
<tr>
<td><strong>BAYBLEND®</strong></td>
<td>PC/ABS-Blends Polycarbonate / Acrylonitrile-Butadiene-Styrene copolymer</td>
<td>High toughness even at low temperatures, high heat resistance, good paint ability, good flowability / good processing behavior</td>
</tr>
<tr>
<td><strong>MAKROBLEND®</strong></td>
<td>PC/Polyester-Blends PBT – Polybutylene terephthalate PET – Polyethylene terephthalate</td>
<td>Good resistance to chemicals, high toughness even at low temperatures, high heat resistance, good paint ability</td>
</tr>
</tbody>
</table>
Makrolon®
Nameplate Capacity Year End 2010

- Antwerp, Belgium 240 kt
- Uerdingen, Germany 330 kt
- Shanghai, China 200 kt (+ 300 kt 2014 – 2016)
- Map Ta Phut, Thailand 270 kt

Total: 1,300 kt

BMS facilities
Polycarbonates and Blends
Compounding Network & Plant Overview 2010

Global: 7 sites

- Newark (OH), USA
- Filago, Italy
- Greater Noida, India
- Map Ta Phut, Thailand
- Uerdingen, Germany
- Caojing, China
- Guangzhou, China
Product overview Makrolon® automotive

- **Transparent grades**
  - Standard grades
    - M 2207
    - M 2407
    - M 2607
    - M 2807
  - AL grades
    - M AL2447
    - M AL2647
  - LED grades
    - M LED2245
    - M LED2445
- **Opaque grades**
  - Bezel grades
    - M1260
    - M2205
    - M2405
  - Translucent colors
  - Signal colors
    - AX2675
  - Reflective White
    - RW2405
    - RW2407
  - Thermal Conductive
    - TC8010
    - TC8030

Automotive Glazing
- AG2677

Automotive eXterior
- AX2675
Product overview Apec® automotive

<table>
<thead>
<tr>
<th>Vicat – Softening Temp. [°C]</th>
<th>158</th>
<th>173</th>
<th>183</th>
<th>203</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy flow, easy release</td>
<td>1695</td>
<td>1795</td>
<td>1895</td>
<td>2095</td>
</tr>
<tr>
<td>Easy flow, easy release + UV stabilized</td>
<td>1697</td>
<td>1797</td>
<td>1897</td>
<td>2097</td>
</tr>
<tr>
<td>Basic grade + UV stabilized</td>
<td>1603</td>
<td>1703</td>
<td>1803</td>
<td></td>
</tr>
<tr>
<td>Easy flow, reflective white</td>
<td>RW1697</td>
<td>RW1795</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Not available in crystal clear (551022)
2) AMECA approval
Product Overview
Standard Grades – Bayblend® T

**Standard grades**

- **XF** grades
  - T50 XF
  - T65 XF
  - T85 XF

- **XG** grades
  - T80XG
  - T90XG

- **HG** grades
  - T65HG*
  - T85HG*

- **PG** grades
  - T45PG

- **Weatherable** grades
  - W85HI
  - W85XF

- **MF** grades
  - T95 MF
  - T90 MF-20

- **GF** grades
  - T88 GF-10
  - T88 GF-20
  - T88 GF-30

- **Special** grades
  - LGX300

* New development
Product Overview
Makroblend® automotive

Standard grades

UT4045 G

GF

PC/PBT

KU2-7912
KU2-7912/4
KU2-7915 S 7916

PC/PET

UT 3905 / 07
UT 6005 / 07
UT 6405 SG

AR205

Mineral Reinforced

PC/PET

KU2-7609

PC/PET

UT 235M
GR 235M
Agenda

- Product Portfolio
- Color Competence
- Interior Application
- Exterior Application
- Lighting Application
Color Competence World Map: Colors can be developed in several sites close to customers.

- Newark (OH), USA
- Filago, Italy
- Greater Noida, India
- Caojing, China
- Guangzhou, China
- Map Ta Phut, Thailand

Once a color is developed, it can be transferred in all the regions within a short time.
Classic Colors: ROYGBV
Classic Colors: Translucency
Color effects: Absorbing and Reemitting Light
Color effects: Metallic and Sparkle
Beyond visible properties
Role of UV: Light fastness

ASTM G26
ASTM G151
ASTM G155
DIN EN ISO 4892 - 2
SAE J2412 (J1885)
SAE J2527 (J1960)
VDA 75202
Beyond visible properties: Role of UV and IR

**Absorption optimization**
Heat reduction & protection: for glazing and safety goggle/shield

**Transmission optimization**
Free transmission IR wavelength: for data transfer and night vision

Heat generating: for laser marking/welding
Understanding Bayer Color Numbers

All Bayer color numbers are composed of six digits

$X_X^2 YYY YYY$

Classification digits (visual appearance)  Administrative digits (random numbers)

$X_1$ identifies the color as follows:

0 = white, 1 = yellow... 8 = brown and 9 = black

Natural is 000000 and colorless Makrolon® polycarbonate is identified with $X_1X_2 = 55$

$X_2$ indicates that the color is opaque, translucent, metallic, transparent, etc.

Source: www.plastics.bayer.com  Contact: plastics@bayer.com  April 2014
Agenda

- Product Portfolio
- Color Competence
- Interior Application
- Exterior Application
- Lighting Application
Bayblend® T grades, non-reinforced

Basic Properties

• Excellent notched and multiaxial impact strength, even at low temperatures

• Excellent processing behavior and finished part accuracy

• Amorphous material, nearly constant E-modulus over relevant temperature range → excellent dimensional stability

• Excellent surface finishing properties for painting, foaming and skinning, typically without surface activation or priming

• Low quantitative emissions (VOC) and very competitive odor level
Emission and Smell Behavior

Emissions according to VDA 277
Automotive Grades: Bayblend®

<table>
<thead>
<tr>
<th>Test plates molded under recommended conditions</th>
<th>µg C/g</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bayblend® T65 XF</strong>&lt;br&gt;(Vicat B/120: 120 °C)</td>
<td>&lt; 20</td>
</tr>
<tr>
<td><strong>Bayblend® T85 XF</strong>&lt;br&gt;(Vicat B/120: 131 °C)</td>
<td>&lt; 20</td>
</tr>
<tr>
<td><strong>Limit</strong>&lt;br&gt;VW (Audi, Volvo)</td>
<td>max. 50 (30)</td>
</tr>
<tr>
<td><strong>Smell behavior</strong></td>
<td>≤ 3 (VDA 270)</td>
</tr>
</tbody>
</table>
Bayblend® T65 XF / T85 XF

Interior trim parts, e.g.
- Safety parts
- Painted parts
- Skinned parts
Bayblend® HG Generation

- New specialty product generation (T65 HG and T85 HG) with the same overall property profile compared to Bayblend XF, including in particular low-temperature ductility, low-emission behavior and paintability.

- New products are especially designed to add value by
  - Processing-stable high gloss on unpainted surfaces
  - Improved colorability (particularly suitable for dark and brilliant colors)
  - Suitable for unpainted combined high-gloss / low-gloss parts due to excellent reproduction of micro-textured injection molding tools
## Bayblend® HG vs. XF

<table>
<thead>
<tr>
<th>Property</th>
<th>T65 XF</th>
<th>T65 HG*</th>
<th>T85 XF</th>
<th>T85 HG*</th>
</tr>
</thead>
<tbody>
<tr>
<td>ak Izod ISO 180A RT [kJ/m²]</td>
<td>45</td>
<td>50</td>
<td>48</td>
<td>50</td>
</tr>
<tr>
<td>Vicat B/120 [°C]</td>
<td>120</td>
<td>120</td>
<td>130</td>
<td>130</td>
</tr>
<tr>
<td>MVR 260°C/5 kg [cm³/10 min]</td>
<td>18</td>
<td>17</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>Shear viscosity 260°C/1000 s⁻¹ [Pa·s]</td>
<td>200</td>
<td>210</td>
<td>250</td>
<td>260</td>
</tr>
<tr>
<td>Tensile modulus [MPa]</td>
<td>2400</td>
<td>2300</td>
<td>2300</td>
<td>2250</td>
</tr>
<tr>
<td>Gloss level @ 20° (260°C/80°C)</td>
<td>90</td>
<td>97</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>Gloss level @ 20° (300°C/80°C)</td>
<td>70</td>
<td>97</td>
<td>50</td>
<td>100</td>
</tr>
</tbody>
</table>

*preliminary product description; data are based on limited production statistics and thus shall not be interpreted to anticipate any future product specification
Individual designs and colors, easy and cost efficient realized

Molding of 3D LaserEngraving structures with cyclic mold temperature

• High gloss and matt on one surface
• Natural scratch protection by structures
• Reproducible design and mapping towards close parts using Laser Engraving technology

Partner:

J.F. Kruth Foamtec Technik Solingen, gwk
Bayblend HG:
- good flowability and high mold temperature enable good casting of mold
- Good thermostability
- high impact strength at lower temperatures
- High gloss level using PC, PC+ABS

Individual designs and colors, easy and cost efficient realized
Bayblend® W

PC/ASA blend tailored for non-painted exterior and interior automotive applications requiring superior light aging stability or weatherability

- High heat resistance
- Melt flow comparable to Bayblend® T
- High impact strength
- Enhanced tensile modulus
- Compliant with European automotive OEMs' low-emission standards
- Good surface cosmetics
- Customer specific color developments on request

Interior light stability tests
e.g. DIN EN ISO 105-B06, VDA 75202, PV 1303, SAE J1885, TSL0601 G Method E
Bayblend® W85 XF
light fastness (interior)

Exposition of Bayblend according to VDA 75202 (smooth surface), determination of the change of the color as deltaE unit

- Bayblend T85 BBS910
- Bayblend W85 XF
- Makrolon 2407

Color white
Bayblend® T45 PG

Electroplating applications

- door handle
- front grille frame
Chrom- and Strukturchrom® -Versions on Bayblend® T45 PG

Bayblend PG for diverse Galvano solutions
Bayblend® GF Grades

- Melt viscosities reduced by 30-40 % vs. conventional Bayblend® GF grades; 
  *T88 GF-10 is successor of T88-2N; T88 GF-20 is successor of T88-4N*
- Increased long term heat aging resistance
- Tensile modulus increased by 25 %; ~ 50 % increase in tensile strength
- Excellent color stability when exposed to (UV) light
- Improved surface cosmetics – benchmark in PC/ABS GF
- Very good adhesion to PU foams / TPU´s – even after aging
- Excellent performance in backmolding of interior wooden trim parts
- Part production with reduced wall thickness - utilizing full potential of new grades
## Bayblend® GF

<table>
<thead>
<tr>
<th>Property</th>
<th>T88 GF-10</th>
<th>T88 GF-20</th>
<th>T88 GF-30</th>
</tr>
</thead>
<tbody>
<tr>
<td>an Izod ISO 180/U RT [ kJ/m² ]</td>
<td>35</td>
<td>38</td>
<td>35</td>
</tr>
<tr>
<td>Vicat B/120 [ °C ]</td>
<td>134</td>
<td>130</td>
<td>134</td>
</tr>
<tr>
<td>Shear viscosity 260 °C/1000 s⁻¹ [ Pa*s⁻¹]</td>
<td>205</td>
<td>210</td>
<td>250</td>
</tr>
<tr>
<td>Tensile modulus [ MPa ]</td>
<td>5100</td>
<td>7500</td>
<td>10000</td>
</tr>
<tr>
<td>Glass fibre content [ % ]</td>
<td>10</td>
<td>20</td>
<td>31</td>
</tr>
</tbody>
</table>
E-modulus over Temperature

![Graph showing E-modulus over temperature for different materials: PP, PP-GF, ABS, (PC+ABS), and (PC+ABS)-GF.](image-url)
Bayblend T88 GF-10 / 20 / 30

Backmoulding of wooden trim parts
- Low CLTE
- High heat resistance
- Excellent flowability
T88 GF-10 for IP-Carrier

Advantage:

- High flowability results in faster cycle times/better profitability
- Thermoageing stable
- Applications: Ford Focus C-Max
Bayblend® T88 GF-10
Centre console (VW Golf)

**Advantages:**

- Good flowability
- High stiffness
- Good warpage behavior
- Excellent retention of ductility upon long-term exposure to (humid) heat
- Low wall thicknesses possible
- Minimized warpage
- Good adhesion of both components
- High dimensions stability, comfortable haptics, good scratch resistant, good light fastness, matt finish

2K centre console
Bayblend® T88 GF-10 + TPU
Bayblend® LGX300

- Inherent low gloss
- High stiffness, high impact High heat resistance
- Good weatherability
- Low emission
- Good flowability

<table>
<thead>
<tr>
<th></th>
<th>A1 polish</th>
<th>texture</th>
</tr>
</thead>
<tbody>
<tr>
<td>LGX300</td>
<td>20° 60°</td>
<td>60° 85°</td>
</tr>
<tr>
<td>ASTM D523 (GU)</td>
<td>32 83</td>
<td>1.8 2.6</td>
</tr>
<tr>
<td>T85XF</td>
<td>98 100</td>
<td>3.1 5.8</td>
</tr>
</tbody>
</table>
Agenda

- Product Portfolio
- Color Competence
- Interior Application
- Exterior Application
- Lighting Application
Automotive Glazing

Roofs, side and rear windows

1st transparent component:
- Makrolon AG 2677,
- IR absorbing colors available

2nd black component:
- Bayblend T95 MF
- Makroblend UT 235 M
Horizontal Parts Applications
Roof Bezels

**OEM:** VW/Audi/Skoda/Seat/Lancia…
**Application:** 1-Piece U-Trim
**Material:** MK 2605 MAS083 black
(=>AX2675) coated with AS 4700 &SHP470FT 2050

Source: Webasto

Source: VW
Bayblend® W85 XF

PC + ASA blend tailored for non-painted exterior and interior automotive applications requiring superior light aging stability or weatherability

- heat distortion temperature superior to competition
- melt flow comparable to Bayblend® T65
- multiaxial ductility down to -20 °C
- enhanced tensile modulus
- compliant with European automotive OEMs’ low-emission standards
- good surface cosmetics
- customer specific color developments on request
Bayblend® Mineral filled Grades

Mineral-reinforced PC/ABS injection molding grade with outstanding heat distortion temperature

- improved balance of ductility and stiffness vs. GF grades
- heat distortion temperature similar to pure PC
- reduced CLTE and molding shrinkage vs. non-reinforced PC/ABS blends
- isotropic molding shrinkage behavior
- nearly isotropic CLTE
- high dimensional stability
- superior melt flow vs. comparable Makroblend® grades
- high energy uptake capacity under multi-axial impact load down to temperatures as low as -30 °C
- class A, low gloss surface appearance
## Bayblend® Mineral Grades

<table>
<thead>
<tr>
<th>Property</th>
<th>T95 MF</th>
<th>T90 MF-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>an Izod ISO 180/U RT [ kJ/m² ]</td>
<td>≥ 150</td>
<td>33</td>
</tr>
<tr>
<td>Vicat B/120 [ °C ]</td>
<td>142</td>
<td>130</td>
</tr>
<tr>
<td>MVR 260 °C/5 kg [ cm³/10 min ]</td>
<td>18</td>
<td>12</td>
</tr>
<tr>
<td>Shear viscosity 260 °C/1000 s⁻¹ [ Pa*s ]</td>
<td>410</td>
<td>230</td>
</tr>
<tr>
<td>Tensile modulus [ MPa ]</td>
<td>3350</td>
<td>5200</td>
</tr>
</tbody>
</table>
Roof Spoiler

- 20% mineral filled grade, low CLTE, isotropic behavior
- Class-A-surface
- Excellent paint adhesion
- Fully amorphous material, high modulus up to > 100°C

- Excellent Flowability
- Target: Metal- and SMC-replacement
Bayblend® T85 XF

Rear Spoiler

- Class-A-surface
- Excellent paint adhesion
- High heat resistance and for large horizontal parts
- Excellent Flowability, 15-20 % improved to Bayblend T85
- Metal- and SMC-replacement in large horizontal body panel applications

SGM 258 MPV spoiler T85XF
Front and Rear Bumper
Makroblend PC+PBT  KU2-7912

OEM: Bentley
Type: Continental Flying Spur

OEM: VW
Type: Phaeton

Weight per part 5.2 kg

The three bumper elements of lower section, protective strip and cover are injection molded by system suppliers, and then painted without plasma pretreatment or flame treatment.
Makroblend® UT 6007 (PC/PBT)

- Improved weatherability
- High impact strength
- Excellent chemical resistance

- Target: truck exterior including non-painted mudguards
- Non-painted front grille
Makroblend® AR 205 (PC+PET)

New easy flowing PC+PET - Blend for Automotive Radiator grills

Outstanding properties:
• Easy flowing
• Excellent processing stability
• Good surface quality
• High heat resistance
• Easy release
• Excellent paintable (single layer coating systems or high gloss piano black systems working well)
## Comparison AR 205 vs DP7645

<table>
<thead>
<tr>
<th>Property</th>
<th>AR 205</th>
<th>DP7645</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVR 270°C / 5 kg</td>
<td>40</td>
<td>24</td>
</tr>
<tr>
<td>Melt viscosity 270 °C / 1000 s⁻¹</td>
<td>220</td>
<td>240</td>
</tr>
<tr>
<td>Tensile modulus [ MPa ]</td>
<td>2200</td>
<td>2100</td>
</tr>
<tr>
<td>an IZOD ISO 180U -30 °C [ kJ/m² ]</td>
<td>n.b.</td>
<td>n.b.</td>
</tr>
<tr>
<td>ak IZOD ISO 180A 23 °C [ kJ/m² ]</td>
<td>39</td>
<td>50</td>
</tr>
<tr>
<td>ak IZOD ISO 180A -20 °C [ kJ/m² ]</td>
<td>18</td>
<td>23</td>
</tr>
<tr>
<td>Vicat B/120 [ °C ]</td>
<td>137</td>
<td>133</td>
</tr>
<tr>
<td>HDT-B [ °C ]</td>
<td>125</td>
<td>120</td>
</tr>
<tr>
<td>Shrinkage [ % ]</td>
<td>0.6 – 0.8</td>
<td>0.6 – 0.8</td>
</tr>
</tbody>
</table>
## PC+PBT / PC+PET mineral filled

<table>
<thead>
<tr>
<th>Property</th>
<th>KU 2-7609</th>
<th>UT235M</th>
<th>GR235M</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVR 260°C/5 kg [ cm³/10 min ]</td>
<td>11</td>
<td>16*</td>
<td>18*</td>
</tr>
<tr>
<td>Shear viscosity [Pa*s] 260 °C /1000 s⁻¹</td>
<td>370</td>
<td>230*</td>
<td>280*</td>
</tr>
<tr>
<td>Tensile modulus [ MPa ]</td>
<td>3400</td>
<td>4200</td>
<td>4600</td>
</tr>
<tr>
<td>an IZOD ISO 180U 23 °C [ kJ/m² ]</td>
<td>160</td>
<td>110</td>
<td>100</td>
</tr>
<tr>
<td>ak IZOD ISO 180A 23 °C [ kJ/m² ]</td>
<td>20</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Vicat B/120 [ °C ]</td>
<td>120</td>
<td>140</td>
<td>142</td>
</tr>
<tr>
<td>HDT-B [ °C ]</td>
<td>106</td>
<td>130</td>
<td>-</td>
</tr>
<tr>
<td>Shrinkage [ % ]</td>
<td>0.4 - 0.6</td>
<td>0.5 - 0.6</td>
<td>0.5 - 0.6</td>
</tr>
<tr>
<td>CLTE [10⁻⁴/K]</td>
<td>0.7</td>
<td>0.45</td>
<td>0.46</td>
</tr>
</tbody>
</table>

* * at 270 °C
Makroblend® UT235M  
(15% mineral filled PC/PET)

- Preferred grade for horizontal exterior parts with low CLTE
- Much better flowability than DP7665
- Less mineral streaks
- Coefficient of linear thermal expansion < 0.5 [10-4/K]
- Low isotropic shrinkage (nearly same than DP7665)
- Good paint adhesion
Makroblend® UT235M
(15% mineral filled PC/PET)

OEM: Audi A7
Part: Cover and structural part for tailgate

**Structural part:**
- unpainted, partly visible
- UV-protection needed > adjusted AUDI specification
- chemical resistance to gasoline /
- cleaning agents
- gluing behavior to cover

**Cover:**
- painted (primer, base coat, clear coat)
- class A surface
- gluing behavior to structural part
Makroblend® UT235M
(15% mineral filled PC/PET)

- Opel Insignia Sports Tourer
- Rear spoiler
- Audi A5 cabriolet
- Cover for the convertible top box
Makroblend® UT235M
(15% mineral filled PC/PET)

Mercedes SLK (R172): Pillar and roof trim
Makroblend® GR235M (PC/PET)
(15% mineral filled PC/PET)
Agenda
- Product Portfolio
- Color Competence
- Interior Application
- Exterior Application
- Lighting Application
PCS automotive lighting applications

- Head lamp lens and fog lamp lens covers
- Bezels and reflectors
- Indicator and break lights: signal colors
- Rear Lamps
- LED
- Collimator lenses
Head Lamp Lens and Fog Lamp Lens

Material grades:
Makrolon: M. AL2447; M. AL2647 (550396)
Apec: A.1603; A.1703; A.1803; A.1897

- UV stabilized
- High impact strength
- Optical quality / High transparence
- Easy-moldability
- SAE/ECE approvals

Resistance to UV light, chemical attack and scratches by special hard coat
Head Lamp Lens and Fog Lamp Lens

Apec 1603 551022 for fog lamps
### Bezels/Reflectors

<table>
<thead>
<tr>
<th>Material</th>
<th>Bayblend® T80XG</th>
<th>Bayblend® T90XG</th>
<th>Makrolon® 1260, 2205, 2405</th>
<th>Apec® 1695</th>
<th>Apec® 1795</th>
<th>Apec® 1895</th>
<th>Apec® 2095</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicat Temperature* 50 N, 120K/h</td>
<td>127°C</td>
<td>130°C</td>
<td>143°C</td>
<td>158°C</td>
<td>173°C</td>
<td>183°C</td>
<td>203°C</td>
</tr>
<tr>
<td>Typical Application</td>
<td>Bezel for rear lamps</td>
<td>Bezel for rear lamps</td>
<td>Bezel for forward lighting and rear lamps</td>
<td>Bezel for forward lighting</td>
<td>Bezel for forward lighting</td>
<td>Bezel for forward lighting</td>
<td>Bezel for forward lighting</td>
</tr>
</tbody>
</table>

* Please take the UL RTI temperature into account

* Tailor-made materials for a broad range
Bayblend® T80 XG

**Automotive light reflector applications requiring class-A, high-gloss appearance after metallization**

- excellent processing behavior
- homogenous high-gloss surface appearance
- good metallization behavior
- high heat distortion temperature
- welding ability with PC and PMMA
- high ductility at application temperatures
Indicator and break lights: Signal Colors

Material grades:

- Makrolon: M.2207; M.2407; M.2607; M.2807
- Apec: A.1697; A.1797; A.1897

- Special colors within the defined signal color range
- AMECA approval for signal colors
- High purity and tight color specifications
- High variety of signal colors to fulfill individual needs
Many rear lamp components are made of Makrolon!
LED Auto lighting

Motivation for OEMs and Tier1:
- Energy saving
- Weight saving
- Design freedom
- Longer lifetime

BMS perspective:
- Makroton for light guides, collimator optics, reflectors and other parts
- Development activities BMS:
  - Makroton LED2245/LED2445
  - Molding technology

Lamp cover made in glass
Lamp covers made in PC
Lenses made in glass
Lenses made in PC
# Makrolon® Grades for Optical Lens Applications

<table>
<thead>
<tr>
<th>Makrolon grade</th>
<th>Makrolon OD2015</th>
<th>Makrolon LED2045/LED2245**</th>
<th>Makrolon LED2245</th>
<th>Makrolon AL2447/AL2647</th>
<th>Makrolon LQ2647</th>
<th>Makrolon LQ3187</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color code</td>
<td>000000</td>
<td>000000</td>
<td>550207</td>
<td>550396</td>
<td>550115</td>
<td>550131</td>
</tr>
<tr>
<td>Color</td>
<td>Non tinted</td>
<td>Non tinted</td>
<td>Ice color</td>
<td>Crystal clear</td>
<td>Crystal clear</td>
<td>Crystal clear</td>
</tr>
<tr>
<td>MVR (cm³/10 min @ 300°C)*</td>
<td>61</td>
<td>61/36</td>
<td>36</td>
<td>19 / 12</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Transmission (4 mm)*</td>
<td>90 %</td>
<td>90 %</td>
<td>89~90%</td>
<td>88 %</td>
<td>88 %</td>
<td>86 %</td>
</tr>
<tr>
<td>Transmission (20 mm)*</td>
<td>88-89 %</td>
<td>88-89 %</td>
<td>85-87 %</td>
<td>83 %</td>
<td>83 %</td>
<td>tbd</td>
</tr>
<tr>
<td>Application</td>
<td>CD/DVD</td>
<td>Light guide</td>
<td>Lenses Light guide</td>
<td>Head lamp lenses</td>
<td>Ophthalmics, visors</td>
<td>Ophthalmics, visors</td>
</tr>
<tr>
<td>UV-protected</td>
<td>no</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>UVcut 380</td>
<td>UVcut 400</td>
</tr>
</tbody>
</table>

* Typical values, no specification
** Availability depends on region
Optical properties of standard, optical and LED Makrolon® grades

- LED grades: enhanced transmission, decreased yellowness index and improved LED light stability
LED Auto lighting

Makrolon® 2405 MAS048 901510
Makrolon® AL2447 550396
Makrolon® LED2245 000000

Audi A8
Makrolon light guides in door panels (Audi A6)
LED internal lighting (Audi A8)
LED Grade Ice Color

Makrolon®
LED 2245 550207
Ice color

- High transmission (>89%, 4mm)
- Low YI (<M.LED2245 000000)
- Low haze (<M.LED2245 000000)
Collimator lenses

Makrolon/Apec are the right material for all these complex lenses
Thank you!
Forward-Looking Statements

This presentation may contain forward-looking statements based on current assumptions and forecasts made by Bayer Group or subgroup management.

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 Bayer’s public reports which are available on the Bayer website at www.bayer.com.

The company assumes no liability whatsoever to update these forward-looking statements or to conform them to future events or developments.